Wm Thomas

A NEW TREATISE

ON THE

PRACTICE OF NAVIGATION AT SEA

CONTAINING

ALL THE DETAILS NECESSARY TO ENABLE THE MARINER TO BECOME A GOOD PRACTICAL NAVIGATOR.

ILLUSTRATED BY A NEW MODE OF

ENGRAVED DIAGRAMS AND FIGURES,

DESIGNED WITH THE INTENTION OF MECHANICALLY INSTRUCTING THE LEARNER IN THE MEANING AND USE OF THE VARIOUS

PROBLEMS IN NAVIGATION AND NAUTICAL ASTRONOMY,

IN ROOM OF THE TEDIOUS SOLUTIONS OF GEOMETRY AND TRIGONOMETRY. THE USUAL TABLES ARE GIVEN WHICH ARE INDISPENSABLE IN A WORK OF THIS KIND, SOME OF WHICH ARE IMPROVED, AND NEW ONES INTRODUCED FOR THE FIRST TIME, WITH A VIEW OF SHORTENING THE LABOR OF COMPUTATION.

THE WHOLE BEING

EXPRESSLY ADAPTED FOR THE USE OF SEAMEN.

BY CAPTAIN WILLIAM THOMS,

TWENTY-FIFTH EDITION.

NEW YORK:

PRINTED FOR THE AUTHOR AND SOLD BY JOHN BLISS & CO.,

NAVIGATION WAREHOUSE, 128 FRONT STREET, NEW YORK; F. A. ASHTON, 259 WINTHROP STREET, BROOKLYN, AND ALL THE PRINCIPAL NAUTICAL BOOKSTORES IN NEW YORK AND THROUGHOUT THE UNION.

1902.

TO THE

COMMANDERS, OFFICERS, AND SEAMEN,

EMPLOYED IN THE

MERCHANT MARINE OF THE UNITED STATES,

This Volume,

(THE FIRST ATTEMPT OF THE KIND BY A MEMBER OF THAT SERVICE,)

IS RESPECTFULLY DEDICATED,

BY

THE AUTHOR.

PREFACE.

THIS work is intended exclusively for the use of seamen, and has been compiled by the author from an experience of more than twenty-five years, in the practice of navigating a ship at sea, in nearly all parts of the world. Consequently, a competent knowledge has been acquired, during that period, of what is actually required to be known, in order to become an expert practical navigator. This work is, therefore, confined to the practice at sea; that is, navigation proper, or that which has reference to the ship's place on the ocean.

Thus knowing what is required, and also the distaste which seamen have for long and tedious calculations. I have endeavored to simplify the various rules and tables, and to strike out all unnecessary matter, which is not required, and in the room of which, introduced diagrams of the various cases, which will convey mechanically the whole state of the case to the mind of the reader at once.

The tedious and unprofitable solutions of geometry and triginometry are, therefore, abolished, together with the tables of the logarithms of numbers, which are never used at sea, even by those persons who have previously studied the subject, and who have eventually to fall back upon the method now used in this work.

The sailings are therefore explained by diagrams, and worked out by inspection of the traverse tables only, the same as we actually do at sea, and which is correct enough for all practical purposes; thus relieving the learner from the embarrassment of having several methods given of doing the same thing.

The names of the parts of the diagram are inserted against them, which makes it easier to comprehend the meaning of the case, and will be found an improvement upon the old system of marking them alphabetically for the purpose of reference.

Every diagram in this work is drawn on the same scale, that is, with the chord of 60°, taken from the plane scale, (and which is in general use on board ship.) Instructions are also given how to construct the diagrams, so that the learner may teach himself in a mechanical manner, and which will give him more insight into the nature of the problem than the study of geometry and trigonometry will.

In Parallel and Middle Latitude Sailings, diagrams of semi-hemispheres are introduced, showing the contraction of the meridians towards the poles, and the comparative length of the degrees of longitude in the various parallels of latitude. And in Mercator's Sailing, a diagram showing the meridians all parallel to each other, and the expansion of the degrees of latitude towards the poles.

Current sailing is gone into at some length, and rules given as they are applied in the practice at sea, in this difficult branch of the study.

Taking departures, or ascertaining the ship's place by the bearing of the land, is introduced, and a table given to find the ship's position by two bearings of the same object, having the course and distance sailed between them. This will be found very useful to a ship coasting along shore, as her distance off shore can be easily found by the use of this table; and upon the same principle her distance off shore may be ascertained by projecting the accompanying diagram.

The time of high water is found by the usual rules, and is only an approximation. Local tide table only can show the time of high water with any degree of certainty. The navigator will naturally consult those tables in preference to any general rule, where accuracy is required.

A short account of the prevailing winds and currents in the various parts of the world are introduced, chiefly derived from my own experience, and will be found interesting and useful to the young navigator.

The cause and effect of hurricanes are also explained in a short and familiar manner, and practical rules given to avoid their fatal effects, illustrated by diagrams of the storm circles in both North and South latitude, and which, by giving the subject a little attention, will be easily understood. The rules given to avoid the focus, and the general handling of a ship, on approaching the verge of the storm circle, the falling of the barometer, etc., are also derived from my own experience, the facts having been recorded in the journals I have kept of many voyages, where they prevail.

The usual rules are given for the construction of a general chart on Mercator's projection, illustrated by a diagram chart of part of the North Atlantic Ocean. The use of it is explained, and a number of questions proposed, and the answers given, so as to enable the learner by himself to obtain a thorough knowledge of this most important subject.

Rules are also given to construct a coasting chart on a large scale, illustrated by a diagram, and the use of it explained, under all the possible circumstances in which a ship may be placed, and questions and answers given in like manner, which will be found of much importance to the learner

The manner of sounding with the lead recommended, on a ship's approaching the coast in thick weather, and the method of tracing out her track, by soundings, on the chart, when no observations of the heavenly bodies can be obtained, and will be found of much service to the young navigator.

Nautical astronomy is then introduced, containing the various methods of finding the ship's place on the ocean from astronomical observations, and commences with a diagram of the solar system, showing the real state of the case, and the motion of the earth, and of those planets only which are used in navigation, round the sun.

Nautical astronomy is then defined, and diagrams of the sphere given, showing the case reversed and the earth is treated as a mere speck in the centre of the universe, and all the heavenly bodies revolving round it, the spectator being supposed to be situated at an immense distance to the Eastward of it.

These diagrams will be found of great importance in giving the learner a mechanical knowledge of the nature of the circles and angles supposed to be drawn in the heavens, and will show at once the meaning of the various terms used in nautical astronomy, and which any amount of description would fail to do without them. The manner of constructing those diagrams, from the use of the plane scale, and the measuring of the various circles and angles, are also given, with the view of exercising the learner, and to impress the figure on his mind; and they are generally so arranged that the description is given on the page facing them.

The projection of the heavens in two hemispheres, shows at once the nature of the right ascension and declination of the heavenly bodies, the sun's path in the heavens, the signs of the zodiac, etc.

And the diagram of motion round the pole will give a distinct idea of the movement of the hour angles of the heavenly bodies in an opposite direction to their movements in right ascension.

As it is of much importance to seamen to be able to find the latitude from the meridian altitude of a star, I have introduced several diagrams, showing the nature of a meridian altitude, and how it may be computed, and also a new table, containing the meridian passages of those stars of the first magnitude which are generally used at sea, for every third day throughout the year, by which means a person otherwise unacquainted with the stars in the heavens may be enabled to find any star on the meridian without knowing it, and find his latitude thereby.

The planets are also found by the same method, having the time they pass the meridian from the Nautical Almanac.

Diagrams showing the effect of the dip of the horizon, refraction, and parallax, which is fully explained on the opposite page

A diagram showing the manner of observing altitudes of the heavenly bodies and the nature of the correction for semi-diameter.

The instruments of navigation and nautica. astroncmy are then explained, and the manner of reading off and adjusting them.

The use of the quadrant for taking altitudes, and the sextant for measuring angular distances between the sun and the moon, or the moon and stars, are fully explained, together with a new method of causing the moon to measure her own distance from the sun or a star.

The artificial horizon is explained, and a diagram showing the cause of the double reflection, this being a most useful instrument for rating a chronometer on shore, when the sea horizon is not visible.

The use of the chronometer is now explained, and the various practical rules given for its management on board ships at sea, which will be found of great service to the young navigator.

The azimuth compass is next explained, and the manner of taking azimuths and amplitudes, as practiced at sea.

Then follow remarks on the action of the barometer and thermometer, derived from experience in the use of these instruments for the last twenty-five years. The action of the new or Aneroid Barometer is also explained.

The sun being the most important of all the heavenly bodies on which observations are made, the manner of correcting his declination is first introduced, and the latitude deduced from his meridian altitude, illustrated by diagrams of all the various cases, which will give the learner a complete insight into the meaning and nature of finding the latitude, not only by the sun, but by the meridian altitude of any other heavenly body.

Finding the latitude by an altitude of the sun out of the meridian, is then introduced, having the time from noon, or, which may be deduced from the Greenwich time by chronometer, and by the help of a new table for that purpose, a correction is found, which, added to the observe altitude, gives the meridian altitude. The latitude is then found in the usual manner.

The latitude is also found by two altitudes of the sun, misnamed double altitudes, by a new method of using the hour angle of the lesser altitude, to which is applied the interval of time between the observations, corrected for the ship's change of longitude in time, and the result is the inner hour angle, or the time from noon, at which the greater altitude was observed, it now becomes the same case as if only one altitude had been observed. This will be found a more direct and easier mode of solving the problem than by the old and tedious methods of double altitudes given in works of this kind.

A method is also given of finding the latitude by measuring the change of altitude of any of the heavenly bodies on the prime vertical in one minute of time; and this portion of altitude found in a table constructed for the purpose, will point out the latitude corresponding, within certain limits.

The latitude by the meridian altitude of the moon is found in the usual manner, only it is much simplified by the introduction of a new table, containing the correction for the moon's parallax in altitude, given in minutes and tenths of minutes, and taken out for the nearest degree of apparent altitude and the nearest minute of parallax, which is sufficiently near enough for all practical purposes. Because, if the Greenwich time be not accurately known, the moon's declination cannot be found within ten times the amount of the difference between this table and the most rigorous method of finding this correction, a new table is also given to correct the moon's declination to the Greenwich date.

The method of finding the planets on the meridian, and the latitude obtained from their meridian altitude, also the mode of finding the stars on the meridian, further explained, with the manner of finding the latitude from their meridian altitudes fully explained, and which may be put in practice by any person, otherwise unacquainted with the stars in the heavens, by simply following the directions given in this work. The manner of finding the latitude by the meridian altitude of the pole star, both above and below the pole, and the usual table for finding the latitude by that star at any other time of the night, which has been constructed for this year, but will serve for several years hereafter.

A method of finding the correct latitude in the night time, when the horizon is often obscured and doubtful, by observing stars both North and South of the meridian, and can be practiced in either hemisphere, will be found of great use, from its extreme simplicity, as will also the finding of the latitude by the moon, planets, or stars out of the meridian. For instance, if the latitude is required to be known at twilight, (which is the best time for taking altitudes of the stars, the horizon being then distinctly visible,) it may happen that there are no stars on the meridian at that time. Now, if an altitude of a star, which is nearest to the meridian, be observed, and the apparent time of the observation noted, (as in the case of the sun,) the apparent time at ship may be deduced from the Greenwich time by chronometer, it is easy to find the star's distance from the meridian, (which with the sun is the time from noon,) and is used in the tables in the same manner, by which means we obtain a correction to be added to the observed altitude of the star Thence the meridian altitude is obtained and the latitude is found as correctly as if the meridian altitude had been actually observed.

The finding the variation of the compass at sea by amplitudes and azimuths, is now introduced, illustrated by diagrams showing the real state of the case, and also why the variation is called easterly and westerly.

Then follows a diagram showing the effect of local attraction on a ship's compass, the manner of detecting the same, and the best means of remedying the error, and remarks on fixing up a standard compass.

Diagrams showing the nature of hour angles, and the terms used in the computation, clearly explained, and the apparent time at ship found from a set of altitudes of the sun, the corresponding time being noted by a watch or chronometer, as is usually done at sea. The time tables used in this work are simply the co-secants for degrees and minutes of the polar distance, the secants for the latitude, the co-sines of the half sum, and the sines of the difference or remainder.

The apparent time from the preceding noon or midnight, in the case of the sun, or the hour angles of the other bodies, may be taken out at once from these tables.

The logarithms in these tables are also used for other purposes in this work. The old standard tables of logarithms, sines, tangents, secants, etc., are not required.

Finding the time at sunrise and sunset is illustrated by diagrams showing the nature of the case, and the degree of dependence to be placed thereon.

The method of finding the apparent time at noon from equal altitudes of the sun, is also introduced, and is valuable from its extreme simplicity.

The finding the time on shore by the use of the artificial horizon.

The mode of finding the time at sea by an altitude of the moon, planets, and stars, and also the manner of finding any particular planet or star in the heavens at any given time, when above the horizon; in like manner, the name of any star of the first magnitude, or planet, whose altitude has been observed, may be known.

After thus having given all the various modes of finding the time at ship, the longitude by chronometer is then gone into, and every possible case is taken notice of and exemplified, first by the sun, in which the cases are all worked out in full, and every necessary correction fully explained, to which are added the practical rules as they are worked out at sea. A new table is here added, to correct the longitude by chronometer, when the latitude used in computing the time at ship is proved to have been in error; thus saving the time and trouble of working i over again.

The longitude by chronometer is found at sun rising and setting, and also from equal altitudes at noon, and from the altitudes of the moon, planets, and stars. The mode is also given of combining observations of two different bodies, with the view of finding both latitude and longitude by chronometer, at the same instant of time.

Sumner's method is now introduced, explained and exemplified, according to the mode I have been in the habit of using myself at sea, and illustrated by a diagram, showing its great utility and use to the navigator, when the ship is approaching land or a danger.

The method of rating chronometers at sea, from time to time during the voyage, when in sight of land, is fully explained and exemplified, and also when in port, either by the sea or by an artificial horizon. This is worthy the attention of navigators who carry chronometers, from the fact that chronometers generally alter their rate after being received on board, and acquire what is termed a sea rate, and which is easily ascertained by the above method.

In treating of lunar observations, diagrams have been introduced, showing the nature of the corrections required in clearing the lunar distance, and a case projected exhibiting the relative positions of the two bodies in the heavens, and the hour angle of one of them used in finding the time at ship.

The various methods of observing and writing down this observation is given as practiced at sea, and distances exemplified in all the various cases, between the sun and moon, and between the moon and planets and stars.

In clearing the lunar distance, one method only has been adopted, which is that by Lyons, and is nearly the same as that given in Thompson's Tables, and which I have found from experience to be the most simple and easiest understood of any mode now in use, and is correct enough in practice.

Much precision in clearing the lunar distance is not aimed at in this work, therefore many tedious corrections are omitted, which only tend to embarrass the navigator, and which are seldom applied in practice, and from the nature of errors in observing the distance itself, they do not seem to be required.

The lunar observation in this work is therefore considered only as a means of detecting any very gross error in the longitude by chronometer, during a long voyage.

A method is here also given of finding the longitude by a lunar observation on shore, one altitude being observed in the artificial horizon, and the other computed.

I have also introduced a new method of my own, which I have often used at sea, which is that of finding the longitude by measuring the moon's declination, illustrated by diagrams of the meridian altitudes of the moon and a star. The principle of this method is simply to observe the distance between the bodies on the meridian. Then the star's declination being known, (taken from the almanac or table,) furnishes the moon's declination. Or, the meridian altitudes of the bodies being observed, (though not necessarily on the meridian together,) the star's declination applied to the difference of the altitudes, gives the moon's declination. Now, where this declination so measured is found in the nautical almanac, will give the Greenwich time. Then the difference between this time and the mean time of the moon's passing the meridian of the ship, is the longitude in time, etc.

The method of working days works and keeping the ship's reckoning at sea, adapted to the present age, is thoroughly explained and exemplified, and the various rules given in the first part of this work are now applied, as are also those in nautical astronomy, to find her position from celestial observations.

The method of navigating a ship is now introduced, showing the mode of applying all the details which have been previously gone through, and many useful suggestions given, which have been derived from my own experience of a sea life, and will be found of service to the young navigator in times of peril and danger.

Amongst which the rules given for avoiding a collision on ships meeting each other at sea, will be found of great importance, and should be thoroughly understood by every seaman. I have, therefore, put them into a practical shape. These rules are recognized by courts of law in deciding cases of collision.

The method of keeping a log-book is explained, and various remarks made thereon, exemplified by a harbor log, the manner of keeping the log at sea by civil time, and also in the usual mode by sea time. The whole is then wound up by the journal of a voyage in a clipper ship, in which every circumstance is noted in the log-book, as it would actually be done at sea, and showing the care and circumspection necessarily required in navigating a fast-sailing vessel, from the fact that an error in the course of such a vessel will produce an error in the dead reckoning, in one day's run, of from two to three times the amount greater than what the same error in the course of a slow-sailing vessel would produce.

Many new tables have been introduced into this work, with the view of shortening the compu tations, and they are so arranged as to be easily referred to in practice, the one following the other as they are required to be used at sea.

The tables usually given in works of this kind are rejected, except those only which have a direct bearing upon the practice of navigation at sea.

The tables containing the times of high water at full and change, the variation of the compass in nearly all parts of the world, deduced from actual observation at sea, and the very important one of the position of places, which is taken from the best English authorities on those subjects, in which the principal headlands, ports and islands only are given, with the view of enabling the navigator to verify his chronometer on sighting the land at any time during the voyage, or rating it while in port, the position of shoals, etc., are not given, the navigator will naturally look for information on this subject from his chart, which will furnish the most proper and correct delineation of their extent and position, which cannot be obtained from a table.

From the foregoing prefatory remarks, it will be perceived that no very great amount of mathematical knowledge is required, beyond the common rules of arithmetic, to become a good practical navigator.

Practical navigation does not, therefore, consist of a tedious set of calculations, with a view of obtaining a very nice precision at any given time, but in the *tact* with which the navigator can single out and employ the heavenly bodies, in finding his ship's position therefrom, either by day or by night, and by increasing the number of observations, serve as a check upon each other, and thus verify her position in short intervals of time, in the shortest and simplest manner possible, having a due regard at the same time to its general correctness; and which has been the aim of this work to accomplish.

Having been engaged for some years in the instruction of seamen in navigation, I find that the chief difficulty lies in the fact that the generality of them cannot spare time sufficient on shore for the purpose of studying, and that they are obliged to pick up scraps of it here and there, as they best can, from whatever book falls in their way; and not being able to discriminate between what is really useful in practice or otherwise, many of them form very erroneous ideas, in their laudable attempt at self-instruction.

Therefore the chief inducement I had in writing this work, was to place it within their reach, divested of everything but what has a direct bearing on the practice at sea, whereby they might instruct themselves with greater ease than formerly, as it will lead them step by step from the lowest up to the highest branches of the science, and it embraces everything that is required to form a good practical navigator.

Here I may remark, that the entire work has been computed and written by myself, from the observations and memoranda contained in the journals of many voyages I have made to nearly all parts of the world, the examples having been reduced to the present year of 1854, for the sake of uniformity; and to accommodate those persons who may not have an almanac for that year at hand, I have added a table of extracts from the Nautical Almanac, containing the data for working the examples.

Seamen will please to bear in mind that the work has been written by one of themselves, and with a sincere desire for their improvement and instruction, and should it meet with their approval, (equal to the amount of labor bestowed on it,) would leave nothing more to be desired.

And, without meaning any disrespect to the generality of navigators, I may add, that from my own experience I know that there are many who are very deficient, not from the want of the capacity of becoming so, but from the want of the proper means of instruction, and which would seem to verify the words of the ancient sage, on being interrogated by the youth. "*My son*," said he, "*when you come to the years of manhood, you will be astonished to find how little wisdom is used in the governing of the world.*"

I cannot close the preface to a work of such immense labor, without soliciting the indulgence of the reader to any errors or inaccuracies which may have unavoidably crept in, notwithstanding the extreme care I have taken in revising the work over several times, both before and after committing it to the press. I, however flatter myself that few will be found to exist of much importance.

WILLIAM THOMS.

CONTENTS.

NAUTICAL ASTRONOMY.

NOTICE TO THE THIRD EDITION.

This edition has been further revised and corrected; and a new and complete set of Tables, for finding the Time at Ship (and thence the Longitude by Chronometer), have been added.

NOTICE TO THE SECOND EDITION.

This work has been revised and corrected, and an addition made of a separate *Explanation of the Tables*, and it is hoped that no error of importance will now be found to exist. It may be necessary here to say, that the author, in writing this work, did not consider a separate Explanation of the Tables requisite, as he had been particular in explaining them in different parts of the work when THEY were used. But as some navigators have recommended it, the following has been added, which will be found useful, as by glancing over *them* you can rapidly see, what the book contains, where the *tables* can be found, how and where they are used.

EXPLANATION AND USE OF THE TABLES.

Note.—The number of the page, which is placed on the same line with the number of the *table*, refers to the second part of this work, where the table will be found, and the numbers of pages in the *margin* refer to the first part of this work, where the table is used and explained.

TABLES I. AND II.—PAGE 1 TO 61.

Difference of Latitude and Departure.

These tables are of very extensive use in Navigation, affording an easy and expeditious method of solving problems in right-angled plane trigonometry, and consequently applicable to every variety of sailing. Table I. contains the difference of latitude and departure (in whole numbers and tenths) answering to distances not exceeding 300, and for courses to every point of the compass. Table II. is of the same nature and extent, but for courses consisting of whole degrees. The courses are set down at the top of the pages when they do not exceed 4 points or 45 degrees, and at the bottom when they are greater than these quantities; and it must be observed that when the *course* is taken from the *top* of the page, the *diff. of Lat.* and *Dep.* must be taken from the top also, but when the *course* is taken from the *bottom* the *diff. of Lat.* and *Dep.* must be taken from the bottom. Hence, when these tables are applied in *Parallel* or *Middle Latitude* sailing the co. lat. or co. mid. lat. is taken as a course, the departure or meridional distance is found in the *Dep.* column, and the difference of longitude in the *Dist.* column. In *Mercator's* sailing, the meridional difference of latitude is taken out in the *Lat.* column, and difference of longitude in the *Dep.* column. When any of the given parts (excepting the courses,) exceed the limits of the table, any aliquot part, as a half, third, fourth, &c., is to be taken; and those found corresponding are to be multiplied by the same figure that the given number is divided by.

Page 9 to 17. *Page 18 to 24.* *Page 25 to 28.*

TABLE III.—PAGE 62 TO 67.

Meridional Parts.

This table is used in resolving problems by Mercator's sailing, and in constructing charts on Mercator's projection. The meridional parts are to be taken out for the degrees answering to the given latitude, at the top or bottom, and for the minutes at either side column. *Page 25 to 28.*

1* TABLE IV.—PAGE 68.

Mean Refraction

This table contains the mean refraction of the heavenly bodies, in minutes and seconds, at a mean state of the atmosphere, and corresponding to their observed altitudes This correction is always to be substracted from the observed altitude of the object. *Page 67 and 86.*

*2 TABLE V.—Page 69.

Dip of the Horizon

Page 67 and 86. The corrections taken out from this table, answering to the height of the eye, above the sea in feet, are to be subtracted, from an altitude taken by a fore observation, or added to those taken by a back one.

*3 TABLE VI.—Page 69.

Sun's Parallax in Altitude.

Page 67 and 86. This correction is to be taken out opposite the Sun's altitude, and is always additive to it.

* *Note*—The joint effect of the corrections taken from these three tables, together with the Sun's semi-diameter, can be taken at once from Table IX. when the altitude of the Sun's lower limb is taken by a fore observation.

TABLE VII.—Page 69.

Moon's Augmentation.

Page 101. The Moon's apparent horizontal semi-diameter, as given in the Nautical Almanacs, is to be increased by a number of seconds, called the augmentation, taken out from this table, answering nearest to her altitude. *Note.*—In practice this is seldom used, except in working a Lunar. *See* page 165.

TABLE VIII.—Page 69.

Dip at Different Distances.

Page 90. When that part of the horizon immediately under the Sun is obstructed by land, the *dip* is to be taken from this table, (with the height of the eye at the top, and the estimated distance from the land in miles in the side column) instead of Table V.

TABLE IX.—Page 70.

To Correct the Observed Altitude of the Sun's Lower Limb.

Page 86. This table is intended to simplify the *usual method of correcting the observed altitude* of the Sun's lower limb, when taken by a fore observation, by showing the correction at once for the joint effect of the Sun's semi-diameter, dip of the horizon, refraction, and parallax. These corrections being computed to minutes and tenths, the tenths may easily be reduced to seconds by multiplying them by six. In this table the Sun's semi-diameter is assumed at 16 minutes, and its variation from that quantity in each month of the year, given at the bottom of the table, is to be applied to the *corrections found in the table* according to the sign + or — prefixed it.

TABLE X.—Page 71 and 72.

Sun's Declination.

The Sun's declination is given in this table in degrees and minutes for the years 1854–55–56–57, at noon on each day of the year under the meridian of Greenwich; but will answer for several subsequent years, by applying the corrections from Table XII.

TABLE XI.—Page 73.

To Correct the Sun's Declination for Longitude and for Time.

Page 84 and 85. As the Sun's declination in table X. is adapted to the meridian of Greenwich at noon, when the ship is to the eastward or westward of that meridian, *it* should be corrected by this table; also when *it* is required for any other time than noon, it can be corrected by this table, and applied as directed below the table. *Note.*—Rules for correcting the declination (taken from the Nautical Almanac) to Greenwich time, at page 124

TABLE XII.—Page 73.

Correction of the Sun's Declination every 4 years.

This table is intended to correct the Sun's declination given in Table X., for the change that takes place in periods of four years. See note below the table.

TABLE XIII.—Page 74.

Sun's Right Ascension.

The Sun's mean right ascension contained in this table, is to be taken out with the month at the top, and the day in the side column. When great accuracy is necessary, it must be taken from Nautical Almanac. *Page* 62.

TABLE XIV.—Page 74.

Equation of Time and Table of Corrections.

The Equation of time for apparent noon at Greenwich, is given in this table for the years 1854–55–56 and '57, and which will answer nearly for sixteen years. A table adjoining is given for correcting the Equation of time for Longitude and for time. This table is entered with the *daily change* of the variation at the top, and the Longitude at the left side, (or if for time, at the right side) and the angle of meeting points out the correction in sec. and tenths of sec. to be applied as directed at the bottom of the table. *Note.*—Rule for correcting the Equation of time from the Nautical Almanac is given at page 124. *Page* 124.

TABLE XV.—Page 75 to 80.

For Finding the Latitude out of the Meridian.

This table was *first* calculated and published by the author in a separate form, (called Thom's Tables) but on writing this work was introduced in it; it is divided into five parts, and explained at Page 93. *Page* 93.

TABLE XVI.—Page 81 to 83.

Apparent Time of Sun's Rising and Setting.

This table is entered with the declination at the top and the latitude at the side, and the angle of meeting will point out the time of rising and setting from the *top* when the Latitude and declination are of the same name, or from the *bottom* when they are of contrary names.

To Find the Time of Rising and Setting of any other Celestial Object.

This table also exhibits half the time that an *object* continues above the horizon in the column of *Sett.*, and half the time that it continues below in the column of *Ris.*, from the top of the page, when the latitude and *declination of the object* are of the same name, and from the bottom when they are of contrary names. Therefore, to find the time of *the object's* rising, subtract *half* the time that it continues above the horizon, from the time of *its* passing the meridian, and to find the time of setting *add* half the time that it continues above the horizon to the time of its passing the meridian. *Note.*—The rule for computing the meridian passage of the Stars is given at page 111. Table XVIII. also gives the Mn. Passages of the Stars Page 85 to 90.

Moon's M. P., *Page* 101.
Star's M. P., *Page* 106.
Planet's M. P. *Page* 115.

TABLE XVII.—Page 84.

Altitudes by which the Apparent Time may be found with the greatest accuracy.

When the latitude and declination of an object are of the same name, by entering this table with the declination at top or bottom, and the latitude at the side, the angle of meeting points out the altitude of the object nearly, when it is in the prime vertical, or at its nearest approach thereto, and which is the best altitude for ascertaining the apparent time. When the latitude and declination of an object are of contrary names the *object* is nearest the prime vertical, when in the horizon, but an altitude less than 6° or 7° should not be used on account of the uncertainty of refraction at low altitudes. *Page* 122.

TABLE XVIII.—PAGE 85 to 90.

For finding the Apparent Time of 24 Principal Stars passing the Meridian throughout the year.

Page 106.

TABLE XIX.—PAGE 91.

Page 106.

Right Ascension and Declination of 24 Principal Stars.

TABLE XX.—PAGE 91.

For Correcting the Observed Altitude of a Star or Planet.

Page 108.

This table contains the corrections in minutes and tenths to be *subtracted* from the observed altitude of a Star or Planet to find its true altitude, being the joint effect of refraction and dip of the horizon.

TABLE XXI.—PAGE 92.

To find the Latitude by an Altitude of the Polar Star.

Pag 109 *and* 71.

This table is explained on its own page, and on the right hand column is the *variation* of the correction in 10 years, which is to be substracted from the correction for that period of time.

TABLE XXII.—PAGE 93.

For Correcting the Time of the Moon's M. Passage at Greenwich to the time of her passing over any other Meridian.

This table is entered with the daily variation of Moon's M. Passage to the nearest minute at the top, and the longitude of the place in the left side column, and the angle of meeting points out the minutes to be *added* to the time of Moon's passing the Meridian of Greenwich in west longitude or subtracted in east. The sum or remainder will be the time of her passing the Meridian of the place. *Page* 101.

TABLE XXIII—PAGE 94.

For Reducing the Moon's Declination to the Greenwich Time of the Observation.

Page 102.

This table is only used with an Almanac that has the Moon's Declination given for every noon and midnight.

TABLE XXIV.—PAGE 95.

To Correct the Moon's Semi-diameter and Horizontal Parallax.

Page 101.

This table is explained at Page 95, below the table.

TABLE XXV.—PAGE 96.

Page 102.

To Correct the Moon's Apparent Altitude.

TABLE XXVI.—PAGE 97.

To Turn Time into Degrees or Degrees into Time.

Page 140.

This table is entered with degrees in one column, and opposite the time correspond ing is found.

TABLE XXVII.—PAGE 98 TO 106.

Logarithms of the Latitude and Polar Distances.

Page 123.

This table contains Logs. of latitude and polar distance for finding the time, and thence the *longitude by chronometer.* The latitude in degrees is taken from the top and miles from left hand side, the polar distance in degrees is taken from the bottom and miles from right hand side, except when the polar distance is above 90°, it is then taken from the top.

TABLE XXVIII.—Page 107, 115.

Logarithms of the Half Sum and Difference.

This table contains the Logs. of the half sum and difference for finding the time, and thence the *longitude by chronometer.* The half sum is taken from the top and difference from bottom. *Page* 123.

TABLE XXIX.—Page 116 to 124.

Logarithms of Apparent Time or Hour Angle.

For explanation, see *note* at bottom of page 125, first part of this work. *Page* 128.

TABLE XXX.—Page 125.

For Correcting the Longitude by Chronometer for the effect of an error in the Latitude used in finding Time.

This table saves the trouble of working the *sights* over again at noon, when you find you have used a wrong latitude in finding the time at sea in the morning. *Page* 144 *and* 145.

TABLE XXXI.—Page 126 to 137.

Logarithms of the Apparent Lunar Distance.

This table contains the Logs. sines and Logs. tangent of the apparent lunar distances. *Page* 165.

TABLE XXXII.—Page 138 to 152.

Logarithms of the First and Second Corrections.

This table contains the first and second corrections to be applied to the apparent distance. *Page* 166.

TABLE XXXIII.—Page 154 to 205.

Logarithms of the Third Correction.

This table contains the third correction to be *added* to the first and second corrections and apparent Lunar distance to find the true distance. *Page* 166.

TABLE XXXIV.—Page 206 to 220.

Proportional Logarithms.

This table is explained at bottom of page 133, first part of this work. *Page* 133.

TABLE XXXV.—Page 221, 222.

Amplitudes.

This table is intended to expedite the method of finding the variation of the compass. *Page* 196.

TABLE XXXVI.—Page 223 to 225.

Extracts from the Nautical Almanac.

This table contains extracts from the Nautical Almanac for the year 1854, for the purpose of working out the examples given in this work.

TABLE XXXVII.—Page 226 and 227.

Variation of the Compass.

This table contains the approximate variation of the compass, and is to be entered with the

Page 116. longitude at top of page 226 when west, or 227 when east, and the latitude at the side, and the angle of meeting points out the degrees of variation and is marked east or west. The longitude is given for every 10 degrees, and the latitude for every 2 degrees. If the variation be required for any intermediate position, it may be found by taking the mean between the *two* or *four* variations which are given for places on each side of the required position.

TABLE XXXVIII.—Page 228 to 230.

Times of High Water at the principal Ports.

This table contains the times of high water at the full and change of the moon. It is alphabetically arranged, and entered accordingly; when opposite the name of the place, will be found the time of high water.

TABLE XXXIX.—Page 231 to 243.

Position of Places.

This table contains the Latitudes and Longitudes of the most prominent places in the world; the manner of finding any required place, supposing its situation nearly known—needs no explanation.

TABLE XL.—Page 244 to the end.

Positions of Places.

In this Table the Latitudes and Longitudes of Places has been extended, and some places of importance (omitted in Table XXXIX) have been inserted.

TABLE AT PAGE 18—First Part of this Work:

Page 18. Shows the number of minutes and seconds contained in each degree, or 60 miles of *longitude*, for every degree of latitude.

TABLE AT PAGE 32—First Part of this Work.

Page 32. *For finding the distance of an object by two bearings and the distance sailed between them.*

This table is particularly useful to *coasters*.

TABLE AT PAGE 37—First Part of this Work.

Page 37. This table is used for finding the time of *high water* at any place by correcting for the moon's horizontal parallax.

TABLE AT PAGE 100—First Part of this Work.

To find the Latitude from Sun's change of Altitude.

Page 100. This table contains the Sun's change of altitude in one minute of time for every degree of latitude when on the Prime Vertical.

TABLE AT PAGE 153—Second Part of this Work.

This table contains the Sun's change of altitude in one minute of time for every degree of latitude when *not* on the Prime Vertical.

JAMES H. BROWNLOW

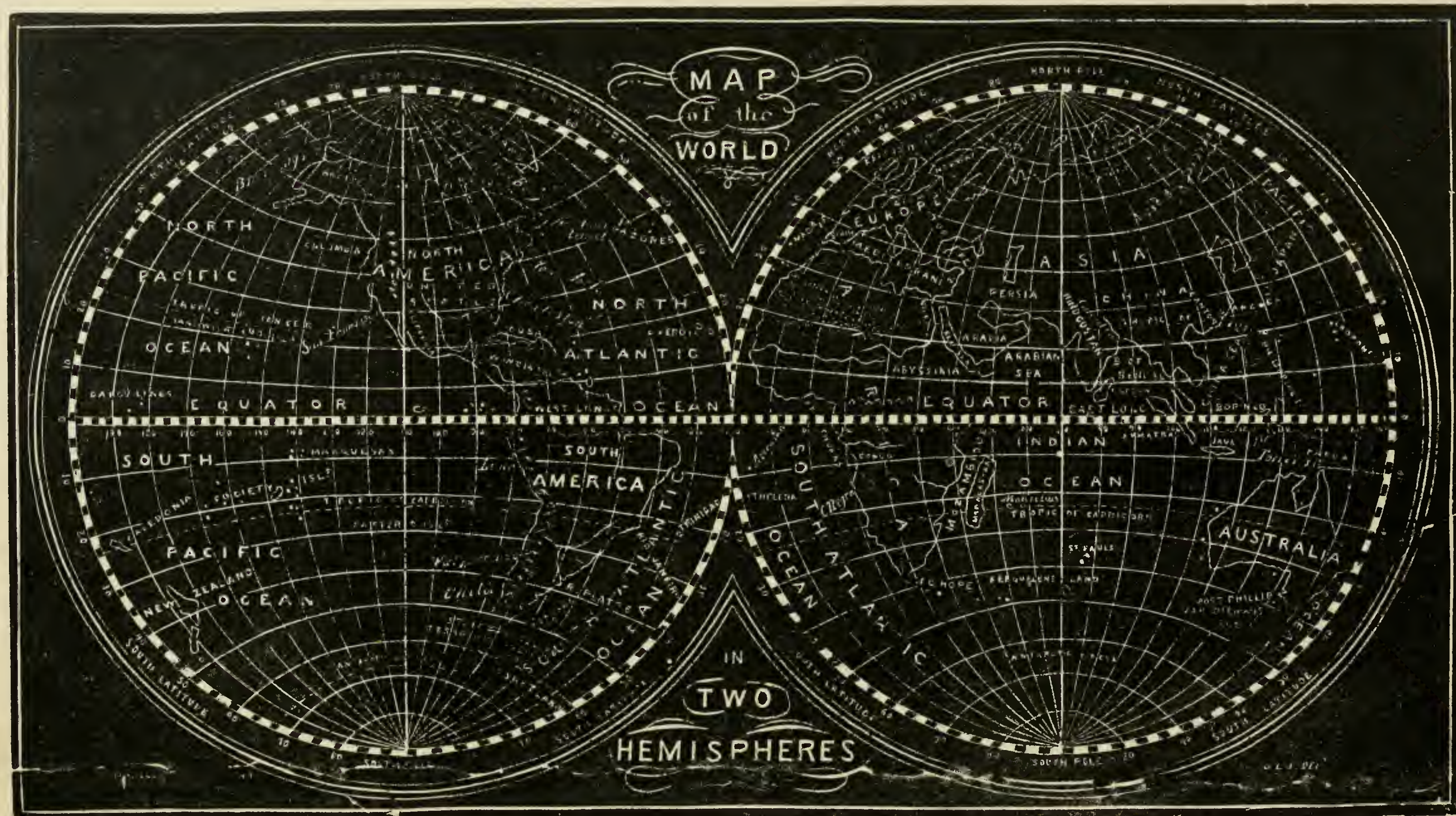

MAP
of the
WORLD
IN
TWO
HEMISPHERES
NORTH
PACIFIC
OCEAN
EQUATOR
SOUTH
PACIFIC
NEW ZEALAND
OCEAN
NORTH
AMERICA
NORTH
ATLANTIC
OCEAN
SOUTH
AMERICA
ATLANTIC
OCEAN
EUROPE
ASIA
PERSIA
CHINA
ARABIA
ARABIAN
SEA
ABYSSINIA
EQUATOR
INDIAN
OCEAN
SOUTH ATLANTIC
OCEAN
AUSTRALIA
TROPIC OF CAPRICORN
NORTH POLE
SOUTH POLE

Fig. 3.

PRACTICAL NAVIGATION.

INTRODUCTION.

NAVIGATION is the art of conducting a ship from one port to another, through the wide and trackless ocean, with the greatest safety, in the shortest time possible, and to find her position on the globe at any given time.

To be able to do this, the mariner is required to have a knowledge of certain imaginary circles, supposed to be drawn on the surface of the earth, together with the most practical and easy method of finding a ship's position thereon, from the course steered by the compass, and her distance sailed, and also the course and distance to her intended port. This constitutes what is called Navigating by Dead Reckoning; but as it is liable to be greatly in error, even in short distances run, from many causes (which will be explained in this work), it cannot therefore safely be depended on.

Consequently, the mariner must have some other resource to apply to, with the view of ascertaining his ship's true position. This can only be derived from the observations of the heavenly bodies; but to do this, he is required to have a knowledge of certain imaginary circles supposed to be drawn in the heavens, corresponding to those already supposed to be drawn on the earth's surface; by which means he obtains the positions of the heavenly bodies themselves, in the same manner as the position of the ship is indicated by the circles on the earth; and it will be the object of this work to instruct him how to find his ship's position, from the observations of any of the heavenly bodies which may be visible, either by day or by night, and avoiding all the tedious details and intricate calculations which are not necessary, thereby saving much valuable time and labor; the results, by this method, having been found from actual experience to be sufficiently accurate for all practical purposes.

In this work the mariner will therefore not be required to go through a tedious training in decimal and logarithmical arithmetic, nor is it required that he should have a previous knowledge of either geometry or trigonometry, which are usually given in works of this kind; all the matter which treats on those subjects is therefore discarded, except such part of it as has a direct bearing on the practice of navigation at sea.

All that is then required of him is to have a previous knowledge of the common rules of arithmetic; that is, addition, subtraction, multiplication, division, the rule of three, and the practice of aliquot parts; or that amount of education only which would be required to fit a person to fulfil the ordinary business of life.

In the room of the above-mentioned discarded matter, Diagrams or figures of the subject under consideration will be introduced in their proper places, and the explanation of each Diagram facing it on the same or opposite pages, thereby enabling the learner to comprehend mechanically the whole case at one view.

The construction and use of both General and Coasting Charts, with the manner of taking Soundings on the Coast, the prevailing Winds and Currents in different parts of the world, and Storms and Hurricanes, will all be explained, and practical rules given to avoid the latter, derived from actual experience. The Instruments of Navigation will also be explained, and the manner of adjusting, correcting, and using them at sea.

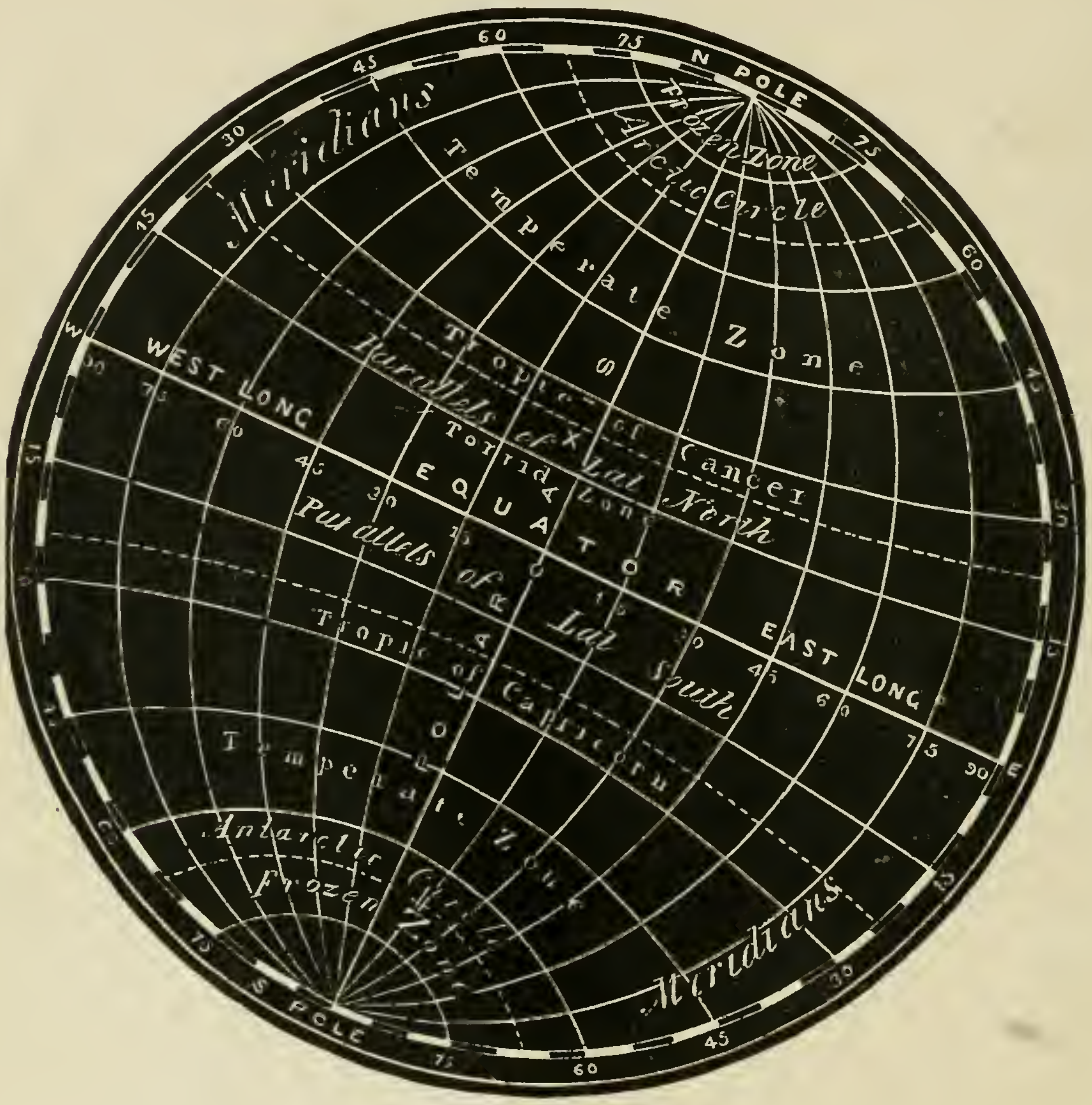
In treating of Nautical Astronomy, the subject will be illustrated by Diagrams, and the cases proved by projection only, in the room of going into the tedious solutions of Spherical Trigonometry, except in those cases where a Rule is required; and much new matter on this subject will be introduced, in connection with the use of the Chronometer. Many new Tables will also be introduced, with a view of shortening the labor in the computations.

Although this work is intended to treat only on those subjects which have reference to the place of the Ship on the Ocean, nevertheless much useful matter will be found which will be interesting to the young officer, in regard of Navigating the Ship. The whole being original matter, which the author of this work has derived from a personal experience of more than a quarter of a century, in Navigating Ships to nearly all parts of the world. The work will be closed with the methods of Keeping a Log-Book, exemplified by a Journal of a Voyage, with remarks on the same, as would actually be done at sea.

DIAGRAM OF THE EARTH,

Showing its inclination to the Plane of its Orbit of 23° 28′, and the imaginary Circles drawn on its surface

FIG. 1.



DESCRIPTION AND DIMENSIONS OF THE EARTH.

The Polar Diameter is 7899, and the Equatorial Diameter 7926 miles; the latter being the greatest, is caused by the revolution of the Earth on its axis, and as the greater portion of the surface is covered with water, it recedes from the poles towards the Equator, until its tendency to run back towards the poles just balances the effects of the centrifugal force. This causes the Equatorial Diameter to be about 27 miles greater than the Polar Diameter. If the Earth should stop revolving on its axis, the water at the Equator would settle away towards the Poles until it assumed the form of a Globe as near as possible. Thus, large portions of land in the Torrid Zone which are now covered by the ocean would be left dry, and new continents and islands formed.

The Polar Axis is not perpendicular, but inclines to the plane of its orbit at an angle of 23° 28′, and performs its revolution round the sun in one year, or 365 days 6 hours, or at the rate of 68,000 miles an hour; at the same time it performs its daily revolution round its axis at the rate of 15° to the hour—equal to 900 miles, or 15 miles in 1 minute of time.

Latitude is measured in Degrees, Minutes, and Seconds from the Equator towards the Poles, from which it is 90° distant; each Degree contains 60 Minutes, and each Minute contains 60 Seconds. 1 Minute or Nautical Mile contains 6082 feet, or 1013 fathoms, and therefore a Second is about 101 feet, or 17 fathoms nearly.

The Circumference of the Earth at the Equator is 360 Degrees of the same length as the Degrees of Latitude; consequently, Degrees of Latitude and Longitude are the same length on the Equator. But on sailing North or South from the Equator, the Meridians contract, and the Degrees of Longitude become less, (but still contain or are divided into 60 minutes,) until they finally meet at the Poles, where there is no Longitude.

The Earth revolves from West to East, which is the cause of all the heavenly bodies appearing to rise in the East and set in the West.

GEOGRAPHY,

AS APPLIED TO THE PRACTICE OF NAVIGATION AT SEA.

DEFINITIONS.

PRACTICAL NAVIGATION relates to two methods, independent of each other—the first is that usually called Dead Reckoning, and the other by Astronomical Observations; but in practice they are generally carried on together, as a check upon each other.

The first of these methods requires a knowledge of the imaginary lines and Circles on the surface of the Globe, or Earth, which we inhabit, and which turns round once in every 24 hours; the line round which it revolves, and which is the shortest diameter, is called the Polar Axis, and drawn between the North and South Poles.

90° from the Poles is the great Circle, called the Equator, passing round the earth and dividing it into two equal parts, or Hemispheres. At all places on this circle the sun rises and sets at 6 o'clock all the year round, and the days and nights are equal, being divided into 12 hours each.

A Meridian is a circle passing through both poles, and cutting the Equator at right angles. Places situated on this Circle are said to be on the same meridian North or South of each other.

Latitude is the distance from the Equator, measured in Degrees and Minutes, on a meridian towards the North or South Poles, and named accordingly.

The Co-latitude is the difference between a given Latitude and 90°, or the Pole.

Parallels of Latitude are Circles parallel to the Equator, running East and West. Places on this circle are said to lie on the same parallel of latitude.

The Difference of Latitude of two places is the portion of the meridian included between their parallels.

The Difference of Latitude of a Ship is therefore the distance she makes good in a North or South direction.

It is evident that when two places are on the *same* side of the Equator, their difference of Latitude is found by subtracting the lesser latitude from the greater, and that when they are on opposite sides of the Equator, that is, when one place is in North Latitude, and the other in South Latitude, the sum of their Latitudes is the difference of Latitude.

EXAMPLE 1.

Find the difference of Latitude between New York and Charleston, S. C.

New York, Latitude.....	40° 43′	N.
Charleston.... "	32 46	N.
Difference of Latitude..	7° 57′.	

EXAMPLE 2.

Find the difference of Latitude between Cape Henry and Cape St. Roque.

Cape Henry, Latitude..	36° 56′	N.
Cape St. Roque.. "	5 28	S.
Difference of Latitude ..	42° 24′.	

EXAMPLE 3.

A ship sails from Latitude 50° 19′ N. to 48° 12′ N. find her difference of Latitude.

Latitude left...........	50° 19′	N.
Latitude in............	48 12	N.
Difference of Latitude....	2° 7′	= 127 miles

EXAMPLE 4.

A ship sails from Latitude 1° 11′ N. to 0° 13′ S., find her difference of Latitude.

Latitude left........	1° 11′	N.
Latitude in..........	0 13	S.
Difference of Latitude	1° 24′	or 84 miles

NOTE.—When a Ship in north latitude sails North, she evidently increases her latitude, and so likewise when in south latitude she sails South, because in these cases she increases her distance from the Equator, at which the latitude begins.

But if in north latitude she sails South, or in south latitude she sails North, she diminishes her latitude; hence, when one latitude and the difference of latitude are given the other latitude is easily found.

EXAMPLE 1.

A Ship from 43° 30′ S. sails 219 miles South, required her latitude in.

Latitude left............. ...	43° 30′	S.
Diff of Lat. 219 divided by 60 =	3 39	S.
Latitude in...............	47° 9′	S.

EXAMPLE 2.

A Ship from latitude 43° 11′ N. makes 194 miles southing, required her latitude in.

Latitude left................	43° 11′	N.
Difference of Latitude ....194 =	3 14	S.
Latitude in	39° 57′	N

EXAMPLE 3.

A Ship from Latitude 1° 3′ N. sails 123 miles South required her latitude in.

Latitude left................	1° 3′	N.
Difference of Latitude 123 =	2 3	S
Latitude in................	1° 0′	S.

NOTE.—The Ship being in 1° 3′, or 63 miles N. of the Equator, must evidently be in South Latitude after making 123 miles southing.

Thus, in subtracting one of the quantities from the other, the difference takes the name of the greater.

Longitude is the distance measured on the Equator, between the Meridian of a given place and another, called the first meridian. The choice of a first meridian is arbitrary. The Americans, English, and other nations adopt Greenwich Observatory in England as the first Meridian.

The Longitude of a place is named East or West, according as it is East or West of Greenwich, as far as 180°, and which is the opposite meridian to Greenwich, or one-half of the circumference of the Earth. A Ship sailing East beyond 180° East Longitude, would then be in West Longitude, and sailing West beyond 180° West Longitude, would then be in East Longitude.

Longitude is measured either in Degrees, Minutes, and Seconds, or in Time, that is, in Hours, Minutes, and Seconds, each hour being equal to 15°; for the Sun, which regulates the time, returns to the same meridian again after describing a complete circle, or 360°, in 24 hours, and 15° multiplied by 24, makes 360°.

The Difference of Longitude of two places is the portion of the Equator included between their meridians. To measure, therefore, the difference of Longitude between two places, we must follow down their meridians to the Equator, and then take the included portion of the Equator itself.

The Degrees of Latitude and Longitude are of the same length on the Equator; but as the meridians contract and meet at the Poles, the greater the Latitude the Degrees of Longitude become less; that is, the space contained in a Degree of Longitude becomes less as the Latitude increases, until at the Poles the Longitude ceases altogether.

When two places are on the same side of the first meridian, their difference of Longitude is found by subtracting the lesser from the greater.

When two places are on opposite sides of the first meridian, that is, when one place is in East Longitude and the other in West Longitude, the sum of their Longitudes is the difference of Longitude.

When one Longitude is East and the other West, and their sum exceeds 180°, subtract from 360° will give their difference of Longitude.

EXAMPLE 1.

Find the difference of Longitude between New York and Charleston, S. C.

New York, Longitude.....74° 0′ W.
Charleston.... " ....79 54 W.
Difference of Longitude.... 5° 54′.

EXAMPLE 2.

Find the difference of Longitude between the Cape of Good Hope and Cape St. Roque.

Cape of Good Hope, Longitude 18° 30′ E.
Cape St. Roque....... " ....35 17′ W.
Difference of Longitude........53° 47′.

EXAMPLE 3.

A Ship sails from Longitude 50° 10′ W. to 60° 30′ W., find the difference of Longitude.

Longitude left...........50° 10′ W.
Longitude in............60 30 W.
Difference of Longitude.. 10° 20′.

EXAMPLE 4.

A Ship sails from Longitude 5° 40′ W. to 2° 10′ E. find her difference of Longitude.

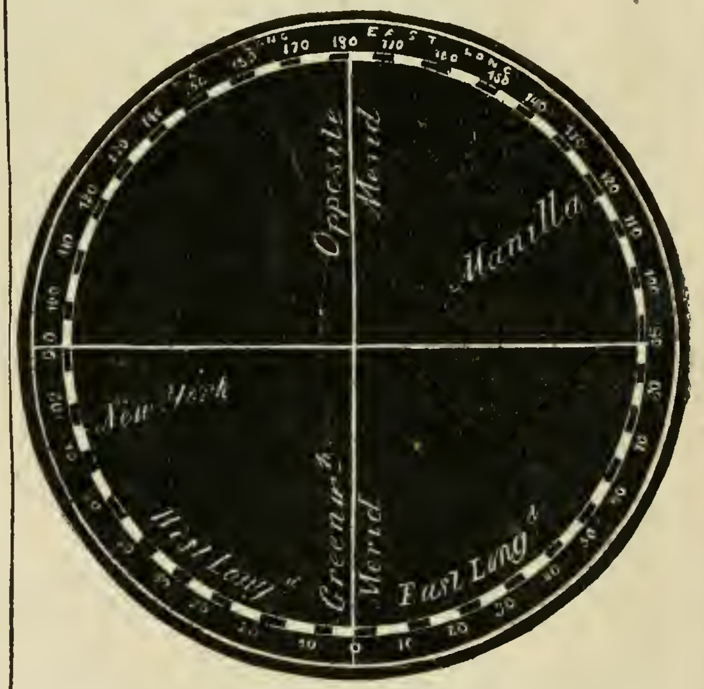
Longitude left...........5° 40′ W.
Longitude in............2 10 E.
Difference of Longitude...7° 50′.

EXAMPLE 5.

Find the difference of Longitude between New York and Manilla.

New York, Longitude......74° 1′ W.
Manilla........ " ......121 2 E
Sum.................. 195° 3′.
Subtract from.......... 360 0.
Difference of Longitude.. 164° 57′

Fig. 2.
THE EQUATOR.



Note.—A Ship in East Longitude sailing East, or in West Longitude sailing West, increases her Longitude, but in East Longitude sailing West, or in West Longitude sailing East, she diminishes her longitude; and when the Longitude exceeds 180°, subtract it from 360, will give the Longitude in of a contrary name.

EXAMPLE 6.

A Ship from Longitude 85° 25′ W. sails East 3° 40′, find the Longitude in.

Longitude left........ 85° 25′ W.
Difference of Longitude 3 40 E.
Longitude in... ..... 81° 45′ W.

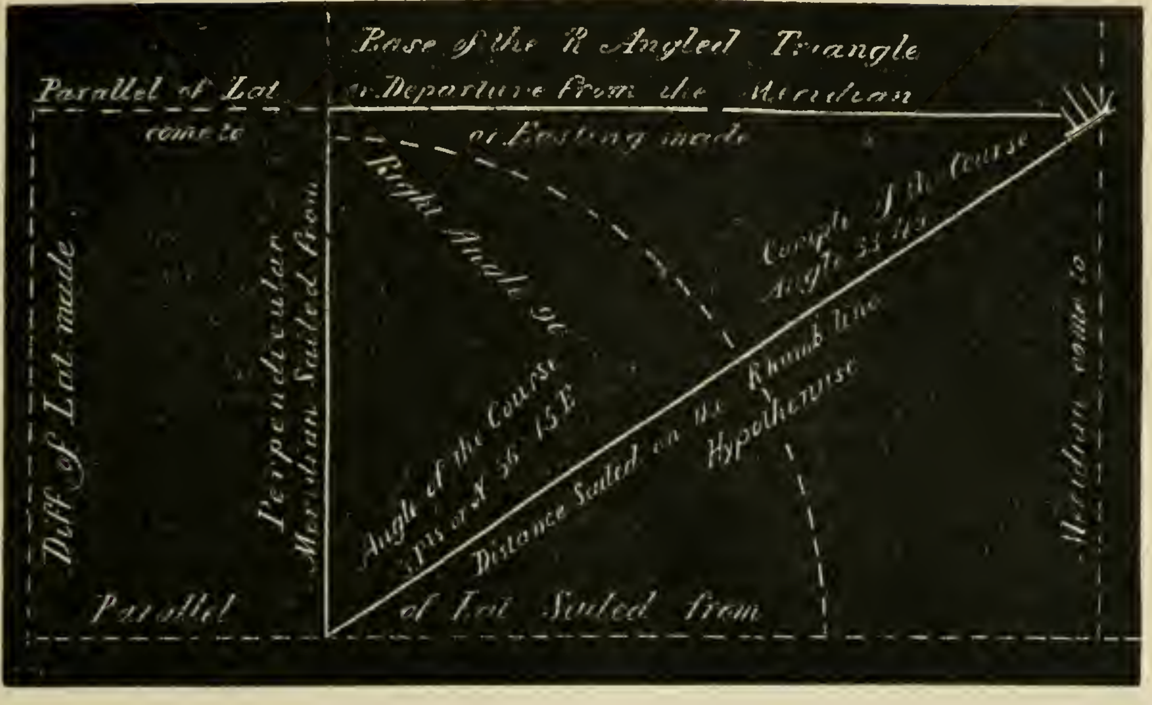
EXAMPLE 7.

A Ship from Longitude 179° 32′ E. sails East 2° 30′, find the Longitude in.

Longitude left........179° 32′ E.
Difference of Longitude..2 30 E.
Sum.................182° 2′
Subtract from........360 0
Longitude in ....177° 58′ W.

Fig. 4.

DIAGRAM OF THE RIGHT-ANGLED TRIANGLE.



PRINCIPLES OF THE RIGHT-ANGLED TRIANGLE.

The Course steered is the angle between the Meridian and the Ship's head; the Course made good is the angle between the Meridian and the Ship's real track on the ocean.

The Course is reckoned from the Meridian accordingly, North or South towards the East or West, if less than eight points, or 90 Degrees.

The Course is measured in points of 11° 15′ each, or in Degrees and Minutes.

The Rhumb line is the Ship's track when crossing all the Meridians at the same Angle.

The Distance between two places, or the Distance sailed by the Ship on a certain course, is measured in nautical miles of 60 to the Degree of Latitude, each containing 6,082 feet.

Three such miles make a League.

The Departure is the Distance made good by the Ship due East or West, or the distance she departs from her first Meridian, and are always of the same length as the miles of Distance, or difference of Latitude, it is also called Easting or Westing, and always expressed in miles. When a Ship sails East or West she makes no difference of Latitude.

The difference of Latitude is the space contained between two parallels of Latitude, and is counted on the meridian. When a ship sails North or South she makes no Departure.

Taking a departure means taking the bearing of any object by compass, or its angle with the Meridian, and estimating its distance from the Ship on leaving the land.

The above figure represents a case in Plane Sailing, in which all the above terms are explained. The thick lines form a Right-Angled Triangle, of which the Perpendicular is the Difference of Latitude. The Base, the Departure; the Angle between them is a Right Angle, or 90°; and the Hypothenuse is the Distance sailed; the Angle between the Hypothenuse and the Perpendicular is the Course reckoned from the Meridian; and the opposite Angle is found by subtracting it from 90°; because these two Angles are equal to the Right Angle, or 90°. We have now the four terms of a Right-Angled Triangle, corresponding to the Course, Distance, Difference of Latitude, and Departure, and by the well-known properties of that figure, any two of which being given, the other two can readily be found by the rules given for projecting the case; and to obviate the labor of calculating the terms by Logarithms, Tables have been long in use containing all that is necessary for solving the problems, sufficiently accurate for the purpose intended. They are called the Traverse Tables, and the quantities are taken out by inspection; and as this is the method invariably used at sea, all the other methods are neglected, and never used even by those who have a thorough knowledge of Trigonometry, and many navigators consider them a useless appendage to a work on Practical Navigation.

INSTRUMENTS OF NAVIGATION.

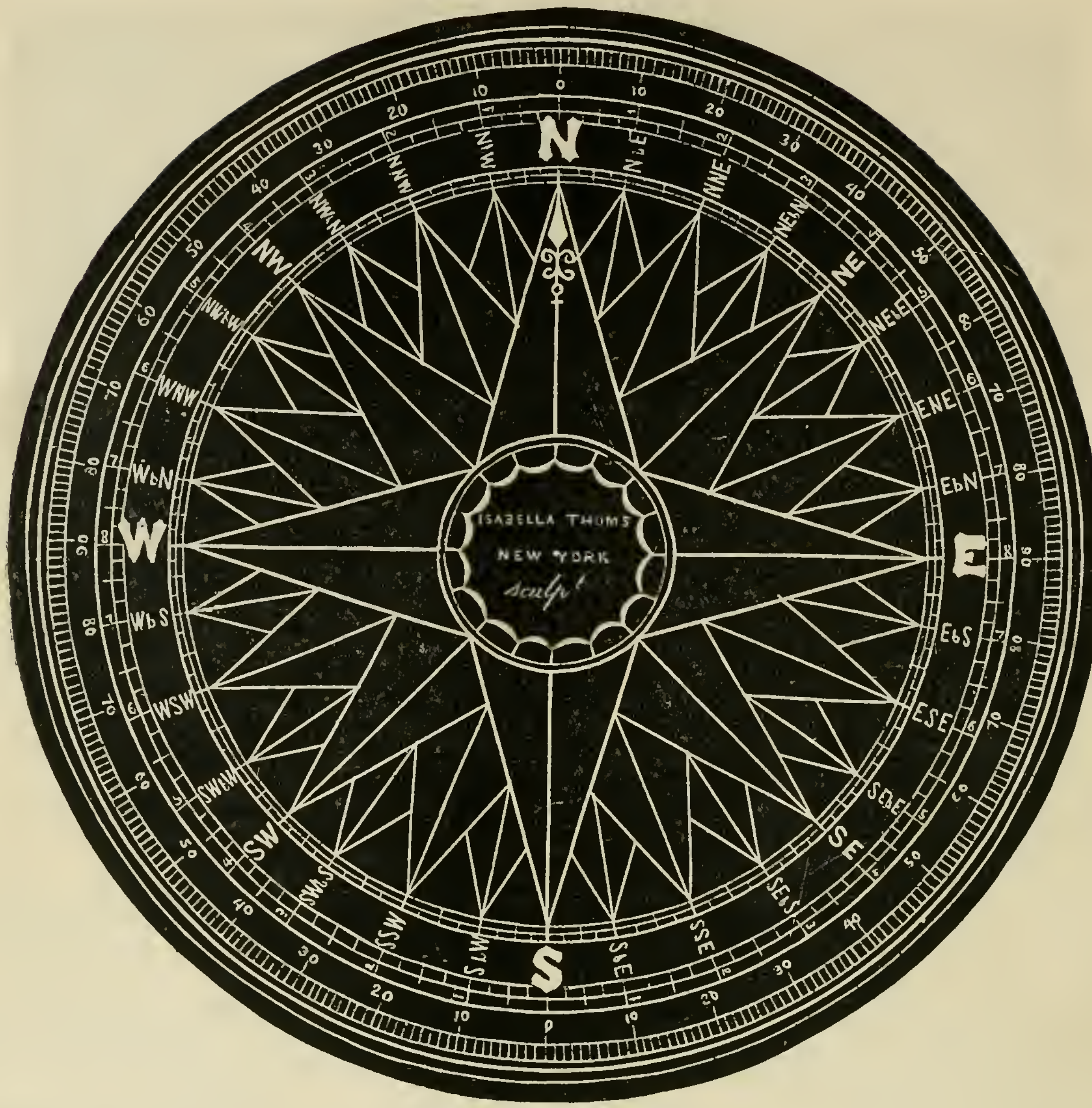
The Instruments used in Navigation are the Compass, the Log, and Glass. The former shows the direction of the Ship's track, and by means of the latter her distance run is measured.

The Log Ship is a small triangular-shaped piece of wood, one side being loaded so as to cause it to swim upright; sometimes a funnel-shaped bag is used instead. This is attached to the line in such a manner that when the glass has run out, and the line checked, one of the corners (being fastened by a peg of wood or bone), is released, or the bag reversed, which allows it to be easily hauled on board again. At 12 or 15 fathoms from the Log Ship the line is marked with a strip of Rag; this is called the Stray line, which enables the Log to go clear of the Ship before the time is counted, or the Glass turned. From this mark the line is measured and divided into Knots and Half Knots, and marked at each Knot with a bit of string with the number of Knots upon it.

The length of a Knot depends upon the number of seconds which the Glass measures.

Fig. 5.

THE MARINER'S COMPASS.



As the Ship's Course is sometimes expressed in Points and sometimes in Degrees, the following Table will be found useful for reference.

NORTH AND EAST.	NORTH AND WEST.	SOUTH AND EAST.	SOUTH AND WEST.	POINTS.	D. M. S.
North.	North.	South.	South.	0	° ′ ″
N. ¼ E.	N. ¼ W.	S. ¼ E.	S. ¼ W.	¼	2 48 45
N. ½ E.	N. ½ W.	S. ½ E.	S. ½ W	½	5 37 30
N. ¾ E.	N ¾ W.	S. ¾ E.	S. ¾ W.	¾	8 26 15
N. by E.	N. by W.	S. by E.	S. by W.	1	11 15 00
N. by E. ¼ E,	N. by W. ¼ W.	S. by E. ¼ E.	S. by W. ¼ W.	1¼	14 3 45
N. by E. ½ E.	N. by W. ½ W.	S. by E. ½ E.	S. by W. ½ W.	1½	16 52 30
N. by E. ¾ E.	N. by W. ¾ W.	S by E. ¾ E.	S. by W. ¾ W.	1¾	19 41 15
N. N. E.	N. N. W.	S. S. E.	S. S. W.	2	22 30 00
N. N. E. ¼ E.	N. N. W. ¼ W.	S. S. E. ¼ E.	S. S. W ¼ W.	2¼	25 18 45
N. N. E. ½ E.	N. N. W. ½ W.	S. S. E. ½ E.	S S. W. ½ W.	2½	28 7 30
N. N E. ¾ E.	N. N. W. ¾ W.	S. S. E. ¾ E.	S S. W. ¾ W.	2¾	30 56 15
N. E. by N.	N. W. by N.	S. E. by S.	S. W. by S.	3	33 45 00
N. E. ¾ N.	N. W. ¾ N	S. E ¾ S.	S. W. ¾ S.	3¼	36 33 45
N. E. ½ N.	N. W. ½ N	S. E. ½ S.	S. W. ½ S.	3½	39 22 30
N. E. ¼ N.	N. W. ¼ N.	S. E. ¼ S.	S. W. ¼ S.	3¾	42 11 15
N. E.	N. W.	S. E.	S. W.	4	45 00 00
N. E. ¼ E.	N. W. ¼ W.	S. E. ¼ E.	S. W. ¼ W.	4¼	47 48 45
N. E. ½ E.	N. W. ½ W.	S. E. ½ E.	S. W. ½ W.	4½	50 37 30
N. E. ¾ E.	N. W. ¾ W.	S. E. ¾ E.	S. W. ¾ W.	4¾	53 26 15
N. E. by E.	N. W by W.	S. E. by E.	S. W. by W.	5	56 15 00
N. E. by E. ¼ E.	N. W. by W ¼ W.	S. E. by E. ¼ E.	S. W. by W. ¼ W.	5¼	59 3 45
N. E. by E. ½ E	N. W. by W. ½ W.	S. E. by E ½ E.	S. W. by W. ½ W.	5½	61 52 30
N. E. by E. ¾ E.	N. W. by W. ¾ W.	S. E. by E. ¾ E.	S. W. by W. ¾ W.	5¾	64 41 15
E. N. E.	W. N. W.	E. S. E.	W. S. W.	6	67 30 00
E. by N. ¾ N.	W. by N. ¾ N	E. by S. ¾ S.	W. by S. ¾ S.	6¼	70 18 45
E. by N. ½ N.	W. by N. ½ N.	E. by S. ½ S.	W. by S. ½ S.	6½	73 7 30
E. by N. ¼ N.	W. by N. ¼ N.	E. by S. ¼ S.	W. by S. ¼ S.	6¾	75 56 15
E. by N.	W. by N.	E. by S.	W. by S.	7	78 45 0
E. ¾ N.	W. ¾ N.	E. ¾ S.	W. ¾ S.	7¼	81 33 45
E. ½ N.	W ½ N.	E. ½ S.	W. ½ S.	7½	84 22 30
E. ¼ N.	W. ¼ N.	E. ¼ S.	W. ¼ S.	7¾	87 11 15
East.	West.	East.	West.	8	90 00 00

The length of a nautical mile being about 6,080 feet, the 30 Second Glass should have a length of Knot nearly 51 feet. To determine the length of Knot to any length of glass, the Rule is, as 30 Seconds is to 51 feet, so is 28 Seconds to the Knot of 47 feet, and so on.

But in practice a 45 feet length of Knot is found to correspond best with a 28 Second Glass. The difference is caused by the Log Ship coming home when hove, and 47 feet gives the Distance run too small.

Before the line is measured it should be well stretched, and then made wet. Nails should be placed in the Deck at the proper length of the measured Knot, so as to verify the marks frequently, as the line is liable either to stretch or run up.

Sometimes the Knots and half Knots only are inserted in the Log Board, but in general the Knot is divided into 10 fathoms, and the odd fathoms inserted for handiness in adding up. This fathom is not 6 feet, but the tenth part of the Knot only.

The Log line, after being thus measured, is fastened to a Reel and wound up, ready for use. The manner of heaving the Log can only be learned at Sea, but it may be useful to remark that the line is faked in the hand, not coiled, and the Log Ship is to be thrown well out to Leeward of the Ship's wake, and in such a manner that it may take hold of the water at once, and that before a heavy Sea the line should be paid out rapidly when the Stern is rising, and retarded a little when the Stern is falling.

Whichever length of Glass is adopted, there should always be another of half the length, usually called the short glass, and used when the Ship is going rapidly through the water, as only half of the length of line is required, and by doubling the number of Knots run out, the same result is obtained as if the whole line had been used.

The Glass should be kept dry, and verified occasionally with the second hands of a Chronometer.

THE COMPASS.

The Mariner's Compass consists of a circular card, the edge being divided into 32 Points, Half Points and Quarter Points, and into 360 Degrees.

The four principal points, or, as they are called, the cardinal points, are North, South, East, and West, the East being towards the right when facing the North.

A farther description of this well-known Instrument is not required, except that in North Latitude the North Pole of the magnetized bar is drawn or attracted in that direction, and in South Latitude the South Pole is attracted towards the South. The Dip, or attraction towards the centre of the Earth is greatest in high Latitudes, and is frequently the cause of a sluggish movement of the Card in common compasses. The magnetic pole dipping, a balance-weight of Sealing-Wax or other substance is required at the other end of the bar, to make it swing freely round, which can be removed again in low Latitudes. The pin on which the card is balanced sometimes becomes blunt by constant use, which can be sharpened with a fine-grained file or a set stone.

The Lubber's Point is a perpendicular mark in the centre of the forward part of the Compass Bowel and represents the line of the Ship's Keel, (or a line parallel to it) By endeavoring to keep a given point of the Compass card at this mark, constitutes what is called steering a course by Compass.

THE VARIATION OF THE COMPASS.

The Needle points to the Magnetic North, which in few parts of the world agrees with the true North, the difference between them is called the Variation of the Compass. See page 116.

The Variation is named Easterly when the North end is drawn towards the East of the true North, and Westerly when drawn to the Westward. The variation is different in different places, and is constantly though slowly changing.

To correct compass courses and bearings for variation, if the variation is Easterly, apply it to the right hand of the Compass course or bearing. When Westerly, apply it to the left hand, looking towards the point representing the given course or bearing.

A True course or bearing is reduced to the Compass course or bearing by applying the variation the contrary way.

LOCAL ATTRACTION.

The Compass in every Ship is more or less affected by the Iron used in her construction, and by Iron on board as cargo. It is most sensibly felt when the Ship's head is East or West, because in North Latitude the North Point is drawn forward, and the reverse in South Latitude; but when her head is North and South, the Magnetic and true meridians nearly coincide with the disturbing force, situated in the forward part of the Ship, and the effect is not so sensible. It may be detected by taking frequent observations to find the variation of the Compass, (which will include the Local Attraction;) then the difference between that and the variation laid down on the Chart will be the Local Attraction. This subject will be found treated of more at length at page 120.

PRACTICAL NAVIGATION.

INTRODUCTION TO THE SAILINGS.

The Methods used in navigating a Ship by Dead Reckoning are the Plane and Traverse Sailings, Parallel, Middle Latitude, and Mercator Sailings; Current Sailing being merely a modification of the others, all of which will be explained and exemplified under their proper heads.

It has not been deemed necessarily within the scope of this work to include Great Circle Sailing, simply because the track of a Ship, as given by the general rules in Great Circle Sailing, cannot be practically adopted by a Sailing Vessel, from many causes which it is not necessary here to explain, and which has been the cause of leading many vessels astray that had adopted it.

A Ship may, however, adopt a modification of the Track on the Great Circle without reference to any general rules, as follows:

Great Circle Sailing supposes a Ship to Sail on a circle on the Earth's surface, having the Centre of the Earth as a Centre. When a Ship sails true North or South, she sails on the Arc of a Great Circle; and when she sails true East or West on the Equator, she also sails on the Arc of a Great Circle, because these Circles have the Earth's Centre for a Centre; but in sailing on a straight Rhumb line in any other direction, which, although it may appear perfectly straight on the Chart, nevertheless, if her positions at Noon were laid off on a Terrestrial Globe, it would be found that she had described a Curve with its back towards the Equator, and been sailing on a Small Circle. Now the object to be attained in Great Circle Sailing is to adopt a curve or track on the Chart, the back of which shall be turned towards the Pole of that Latitude in which she is Sailing. Then, supposing her positions at Noon to be laid off on the Globe as before, it will be found that she has been sailing on a circle which has the centre of the Earth as a centre, the distance measured between any two places on this Great Circle is the least distance between them; but, as before observed, this is not always practical. A modification may be adopted by tracing upon a Chart of the intended voyage a curved Track from Port to Port, having its back towards the North in North Latitude, or towards the South in South Latitude, and which shall keep the Ship free from being entangled with the Land, and at the same time placing her in the most favorable position to take advantage of the prevailing Winds and Currents.

The manner of doing this is simply to draw a line between the two places on the Chart, and to mark the extent to which the curve may be judiciously made on the polar side of the middle of that line; then through these three points trace a curved line, which will approximate to that of a Great Circle. Now it is evident that to sail on this curved track, the course must be shaped accordingly, and that it will be required to be reshaped or changed at the end of every 60 or 100 miles of Distance run by the Ship. The extent of this curve must be greatest in high Latitudes, and on crossing the Equator it changes to the opposite side of the straight line. See the Great Circle track from Santa Cruz to St. Johns, on the Chart at page 46

PLANE SAILING.

Plane Sailing is the Art of Navigating a Ship on plane surface, supposing the surface of the Earth to be an extended plane, and the meridians all parallel to each other. This supposition is nearly true for small portions of the Earth's surface, and for a considerable space on each side of the Equator.

But as the Meridians contract in Sailing from the Equator towards the Poles, the sides of the Right Angled Triangle do not bear the same relation to each other on large portions of the Earth's surface.

Plane Sailing also supposes the parallels of Latitude to be at right angles to the Meridians, and th length of a degree on the Meridian, Equator, and parallels of Latitude, everywhere equal.

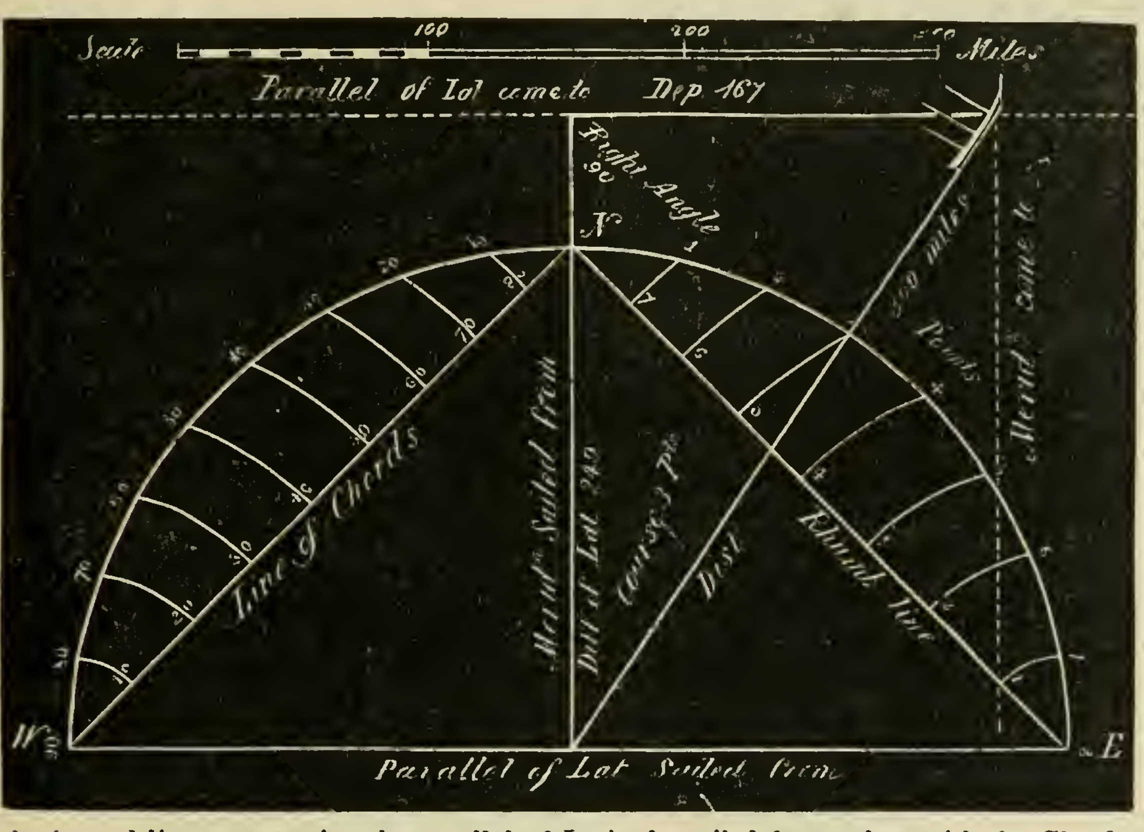
CASE I.

The Course and Distance given to find the Difference in Latitude and Departure.

Example.—A Ship from Latitude 48° 30′ N. Sails North-East by North 300 miles. Required her Latitude in and Departure from the Meridian.

BY PROJECTION ON THE PLANE SCALE.

Fig. 6.



Draw a horizontal line representing the parallel of Latitude sailed from; then with the Chord of 60° in the dividers, and one foot on this line, describe a Semicircle; divide this Semicircle into equal parts of 90° each, (or a Quadrant); divide the right hand Quadrant into 8 equal parts, which transfer to a line drawn across the Quadrant, will give the line of Rhumbs. Divide the left hand Quadrant into 9 equal parts, and transfer them to a line drawn across the Quadrant in like manner, will give the line of Chords. Those figures are always drawn so that the upper part represents the North, and the ship is supposed to sail from the centre on a given course towards the circumference or horizon, the course North-East by North, 300 miles given. Take 3 points from the line of Rhumbs and lay it off from the North towards the East, and draw the Rhumb line, which will represent the Ship's Course, and on which measure off the Distance Sailed; this will give the Ship's place. Draw a parallel of Latitude through this place, and through the Meridian sailed from, and the space between the Parallels of Latitude is the Difference of Latitude made, measured on the Meridian. Draw a Meridian through the Ship's place parallel to the Meridian sailed from, and the space between the Meridians is the Departure made.

BY INSPECTION. TRAVERSE TABLE.

Course North-East by North, or 3 Points, and Distance 300 miles. In the Traverse Table gives

Difference of Latitude....	249.4 miles, and the Departure 167 miles.
	= 4° 9′ N
Latitude left............	48 30′ N.
Latitude in.............	52° 39′ N

Note.—These Tables contain *four terms*, any two of which being given, the other two can be found by inspection; and it must be observed that in using these Tables the terms Distance, Latitude, Departure, must be found at the top, if the Course is found there: but if the Course is found at the bottom, those names or terms must be found at the bottom Thus, the Course North-East by North, or 3 Points, is found at the top, and the columns headed Latitude and Departure are to be used from the top, and against Distance 300 stands Difference of Latitude 249.4, and Departure 166.7. In practice, should the tenths be less than 5, we throw them away; if more than 5, we call the sum one mile more.

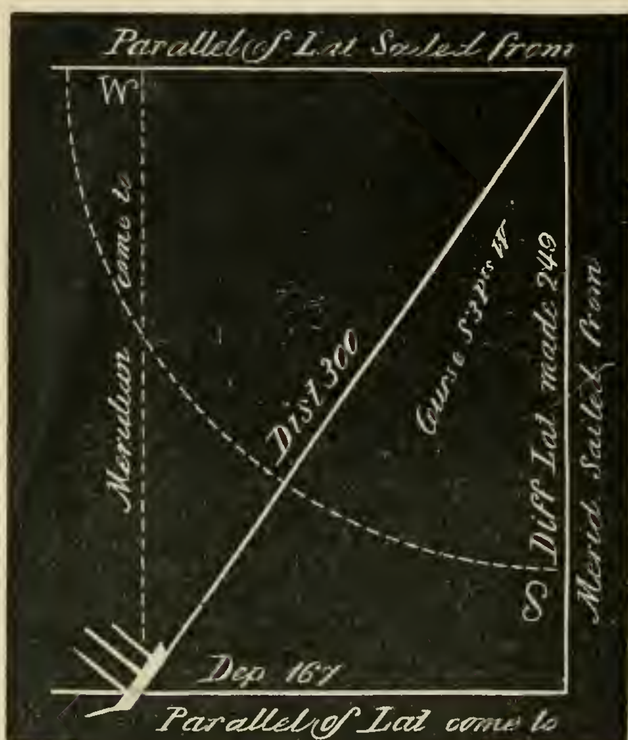
When the Distance is more than 300, or if any of the other terms be too great for the Tables, we take one-half, one third, one-fourth, or one-tenth, and multiply the terms thus found by the same quantity that they were reduced by.

CASE II.

The Difference of Latitude and Course given to find the Distance and Departure.

Example.—A Ship from Latitude 52° 39′ North, sails South-West by South until her Latitude observed was 48° 30′ North. Required the Distance run and her Departure from the Meridian.

Fig. 7.



Latitude left..	52° 39′	N.
Latitude in...	48 30	N.
	4° 9′	N.
	60 0	
Diff. of Lat....	249	miles.

PROJECTION BY THE PLANE SCALE.

Draw a horizontal line to represent the parallel of Latitude Sailed from; then with the Chord of 60° in the dividers, and one foot on this line as a Centre, make the Arc of a Circle towards the left hand downwards, which will represent the Southwest Quadrant. Take 90° in the dividers, and with one foot on the line where it joins the Circle, extend the other downwards, and mark the Circle. A line drawn through this mark to the Centre will form a Right Angle with the other line, and represents the Meridian sailed from. Lay off the Difference of Latitude on this Meridian towards the South, and draw the parallel of Latitude come to. Take 3 Points from the line of Rhumbs, and lay it off from the Meridian South, towards the West, and draw the Rhumb line, and where it cuts the parallel of Latitude is the Ship's place, and gives her Distance Sailed. Draw a line parallel to the Meridian through the Ship's place, will give the Meridian come to, and the space between the Meridians is the Departure.

BY INSPECTION. TRAVERSE TABLES.

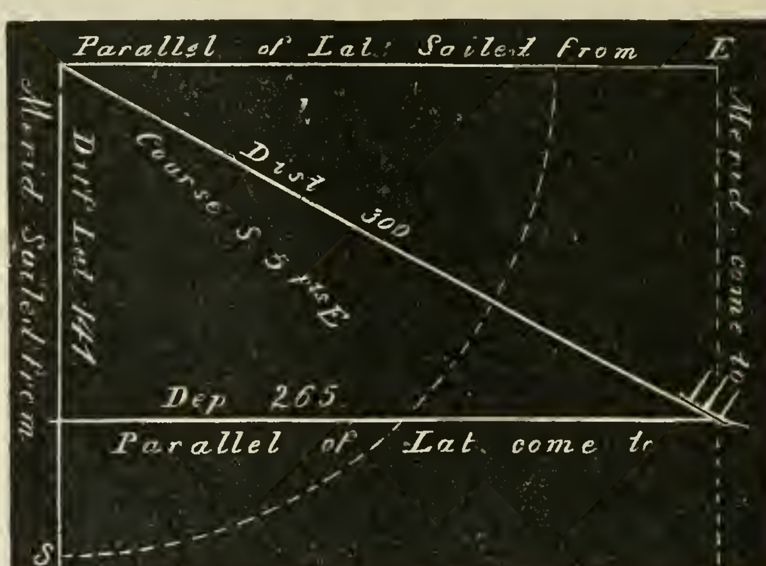
I open the Table at a 3-Point Course, and find the Difference of Latitude 249 miles in its column, (at the top of the page, marked Latitude,) and against it, in the Distance column, stands 300 miles, the Distance required, and opposite, in the column marked Departure, stands the Departure required, 167

CASE III.

The Difference of Latitude and Departure given to find the Course and Distance.

Example.—A Ship from Latitude 32° 31′ North sails between the South and East until her Latitude in is 30° 10′ North, having made 265 miles of Departure. Required her Course and Distance sailed.

Fig. 8.



Lat. left..	32° 31′	N.
Lat. in...	30 10	N
	2° 21′	
	60	
Diff. Lat.	141	

PROJECTION BY THE PLANE SCALE.

Draw a Horizontal line to represent the parallel of Latitude sailed from, then with the Chord of 60° in the dividers, and one foot on this line as a Centre, make the Arc of a Circle towards the right hand downwards, and which will represent the South-East quarter of the Compass. Take 90° in the dividers, and with one foot on the line where the circle meets it, extend the other downwards, and mark the Circle; then a line drawn through this mark to the Centre will form a Right Angle with the other line, and represents the Meridian sailed from. Lay off the Difference of Latitude, 141, on the Meridian from the parallel of Latitude sailed from downwards, or towards the South, and draw the parallel of Latitude come to.

From the meridian line towards the East, or right hand, lay off the Departure, 265 miles, and draw the meridian come to parallel with it. Then where this meridian cuts the parallel of Latitude come to is the Ship's place. Draw the Rhumb-line between the Ship's place and the centre, which will give the Distance Sailed; and where this line cuts the Circle will be the Course 5¼ Points measured from the meridian line, or from the South towards the East.

BY INSPECTION. TRAVERSE TABLES

With the difference Latitude 141, and the Departure 265, I enter the Table for Points, and I find them to agree nearly to the Course 5¼ Points, and the Distance opposite is 300 miles.

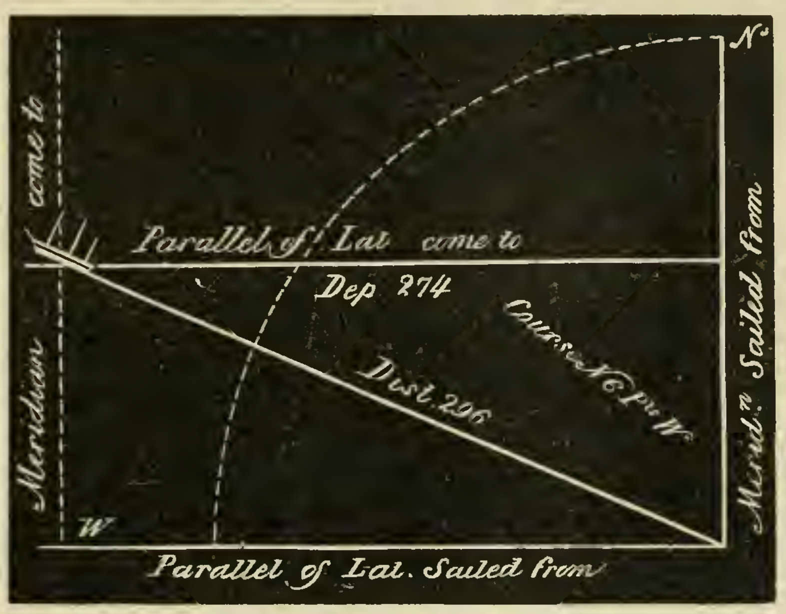
Or, in the Table for Degrees the nearest is 264.9 and 140.8, which gives the Course Sailed 62° E., and distance 300 miles. The Departure being the greatest the Course is found at the bottom of the page

CASE IV.

The Difference of Latitude and Distance Sailed, given, to find the Course and Departure.

A Ship from Latitude 38° 20′ N. sails 296 miles between the North and West, until the Latitude observed was 40° 13′ N. Required her Course and Departure.

FIG. 9.



Lat. left,	38° 20′ N.
Lat. in,	40 13 N.
	1° 53
	60
Dif. Lat.	113′

PROJECTION BY THE PLANE SCALE.

Draw a horozontal line representing the parallel of Latitude sailed from. Then with the Chord of 60° in the dividers, and one foot on this line as a Centre, draw the Arc of a Circle to the left hand upwards, which will represent the N. W. quarter of the Compass. Take 90° in the dividers, and with one foot on this line where the circle meets it, extend the other upwards and mark the circle, draw a line through this mark to the centre, and it will form a Right Angle with the other line and will represent the meridian sailed from. Lay off the Difference of Latitude, 113, on this meridian line from the parallel of Latitude sailed from towards the N. and draw the parallel of Latitude come to. Take the Distance 296 miles in the dividers, and with one foot on the centre extend the other and cut the parallel of Latitude come to, which is the Ship's place. Draw the Rhumb line between the Ship's place and the Centre, and where it cuts the circle shows the Angle of the Course N. 6 points W. Through the Ship's place draw a line parallel to the meridian sailed from, which will be the meridian come to, and the space between the meridians is the Departure.

BY INSPECTION. TRAVERSE TABLES.

With the Distance 296 miles and Difference Latitude 113, I enter the Table for Degrees, and find them to agree between 67° and 68°, or, N. 67° 30′ W., and the Departure 274. The manner of doing it is thus I take the Distance 296 miles and the nearest Difference Latitude greater than the one sought, is found to be 115.7 at Course 67°, and the nearest less Difference Latitude 110.9 at Course 68°. The half between them is the course required. The Departure at Course 67° is 272.5, and at 68° is 274.4. The mean or half between the two is 274, nearly, which is the Departure required.

Or, enter the Table of Points with Distance 296 and Difference Latitude 113. The nearest to it, 113.3, gives a six point Course, and the corresponding Departure is 273.5.

NOTE.—In all those cases where the Course is required, consider whether the Difference of Latitude or the Departure is the greatest. If the Departure is the greatest, the Course is found at the bottom of the page; but if the Departure is the least of the two, the course will be found at the Top of the page.

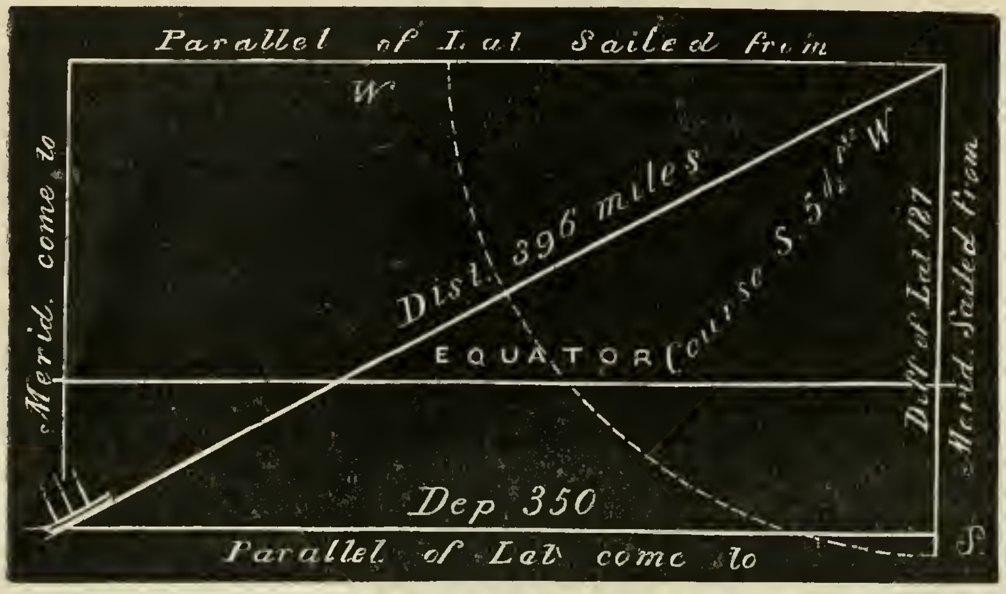
Because those Tables are calculated as far as Four Points or 45° at the Top, for Distance, Difference of Latitude, and Departure; they then commence at the Bottom of the page, and go backwards for the remaining Points or Degrees of the Quadrant, and the angle of the Course being greater, the Latitude and Departure columns are reversed at the Bottom, and marked accordingly.

CASE V.

The Course and Departure given to find the Distance and Difference of Latitude.

Example.—A Ship from Lat. 2° 7′ N sails South-West by West half West until she has made 350 miles of Departure. Required her Latitude in and Distance Sailed.

Fig. 10.



Latitude left 2° 7′ N.
Diff. of Lat...3 7 S.
Latitude in..1° 0′ S

PROJECTION BY THE PLANE SCALE.

Draw a horizontal line to represent the parallel of Latitude sailed from. Take the Chord of 60° in the dividers, and with one foot on this line as a Centre, make the Arc of a Circle towards the left downwards, which will represent the South-West quarter of the Compass. Take 90° in the dividers, and with one foot on the line where the Circle joins it, extend the other and mark the Circle. A line through this mark to the Centre will form a Right Angle with the other line, and which will represent the Meridian sailed from. Take 5½ Points from the line of Chords, and lay it off from the South towards the West, and mark it on the Circle. Draw the Rhumb line through this mark to the Centre, and it will form an Angle with the Meridian or the Course.

Lay off the Departure 350 miles from the Meridian towards the West, and draw the Meridian come to parallel with the other; then where it cuts the Rhumb line is the Ship's place. Extend the dividers between this place and the Centre, will give the Distance sailed 396 miles. Through the Ship's place draw the parallel of Latitude come to. and the space between the parallels of Latitude is the Difference of Latitude, 187, or 3° 7′ South, and the Latitude in is 1° 00′ South. In this case the Ship has crossed the Equator.

BY INSPECTION. TRAVERSE TABLES.

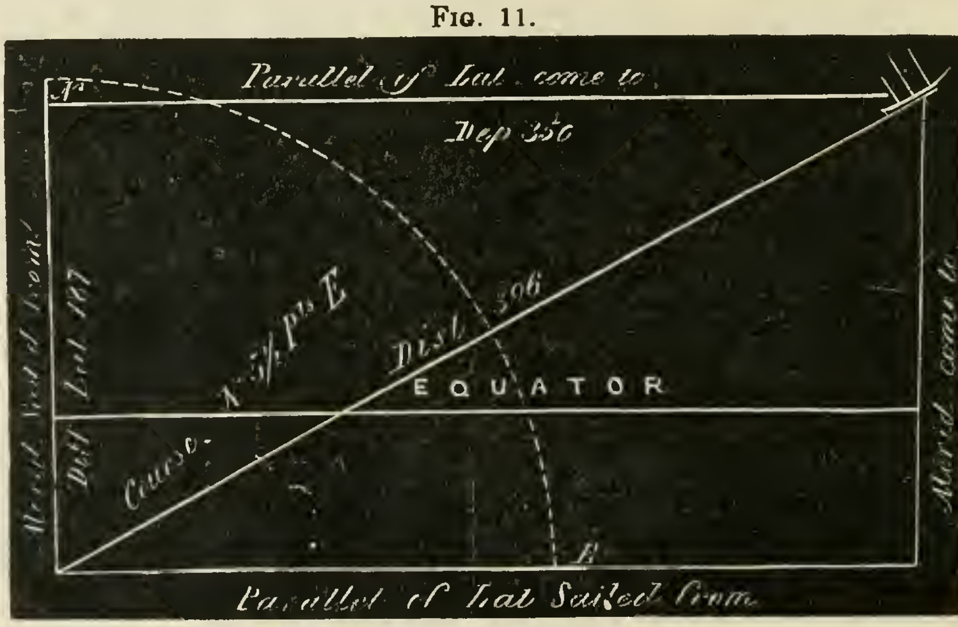
Find the Course 5½ Points at the bottom of the page of the Table for Points. Take half the Departure, 350 miles, which is 175, in its column, the nearest to it, is 174.6; opposite, in the Distance column, stands 198, and in the Latitude column 93.3, which is half the Distance and half the Departure, which, being doubled gives the whole Distance, 396 miles, and the whole Difference of Latitude 186.6, or divided by 60, 3° 7′ South. The Latitude sailed from was 2° 7′ North, which, subtracted from the Difference of Latitude made, gives the Latitude in 1° 0′ South, and the Ship in this case has crossed the Equator

CASE VI.

The Distance and Departure given to find the Course and Difference of Latitude

Example.—A Ship from Latitude 1° 0′ South sails between the North and East 396 miles, until her Departure is 350 miles. Required the Course steered and her Latitude in.

Fig. 11.



PROJECTION BY THE PLANE SCALE.

Draw a horizontal line to represent the parallel of Latitude sailed from. Take the Chord of 60° in the dividers, and with one foot on this line as a centre, make the Arc of a circle towards the right hand upwards, which will represent the North-East quarter of the Compass. Take 90° in the dividers, and with one foot on this line where the Circle joins it, extend the other upwards, and mark the Circle. A line drawn through this mark to the Centre will form a Right Angle with the other line, and which will represent the Meridian sailed from. Lay off the Departure 350 miles from the Meridian towards the right or the East, and draw the Meridian come to parallel with the other. Take the Distance, 396 miles, in the dividers, and with one foot on the centre, extend the other, and cut the Meridian come to, which will be the Ship's place. Draw the Rhumb line between the Ship's place and the centre, and where it cuts the Circle will be the Course North 5½ Points East, and measured on the line of Rhumbs. Through the Ship's place draw the parallel of Latitude come to, and the space between the parallels is the Difference of Latitude, 187 miles, or 3° 7′, the Latitude in being 2° 7′ North.

In this case the Ship has crossed the Equator.

BY INSPECTION. TRAVERSE TABLES.

Take half the Distance, 198, and half the Departure, 175. Seek in the Tables till opposite the former, the nearest to the latter is found to be 174.6, adjoining to which stands half the Difference of Latitude, 93.3, which doubled is 186.6, or 3° 7′ North, from which subtract the Latitude left, 1° 0′ South, gives the Latitude in 2° 7′ North, and the Departure being greater than the Difference of Latitude, the Course is found at the bottom of the page to be North 5½ Points East, or North 62° E. in the Table for Degrees.

The above Six cases comprehend all the varieties of Plane Sailing, but as it is of great importance to have a thorough knowledge of the principles of Plane Sailing before going into the other Sailings, (because it is used in all the other Sailings,) and also to exercise the learner in the use of the Traverse Tables, the following questions are given for exercise.

Question 1. A Ship from Latitude 36° 30′ North sails South-West by West 420 miles. Required her Latitude in and her Departure from the Meridian.

Answer. Latitude in 32° 37′ North, and Departure 349′.2 West.

Question 2. A Ship from Latitude 3° 54′ South sails North-West ¾ West until her Latitude in is 2° 14 North. Required her Distance run and Departure made good.

Answer. Distance 618 miles, and Departure 496.4 West.

Question 3. A Ship from St. Helena, in Latitude 15° 55′ S sails South-South-East ½ East till she has made 115 miles of Departure. Required her Latitude in and the Distance run.

Answer. Latitude in 19° 30′ South, and Distance 244 miles.

Question 4. A Ship from Latitude 28° 20′ North sails between the North and East 486 miles, and finds by Observation that she is in Latitude 32° 17′ North; what Course has she steered, and what Departure has she made?

Answer. Course N. 61° East, or North-East by East ½ East nearly, and Departure 425 East.

Question 5. A Ship sails between the North and West 170 Leagues from a Port in Latitude 38° 42′ North until her Departure be 98 leagues. Required her Course and Latitude in.

Answer. Course North 35° West, or North-West by North ¼ West nearly, and Latitude in 45° 40′ North.

Question 6. A Ship from Sandy Hook in Latitude 40° 28′ North, sails between the South and East until her Latitude observed is 38° 20′ North, and having made 100 miles Departure. Required the Course and Distance Sailed.

Answer. Course South 38° East, Distance 163 miles.

Question. 7. A Ship off Cape Henry in Latitude 36° 56′ North, is bound to Bermuda, in Latitude 32° 19′ North, and which lays 552 miles to the Eastward of the Cape. Required her Course and Distance to it.

Answer. Course South 63° East, or South-East by East ½ East nearly, and the Distance 618 miles.

Question 8. Five Days ago we were in Latitude 3° 10′ North, and since then have sailed on a South-West Course, at the rate of 10 knots an hour. Required the Latitude in and the Departure made to the Westward.

Answer. The Latitude in is 10° 59′ South, and the Departure made is 849 to the Westward.

Question 9. A Ship from Latitude 4° 10′ South is bound to a Port in Latitude 3° 10′ North, and bearing from the Ship North-North-West. Required how far that Port lies to the Westward, and the Ship's Distance from it.

Answer. The Port lies 183 miles to the Westward, and the Distance is 478 miles.

Question 10. Required the Bearing and Distance between Neversink Light in Latitude 40° 24′ North and the Island of Porto Rico in Latitude 18° 29′ North, and which lies 413 miles to the Eastward of the former.

Answer. The Bearing is South 17° 30′ East, or South by East ½ East, and the Distance 1,380 miles.

TRAVERSE SAILING.

This is a variety of Plane Sailing in which the Ship makes two or more Courses in succession, and the method of reducing these several Courses and Distances into a single Course and Distance is called working a Traverse.

TO WORK A TRAVERSE.

Make a Table, and divide it into six columns; in the first of these set down the several Courses, and opposite to them, in the second column, their corresponding Distances. The third and fourth columns are to be marked North and South at the top, and are to contain the Differences of Latitude. The fifth and sixth are to be marked East and West, and to contain the Departures.

Find the Difference of Latitude and Departure corresponding to each Course and Distance by the method of Plane Sailing. Set these down opposite the Distance in their proper columns, that is, if the Difference of Latitude is north, it must be placed in the North column, and if South in the South column, and that if the Departure is Easterly it must be placed in the East column, and if Westerly it must be placed in the West column. When the Course is due North, South, East, or West, set down the Distance in that column answering to it. Add up the columns of Northing, Southing, Easting, and Westing, and set down the sum of each at the bottom, then the difference between the sums of the North and South columns will be the whole difference of Latitude made good, of the same name as the greater, and the Difference between the sums of the East and West columns is the whole Departure made good of the same name as the greater; then with the whole difference of Latitude and Departure made good, find the direct Course and Distance.

EXAMPLE 1.

A Ship takes her Departure from an Island in Latitude 35° 10′ North, the centre of which bore West-North-West 10 miles, and sailed on the following Courses; North-East 30 miles, West by North 50 miles, South-South-West 36 miles, East 20 miles, South 14 miles, East by North 50 miles, and South-West by West 70 miles. Required her Latitude in, the Course and Distance made good, and the bearing and Distance of the Island.

TRAVERSE TABLE.

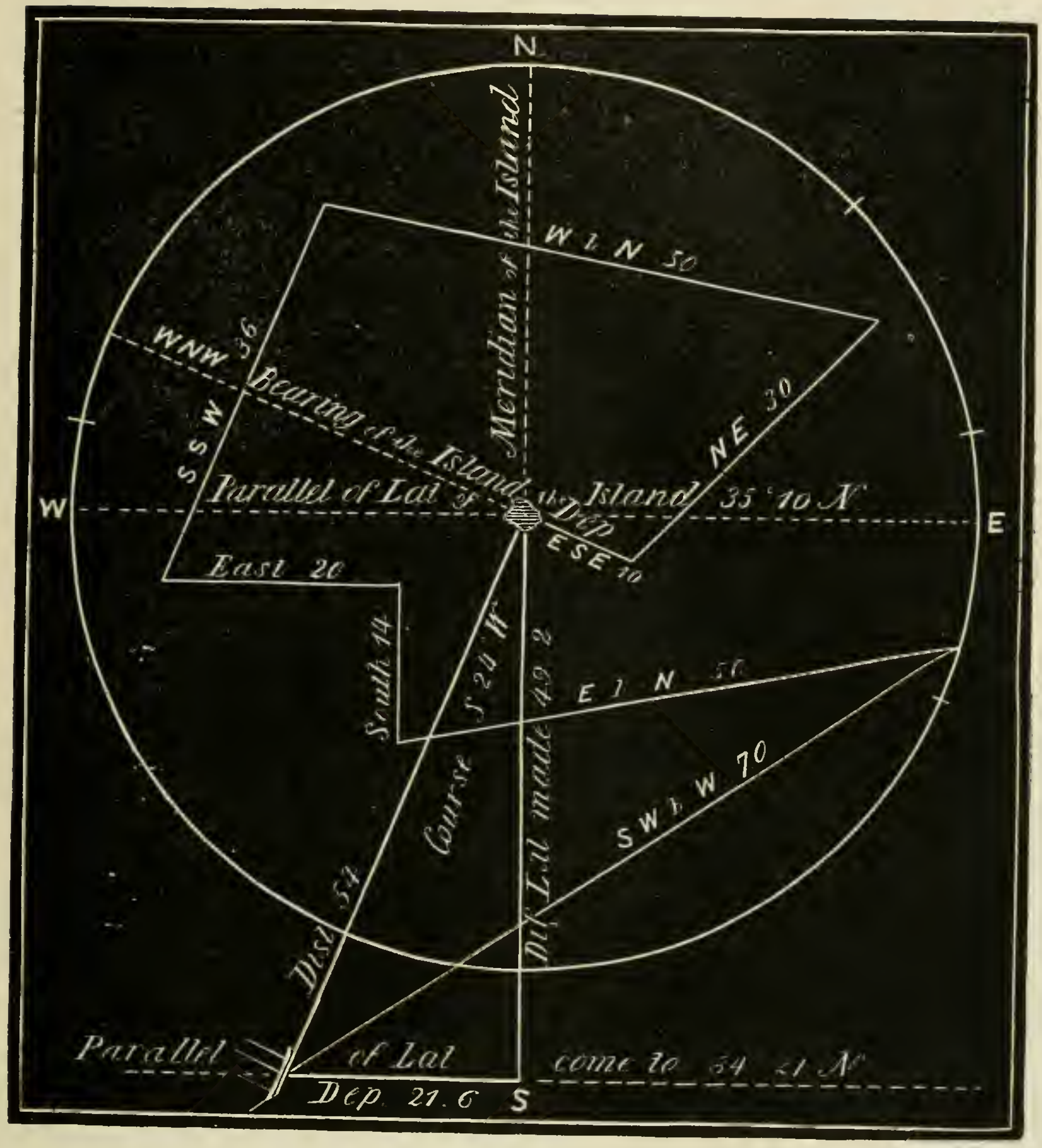
		DIFF. OF LAT.		DEPARTURE.	
COURSES.	DIST.	NORTH.	SOUTH.	EAST.	WEST.
Bearing W. N. W...	....	....	....	....	....
Opposite Pt. E. S. E.	10	....	3.8	9.2	....
N. E.	30	21.2	....	21.2	....
W. by N.	50	9.8	....	....	49.0
S. S. W.	36	....	33.3	....	13.8
East	20	....	....	20.0	....
South	14	....	14.0	....	....
E. by N.	50	9.8	....	49.0	....
S. W. by W.	70	....	38.9	....	58.2
		40.8	90.0	99.4	121.0
			40.8		99.4
Diff of Lat. made			49.2S., & Dep. made 21.6		
Lat. of the Island			35 10 N.	West.	
Lat. of the Ship			34° 21′ N.		

With the Difference of Latitude 49.2, and Departure 21.6, seek in the Table for the nearest corresponding sums, which are found to be 49.3 and 22.0, and opposite to them stands the Distance, 54, in its column. and the Course is found at the top of the page, because the Departure is less than the Difference of Latitude. The Course made good in this case is South 24° West, or South-South-West ¼ West nearly, and the Distance 54 miles.

The Bearing of the Island from the Ship is just the reverse of the Course made good, that is, North 24° East, because the Departure was taken from it, and the Distance is the same as the Distance made good by the Ship, which is 54 miles.

PROJECTION BY THE PLANE SCALE.

Fig. 12.



With the Chord of 60° describe a Circle. Take 90° in the dividers, and mark the circumference of it into four equal parts, representing the Points of the Compass, and mark it North at the top, South at the bottom, East on the Right, and West on the left hand, and mark the Centre as the place of the Island. Take the bearing North 6 Points West, in the dividers, from the line of Rhumbs and lay it off from the North towards the West, and draw a line to the Centre, which, prolonged to the opposite side, will pass through the Ship's place to South 6 Points East. Take the distance of the Ship from the Island, 10 miles, in the dividers, and lay it off from the centre on this line, which will be the Ship's place at the time of taking her departure. Take 4 Points in the dividers, and lay it off from the North towards the East, and mark it on the Circle; lay the edge of the parallel ruler over this mark, and that of the Centre, and transfer this Course to the Ship's place, and draw a line in that direction; take 30 miles, in the dividers, and lay it off from the Ship's place of departure on this line, and which will be the Ship's second place after completing her first Course and Distance.

In like manner, lay off all the other Courses and Distances. Then draw a parallel of Latitude through the last place of the Ship, and where it cuts the Meridian will be the Difference of Latitude made, 49. Draw a line from the Centre to the Ship's place, and where it cuts the Circle will be the Course made good, measured from the South 24° West, and the Distance, 54 miles. A line drawn through the Ship's place, parallel to the Meridian of the Island, will give the Meridian come to, and the space between them is the Departure, 22 miles. The bearing of the Island from the Ship is the opposite point to the Course made good North 24° East; the Distance from the Island is 54 miles, which is equal to the Distance made good.

EXAMPLE 2.

A Ship from Latitude 43° 10′ North, is bound to a port in Latitude 42° 20′ North, and which lies 50 miles to the Westward of the Ship. But by reason of contrary winds, and other causes, she has sailed on the following Courses, viz.: N. N. W. 30 miles, E. S. E. 30, South 20, W. ½ S. 39, S. E. 15, and W. by S. 22. Required the Bearing and Distance of the Port from her first position, her Course and Distance made good, her Latitude come to, and the Course and Distance to her intended Port.

TRAVERSE TABLE.

COURSES.	DIST.	DIFF. LAT. NORTH.	DIFF. LAT. SOUTH.	DEP. EAST.	DEP. WEST
N. N. W.	30	27.7	....	....	11.5
E. S. E.	30	....	11.5	27.7	....
South.	20	....	20.0	....	....
W. ½ S.	39	....	3.8	....	38.8
S. E.	15	....	10.6	10 6	....
W. by S.	22	....	4.5	....	21.6
		27.7	50.2	38.3	71.9
			27 7		38.3

To find the Bearing and Distance of the Port from the Ship's first position.

Lat. of the Ship....43° 10′ N.
Lat. of the Port....42 20′ N.
Diff. Lat.......... 50 Dep. 50,
Gives the Bearing............S. W
And the Distance.............70 miles

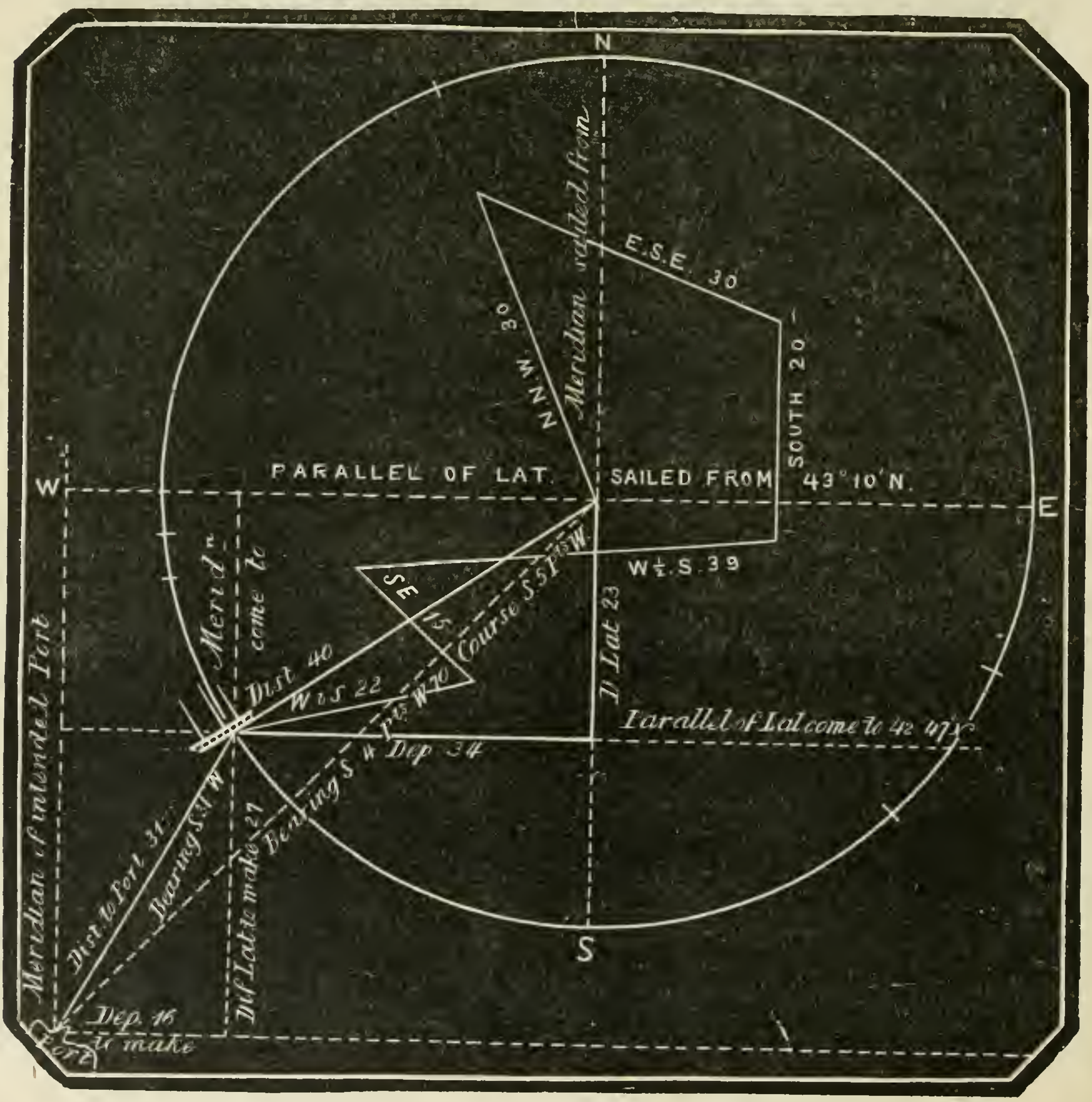
Diff. Lat................22.5 S. and Dep...33.6 W., gives the Course made good, S. 56° W., or S.W. by W and the Distance 40 miles.
Lat. left.............43° 10′ N.

Lat. come to..........42° 47′. To find the Bearing and Distance of the intended Port. Take the whole Diff. of Lat. between the Ship's 1st position and that of the Port, which is 50 miles, and the whole Departure 50.
From which subtract the Diff. Lat. made good.................23 " and Dep. made good....34.
Leaves the Difference of Latitude to make.....................27 " and the Dep. to make...16

These agree in the Tables to the Course 31°, or 2¾ points, nearly, and the Distance 31 miles; and as the intended Port lies to the South and West of the Ship, she must steer S. 31° W., or S. S. W. ¾ W., 31 miles.

PROJECTION BY THE PLANE SCALE.

FIG. 13.



Draw a figure as in the preceding example, the Ship's position being in the Centre. Draw her parallel of Latitude and her Meridian; from the Centre lay off the first Course North 2 Points West 30 miles; lay off 6 Points from the South towards the East for the second Course, and mark it on the Circle. Lay the parallel ruler over this mark and the centre, and transfer this Course to the Ship's place, and draw a line, on which lay off the Distance, 30 miles. Lay off the other Courses and Distances in like manner, and at the end of the last one is the Ship's place. From the Ship's place draw a line to the Centre, which will be the Distance made good, 40 miles, and the Angle which this line makes with the Meridian is the Course made good South 5 Points West. Through the Ship's place, draw the parallel of Latitude come to, and the space between the parallels of Latitude is the difference of Latitude made good, 23 miles. Draw a Meridian line through the Ship's place, and the space between the Meridians is the Departure made good, 34 miles.

Take the Difference of Latitude between the Latitude sailed from, and the Latitude of the intended Port, 50 miles. Lay this off to the South on the Meridian sailed from, and draw the parallel of Latitude of the Port on this line. Lay off 50 miles, which the Port lies west of the Meridian of the Ship, and draw the Meridian of the Port; where these lines intersect each other, is the intended Port. Draw a line between the intended Port and the Ship's place, will give the Distance from it, 31 miles, and the Angle between this line and the Meridian of the Ship will be the Course. Lay the ruler along this line, and transfer it to the Centre, and where the edge of the ruler cuts the Circle is the measurement of the Course South 31° West to her intended port. Draw a line between the Port and the Ship's first position in the Centre, will give its Distance, 70 miles, and the Angle between this line and the Meridian of the Ship is the bearing of the Port, which is South-West.

EXAMPLE 3.

A Ship from a Port in Latitude 38° 42′ North, bound to another Port, situated in Latitude 36° 32′ North, and 137 miles to the Eastward, sails on the following Courses; South by West ½ West 55 miles, South-West by South ½ West 37 miles, South 60 miles, East-South-East 40 miles, South-East by South ½ East 32 miles, and North-East by East ½ East 58 miles. Required her Course and Distance made good, her present Latitude, and the direct Course and Distance to her intended Port.

Answer. The Course made good is South 23° 30′ East, and the Distance 169 miles, the Latitude in 36° 7′ North the Course to the intended Port North 70° East, and the Distance 74 miles.

EXAMPLE 4.

A Ship takes her Departure from Cape Henry Light House, in Latitude 36° 56′ North, bearing West-North-West 7 leagues, bound to the Island of Bermuda, in Latitude 32° 19′ North, and which lies 552 miles to the Eastward of the Cape, but by reason of contrary winds has sailed on the following Courses: South-East by East 50 miles, South-South-East 40 miles, South 20 miles, East 60 miles, East by North ½ North 30 miles, North-East ½ East 40 miles, and East by South ½ South 50 miles. Required the Difference of Latitude and Departure made good, her direct Course and Distance made good, her present Latitude and the Bearing and Distance of Bermuda Island.

COURSES.	DIST.	NORTH	SOUTH.	EAST.	WEST.
E. S. E.	21	....	8.0	19.4	....
S. E. by E.	50	....	27.8	41.6	....
S. S. E.	40	....	37.0	15.3	....
South.	20	....	20.0	....	....
East.	60	....	....	60.0	....
E. by N. ½ N.	30	8.7	....	28.7	....
N. E. ½ E.	40	25.4	....	30.9	....
E. by. S. ½ S.	50	....	14.5	47.8	....
		34.1	107.3	243.7 of Easting.	
			34.1		

Difference of Lat. made good is 73.2 or 1° 13′ S. and Dep. 243.7, gives the Course and Distance made good E. by S. ½ S. 254 miles.

Latitude of Cape Henry.....36 56 N.
Latitude of the Ship........35° 43′ N.

Latitude of Cape Henry 36° 56′ N.
Latitude of Bermuda... 32 19 N.
4° 37′
60

Whole Diff. of Latitude 277 S., and Dep. 552 E.
Diff. of Latitude made.. 73 S., and Dep. 244 E.
Leaves Diff of Lat.....204 and Dep....308 miles to make.

One-tenth of these Sums are found to agree nearly to a Course of 56° and the Distance corresponding 370 miles.

The true Bearing of Bermuda from the Ship is, therefore, South 56° East, or South-East by East nearly distant 370 miles.

PARALLEL SAILING.

In Plane Sailing the Earth is considered to be an extended plane, and the Meridians all parallel to each other, and the length of a Degree everywhere equal, which supposition will give just conclusions, so far as the Course, Distance, Difference of Latitude and Departure are concerned; because a Ship, when sailing on a Rhumb line, makes equal Angles with the Meridian.

But as the Earth is a Globe or Sphere, and the Meridians meet at the Poles, it is evident that the Distance between any two Meridians must vary in every Latitude; their greatest Distance being at the Equator on which the Difference of Longitude is measured; hence the difference of Longitude always exceeds the Departure or Meridian Distance, (except on the Equator, where they are the same), in proportion as the given places are situated farther from the Equator.

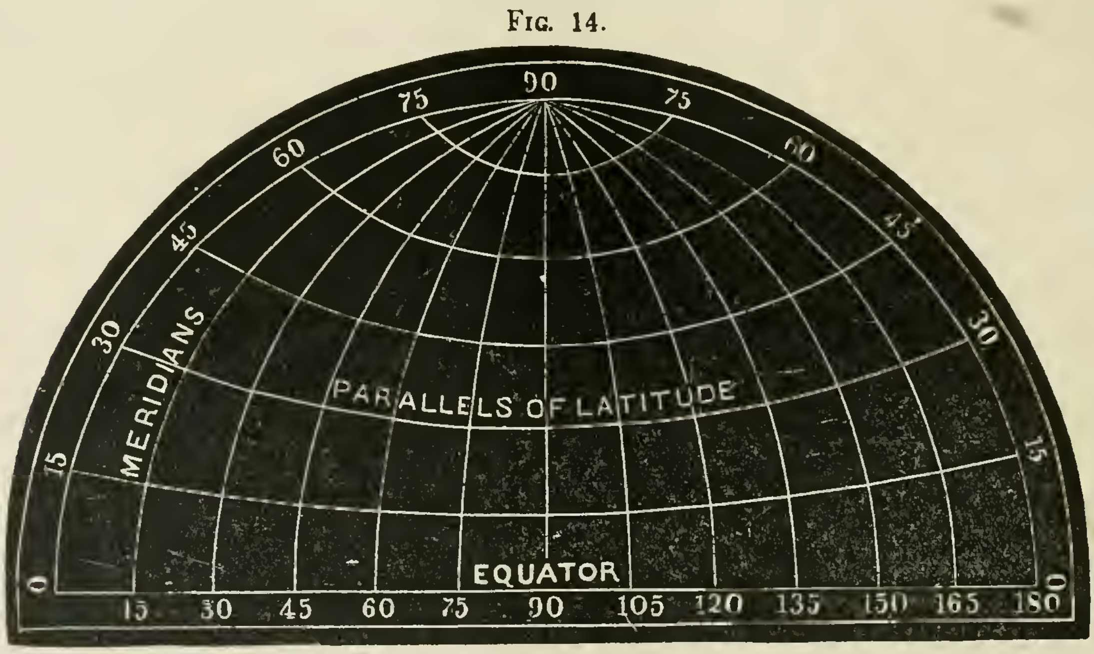
The following Table, showing the number of Minutes and Seconds contained in each Degree or 60 miles of Longitude for every Degree of Latitude, will be found useful.

LAT.	MIN. SEC.	LAT.	MIN. SEC.	LAT.	MIN. SEC.	LAT.	MIN. SEC.	LAT.	MIN. SEC.
°	″	°	′ ″	°	′ ″	°	′ ″	°	′ ″
1	59.59	19	56.44	37	47.55	55	34.25	73	17.33
2	59.58	20	56.22	38	47.15	56	33.30	74	16.33
3	59.55	21	56.00	39	46.38	57	32.41	75	15.31
4	59.51	22	55.38	40	45.58	58	31.48	76	14.31
5	59.46	23	55.14	41	45.17	59	30.54	77	13.30
6	59.40	24	54.49	42	44.35	60	30.00	78	12.28
7	59.33	25	54.23	43	43.53	61	29.06	79	11.27
8	59.25	26	53.56	44	43.10	62	28.10	80	10.25
9	59.16	27	53.28	45	42.26	63	27.15	81	9.24
10	59.06	28	52.59	46	41.41	64	26.18	82	8.21
11	58.54	29	52.29	47	40.55	65	25.22	83	7.19
12	58.41	30	51.58	48	40.09	66	24.24	84	6.16
13	58.28	31	51.26	49	39.22	67	23.26	85	5.14
14	58.14	32	50.53	50	38.44	68	22.28	86	4.12
15	57.58	33	50.19	51	37.46	69	21.30	87	3.09
16	57.41	34	49.45	52	36.57	70	20.31	88	2.02
17	57.23	35	49.09	53	36.07	71	19.32	89	1.03
18	57.04	36	48.33	54	35.18	72	18.33	90	0.00

DIAGRAM

Showing the Contraction of the Meridians from the Equator towards the Pole, and the Parallels of Latitude crossing the Meridians.

FIG. 14.



Parallel Sailing is the method of finding the Distance between two places in the same Parallel of Latitude when their difference of Longitude is known, or of finding the difference of Longitude answering to the Distance or Departure made good when a Ship sails due East or West. Distance sailed and Departure are the same thing in Parallel Sailing.

NOTE.—This Sailing is particularly useful in making a small or low Island, in which case it is usual to run into the Latitude, and then steer East or West, care being taken that the Ship is on the proper side of the Meridian of the Island.

CASE I.

The Difference of Longitude between two Places, both in one Parallel of Latitude, given, to find their Distance.

EXAMPLE.

A Ship in the Latitude of 32° 9′ N. and Longitude 69° 50′ W., and bound to Bermuda, in the same Latitude, and Longitude 64° 50′ W., what distance must she run to the Eastward to arrive at the Island?

BY INSPECTION.

Longitude of the Ship. . 69° 50′ W. } Parallel of Latitude of the Island 32° 9′ N.
Longitude of Bermuda. . 64° 50′ W. }

5° 0′
60

RULE.—Take the Parallel of Latitude 32° as a Course and the Difference of Longitude in miles 300 in the Distance Column, and the Distance (or Departure) 254.4 will be found in the Latitude Column. The Ship has, therefore, to run 254 miles to the Eastward to arrive at the Island.

CASE II.

The Distance between two places given, both in the same Parallel of Latitude, to find the Difference of Longitude.

EXAMPLE.

A Ship from the Island of Bermuda, in Latitude 32° 9′ N. and Longitude 64° 50′ W., sails due W. 254 miles. Required her Longitude in.

RULE.—Take the Parallel of Latitude 32° as a Course, and the Distance, 254, in the Latitude Column, and the Difference of Longitude will be found in the Distance Column, 300 miles.

Longitude of Bermuda. . 64° 50′ W.
Diff. Long. made 300. . — 5 0 W.
Longitude in. . . . 69° 50′ W

CASE III.

The Difference of Longitude and Distance between two places in the same Parallel of Latitude given, to find the Latitude of that Parallel.

EXAMPLE.

A Ship sails due East 254 miles, and then finds she has altered her Longitude 300 miles. Required the Parallel of Latitude she sailed in.

RULE.—Seek in the Tables until the Difference of Longitude, 300, is found in the Distance Column, and the Distance sailed, 254, is found in the Latitude Column; then the Course 32°, at the top of the page, will be the Parallel of Latitude sailed in, because 254 is found in the Column headed Latitude at the top of the page.

QUESTION FOR EXERCISE.

A Ship from Latitude 48° 39′ N. and Longitude 60° 10′ W., sails due West 350 miles. Required her Longitude in.

With Latitude 48°, and half the Distance, 175, (the whole being too great for the Tables,) in the Latitude Column, I find half the Difference of Longitude, 262, in the Distance Column. Then, with Latitude 49° as a Course, and Distance 175 in the Latitude column, I find 267 in the Distance column. Add these Differences of Longitude together, and take their half Sum for the Difference of Longitude, corresponding to the Latitude 48° 30′, which doubled will give the required Difference of Longitude. 529 = 8° 49′ W and Longitude in 68° 59′ W., as follows:

Latitude 48° difference Longitude 262
Latitude 49° difference Longitude 267
)529
Half Difference of Longitude . 264.5
2
Whole Difference of Longitude. 529.0 miles,
Which divided by 60° gives. . . . 8° 49′ W.
Longitude left. . . . . 60 10 W.
Longitude in. . . . . 68° 59′ W.

MIDDLE LATITUDE SAILING.

This method is founded upon the same principle as Parallel Sailing; that is, of converting the Departure into Difference of Longitude, and Difference of Longitude into Departure. When the Ship's Course lies obliquely across the meridians, that is, when, besides Departure, she makes Difference of Latitude she leaves a certain Parallel of Latitude and arrives at another, the Space or Departure between the Meridians sailed from and come to differ, the one being greater than the other, and it is evident neither of these Departures can be used singly, to find the Difference of Longitude.

But if we take the Middle Parallel of Latitude between the Latitudes sailed from and come to, we get the middle Departure between them. In the greater Latitude the Departure is less, and in the less Latitude the Departure is greater, than the Departure corresponding to the Middle Latitude. Hence this method, which is compounded of Plane and Parallel Sailings, is called Middle Latitude Sailing.

The Middle Latitude is half the Sum of the two Latitudes when they are of the same name. Near the Equator, when the Latitudes are of contrary names, no sensible error can arise from taking the Departure itself, made good from day to day as the Difference of Longitude, because the Degrees of Latitude and Longitude are of the same length on the Equator, and the latter is only diminished by 1 mile at the 10th Parallel of Latitude; therefore in practice at Sea, Longitude and Departure may be considered the same for several Degrees on each side of the Equator.

In using the Traverse Tables, it is enough to take the Latitude for the nearest Degree.

In greater distances between places whose Latitudes are of contrary names, the proper rule is to take *half the greater Latitude as the Middle Latitude.** (See the annexed Diagram.)

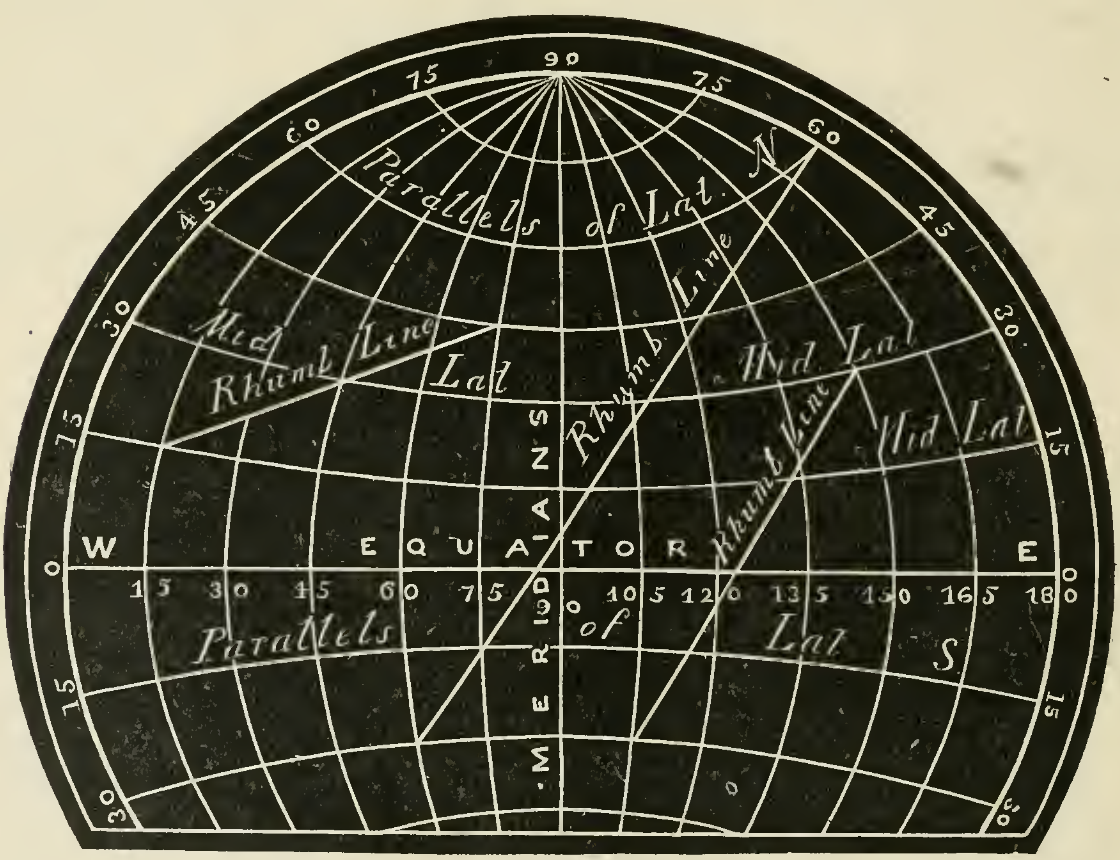
The Difference of Longitude found by this Sailing is true at the Equator, and very nearly true for short distances in all Latitudes, especially when the course is nearly East or West. In High Latitudes, when the Distance is great and the Course oblique, the error becomes considerable; but the result may be made nearly true by subdividing the Distance Sailed into small portions, and finding the Difference of Longitude for each portion separately, and then adding the whole together.

In like manner the Bearing and Distance between places near the Equator by this Sailing are correct. But in High Latitudes the result cannot be rendered accurate by subdividing the Distance into small portions, as above, because it is not known. Such cases are truly solved by Mercator's Sailing

DIAGRAM,

Showing the Middle Latitude between the Parallels of Latitude North and South of the Equator

Fig. 15



* Or add together the half of the greater Latitude to the half of the less Latitude, and their half sum will be the Middle Latitude required. See also the Note at page 28.

CASE I.

One Latitude and Longitude, Course and Distance given, to find the Difference of Latitude and Longitude.

EXAMPLE 1.

A Ship from Latitude 52° 6′ N. and Longitude 35° 6′ W. sailed S. W. by W. 256 miles. Required her Latitude and Longitude in.

Course S. 5 pts. W.
Distance 256 miles, } gives the Diff. Lat.)142 and the Dep. 212.9, the half, 106.4, taken in the Latitude Col. of Mid. Lat. 51°. as a Course, then Half Diff. of Long. is found in the Dist. Column to be 169

Summary.

Diff. Lat........142 S.
Departure..... 213 W.
Lat. in......49° 44′ N.
Diff. Long.... 5° 38′ W.
Long. in.... 40° 44′ W.

Diff. Lat...2° 22′ S.
Lat. left. 52° 6′ N.
Lat. in..49° 44′
Sum...101 .50
Mid. Lat. 50° 55′

2
)338
Diff. Long. made.. 5° 38′ W.
Long. left........35 6 W.
Long. in........ 40° 44′ W.

The Difference of Latitude and Departure are found as in Plane Sailing. The Latitude in, and thence the Middle Latitude, by adding the two Latitudes together, and taking their half Sum for the Middle Latitude. The Departure being too great for the Tables, the half is taken. Then, with Middle Latitude as a Course and half the Departure in the Latitude column, half the Difference of Longitude is found in the Distance column. This being doubled and divided by 60 gives Degrees and Minutes. Ship in West Longitude sailing West, add Difference of Longitude to Longitude left.

This is the usual case at Sea in working a day's work.

Two Latitudes and Course given, to find the Distance and Difference of Longitude

EXAMPLE 2.

A Ship from Latitude 49° 44′ N. and Longitude 40° 44′ W., sails N. E. by E. until by observation she is in Latitude 52° 6′ N. Required her Distance run and Longitude in.

Summary.

Course N. 5 pts. E.
Dist......256
Diff. Lat... 142 N.
Dep....... 213 E.
Lat. Ob. 52° 6′ N.
Diff. Long. 5° 38′ E.
Lon. in..35° 6′ W.

Lat. left ...49° 44′ N.
Lat. in .... 52° 6 N.
2° 22
60

Lat. left....49° 44′ N
Lat. in.....52 6 N
Sum..... 101 .50
Mid. Lat...50° 55′

Course 5 pts. and 142 Difference Latitude in its column gives the Dep.)213 and Dist. 256,
Mid. Lat. 51° as a Course, and half the Departure,............ 106.5 in the Lat. Column, half the Diff. of Long. is found in the Dist. Column to be 169

2
)338
Diff. of Long..... 5° 38′ E.
Long. left...... 40 44 W.
Long. in........ 35° 6′ W.

In a fast-sailing ship, where it is found difficult to measure the Ship's rate of sailing by the Log, this Example may be used with advantage.

Two Latitudes and Distance given, to find the Course and Difference of Longitude.

EXAMPLE 3.

A Ship from Latitude 3° 20′ N. and Longitude 22° 30′ W., runs for 4 days between the South and West, at the rate of 10 knots an hour, and then by observation finds her Latitude to be 10° 40′ S. Requred the Course and the Longitude in.

Summary.

Course ....S. 29° W
Dist.........960
Diff. Lat.... 840 S.
Dep.........465 W.
Lat in....10° 40′ S.
Diff. Long.. 7 47 W.
Long. in..30 17 W

Lat. left.... 3° 20′ N.
Lat. in.... 10 40 S.
Diff. of Lat. 14° 0′
60

Greater Lat......10° 40′ S.
The half of which, 5° 20′
to be taken as Mid. Lat......

Run.. 4 days.
24
96 hours,
10 knots an hour.

The 10th part of 840 Differ. Latitude and 10th part of the Distance, 960, are found to agree at Course S. 29° W., and gives the tenth part of the Departure. 46.5, then with half the greater Lat. 5° for the Middle Latitude as a Course, and the tenth part of the Dep., 46.5, in the Latitude column, the tenth part of the Diff. of Long. is found in the Distance column to be 46.7, and the whole is)467

Diff. Long. 7° 47′ W.
Long. left 22 30 W
Long. in 30° 17′ W.

By this Example it appears that there are only 2 miles difference between the Departure and the Difference of Longitude as found in the run of nearly 1000 miles.

One Latitude, Course and Distance given in a High Latitude, to find the Latitude and Longitude in.

EXAMPLE 4.

A Ship from Latitude 58° 30′ S. and Longitude 178° 10′ W., sails S. W. by W. 300 miles. Required her Correct Latitude and Longitude in. By taking Short Distances run, and also the same by the Whole Distance run, in the usual way.

TRAVERSE TABLE.		D. LAT.	DEP.	LONGITUDE TABLE.			
Course.	Dist.	S.	W.	Lat. Left.	Lat. in.	Mid. Lat.	Dif. Long. made.
S. W. by W.	50	27.8	41.6	58° 30′	58° 58′	58° 44′	80′
"	50	27.8	41.6	58 58	59 26	59 12	81
"	50	27.8	41.6	59 26	59 54	59 40	82
"	50	27.8	41.6	59 54	60 22	60 8	83
"	50	27 8	41.6	60 22	60 50	60 36	84
"	50	27.8	41.6	60 50	61 18	61 4	86
S. W. by W.	300 m.=166.8		)249.6				)496′

Diff. Lat. 2° 47′ S. Dep. 124.8 W.=249.5
Lat. left 58° 30′ S. 2
Lat. in 61° 17′ S.)499.0
119° 47′ Diff. Long. . 8° 19 W.
Mid. Lat. 59° 54′

SUMMARY.
Course. . S. W. by W.
Dist. 300
Diff. Lat. 167
Dep. 250
Lat. in. . . . . 61° 17′ S.

Diff. of Long. 8° 16′ W.
Long. left. . 178° 10′ W.
186° 26′
360° 0′
Long. in. . . 173° 34′ E.

The Short Distances give Diff. Loug. . . . 8° 16′ W.
Whole Distance. . . . . do. . . . . . . 8° 19′ W.
Long. in is. . . . . 173° 34′ E.

In this Example, by taking Short Distances on the same Course and finding the Difference of Longitude corresponding to each, and adding the whole together, there appears to be a difference of 3 miles between that and the Difference of Longitude found from the whole Course and Distance, the former being the correct Difference of Longitude, the Distance in this Example not being great.

One Latitude, Course and Departure given, to find the Latitude and Longitude in.

EXAMPLE 5.

A Ship from Latitude 38° 40′ S. and Longitude 1° 15′ W., sails N. E. ½ E. until her Departure is 250 miles. Required the Latitude and Longitude in.

Course. . . . 4½ pts. and half the Departure, 125, gives half the Dist. 162, and half Diff. Lat. 102.8
2 2
Dist. 324 Diff. Lat.)205.6
Mid. Lat. 37° and half the Dep. 125—D. Long. 157 3° 26′ N.
2 Lat. left. . . . . 38° 40′ S.
)314 Lat. in. . . . . . . 35° 14′ S.
Diff. of Long. . . 5° 14′ E. Sum. . . . . 73° 54′
Long. left . . . . . 1° 15′ W. Mid. Lat. . . . 36° 57′
Long. in. . . . . . 3° 59′ E.

Summary.
Dist. 324
Diff. Lat. . . 206
Dep. 250
Lat. in. . . 35° 14′ S.
Diff. Long. 5° 14′ E.
Long. in. . 3° 59′ E.

QUESTIONS FOR EXERCISE.

Question 1.—A Ship from Latitude 25° 35′ N. and Longitude 60° W., sails N. N. E. 296 miles. Required her Latitude and Longitude in.
Answer.—Latitude in 30° 9′ N. and Longitude 57° 52′ W.

Ques. 2.—A Ship from Latitude 3° 10′ N. and Longitude 25° 0′ W. sails on a S. W. by S. Course until her Latitude observed was 2° 16′ S. Required the Distance run and Longitude in.
Ans.—The Distance run is 392 miles and the Longitude in 28° 38′ W.

Ques. 3.—A Ship from Latitude 30° 15′ S. and Longitude 178° 10′ E., sails on a N. E. Course until her Departure is 150 miles. Required the Distance run and the Latitude and Longitude in.
Ans.—Distance sailed 212 miles, Latitude in 27° 45′ S. and Longitude in 178° 58′ W.

Ques 4.—A Ship from Sandy Hook, in Latitude 40° 28′ N. and Longitude 74° 0′ W., sails between the South and East until her Latitude observed is 37° 6′ N. and her Departure made good is 500 miles. Required the Course and Distance sailed and the Longitude in.
Ans.—Course S. 68° E., Distance 540 miles, and the Longitude in 63° 16′ W

CASE II.

Two Latitudes and Longitudes given, to find the Bearing and Distance.

EXAMPLE 1

Required the Bearing and Distance between Cape Henry, in Latitude 36° 56′ N. and Longitude 76° 0′ W., and the Island of Bermuda, in Latitude 32° 18′ N. and Longitude 64° 50′ W.

Lat. Cape Henry....36° 56′ N.	36° 56′ N.		Long. of Cape Henry	76° 0′ W
Lat. Bermuda.......32 18 N.	32 18 N.		Long. of Bermuda...	64 50 W
4° 38′	69° 14′			11° 10′
60	34° 37′	Middle Latitude.		60
Diff. Lat. in miles.....278			Diff. Long. in miles...	670

Rule.—With Middle Latitude 34° 30′ as a Course, taken out first with 34° and then with 35°, and the tenth part of the Difference of Longitude, 67.0, in the Distance Columns, the tenth part of the Mean Departure, 55.2, will be found in the Latitude Columns. Then with this Departure, 55.2, and the tenth part of the Difference of Latitude, 27.8, enter the Tables again, and where they are found to agree in their columns, gives the Course at the bottom of the page, 63°, because the Departure is greater than the Differeuce of Latitude, and the corresponding Distance opposite is 61.5, which multiplied by 10 gives the Whole Distance, 615 miles.

Hence the Bearing of Bermuda from the Cape is S. 63° E., because the Latitude and Longitude of the former is to the Southward and Eastward of the latter, and the Distance beween them is 615 miles.

Two Latitudes and Longitudes given, to find the Course, Distance and Departure.

EXAMPLE 2.

A Ship from Latitude 30° 15′ N. and Longitude 45° 20′ W., sails between the North and West until by observation she is in Latitude 33° 45′ N. and Longitude 50° 10′ W. Required the Course and Distance made good, and her Departure from the Meridian.

Summary.			
Course...N. 50° W.	Lat. left....30° 15′ N.		Long. left....45° 20′ W.
Dist.....322	Lat. in.....33 45 N.	Lat. left....30° 15′ N.	Long. in.....50 10′ W.
Diff. Lat..210	3° 30′	Lat. in.....33 45 N.	Diff. Long.....4° 50′
Dep..... 246	60	Sum.......64 .0	60
	Diff. Lat....210 N.	Mid. Lat.....32°	

as a Course, and 290 in the Distance column gives the Departure in the Latitude column 245.9. Then with half the Difference of Latitude, 105, and half the Departure, 123, found in their columns, where they agree nearest, and the Course must be taken from the bottom of the page at 50°, (because the Departure is greater than the Difference of Latitude,) and half the Distance is found opposite to be 161, which doubled gives 322 miles. Hence the True Course and Distance sailed is N. 50° W., or N. W. ¼ W., 322 miles, and the Departure from the Meridian 246 miles.

One Latitude and Longitude, with the Difference of Latitude and Departure given, to find the Latitude and Longitude in, and the Bearing and Distance of the Intended Port.

EXAMPLE 3.

A Ship from Montauk Point, in Lat. 41° 4′ N. and Longitude 71° 51′ W., and bound to Santa Cruz (one of the Cape Verd Islands) in Latitude 17° 2′ N. and Longitude 25° 15′ W., sails between the South and East until she has made 300 leagues of Southing and 400 leagues of Easting. Required the Latitude and Longitude in, and the Course and Distance to her intended port.

Course..S. 53° E. Diff. Lat. 300 Leagues. Dep. 400 Leagues.
Dist. 1500 miles sailed. 3 3

Diff. Lat. in miles.....) 900	Dep. in miles.1200	The tenth part of the Departure, 120, found in the Lat. column, of the Middle Latitude, 33, gives the 10th part of the Diff. Long. in Dist. column, 143. Middle Lat. 34°, in like manner gives 145, the mean of which is 144 this multiplied by 10 gives the proper Diff. of Long.)1440 miles.
Diff. Lat............15° 0′ S.		
Lat. Montauk Point..41 4 N.		
Lat. of the Ship.....26° 4′ N.		
Sum ....67° 8′		
Mid. Lat.......... 33° 34′		
Lat. of the Ship 26° 4′ N................		Diff. Long..............24° 0′ E.
" Santa Cruz 17 2′ N. Lat. 26° 4′ N.	Long. of Ship 47° 51′ W.	Long. of Montauk Point. 71 51 W.
Diff. Lat...... 9° 2′ Lat. 17 2 N.	" Santa Cruz 25 15 W	Long. of the Ship ......47° 51′ W.
60 Sum 43° 6′	Diff. Long....22° 36′	
Diff. Lat..... 542 Mid. Lat. 21° 33	60	

with Mid. Lat. 21° and 22°, and the tenth part of the Diff. Long. 135.6 in the Dist. column, the tenth part of the Departure 126, is found in the Lat. column. Then with the tenth part of the Difference Latitude 54.2, and the Departure 126 the Course to Santa Cruz is found to be S. 67° E. or E. S. E., and the Distance 1370 miles.

Note.—The rule in the Epitomes, which directs that half the Difference of Latitude between two places on opposite sides of the Equator must be used for the Middle Latitude, being incorrect, (as may be perceived by inspecting Fig. 15, page 20,) the deficiency is supplied by the following Rule: (See Example 4, which is worked out in the following page.) Add the half of the Greater Latitude to the half of the Less Latitude, and take their half Sum for the Middle Latitude. If one Latitude be great and the other small, take the half of the Greater Latitude alone for the Middle Latitude. The Example referred to comes out exactly the same by Mercator's Sailing, which proves this Rule to be correct. But when the Ship sails a greater distance on one side of the Equator than on the other, a greater weight should be given to that Latitude which corresponds to the greater distance. (See the Last Example in this Sailing.)

Two Places, whose Latitudes and Longitudes are of contrary names, given, to find the correct Bearing and Distance between them.

EXAMPLE 4.

Required the Bearing and Distance between New York, in Latitude 40° 43′ N. and Longitude 74° 0′ W., and the Cape of Good Hope, in Latitude 34° 22′ S. and Longitude 18° 30′ E.

Lat. of New York....	40° 43′ N.	Half of the greater Lat....	20° 21′	Long. of New York....	74° 0′ W.
" Cape G. Hope..	34 22 S.	" " less Lat.......	17 11	" Cape Good Hope.	18 30 E.
	75° 5′	Sum..................	37° 32′		92° 30′
	60	Half Sum for Mid. Lat....	18° 46′		60
Diff. Lat. in miles....	4505			Diff. Long. in miles....	5550

In this Example we have to take the 100th part of these Sums to get into the Tables, as follows: With Middle Latitude 19° as a Course, and the 100th part of the Difference of Longitude, 55.5, in the Distance Column. By taking parts we get the Departure in the Latitude Column, 52.45. Then with this Departure and the 100th part of the Difference of Latitude, 45.05, enter the Table again, and they are found to agree to the Course 49°, and Distance 69°. Multiply this Distance by 100, which is the Distance required.

Hence the Bearing of the Cape from New York is S. 49° E., or S. E. ½ E., nearly, and that of New York from the Cape N. 49° W., or N. W. ½ W. Distance 6900 miles.

This Example, worked by Mercator Sailing, comes out the same as above; but by the Old Rule, half the Difference of the Latitudes in this case would be 3° 10′ for the Middle Latitude; which is manifestly incorrect.

The following Example, though not of much practical utility, may exercise the learner.

EXAMPLE 5.

A Ship from 36° 32′ North Latitude sails between the South and West until she has made 480 miles of Departure and 560 miles Difference of Longitude. Required her present Latitude, Course steered and Distance run.

Rule.—Enter the Table with the 10th part of the Departure, 48, in the Latitude Column, and the 10th part of the Difference of Longitude, 56, in the Distance Column, they are found to agree to the Course at the Top of the page, 31°, and which is the Middle Latitude the ship has sailed in. Take the Difference between this Middle Latitude and the Latitude left, which is 5° 32′, and subtract it from the Middle Latitude, because the ship has been sailing South, will give the present Latitude, 25° 28′ N.

Take the Difference between the Latitudes sailed from and come to, which is 664, and the Departure, 480, enter the Tables with the tenth part of the Difference of Latitude, 66.4, and the Departure, 48.0, found in their respective columns, the Course is found to be 36°, and the Distance 82, which multiplied by 10 gives 820. Hence the Latitude in is 25° 28′ N., and the Course S. 36° W., or S. W. ¾ S., Distance 820 miles.

Diff. Long. 56 and Dep. gives the	Mid. Lat. 31° 0′		Lat. left..36° 32′ N.	
	Lat. left..36 32′		Lat. in...25 28 N.	
Diff. between Mid. Lat. and Lat. left......	5° 32′ N.		11° 4′	
	Mid. Lat..31 0		60	
	Lat. in...25° 28′ N.	Diff. Lat.	664 and Dep. 480	=Course S. 36° W., Dist. 820 m.

QUESTIONS FOR EXERCISE.

Question 1.—A Ship from Latitude 60° 10′ N. and Longitude 30° 15′ W., is bound to a Port in Latitude 49° 10′ N. and Longitude 50° 10′ W. Required the Course and Distance.

Answer.—The Course is S. 46° W., or S. W., nearly. Distance 950.

Ques. 2.—A Ship on the Equator, in Longitude 25° 40′ W., and bound to the Port of Rio Janeiro, and wishing to shape a Course for Cape Frio, in Latitude 23° 1′ S. and Longitude 41° 50′ W. Required the correct Course and Distance to it.

Ans.—The Course is S. 35° W., or S. W. by S., nearly, and Distance 1685 miles.

Ques. 3.—Required the Bearing and Distance between the Cape Verd Islands, (say Cape St. Anthony,) in Latitude 17° 12′ N. and Longitude 25° 19′ W., and the Island of St. Helena, in Latitude 15° 55′ S. and 5° 45′ West Longitude.

Ans.—Bearing is S. 30° 30′ E., and Distance 2300 miles

Ques. 4.—Required the Bearing and Distance between Cape Horn, in the Latitude of 55° 59′ S. and Longitude 67° 16′ W., and San Francisco, in Latitude 37° 48′ N. and Longitude 122° 21′ W.

Ans.—The Bearing is N. 27° W., and the Distance 6300 miles.

Note.—In the last Example, half the greater Latitude is taken as a Middle Latitude, and which is increased by 2°, because the greatest distance had to be run to the Southward of the Equator. The Middle Latitude allowed is 30

MERCATOR'S SAILING.

This Sailing is used for the same purposes as Middle Latitude Sailing, and is more correct in long distances, except when the Course is large; that is, near the East or West points.

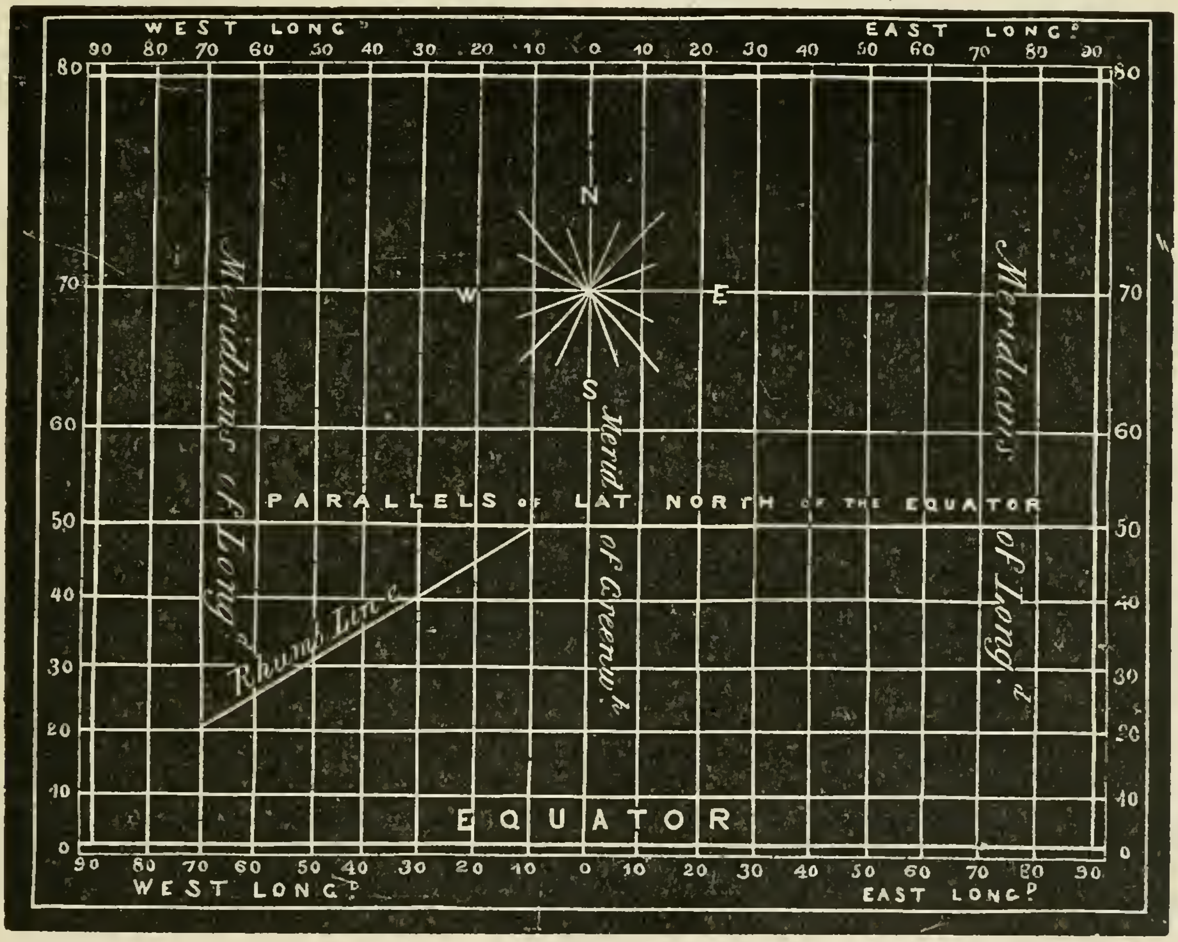
Mercator Sailing is the Art of finding on a Plane Surface the position of a Ship, which shall be true in Course, Distance, Latitude and Longitude.

This method is derived from the Projection of Mercator's Chart, in which the Degrees of Longitude are every where equal, the Degrees of Latitude expand towards the Poles, and the Parallels, Meridians, and Rhumb Lines are all represented by straight lines. In Middle Latitude Sailing the Meridians contract and meet at the Poles, and the length of the Degrees of Longitude also decrease from the Equator towards the Poles. But in Mercator Sailing the Meridians are all parallel to each other. and a Degree of Longitude is 60 miles in length, measured on the Equator, in all parts of the World. To remedy this, the Degrees of Latitude are expanded from the Equator towards the Poles, and the miles of Latitude grow larger; so that in the Latitude of 60° the miles of Latitude are twice the length they are on the Equator, and the Degree of Longitude is only 30 of these miles long; near the Pole one mile of Latitude is nearly the length of 60 miles on the Equator, and the Degree of Longitude only 1 mile long. But as the Polar Seas are not navigable much above 80°, Charts or Tables on this projection are rarely published beyond that parallel.

DIAGRAM OF MERCATOR'S SAILING,

Showing the Expansion of the Parallels of Latitude for every 10 Degrees, and the Meridians (or Parallels of Longitude) all Parallel to each other at 10 Degrees Distance.

FIG. 16.



PROJECTED BY THE FOLLOWING TABLE,

And the Measurements taken from the Degrees on the Equator.

From the Equator to Lat. 10°	the Expansion is	0°	3′	Distance of 1st Parallel	from the	Equator is	10°	3′
From Lat. 10° to 20	"	0	25	" 2d	"	"	20	25
" 20 to 30	"	1	28	" 3d	"	"	31	28
" 30 to 40	"	3	43	" 4th	"	"	43	43
" 40 to 50	"	7	54	" 5th	"	"	57	54
" 50 to 60	"	15	27	" 6th	"	"	75	27
" 60 to 70	"	29	26	" 7th	"	"	99	26
" 70 to 80	"	59	35	" 8th	"	"	139	35

NOTE.—The Calculations in this Sailing are performed by the help of a Table of Meridianal Parts, (Table III.,) showing the Expansion of the miles of Latitude from the Equator towards the Poles.

To find the Meridianal Difference of Latitude. When the Latitudes are of the *same* name, take the difference of the Meridianal Parts for the two Latitudes. When of *contrary* names, take the sum of the Meridianal Parts.

CASE I.

One Latitude and Longitude, Course and Distance given, to find the Latitude and Longitude in.

EXAMPLE 1.

A Ship from Latitude 52° 6′ N. and Longitude 35° 6′ W., sails S W. by W. 256 miles. Required her Latitude and Longitude in.

Here, as in Middle Latitude Sailing, the Difference of Latitude and Departure are found from the Course and Distance by the rules in Plane Sailing.

Course S. 5 pts. W., and Distance 256 miles } gives the Difference of Lat,)142 and the Dep. 213.

Diff. Lat. in Degrees..... 2° 22′ S.
Lat. left.............. 52° 6′ N......Meridianal parts....3675 } Table III.
Lat. in ....49° 44′ N......Meridianal parts....3450 }

Rule.—With the Course 5 points, and the Meridianal Difference of Latitude 225 in the Difference of Latitude column, (here we find it to be too great for the Tables,) we take the half, 112.5. Then half the Diff. of Longitude, 168.8, is found against it in the Dep. Column, which doubled gives the whole Diff. of Long.)337.6

Diff. of Long. in Degrees........ 5° 38′ W
Long. left........ 35° 6′ W.
Long. in........ 40° 44′ W

Two Latitudes and Course given, to find the Distance and Difference of Longitude.

EXAMPLE 2.

A Ship from Latitude 49° 44′ N. and Longitude 40° 44′ W., sails N. E. by E. until by observation she is in Latitude 52° 6′ N. Required her Distance run and Longitude in.

Lat. left................	49° 44′ N.	Merid. parts................	3450
Lat. in	52° 6′ N.	Merid. parts................	3675
Diff. Lat................	2° 22′ N.	Merid. Diff. Lat	)225
	60		112.5

Rule.—With the Course 5 pts. and the Diff. of Lat. 142 in its column, then opposite to it in the Dist. Column stands the Distance, 256 miles. Again, with the same Course, 5 points, and half the Merid. Diff. of Latitude, 112.5, taken in the Latitude column, then half the Difference of Longitude, 168.8, is found in the Departure column, which doubled gives the whole Difference of Longitude, 337.6, or,........ 5° 38′ E.

Long. left........ 40° 44′ W.
Distance sailed, 256 miles, and Long. in........ 35° 6′ W.

Two Latitudes and Distance given, to find the Course and Difference of Longitude

EXAMPLE 3.

A Ship from Latitude 3° 20′ N. and Longitude 22° 30′ W., runs 4 days between the South and West until her Latitude observed is 10° 40′ S. Her rate of sailing was 10 knots an hour. Required the Course she has made and her Longitude in.

Lat. left........	3° 20′ N.	Merid. parts....	200	Run of 4 days.
Lat in........	10° 40′ S.	Merid. parts....	644	24 hours.
Diff. of Lat........	14° 0′	Mer. Diff. Lat..	844	96 hours.
	60			10 knots.

Rule.—Enter the Table with the tenth part of Diff. Lat., 84.0, and the tenth part of the Distance, 96.0 miles, and they will be found to agree at Course 29°. Again, with the same Course, 29°, and the tenth part of the Meridianal Difference of Latitude, 84.4, in the Latitude column, then the tenth part of the Difference of Longitude is found in the Departure column 47, which multiplied by 10 gives, 470, the whole Difference of Longitude.

Diff. Long. in Degrees........ 7° 50′ W.
Long. left........ 22° 30′ W.
The Course steered is S. 29° W. and Longitude in.. 30° 20′ W.

Note.—The above three Examples are the same as are used in Middle Latitude Sailing, and the answers come out the same by Mercator's, and all the others may be done in the same way; observing that we must use the Two Terms given, as in a case of Plane Sailing. Then with the Course made good, and the Meridianal Difference of Latitude found in the Latitude column, the Difference of Longitude required is found opposite to it, in the Departure column.

EXAMPLE 4.

A Ship from Latitude 38° 40′ S. and Longitude 1° 15′ W., sails N. E. ½ E. until her Departure is 250 miles. Required the Latitude and Longitude in.

The Course 4½ points, and half the Departure, 125, in its column, half the Difference of Latitude is found to be 102.8 in its column, which doubled gives 205.6, or 3° 26′, and the Latitude in 35° 14′ S. Find the Meridianal Difference of Latitude, which is 258. Then with the same Course, 4½ points, and half the Meridianal Difference of Latitude, 129, half the Difference of Longitude, 156.9, is found in the Departure column. The whole Difference of Longitude is 313.8, or 5° 14′, and the Longitude in 3° 59′ East.

CASE II.

Two Latitudes and Longitudes given, to find the Bearing and Distance.

EXAMPLE 1.

Required the Bearing and Distance of Cape Henry, in Latitude 36° 56′ N., and Longitude 76° 0′ W., and the Island of Bermuda, in Latitude 32° 18′ N., and Longitude 64° 50′ W.

Lat. of Cape Henry........	36° 56′ N.	Merid. parts........	2388	Long.........	76° 00′ W.
Lat. of Bermuda	32 18 N.	Merid. parts........	2050	Long.........	64 50 W.
	4° 38	Merid. diff. Lat	338 S.		11° 10′ W.
	60				60
Diff. of Lat. in miles	278			Diff. Long. in miles	670

Rule.—Seek in the Tables with the tenth part of the Meridian Difference of Latitude 33.8, and the tenth part of the Difference of Longitude 67.0 until they are found to agree in the Latitude and Departure columns, as if they were Difference of Latitude and Departure. If the Difference of Longitude be *greater* than the Meridian Difference of Latitude, the Course must be taken from the bottom of the page, but if *less*, from the top. They are found to agree in this case nearly to the Course, 63°. Then, with the tenth part of the proper Difference of Latitude, 27.8, in its column on the same page, will be found opposite to it, in the Distance column, the tenth part of the Distance, 61.5, which, multiplied by 10, gives the whole Distance, 615 miles. Hence, the Bearing is South 63° East, because Bermuda lies towards the South and East from the Cape, and the Distance is 615 miles.

Two Latitudes and Longitudes given, to find the Course and Distance.

EXAMPLE 2.

A Ship from Latitude 30° 15′ N., and Longitude 45° 20′ W., sails between the North and West until, by observation, she is in Latitude 33° 45′ North, and Longitude 50° 10′ West. Required the Course and Distance made good.

Lat. left........	30° 15′ N.	Merid. parts........	1906	Long. left........	45° 20′ W.
Lat. in.........	33 45 N.	Merid. parts........	2153	Long. in.........	50 10 W.
	3° 30′ N.	Merid. Diff. Lat.	247		4° 50′ W.
	60				60
Diff. Lat. in miles..	210			Diff. Long. in miles...	290

Rule.—Seek in the Table, with half the Meridian Difference of Latitude, 123.5, and half the Difference of Longitude, 145, and the nearest are found together at the Course 50°. Again, with this Course, 50°, and half the Difference of Latitude, 105, found in its column, then half the Distance is found opposite to it in the Distance column, 163, which doubled, gives the whole Distance 326 miles.

Hence, the Course made good is N. 50° W., or N. W. ½ W. nearly. Distance 326 miles.

Two Places whose Latitudes and Longitudes are of contrary names, given, to find their Bearing and Distance between them.

EXAMPLE 3

Required the Bearing and Distance between New York, in Latitude 40° 43′ North, and Longitude 74° 00′ West, and the Cape of Good Hope, in Latitude 34° 22′ S., and Longitude 18° 30′ E.

Lat. of New York........	40° 43′ N.	Merid. parts........	2679	Long. of New York......	74° 00′ W.
Lat. of Cape Good Hope.	34 22 S.	Merid. parts........	2198	Long. of Cape Good Hope	18° 30′ E.
	75° 05′	Merid. Diff. Lat......	4877		92° 30′
	60				60
Diff. Lat. in miles.......	4505			Diff. Long. in miles........	5550

Rule.—Take the 100th part of the Meridian Difference of Latitude, 48.77, and the 100th part of the Difference of Longitude, 55.50, and seek in the Table until they are found to agree as Difference of Latitude and Departure, which gives the Course, 49°. Again, with this Course and the 100th part of the proper Difference of Latitude, 45.05, taken in the Latitude column, then the Distance, 69, will be found opposite to it, which, multiplied by 100, gives the whole Distance, 6900 miles, and the Bearing South 49° East, or S. E. ¼ E. nearly.

One Latitude, Course and Difference of Longitude given, to find the Distance and Difference of Latitude

EXAMPLE 4.*

A Ship from Latitude 34° 29′ North sails South 41° West till her Difference of Longitude is 682 miles. Required her present Latitude and Distance sailed.

Rule.—Enter the Table with the Course 41° and the tenth part of the Difference of Longitude, 68.2, in the Dep. column, opposite to which, in the Latitude column, stands the Meridian Difference of Latitude, 78.5.

Lat. left.......	34° 29′ N.	Merid. parts........	2207	
		Merid. Diff. of Lat. ..	785	Subtracted from the Merid. parts of Lat. left
Gives the Lat. in	23 3′ N —	Merid. parts........	1422	of the Lat. in.
Diff. of Lat.	11° 26′			
	60			

Course 41°, and D. L. 686 in the Lat. column, gives the Distance 910 miles.

* This Example cannot be solved by Middle Latitude Sailing.

QUESTIONS FOR EXERCISE.

QUESTION 1. Required the Course and Distance from the Cape of Good Hope in Lat. 34° 24′ S., and Long. 18° 32′ E. to the Island of St. Helena in Lat. 15° 55′ S., and Long. 5° 44′ W.

ANSWER. By Middle Lat. Sailing the Course is N. 50° W., and Distance 1725 miles. By Mercator Sailing the Course is N. 50° W., and Distance 1725 miles.

QUESTION 2. A Ship from Lat. 60° 10′ N. and Long. 30° 15′ W. is bound to a port in Lat. 49° 10′ N and Long. 50° 10′ W. Required the Course and Distance.

ANSWER. By Middle Lat. Sailing the Course is S. 46° W., or S. W. nearly, and Distance 950 miles. By Mercator Sailing the Course is S. 46° W., or S. W. nearly, and Distance 950 miles.

QUESTION 3. A Ship on the Equator in the Long. of 25° 40′ W., and bound to the port of Rio Janeiro. Required to shape a Course to Cape Frio in Lat. 23° 1′ S., and Long. 41° 59′ W. Find the Course and Distance to it.

ANSWER. By Middle Lat. Sailing the Course is S. 35° W., Distance 1685 miles. By Mercator Sailing the Course is South 34° 40′ W., Distance 1683 miles.

QUESTION 4. Required the Bearing and Distance between Cape St. Anthony (one of the Cape Verd Islands) in Lat. 17° 12′ N. and Long. 25° 19′ W., and the Island of St. Helena in Lat. 15° 55′ S. and Long. 5° 44′ W.

ANSWER. By Middle Lat. Sailing the Bearing is S. 30° 30′ E., Distance 2300 miles. By Mercator Sailing the Bearing is S. 30° 0′ E., Distance 2295 miles.

QUESTION 5. Required the Bearing and Distance between Cape Horn in Lat. 55° 59′ S. and Long. 67° 16′ W., and San Francisco in Lat. 37° 48′ N., and Long. 122° 21′ W.

ANSWER. By Middle Lat. Sailing the Bearing is N. 27° W., Distance 6310 miles. By Mercator Sailing the Bearing is N. 27° W., Distance 6300 miles.

QUESTION 6. A Ship from Lat. 29° 47′ N., and Long. 24° 36′ W. sails S. S. W. ¾ W. 320 leagues. Required her present Latitude and Longitude.

ANSWER. By Middle Lat. Sailing the Lat. in is 16° 4′ N., and Long. 33° 36′ W. By Mercator Sailing the Lat. in is 16° 4′ N. and Long. 33° 34′ W.

In the preceding examples, both by Middle Latitude and Mercator Sailing, we have always supposed the Ship to sail on a direct Course, but when she makes more than one Course they must be reduced to a single Course by the Traverse Table, and the Latitude and Longitude found as in the following example.

Suppose a Ship from Latitude 32° 36′ N. and Longitude 61 45′ W., sails N. E. 36 miles, N. by W. 14, N. E. by E. ½ E. 58, N. by E. 42, and E. N. E. 29. Required her Latitude and Longitude in

COURSE.	DIST.	NORTH.	SOUTH.	EAST.	WEST.
N. E.	36	25.5	.....	25.5	..
N. by W.	14	13.7	.....	.....	2.7
N. E. by E. ½ E.	58	27.3	.....	51.2	.....
N. by E.	42	41.2	.....	8.2	.....
E. N. E.	29	11.1	.....	26.8	.....
	Diff. Lat.	)118.8		111.7	2.7
	or	1° 59′N.		2.7	

Lat. left .... 32 36 Dep. 109.0 in the Lat.
Lat. in .... 34 35 Column the D. Long. 131.
Sum .... 67 11 Is found in the Dist. col.
Middle Lat. .... 33 35 = D Long. 131 = 2° 11′ E.
Long. left .... 61 45 W.
Long. in .... 59° 34 W.

BY MERCATOR SAILING.

Lat. left .... 32° 36′ N. Mer. Parts, 2071
Diff. Lat 119, or 1 59
Lat. in .... 34° 35 Mer. Parts, 2214
Mer. Diff. Lat. 143

Diff. of Lat. 118.8 and Dep. 109, gives the course 42°30′ This course and the Mer. diff. of Lat. 143 in the Lat. column, the Diff. of Long.)131 is found in the Dep. column.
2° 11 E.
Long. left ... . 61 45 W.
Long. in .... 59° 34 W

Lat. 118.8 and Dep. 109 gives the course N. 42° 30 E.

Summary.

Dist.	161 miles.
Diff. Lat.	119 N.
Dep.	109. E.
Lat. in	34° 35′ N.
Diff. Long.	2° 11 E
Long. in	59° 34 W

CURRENT SAILING.

Current Sailing is the most perplexing subject connected with Navigation, on account of the uncertainty in their direction and velocity. Even those which are ascertained to exist and are well established, have been known to change their rate of running frequently, and sometimes even to run in a contrary direction.

The only safeguard is for the Navigator to be constantly on the alert, and to obtain his Ship's Position from Celestial observations (when the weather will permit) as often as possible in the course of the 24 hours, both by day and night, from the altitudes of the Sun, Moon, Planets or Stars, and comparing her position so found with that given by the Dead Reckoning from time to time; the difference between which will point out the direction and velocity of the Current from the effect it has had upon the Ship's Course and Distance as given by the Compass and Log, provided the Compass is free from local attraction.*

When a Ship is sailing in a known Current, the Course is sometimes changed so as to counteract its effect as much as possible, so that the vessel may be continued on her required Course. Or, when a Ship crosses a known Current obliquely, the direction or set of the Current is taken as a Course, and its velocity or drift per hour as a Distance, and which is entered in the Traverse Table, along with the Courses and Distances the vessel may have made during that day.

CASE I.

Given, the effect of a Current acting on a Ship. Required, its Direction and Velocity.

EXAMPLE 1.

A Ship from Latitude 39° 25′ N. and Longitude 65° 10′ W., by Observation and Chronometer, and on the following day the Latitude in was 36° 40′ N. and Longitude 62° 30′ W., by Observation and Chronometer; the Dead Reckoning carefully kept from her position at the preceding noon, gave the Latitude in 36° 02′ N. and Longitude 63° 18′ W. Required the Set (or direction) and Drift of the Current per hour.

Lat. left........39° 25′ N.	Lat. left........39° 25′ N.	Long. left......65° 10′ W.	Long. left.......65° 10′ W.
Lat. by Obs.....36 40′ N.	Lat. by D. Reck.. 36 02′ N.	Long. Chron.....62 30 W.	Long. D. Reck....63 18 W.
Diff. Lat. by Obs. 2° 45′ S.	D. Lat. by D. R.. 3° 23′ S.	D. Lon. by Chron. 2° 40′ E.	D. Long. by D. R. 1° 52′ E.
	" by Obs... 2 45 S.		D. Long. by Chron. 2 40

Ship Set to the Northward.....................38 miles. Ship Set to the Eastward................48 m. [of Longitude.

Middle Latitude 38° and Difference of Longitude 48′ in the Distance column, gives the Departure 38 in the Latitude column. Then the Difference of Latitude, 38 miles, and the Departure, 38 miles, gives the Course or Set of the Current N. 45° E., and the Drift or Velocity 54 miles in 24 hours, or at the rate of 2¼ miles an hour.

EXAMPLE 2.

At 6 A. M. the Latitude observed was 23° 10′ N. and Longitude 55° 10′ W., and at 6 P. M. the Latitude observed was 22° 03′ N. and the Longitude by Chronometer 54° 01′ W. In the interval the Ship had made a Course good S. 60° E., and the Distance run by Log, 116 miles, which gives the Latitude in 22° 12′ N. and Longitude 53° 22′ W by Dead Reckoning. Required the Set and Velocity of the Current.

Lat. in at 6 P. M. by Observa.........22° 03′ N.	Long. by Chron. at 6 P.M..... 54° 01′ W.
" by Dead Reckon.............22 12	" by Dead Reckon....... 53 22

Ship set to the Southward.................9 miles. Ship Set to the Westward........39 miles of Longitude.

With Middle Latitude 23° as a Course, and Difference of Longitude 39 miles, the Departure 35.9 is obtained. Then with Difference of Latitude 9, and Departure 36, the Course or Set of the Current is found to be S. 76° W., or E by S. ¾ S., true, and the Distance, or Drift of the Current, 37 miles in 12 hours, or 3 knots an hour, nearly.

EXAMPLE 3.

A Ship in the Gulf of Florida, in Latitude 25° 44′ N. and Long. 79° 28′ W., the Gun Key Lights in sight, bearing East distant 13 miles, shaped a true North Course at 8 o'clock in the evening, her rate of sailing all night being 6 knots an hour. At midnight the Latitude oberved by Stars North and South of the Meridian was 26° 24′ N, and at 4 A. M. the Latitude observed by Meridian altitude of the Moon was 27° 08′ N., and at 6 A. M. the Latitude observed by the planet Venus was 27° 28′ N. and the Longitude by Chronometer 79° 20′ W. Required the Velocity of the Stream at the various intervals, and the direction and drift of the Current from 8 o'clock in the evening until 6 o'clock next morning.

Course from 8 P.M. to Mid't, North.............24 miles.	From Midnight to 4 A. M. Dist. run.........24 miles.
Lat. left, 25° 44′ N., Lat. obs. 26° 24′ N., Diff...40	Lat. Mid. 26° 24′ N., Lat 4 A.M. 27° 8′ N., Diff. 44
Northerly Set in 4 hours ....16 miles.	Northerly Set in 4 hours.....................20 miles.
Position of the Ship at 8 P. M., Lat.......... 25° 44′ N.	Long.............. 79° 28′ W.,
" " at 6 A. M., Lat.......... 27 28	Long.............. 79 20 W.
1° 44′	Diff. Long................8 equal to 7 miles Dep.
60	
Diff. Lat. by observation in miles... 104	
Dist. run from 8 P.M. to 6 A.M., 10 h. at 6 knots 60	

Ship Set to the Northward.................. 44 miles, and to the Eastward 7 miles. This gives the Course or true direction of the Current N. 9° E., and the Distance or Drift in 10 hours, 45 miles, or at the rate of 4½ miles an hour.

* An error in the reckoning is frequently caused by local attraction affecting the Ship's Compass, and mistaken for a Current, where none exists. (See page 120.)

When a Current is ascertained to exist, either from recent observations or from the proximity of the Ship's Position to where a certain Current runs, whose rate and drift is known, it is allowed for in the day's work as follows :

CASE II.

The Direction and Velocity of a Current given, to find its effect on the Ship.

EXAMPLE 1.

A Ship from Latitude 39° 25′ N. and Longitude 65° 10′ W., by observation and chronometer, makes a Course good S. 23° 30′ E., and Distance 222 miles, until the Noon of the following day, during which time a Current has been setting to the N. E. (true) at the rate of 2¼ miles per hour. The Latitude observed at Noon was 36° 40′ N and Longitude by Chronometer 62° 30′ W. Required the position of the Ship by Dead Reckoning, allowing for the Current.

COURSE.	DIST.	NORTH.	SOUTH.	EAST.
South 23° 30′ East	222		203	88
N. E. Current 24 h. at 2¼ knots drift	54	38		38

Diff. Lat...38......203 S.......Dep.126 with M. Lat 38
38 N. gives the Diff. Long...160
)165 or 2° 40′ E
Diff. Lat. made.................. 2° 45′ S. Long. left...... 65 10 W
Lat. left............ ....39 25 N. Long. by D. Rec. 62° 30′ W.
Position of the Ship at Noon, Lat. in...... .... 36° 40′ N. by Dead Reckoning.

EXAMPLE 2.

A Ship from Latitude 23° 10′ N. and Longitude 55° 10′ W., sails 12 hours on a true Course S. 60° E., 115 miles, and during which time a Current has been setting her to the W. by S. ½ S. (true) at the rate of 3 knots an hour Required the Latitude and Longitude in.

COURSE.	DIST.	SOUTH.	EAST.	WEST.
South 60° East	115	57.5	99.6	
Current W. by S. ½ S., 12 h. at 3 knots	36	9.0		35.0

Difference Latitude.............66.5..Dep...99.6..Dep...35.0
Difference Latitude made.... 1° 7′ S. 35.0
Lat. left.................. 23 10 N...Dep..64.6 Gives Diff. Lo. 69 = 1° 09′ E.
Lat. in by D. Reckon........ 22 03 N Long. left.........55 10 W
Long. by D. Reck. 54° 01′ W

CASE III.

Given, the Bearing and Distance of the Port, and the Set and Rate of the Current, it is required to shape the Course so as to keep the Port on the same bearing.

RULE.—When the Bearing of the Port and the Set of the Current are nearly at right angles to each other, or the Current sets obliquely across its direction, take their Sum. But when it runs in the same or opposite directions, take the Difference.

With this Sum, (or what it wants of 16 points, or 180°, if it exceeds 8 points, or 90°,) or Difference as a Course, and the Rate of the Current as a Distance, find the Departure.

With this Departure as Departure, and the rate of the Ship's Sailing as a Distance, find the Course.

This Course being applied to the bearing of the port on the *opposite* side to that towards which the Current is drifting the Ship, gives the Course required.

EXAMPLE 1.

The Port bears S. 45° W., the Current sets S. E. by S., or S. 34° E., 3 miles an hour, the Ship's rate of sailing 10 knots an hour. Required to shape the Course so as to keep it on the same Bearing.

Bearing of the Port S. 45° W.
Current oblique... S. 34 E.

Take their Sum, 79°, as a Course, and rate of the Current, 3 miles, as Distance, gives the Departure, 2.9. This Departure and the rate of the Ship, 10 miles, as Distance, gives the Course, 17°. This applied to the right, or added to the bearing, 45°, gives the Course, S. 62° W.; because in facing towards the S. W. the running of the Current is towards the S. E. by S., or to the left of the bearing of the Port.

EXAMPLE 2.

The Port bears N. 45° E., the Current South, 3 knots, rate of sailing 8 knots. Shape the Course so as to keep the Port on the same bearing.

South giving no angle, the first Course is 45°, which with Distance, 3 knots, gives Departure, 2. The Distance, or rate of sailing, 8 and Departure, 2, gives Course, 15°, which applied to the left of the bearing, gives N. 30° E.; because in facing towards the N. E. the Current is setting to the right of the bearing.

EXAMPLE 3.

The Port bears E., the Current sets S. W. by S., 3 knots, rate of sailing 4 knots. East is 8 points, or 90°, which is one of the opposite quarters to S. W. The Difference between them, which is 5 points, as a Course, and Distance 3, the rate of the Current gives the Departure. 2.5. This Departure, and Distance, 4, (the rate of the ship,) gives the Course, 39°. which applied to the left of East, the bearing of the Port, gives the Course to be steered N. 51° E

EXAMPLE 4.

The Port bears N. 82° E., the Current S. 10° W. 4 knots, Ship's rate of sailing 3 knots. N. E. and S. W. being opposite points, the Difference is 72°, as a Course, and rate of Current 4, as Distance, gives Departure, 3.8 This Departure being greater than the ship's rate of sailing, 3 knots, which is impossible, shows that the Ship cannot maintain the bearing of the Port.

OF THE SHIP'S POSITION.

TAKING DEPARTURES, OR FINDING THE POSITION OF THE SHIP FROM THE BEARING OF KNOWN OBJECTS ON THE LAND.

CASE I.

By a single Bearing and estimated Distance.

Set the Bearing by the Compass, and estimate the Distance off. This is the common method, and a person may soon acquire the tact of estimating Distances with much precision by adopting the following suggestion: Compare the Distance required, in your mind, with the known Distances of the surrounding objects, in a locality which is well-known and familiar to you, and take the one that seems to correspond nearest to the required Distance.

RULE. To find the ship's Position, take the opposite point to the bearing of the object, correct for magnetic variation. Enter the Traverse Table with it as a course and the estimated distance, and find the Diff. Lat. and Dep. Take from the Table of Positions the Latitude and Longitude of the object. Apply the Diff. of Lat. to that Lat., which will give the Lat. of the ship. Then with Mid. Lat. as a course, and the Dep., find the Diff. of Long. This applied to the Long. of the object will give the Long. of the ship.

EXAMPLE 1.

The light-house on Neversink bore W. by N. ½ N. 20 miles. Magnetic Variation ½ point Westerly. Required the position of the ship.

Bearing W. by N ½ N.	Lat. of Neversink...........	40° 23′ N.	Long. of Neversink...............	73° 59′ W
Opposite pt. E. by S. ½ S.	Var. ½ pt. = E. *b.* S. 20 m. D L.	0 4 S.	Dep. 19 6 E. Mid. Lt. 40° gives D. Ln.	0 26 E
	Latitude of Ship	40° 19′ N.	Longitude of Ship...............	73° 33′ W.

EXAMPLE 2.

Barnegat light-house bore N. ½ E. 12 miles. Variation ½ pt. Westerly. Required the position of the ship. (This is useful in rateing a chronometer.)

N. ½ E. opposite pt. S. ½ W	Var. ½ pt. W. = South 12 miles. D. Lat.	0° 12′ S.	Dep. 0 D. Long.....	0° 0
	Lat. of Barnegat......	39 46 N.	Longitude.........	74 6′ W
	Latitude of the Ship.	39° 34′ N.	Long. of Ship.....	74° 6′ W

EXAMPLE 3.

Neversink light-houses bore by compass W ½ N. 20 miles. Variation ½ point W. Required the position of the ship.

Bearing W. ½ N. Opposite pt. E. ½ S. Var. ½ pt. W. = E. 20 m = D. Lat.	0° 0′	Dep. 20 Ml. L. 40° = D. L.	0° 26′ E
	Lat. of Neversink	40 23 N.	Long. of Neversink......	73 59 W.
	Lat. of the Ship	40° 23′ N.	Long. of the Ship.......	73° 33′ W.

A ship on leaving the land and commencing a voyage, her departure is taken from the bearing of an object whose position is known, and its estimated distance off, similar to the above, the opposite point to which is taken as a course, and being corrected for the variation of the compass, it is entered into the Traverse Table, along with the other courses and distances the vessel has sailed, up to the following noon. Her position is then deduced from the Latitude and Longitude (taken from the Table of Positions) of the object she took her departure from.

CASE II.

By two Bearings of different Objects at right angles to each other.

RULE. To find the Ship's position, the object bearing true East or West, gives the Ship's Latitude, and the one bearing true North or South gives the Ship's Longitude, because she is on the same parallel of Latitude as the former, and on the same meridian as the latter.

EXAMPLE.

Barnegat light-house bore N. ½ E., and Little Egg Harbor light W. ½ N. Required the position of the Ship.

Bearing N. ½ E.	Var. ½ pt. = true North.	Long. of Barnegat......74° 6′ W.	Long. of the Ship	74° 6′ W
Bearing W. ½ N.	Var. ½ pt. W. = true West.	Lat. of Egg Har. Light..39 30 N.	Lat. of the Ship...	39 30 N.

CASE III.

The Latitude of the Ship and the Bearing of a known Object given.

RULE. Enter the Traverse Table with the True Bearing of the object as a Course, and the Diff. Latitude between the Ship and the object in its column. The Distance will be found in its column—that is, the Distance of the object from the Ship.

EXAMPLE.

The Latitude observed was 40° 10′ N. At the same time Neversink Highland bore N. W. ½ W. by Compass, or N. W. by W. true. Required the Ship's distance off.

True Bearing N. W. by W. or 5 points. Latitude of Neversink 40° 23′ N.
Latitude of the Ship 40° 10′ N.

True Bearing 5 points as a Course and Diff. Latitude 13′ gives the Distance off 24 miles

FINDING THE SHIP'S POSITION FROM TWO BEARINGS OF THE SAME OBJECT.

CASE IV.

Given the Bearing and Distance of the nearest Object from the Ship, and the Bearing and Distance of another from the first Object, to find the Bearing and Distance of the second Object from the Ship.

EXAMPLE.

The Bearing and Distance of Neversink Light-house from Fire Island is known to be W. S. W., true, 37 miles. The point at right angles to that Bearing is N. N. W. The ship having Fire Island Light on that Bearing, (allowing the variation of the Compass), and distant 15 miles, required the Bearing and Distance of Neversink.

Enter the Traverse Table with 37 miles as Departure and 15 as Difference of Latitude, which will give the Course 6 points and the Distance 40 miles. Add this 6 points to the bearing of Fire Island, which was N. 2 points W., and the bearing of Neversink will be obtained N. 8 points W., or due West, distant 40 miles.

TABLE FOR FINDING THE DISTANCE OF AN OBJECT BY TWO BEARINGS, AND THE DISTANCE BETWEEN THEM.

Diff. between the Course and 2d Bearing.	DIFFERENCE BETWEEN THE COURSE AND THE FIRST BEARING. POINTS OF THE COMPASS.																
PNT'S	2	2½	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
3½	1.00																
4	1.00																
4½	0.81	1.23															
5	0.69	1.00	1.45														
5½	0.60	0.85	1.17	1.66													
6	0 54	0.74	1.00	1.35	1.85												
6½	0.49	0 67	0.88	1.14	1.50	2.02											
7	C 46	0.61	0.79	1.00	1.27	1 64	2.17										
7½	0.43	0.57	0.72	0.90	1.11	1.39	1.77	2.30									
8	0 41	0.53	0.67	0.82	1.00	1.22	1.50	1.87	2.41								
8½	0.40	0.51	0.63	0.76	0.92	1.09	1.31	1.58	1.96	2.50							
9	0.39	0.49	0.60	0.72	0.85	1.00	1.18	1.39	1.66	2.03	2.56						
9½	0.38	0.48	0 58	0.69	0.80	0.93	1.08	1.25	1.46	1.72	2.05	2.60					
10	0.38	0.47	0.57	0.66	0.76	0.88	1.00	1.14	1.31	1.51	1.76	2.11	2.61				
10½	0.38	0.47	0.56	0.65	0 74	0.84	0.94	1.06	1.19	1.35	1.53	1.79	2.12	2.60			
11	0.39	0.47	0 56	0.64	0.72	0.81	0.90	1.00	1.11	1.24	1.39	1.57	1.80	2.11	2.56		
11½	0.40	0.48	0.56	0.63	0.71	0.79	0.87	0.95	1.05	1.15	1.27	1.41	1.58	1.79	2.08	2.50	
12	0.41	0.49	0.57	0.64	0.71	0.78	0.85	0.92	1.00	1.08	1.18	1.29	1.41	1.57	1.76	2.03	2.41
12½	0·43	0.51	0.58	0.65	0.71	0.77	0.83	0.90	0.97	1.03	1.11	1.20	1.29	1.41	1.35	1.72	1.96

RULE 1st. To find the Distance of the object when the last Bearing was taken, enter the table with the number of points at the top, contained between the first Bearing and the ship's head, and the number of Points at the side contained between the second Bearing and the ship's head. At the angle of meeting take out the tabular number, which multiply by the number of miles of Distance made good by the ship. The result is the Distance in miles off shore at the time the last Bearing was taken.

RULE 2d. To find the Distance when the first Bearing was observed, enter the table with the difference between these Bearings and 16 points; the second Bearing in this case must be taken from the top, and the first Bearing from the side column. Take out the tabular number corresponding and multiply it by the number of miles of Distance made good by the ship. The result is the Distance of the ship off shore at the time of the first Bearing.

CASE 1.

Finding the Ship's Position from two Bearings of the same Object.

EXAMPLE 1.

At 8 P. M. Fire Island Light bore N. W. ½ N. by Compass. Ship's course W., at the rate of 7 knots an hour, and at 10 P. M. the same light bore N. N. E. ½ E. Required her Distance off at both stations.

1st Bearing N. W. ½ N. / Course West, } Angle 4½ pts. — 2d Bearing N. N. E. ½ E. / Course West, } Angle 10½ pts. gives the Tabular Num. 0.84

Taken at the top of the Table. — Taken at the side of the table. — Dist. sailed 2 h's at 7 knots 14m

336

The Tabular Number multiplied by 14, the Distance sailed, and the two right hand figures struck off (being 84

Decimals) gives the Distance off at 10 P. M. 11¾ miles nearly, or 11.76

To find the distance off at 8 P. M.,

The first angle being .... 4½ points, — the second angle 10½ points } The Tabular number is 0.95

Subtract from .... 16 " — subtract from 16 " } Distance sailed 14m

Taken at the side of the Table 11½ " — Taken at the top 5½ " } 380

95

Gives the distance off at 8 P. M. 13½ miles, or 13.30

EXAMPLE 2

At 6 P. M. Barnegat Light came in sight, bearing by compass S. W. by W. Ship sailed on a S. by W. ½ W course, at the rate of 8 knots an hour, with a 2-knot tide in her favor, until 7h 30m P. M., when the same light was observed to bear N. W. by W. Required her distance off at both stations.

1st. bearing S. W. by W. } Angle 3½ pts.
Course S. by W. ½ W. }
Taken at the top of the Table.

2d bearing N. W. by W. } Angle 9½ pts
Course S. by W. ½ W. }

Taken at the side of the Table, gives the Tabular Number.......		0.69
Distance sailed in 1½ hours..12 miles.	Multiply by..........	15
Add for tide.............. 3		345
Distance made good......... 15 miles.		69
The ship's distance off the Light at 7h 30m P. M. is 10¼ miles, or		10.35

To find the distance off at 6 P. M.,

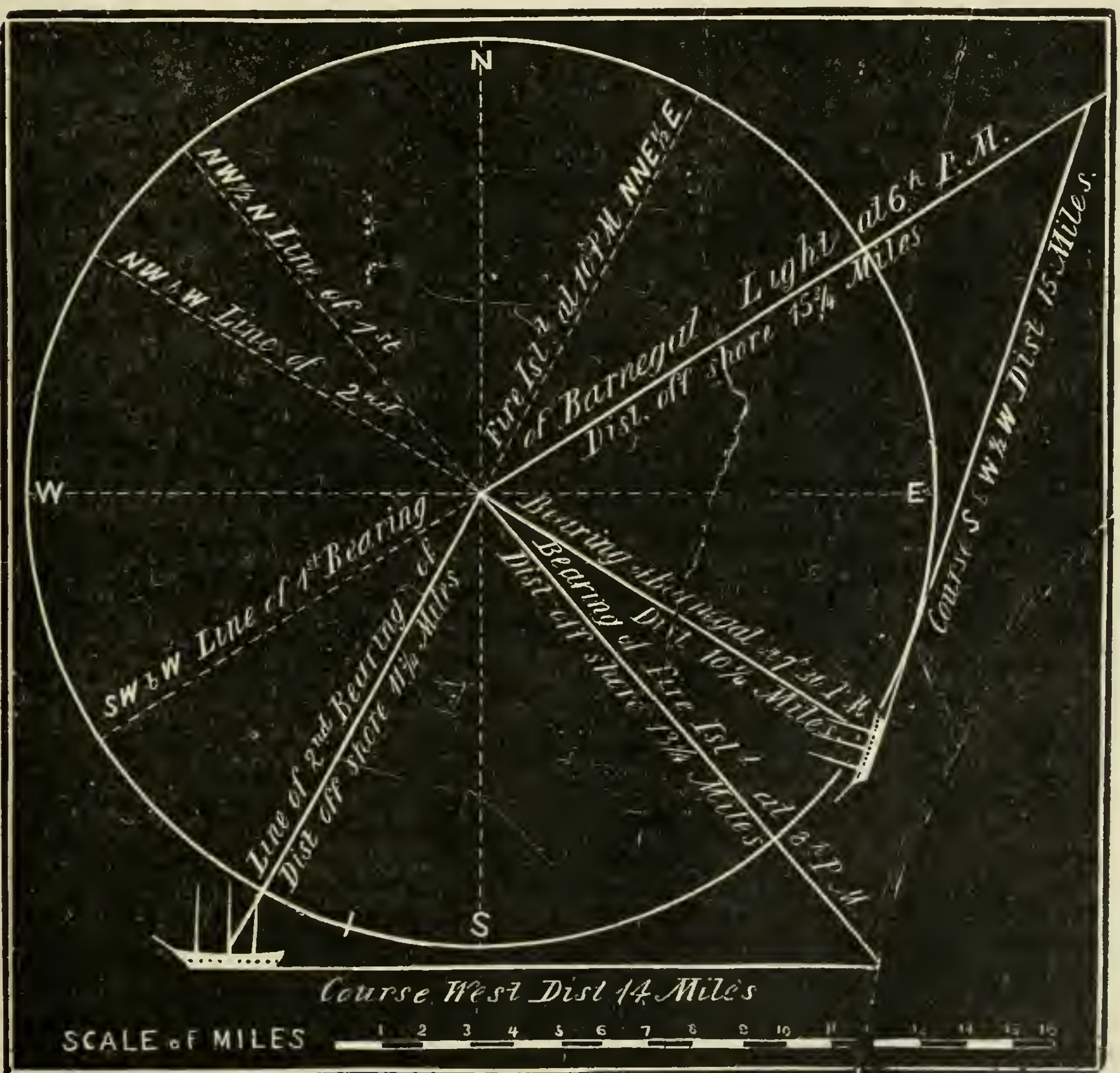
The first angle was	3½ points,	2d angle	9½ points.	
Subtract from	16 "	Sub. from	16 "	
Take at the side	12½ points.	At the top	6½ points.	

The Tabular Number is found to be.........	1.03
Distance made good..........................	15
	515
	103
The ship's distance off the Light when seen at 6 P. M., was 15½ miles, o.	15.45

PROJECTION OF THE ABOVE EXAMPLES,

Showing the Distances found by the Tables to be correct, as measured in the Diagram.

FIG. 17.



FINDING THE SHIP'S POSITION FROM TWO BEARINGS OF THE SAME OBJECT.

CASE II.

Given, two Bearings by Compass of an Object on Shore, with the Distance sailed between them, to find the Ship's correct Position in Latitude and Longitude.

This case is useful in finding the Sea Rate of the Chronometer. (See page 155.)

EXAMPLE 1.

At 5 o'clock A. M., Neversink Light-House bore by Compass W. by S. ½ S. Ship then sailed on a S. ½ W. Course, at the rate of 5½ knots an hour, until 7 A. M., when the same object bore N. W. by N., variation ½ point West. Required, the Ship's Latitude and Longitude at the time of each Bearing.

The 1st Bearing W. by S. ½ S. by Compass.
Corr. for ½ pt. W. var. is W. S. W., } Angle 6 pts.
Course S. ½ W " South, }

2d Bearing N. W. by N. by Compass.
Corr. for ½ pt. var. N. W. ½ N. } Angle 12½ pts
Course............ true S. }

Tabular Number......97
2 hours at 5½ knots=Distance sailed........11
Distance off at time of 2d Bearing at 7 A. M.............. 10.67 miles.

The op. pt. to the 2d Bear. is S. E. ½ S., Dist. 10½ miles, gives D.L. 0° 8′ S., and Dep. 6.7=D. Long... 0° 8′ 45″ E.
Lat. of Neversink,........ 40 24 N. Long. of Neversink..73 58 48 W.
At 7 A. M. the Lat. of the Ship was ..... 40° 16′ N. and Long..............73° 50′ 3″ W.

To find the Position of the Ship at 5 A. M., or time of the 1st Bearing.

1st Angle was................ 6 points. 2d Angle was................12½ points.
Subtract from................16 " Subtract from................16 "
Take........10 points at the side of the Table, and .... 3½ at the top.
Tabular Number...........66
Distance Sailed............11
Dist. off at time of 1st Bear. 5 A. M......... .. 7.26′, or 7½ miles, nearly.

The op. pt. to 1st Bear. is E. N. E., and Dist. 7½, gives Diff. Lat.... 0° 3′ N. Dep. 6.7=D. Long. 0° 8′ 45″ E.
Lat. of Neversink ....40 24 N. Long.... 73 58 48 W
At 5 A. M. the Lat. of the Ship was......... 40° 27′ N. Long.....73° 50′ 3″ W.

The Ship having made a true South Course, she has sailed on the Meridian of 73° 50′ 3″ West, and was in the same Longitude at 7 A. M. as at 5 A. M., and her Difference of Latitude is equal to the Distance sailed.

EXAMPLE 2.

At Noon the N. W. end of St. Anthony (one of the Cape Verde Islands) bore S. E. by E. by Compass. Ship then sailed on a South Course, at the rate of 10 knots an hour, until 4 P. M., at which time it bore N. E. by E. ½ E., the Magnetic Variation here being 1½ points Westerly. Required the Lat. and Long. of the Ship at the time of each Bearing.

The 1st Bear. S. E. by E. by Compass.
Cor. for 1½ pts. W. var. =E. by S. ½ S. } Angle 5 pts.
Course South, corrected,=S. by E. ½ E. }

2d Bear. N. E. by E. ½ E. by Compass.
Cor. for 1½ pts. var.=N. E. } Angle 10½ pts.
True Course....S. by E. ½ E. }

Tabular Number.................... 0.94
4 hours at 10 knots.......... Dist...... 40
Dist. off at the time of the 2d Bear. at 4 P. M.......37.60 miles.

The op. pt. to the 2d Bear. is S. W., and Dist. 37½ miles, gives D. L. 0° 26′ 30″ S. Dep. 26.5=D. L. 0° 27′ 40″ W
Lat. of the N. W. Point of St. Anthony....... 17 12 0 N. and Long. do....25 19 0 W
At 4 P. M. the Lat. of the Ship was......................16° 45′ 30″N. and Long.... .. 25° 46′ 40″ W

To find the Position of the Ship at Noon, or time of 1st Bearing

The 1st Angle was.... 5 points. 2d Angle was....10½ points.
Subtract from........16 " Subtract from... 16 "
Take......11 points at the side of the Table, and .. 5½ at the top. } Tabular No... 1.00 } Dist. sailed... 40
Dist. off at time of 1st Bearing, or Noon.............. 40.00 miles.

The op. pt. to the 1st Bear. is W. by N. ½ N., and Dist. 40=D. L. 0° 11′ 36″ N. Dep. 38.3 W.=D. Long. 0° 40′ W
Lat. N. W. Point of St. Anthony is........17 12 0 N. Long.... 25 19 W
Lat. of the Ship at Noon was......... 17° 23′ 36″ N. Long.... 25° 59′ W

This method of finding the Position of the Ship when in sight of Land, by two bearings of the same object, will be found of great value, when a cross-bearing cannot be obtained. All that is necessary to do, is to select an object, the position of which is given in the Table of Latitudes and Longitudes, and to take a correct bearing of it by the Ship's Compass, and note the time by Watch; and after the bearing has altered not less than 3 points, take a 2d bearing and note the time by the Watch. Thus having the interval of time between the 1st and 2d bearings, and the rate of sailing per hour, the Distance sailed in the interval may easily be obtained, and the Ship's correct Latitude and Longitude found, as explained in the above Examples, at either of the Bearings.

This will be found of importance when the Ship's Chronometers require to be verified, at times during a voyage, when in sight of any known land. Because if the Sights are taken for Time, the Bearing of the Land can be taken at the same time, and another Bearing taken either before or after that time, with the Course and Distance run in the interval, will give the Ship's exact Latitude and Longitude at the time the Sights were taken.

TIDES.

The Tidal Wave is caused by the joint Attractions of the Sun and Moon, but chiefly of the latter body, whereby the Sea is raised or drawn up by that power, in the form of a Swelling Wave, and following the motion of the Moon round the Earth. advances at a prodigious rate. This Water does not, however, partake of any onward motion, but merely rises and falls. The motion of a Tide Wave is represented by the fluttering of an Awning or the shaking of a Sail.

If the Earth was entirely covered with water, the Course of this Wave would be from the East towards the West; but as large Continents and Islands exist, which obstruct its free passage, it diverges into other directions, and the meeting with those obstructions causes the water to acquire a motion conforming to the direction in which the land lies; but still, to a certain extent, under the governing influence of the Sun and Moon, and branching off in all directions until it finds its level.

The Interval of time which the Moon takes in passing the Meridian of any place, and returning to the same again. consists of 24 hours 49 minutes, being the length of a Lunar day. This occasions two floods and two ebbs of the Tide Wave in that time. Therefore one flood and one ebb will occupy about 12 hours 24 minutes, and the Flood tide will run 6 hours 12 minutes, and the Ebb in a contrary direction the same length of time.

But as the Moon comes to the Meridian nearly an hour later every day, the time of High Water is that much later every day. When it is High Water on the shore, or when the Tide has done rising, it continues running longer in the offing. Three hours longer is called Tide and Half Tide, one hour and a half longer, Tide and Quarter Tide.

On the day of the full and change of the Moon, the time of High Water is noted at the various Ports and places of the World, and published in a Table, and which is called the Establishment of the Port or place And all that would require to be done to find the time of High Water on any other given day, would be to add the time of the Moon's Meridian passage to the Establishment of the Port. But on account of the irregular influence of the Sun and Moon, and other causes, together with the effect of gales of wind in accelerating or retarding the times of High Water, an approximate result only can be obtained from any general rule. In some parts of the world Local Tide Tables are constructed, containing the times of High Water at the various places on that Coast, predicted from long experience of tidal observations, and which is of great importance to vessels which are about to enter a Harbor where there is a great rise and fall of the Tide. In many parts of the world there is very little rise and fall; nevertheless, the tide runs with considerable velocity.

And where a Bay or Inlet is exposed to the Set of the Flood Tide, which not having any outlet, the water naturally rises to a great height, as we see in the case of the Bay of Fundy, and other places. In inland Seas, such as the Mediterranean, Baltic, &c., which are composed of narrow stripes of water, there is not sufficient room for the formation of the Tidal Wave; consequently, the tides there are scarcely perceptible.

In some rivers, which, on account of the great quantity of water they discharge, run longer and with greater velocity on the ebb, the flood tide is thereby kept back, until accumulating strength, it rises like a wall above the level of the ebb, and advancing in the form of a Crested Wave, rushes upwards with great strength until it finds its level. This phenomena is called the Bore of the Tide.

When the Sun and Moon are on the Meridian together, their actions concur, and the tide is higher than at any other time. The same holds good when they are in opposition to each other. These highest tides are called Spring Tides, and occur a day or two after New and Full Moon. But when the Sun and Moon are 90° apart, their actions, or power of attraction, neutralize each other, and the tide is lower than at other times. These are called the Neap Tides.

The highest tides happen in the month of January; because the Earth is nearer to the Sun and Moon then, than at any other time of the year; consequently, the highest Spring Tides happen in that month.

When the Moon's Declination is 0, the tides are equally high on that day; and while the Moon has North Declination the higest tides are in the Northern Hemisphere, when she is above the horizon, and the reverse when her Declination is South. The Tides rise highest at places where the Moon is in the zenith; they are also highest at the Equator and lowest at the Poles.

The common method of finding the time of High Water is as follows:

1. TO FIND THE MOON'S AGE.

Rule.—Add together the Epact of the Year, the Epact of the Month, and the Day of the Month. The Sum, if it does not exceed 30, is the Moon's Age; if the Sum exceeds 30, subtract 30 from it, and the remainder will be the Moon's Age on that day of the month required.

TO FIND THE TIME OF THE MOON'S PASSING THE MERIDIAN

RULE.—Multiply the Moon's Age by 8, and point off the right figure under the days, then the left hand figure, or figures, will be the hours, and multiply the right hand figure (which was pointed off) by 6, will be the minutes past noon when the Moon passes the Meridian. If the hours exceed 12, subtract 12 hours from it, which will be the time of her Morning passage.

TABLES FOR FINDING THE MOON'S AGE

THE EPACT OF THE YEAR.

1853.	1854.	1855.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.
d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. d.
20. 1	1. 3	11.18	23.10	4.12	15. 3	25.17	7.21	18.12	29. 3	10. 6	21.21	2.23	13.15	24. 6	6. 8	16.23

THE EPACT OF THE MONTH.

Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.	d. h.
0. 0	1.11	29.11	1.10	1.21	3. 8	3.20	5. 7	6.18	7. 5	8.17	9. 4

TO FIND THE TIME OF HIGH WATER.—1st *Method.*

RULE.—To the time of the Moon's Meridian passage on the given day, add the time of High Water at the given place on the Full and Change days, or, as it is called, the Establishment of the Port. Their Sum is the time of High Water past noon on the given day. If this Sum exceed 12 hours 24 minutes, which is the interval between each succeeding tide, subtract 12 hours 24 minutes from it; or, if it exceed 24 hours 48 minutes, subtract 24 hours 48 minutes from it, and the remainder will be the time of High Water in the afternoon of the given day.

EXAMPLE 1.

Required, the time of High Water at Sandy Hook, October 2, 1854, (Civil time.)

	D.H
Epact for the Year, 1854, is........	1.3
" " Month, October,......	7.5
Day of the Month, October,........	2.0
Moon's Age........	10.8

	D.H.
Moon's Age, October 2, 1854................	10.8
Multiply by........	8
	8h. '2.16
	6
Moon's Meridian Passage..............	8h.16
Establishment of Sandy Hook...........	7 35
Time of High Water in the morning.....	15 51
Subtract........	12 24
Time of High Water at Sandy Hook....	3h.27 in the afternoon

EXAMPLE 2.

Required, the time of High Water at Cape Henry, December 6th, 1854, (Civil time.)

	D.H.
Epact for the Year, 1854, is........	1 3
" " Month, December,....	9.4
Day of the Month, December,.......	6.0
Moon's Age........	16.7

	D.H.
Moon's Age, December 6th,.................	16.7
Multiply by........	8
	13. '0.8
	6
Moon's Meridian Passage................	13h. 2.0
Establishment of Cape Henry...........	7 40
Time of High Water in the morning.......	20 42
Subtract.........	12 24
Do. do. in the evening......	8h.18

As this Rule gives only a rough estimate of the Time of High Water, and may be as much as two hours in error, caused by the variation in the time of the Moon's daily passage over the Meridian, and which varies from about 40 minutes to 66 minutes, at different times in the year. This Rule assumes the interval of her Meridian passage to be 48 minutes or four-fifths of an hour. It, however, may be useful when there is no Nautical Almanac at hand.

The Second Method is more to be depended on. In this case the Moon's Meridian Passage at Greenwich is taken from the Nautical Almanac, and corrected to the time of her passing the Meridian of the Ship, and which is further corrected for her Horizontal Parallax by the annexed Tables.

FINDING THE TIME OF HIGH WATER.—2d *Method.*

RULE. Take out the time the Moon passes the Meridian at Greenwich from the Nautical Almanac, for the day required, and apply the Equation of time the contrary way to the precept at the head of the column, which will be the apparent time at Greenwich of her Meridian passage. Enter the side table with the Longitude of the place and take out a number of minutes, to be added to the Meridian passage if the Longitude be West but subtracted if East, will be the App. time of the Moon's Meridian passage at the place. Take out the Moon's Hor. Parl. nearest to this time on the given day, from the Nautical Almanac. Enter the Table below, with the time of the Meridian passage at the side and the Hor. Parl. at the top, and take out a correction to be applied as directed in the table, to the apparent time of the Moon's Meridian passage at the place, to which add the establishment of the port, and the result is the time of High Water in the afternoon, if less than 12 hours. If it exceed 12 hours, it is the time of High Water next morning; and to obtain the time for P. M. on the present day, subtract 12h. 24m. from it. If the sum exceeds 24 hours, it is the apparent time of High Water P. M. the next day. For the P. M. of the proposed day, subtract 24h. 48m.

Long. of the Place.	Corr. in Min.
°	'
0	0
10	1
20	3
30	4
40	5
50	6
60	8
70	9
80	10
90	12
100	13
110	14
120	15
130	17
140	18
150	19
160	21
170	22
180	23

TABLE FOR FINDING THE TIME OF HIGH WATER.

Moon's Mer. Passage.	Moon's Horizontal Parallax. 54'	56'	58'	60'	Moon's Mer. Passage.	Moon's Mer. Passage.	Moon's Horizontal Parallax. 54'	56'	58'	60'	Moon's Mer. Passage.
	Add	Add	Sub.	Sub.							
h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
0 0	0 6	0 2	0 1	0 3	12 0	6 50	0 45	0 42	0 40	0 38	18 50
	Sub.	Sub.				7 0	0 37	0 35	0 34	0 33	19 0
0 20	0 1	0 4	0 6	0 7	12 20	7 10	0 29	0 28	0 28	0 27	19 10
0 40	0 8	0 10	0 11	0 12	12 40	7 20	0 22	0 22	0 22	0 22	19 20
1 0	0 15	0 16	0 17	0 17	13 0	7 30	0 15	0 15	0 16	0 17	16 30
1 20	0 22	0 22	0 22	0 22	13 20	7 40	0 8	0 9	0 11	0 12	19 40
1 40	0 29	0 28	0 28	0 27	13 40	7 50	0 0	0 3	1 6	0 6	19 50
2 0	0 37	0 35	0 33	0 32	14 0		Add	Add	Add		
2 20	0 43	0 41	0 38	0 37	14 20	8 0	0 9	0 4	0 1	0 1	20 0
2 40	0 50	0 46	0 44	0 42	14 40					Add	
3 0	0 56	0 52	0 49	0 46	15 0	8 20	0 17	0 12	0 8	0 5	20 20
3 20	1 3	0 57	0 53	0 51	15 20	8 40	0 29	0 22	0 17	0 13	20 40
3 40	1 8	1 2	0 57	0 54	15 40	9 0	0 31	0 24	0 19	0 15	21 0
4 0	1 13	1 6	1 1	0 58	16 0	9 30	0 36	0 29	0 23	0 19	21 30
4 30	1 18	1 11	1 5	1 2	16 30	10 0	0 35	0 27	0 22	0 18	22 0
5 0	1 21	1 13	1 7	1 3	17 0	10 30	0 30	0 23	0 18	0 15	22 30
5 30	1 18	1 11	1 5	1 2	17 30	11 0	0 23	0 17	0 13	0 10	23 0
6 0	1 13	1 6	1 1	0 58	18 0	11 30	0 15	0 10	0 6	0 4	23 30
6 20	1 2	0 56	0 53	0 50	18 20				Sub.	Sub.	
6 40	0 53	0 49	0 46	0 44	18 40	12 0	0 6	0 2	0 1	0 3	24 0

EXAMPLE 1.

Required the time of High Water at Sandy Hook, Oct. 2d. 1854. (Sea time.)

Moon's Mer. Passage Oct. 1st, N. A.	8h 11m
Equa. of Time the contrary way, add	10
Apparent time of Meridian passage	8h 21m
Long. of Sandy Hook 74° W., add	10
App. time of the M. Mer. pass. at Sandy Hook.	8h 31m

Moon's Hor. Parl. at time of the Mer. passage is 59'. Then with the Mer. pass at the side of the table, and between 58 and 60 at the top, the Corr. is 0h 10m
to be added to the Meridian passage 8 31
8h 41m
Add the Establishment of the place 7 35
Time of High Water in the morning 16h 16m
Subtract 12h 24m

At Sandy Hook, Apparent time of High Water, in the afternoon 3h 52m

EXAMPLE 2.

Required the time of High Water at Cape Henry, December 6th, 1854. (Sea time.)

Moon's Mer. passage, December 5th, N. A.	13h 3m
Equa. of time the contrary way, add	9
	13h 12m
Long. of Cape Henry 76° West, add	10
App. time of the Moon's Mer. passage	13h 22m

Moon's Hor. Parl. at time of the Mer. passage 55'. Then with the Moon's Mer. passage at the side of the table, and between 54 and 56 at the top, the Corr. is 0h 22m
which, subtracted from the Meridian passage . 13 22
13h 0m
Add the Establishment of the place 7 40

At Cape Henry, apparent time of High Water in the morning 20h 40m
12 24

Time of High Water on the afternoon of the same day 8h 16m

WINDS.

The following short description of the prevailing Winds may be found useful, in the absence of the regular sailing directions for the voyage, which should contain all the necessary information on this head:

The Earth revolving on its axis from West to East. together with the great heat near the Equator, caused by the Sun being always vertical in some part or other of the Torrid Zone, produces the Trade Winds.

The motion of the Earth causes the Wind to blow from East to West, whilst the cold air rushing in from the North and South towards the heated air in the Tropics, produces the N. E. and S. E. Trade Winds, and which blow continually in those directions Their limits extend to about 30° on each side of the Equator, but near to the coasts of America and Africa they extend to 34° sometimes. The limits of the Trade Winds are very variable, even in the same months of the year. When the Sun has great North Declination, their limits are considerably to the Northward of where they are found when the Sun has great South Declination. In the month of June, for instance, the Northern limit of the N. E. Trade may be found in about 30° North Latitude, and the Southern limit of the same in about 10° North of the Equator. A space of calms and rain-squalls intervene. Until the Northern limit of the S. E. Trade is reached in about 4° North of the Equator, its Southern limit at this season extends only to about 20° South of the Equator.

In the month of December, when the Sun has great South Declination, the Northern limit of the N. E. Trade Wind may be expected in about 20° North Latitude, and its Southern limit in about 4° North of the Equator. A space of calms and rain-squalls intervene, and the Northern limits of the S. E. Trade will be found in about 2° North of the Equator, and the Southern limit about 30° South Latitude. It appears, then, that the limits vary to the extent of 10° in 6 months, and that the Northern limit of the S. E. Trade Wind is always found to the Northward of the Equator.

Ships cross the region of calms, &c., between the Trades, quicker bound North, than they do when bound South, by reason of the airs of wind being more favorable.

Ships on approaching the limits of the Trade Wind, fall in with squally weather and heavy rains, a sure indication of a change. On entering the Northern limit of the N. E. Trade, the wind will be found far to the Northward; but as you advance South, the Wind will draw more to the Eastward. And in like manner, the S. E. Trade is found far to the Southward, and draws more to the Eastward as you advance.

Ships bound to the Southward should endeavor to cross the Equator in about Long. 25° W., because they will meet the S. E. Trade sooner than they would if farther to the Eastward. They must, however, be careful not to go too far to the Westward before crossing the Equator, on account of meeting the S. E. Trade Wind far to the Southward, which heads them off to the Westward, and because of the Equatorial Current, which sets in towards the coast of Brazil. But in a fast sailing Ship this may be much modified. When the vessel is caught in the variable weather which exists between the N. E. and S. E. Trade Winds, the rule is to keep on that tack in which she makes the most Southing on, so as to get out of it as quickly as possible.

Far to the Eastward, along the coast of Africa, the S. E. Trade is changed to a S. W. Wind, which blows with little variation throughout the year in that direction, interrupted at times by violent tornadoes, and the Harmattan or East Wind, close to the coast.

A ship taking this Eastern passage to the Cape of Good Hope, would certainly have to beat the whole way, though an advantageous slant is sometimes obtained when the Wind veers at the quarterly changes of the Moon.

After losing the S. E. Trade, the usual variable Winds are met with, but the most prevailing one is from the S. W. When a Ship is bound to the East Indies or Australia, the best parallel of Latitude for running down her Longitude to the East is 39° 0′ S., because there the Westerly Winds prevail, and the weather is not so tempestuous as it is farther South. (See remarks on Great Circle Sailing, Page 6.)

If bound to India, and having reached 70° 0′ E. Longitude, they steer more to the North, and fall in with the Southern limit of the S. E. Trade in about 90° E. The limits of the Trade Winds here are governed by the same laws as they are in the Atlantic Ocean, but do not blow so steadily. The space, between the Northern limits of the S. E. Trade and the Equator is occupied by a Wind which blows 6 months, that is, from May to October, from the Eastward and called the Easterly Monsoon, and the other 6 months of the year in an opposite direction, and then called the Westerly Monsoon.

After crossing the Equator and bound up the Bay of Bengal, the region of the regular Monsoons is reached The S. W. Monsoon commences in May, and brings rain and squally weather, which continues 6 months or until October. The N. E. Monsoon then commences, and during its continuance, from October to May (the other six months of the year), fine dry weather prevails on all the coasts of India. The Monsoons vary their direction according to the locality of the place at which they blow. This includes the China and Arabian Seas. At the changes of the Monsoons, terrific hurricanes frequently occur in all these localities.

In the Pacific Ocean, the South East Trade Wind is found to blow very steadily, with fine serene weather, and its limits are about the same as in the Atlantic Ocean. Not so, however, with the North East Trade; it is generally found light and variable, and hangs far to the Northward, especially when the Sun has great North Declination.

Ship's bound to California generally cross the Equator in about 112° West Longitude; but they seldom find the North East Trade blow with the same force as it does in the Atlantic.

These are the principal winds which blow with any degree of certainty; but where there are large Islands or Continents within the limits of the Trade Winds, the surfaces of which becoming violently heated by the tropical Sun, causes the regular wind to diverge into a local Trade.

THE CURRENTS OF THE OCEAN.

The Trade Wind blowing continually in one direction, causes the water on which they act to acquire a movement in the same direction. This is called a Current; but as neither the direction nor the velocity of a Current continues uniform, it becomes one of the most perplexing problems in Navigation, in making the proper allowance for the effect it may have had on the vessel's course. The only true method is to keep a careful account of the Ship's way by Dead Reckoning, and compare this frequently with the place of the Ship by Celestial observations. The Set and Drift of the Current may thus be ascertained, and proper allowance made until next observations. (See Current Sailing, page 29.)

There are several Currents known to exist in various parts of the world. The one known as the Florida Stream, originates in the Trade Winds which force the Water in towards the West India Islands, and between which it passes into the Gulf of Mexico; but not finding an outlet there, it rushes out between Cape Florida shore and the Islands of Cuba and Bahama, pursuing its course to the North, nearly parallel with the coast of the United States; it then diverges to the Eastward and crosses the Atlantic. One part of it is supposed to enter the Straits of Gibraltar, and the other to proceed along the Coast of Africa. Passing the Cape Verde Islands, it rushes along the S. E. Coast into the Gulf of Guinea.

It is then called the Guinea Current, and which runs to the Eastward, between this Coast and the Equator, until it strikes the South Coast of Africa, by which cause and the prevailing winds together it is forced in and blended with the great Equatorial Current which sets West to the South of the Equator. The author of this work has frequently seen the extraordinary phenomena of these two great Ocean Rivers brushing past each other, side by side, the dividing line marked by a streak of foam, exactly on the Equator.*

It will be perceived that what is called the Florida Stream makes a complete circuit of the Ocean. For by joining this Current, which is formed by the South East Trade Wind, it is again precipitated into the Gulf of Mexico.

The Velocity of the Florida Stream is governed by the force of the Trade Winds and the obstruction it meets with from local causes. About 4 knots an hour is the usual rate off the Bahamas; but as it proceeds to the North and East it becomes less.

But the most interesting fact of its retaining its heat acquired in the tropics, and preserving its borders from mixing with the surrounding Sea, is very extraordinary.

This is of great use to Seamen; because by ascertaining the temperature of the Sea water by the Thermometer, he knows whether he is within the influence of the Stream or not.

The Sea-weed floating about, usually called the Gulf weed, which although brought down by the Stream, is not always an indication of being in it.

The Polar Current is supposed to have its origin in Behring's Straits, in the North Pacific Ocean, and runs South through Davis' Straits into the North Atlantic.

Rennels' Current runs across the mouth of the British Channel towards the North West, and is caused by the water escaping out of the Bay of Biscay, which had been forced in by continued gales of wind from the West.

The action of the Trade Winds in the Indian Ocean produce a Current which sets North West into the Arabian Sea, and having no outlet, the waters make their escape out again in two divisions, one runs to the South East along the Malabar Coast and past the Island of Ceylon, and again joins the Equatorial Current running to the Westward. The other division runs out along the East Coast of Africa, between that Coast and the Island of Madagascar. Pursuing its course to the South West, it passes along the edge of the Agulhas Bank and round the Cape of Good Hope; it then runs to Northward and joins the Equatorial Current which runs to the Westward in the Atlantic Ocean. That part of the Current which sets round the Cape of Good Hope is called the Agulhas Current, and its velocity varies from 5 knots to 0, and a Current has been found sometimes to run in the opposite direction.

A Ship bound to the Eastward should keep in about the Latitude of 40° South when rounding the Cape By that means they will avoid the Current setting to the Westward. On the other hand, a Ship bound to the Westward should endeavor to get into this Current by steering for the coast to the Eastward of the

* Ships on leaving the Gulf of Guinea, or the Bight of Biafra, bound to the Westward, consequently have to beat to windward between the Princes Islands and the main land of Africa, where they find a favorable current running to the Southward, until they have crossed the Equator, when, by then standing to the Westward, they fall in with the regular Equatorial Current running West. Thereby avoiding the Guinea Current which runs in a contrary direction to the Northward of the Equator.

Cape. In Westerly gales the Current running against the wind makes the Sea run heavy and dangerous. But a Ship may find smoother water by standing in for the Agulhas Bank and keeping on it until the gale moderates in the offing. Two Ships becalmed near each other, one may be in the Agulhas Current and the other on its Bank, and it frequently happens that in the course of two or three hours the one in the Current is swept away to the Westward, out of sight of the other, without any visible cause; and before the nature and effect of this Current was understood by Navigators, it gave rise to the superstitious story of the Flying Dutchman.

The Trade Winds in the Pacific Ocean also form a Current which runs to the Westward, and then between the North and West, until it strikes the Coast of China. One division then running through the Indian Archipelago joins the Westerly Current in the Indian Ocean, and the other sets toward Berhing's Straits. Ships bound to California cross the Equator in about 112° West, which is too far to the Eastward, because the effect of the North East Trade Wind is deadened by its proximity to the Continent of North America, which has exactly the same effect on the North East Trade here (that is, of causing light winds from the North and baffling weather) as there is found in the South East Trade in the proximity to the Continent of Africa, where light Southerly winds are found to prevail, and baffling weather; but on getting further to the Eastward they have the regular Trade. Consequently, if Ships were to cross the Equator in the Pacific Ocean in about 130° West Longitude, they would find a steady fresh North East Trade, be enabled to cross it quickly, and then afterwards run down their Easting in a high Latitude, where both wind and current would be found more favorable.

In the Mediterranean Sea, there exists the curious phenomena of its receiving the Currents from the Black Sea, and large rivers running into it, besides the regular Current from the Atlantic Ocean, which flows in through the Straits of Gibraltar. Those waters have no visible outlet; but they are known to make their escape out into the Atlantic Ocean through the Straits of Gibraltar, underneath the Current which runs in on the surface. This has been proved by vessels which have been sunk at some distance inside of the Straits, the wrecks of which were afterwards cast on shore to the Westward, or outside of the entrance.

The submarine mountains rising from the bottom of the Sea, the tops of which are alone visible in the form of Shoals or Rocks, are no doubt the fertile cause of many of the extraordinary Currents which are met with at Sea. Because a body of water striking these elevations at right angles would be turned out of its original course, and rising to the surface, pursue one which would be parallel with the Mountain range.

This is a subject, however, of which very little knowledge can ever be obtained; at least to be of any benefit to Navigators. Because the effect produced by the surface Current which acts on the Ship would be just as uncertain as ever.

HURRICANES

Hurricanes are caused by a portion of the Atmosphere becoming violently heated, and thereby acquiring a circular motion around a center or focus, (at which the air is stationary,) and around this Focus the wind rushes with great violence. The Meteor has also a progressive motion to the Westward, at a rate varying from 12 to 30 miles an hour.

The diameter of these Meteors vary from 100 to 300 miles. The wind blows with the greatest fury near the centre or Focus, and there also the Shifts of wind are most rapid. Towards the circumference the wind has less force and the shifts of wind are longer. The places most subject to Hurricanes are the Northern limits of the North East Trade Wind, to the Eastward of the meridian of the West India Islands in the North Atlantic Ocean, and the Southern limits of the South East Trade, to the Eastward of the meridian of the Island of Mauritius, in the South Atlantic. Hurricanes also occur in the Bay of Bengal and its vicinity, at the change of the Monsoons in May and October.

Those in the China Seas are called Ty-foongs, and are produced from the same cause. These Hurricanes, or Meteors, are governed by certain Laws, and which are of the greatest importance to Seamen to have a knowledge of. Thanks to Colonel Reed, Mr. Peddington, and other scientific men, who have, by patient investigation, traced out and explained the nature of those destructive Meteors, and given rules whereby they may be avoided: or, at least, by which a vessel may suffer the least from their effects.

The following Remarks, which are derived from the experience of Hurricanes in both Hemispheres, in which the theory and practice are combined, may be of some service, when the more regular Book on Storms is not at hand.

HURRICANES IN NORTH LATITUDE.

These commence on the Northern limits of the North East Trade wind, in August and September, and travelling to the Westward, visit the West India Islands, and thence pursue a North East course parallel with the Gulf Stream, along the Coast of the United States of North America. The diameter of this Meteor varies from 100 to 200 miles, and its progress at the rate of about 17 miles an hour. But the most distinctive feature of this Hurricane is, that the wind blows in a Circle from Right to Left, (or, as Seamen would say, the Left-handed way,) around a Focus or Centre, the centre itself being a calm space. The changes of wind near the Focus are very rapid and blow with destructive violence; hence our chief care is to avoid this Focus. The Focus of these Meteors can be easily ascertained from the direction in which the Hurricane Wind is blowing at the time, and also points out on which side of the Storm Circle the Ship is. Suppose the Ship to have entered the Storm, and has the wind at East, Barometer 29, and falling. The Rule is, Turn your back to the Wind, and the Left hand will point to the Focus, bearing South, and by referring to the Diagram on the next page, it will be perceived that the Ship is on the Northern verge. Now, if a Ship is to the Eastward of the West India Islands, by standing to the Northward she will get out of its range; or by heaving to on the Port Tack, with her head to the Southward, (in the direction of the Focus,) the wind as it veers from right to left will be found to draw aft, and the Ship will luff up, and Bow the Sea with safety. But heaving to on the opposite tack would ensure her destruction. Because the wind veering would head the Ship off, and she would be laid in the trough of the Sea; and in such cases the violence of the wind is so great that to wear round on the other tack would be found to be impossible. The effect on a Ship standing to the Southward with this Easterly wind, would be a fall of the Barometer and an increase of the Storm; and as long as she carries sail she is rushing towards the Focus, and almost certain destruction. The most dangerous part of this Storm Circle is its Western side. You will then have the wind at North. By turning your back to the Wind, your left hand points to the East, and which is the bearing of the Focus. Now, as the Meteor in this locality is travelling to the Westward, it is evident it will overtake the Ship in its course, unless she gets out of its path. The Rule in this case is, to bear away under what sail the vessel can carry towards the South East, and then to heave to on the Port Tack, allowing the Meteor to pass to the North West of her.

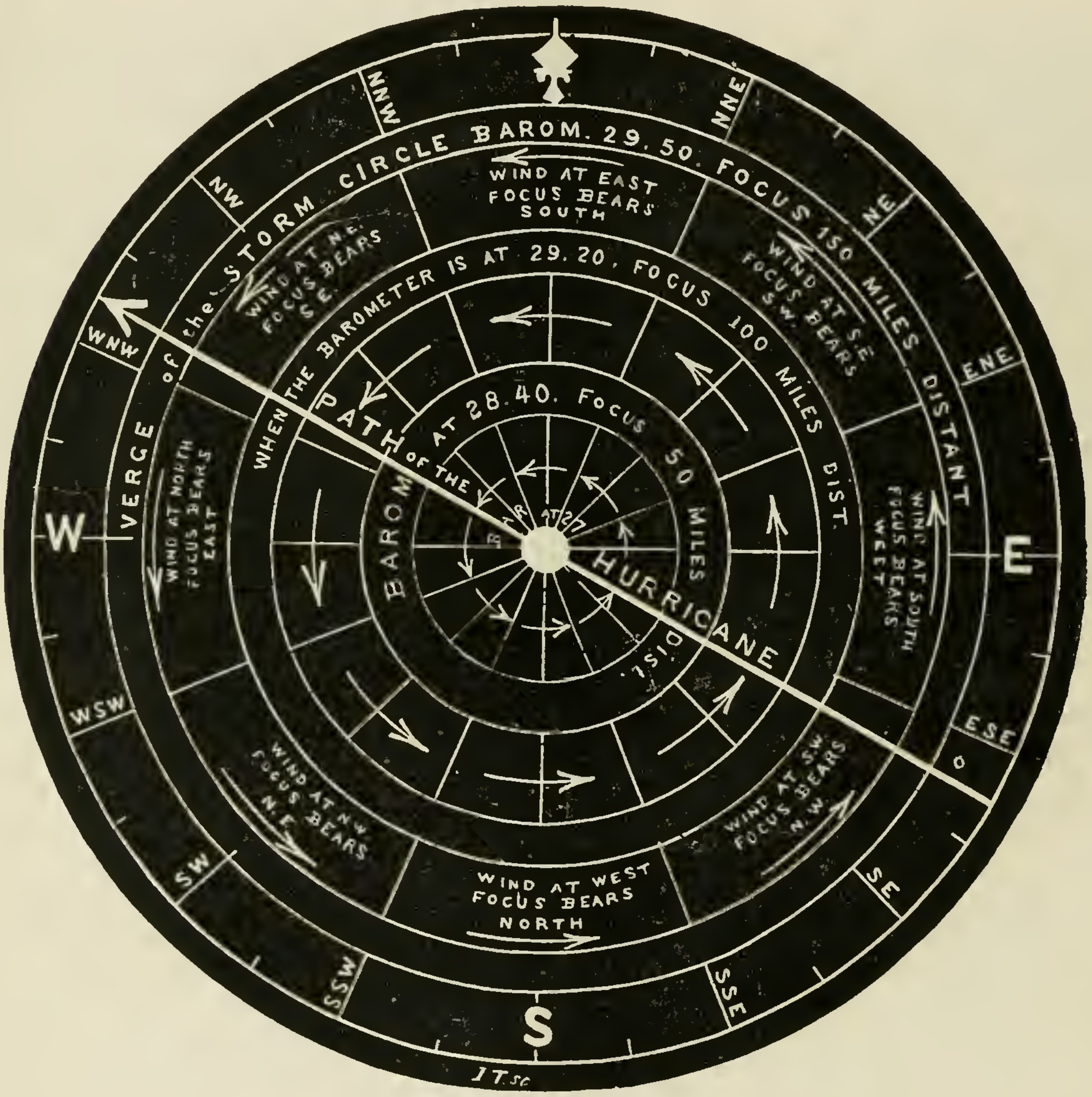
As before mentioned, the path of these Hurricanes, after leaving the limits of the North East Trade Wind, is towards the North East, and a Ship having the wind at East, the Focus would bear South as before, and the Ship is then on the Northern verge of the advancing Storm. Now, by steering about 50 miles to the North West, and then heaving to on the Port Tack as before, the Meteor will pass to the Eastward of her, and when the wind has veered to the North East she will have the

Focus bearing South East, and be at right angles to its path. But if this cannot be done on account of her proximity to the land, heave to on the Port Tack. Advantage of gaining an offing at the commencement of the Storm, when the wind is at South or South East, may be done by running off to the Eastward as long as sail can be carried, and then Wearing Ship, heave to on the Port Tack, and by that means the Focus will pass to the Westward of her position. But crossing in front of the advancing Storm is always attended with danger because the Ship may be taken aback before she gets to the Eastward of its path.

The Barometer should be carefully watched when in the vicinity of those Latitudes where Hurricanes may be expected, and when it falls rapidly to 29.50, the weather threatening, and the clouds of a bluish, gloomy appearance, the Ship is then on the verge of the Storm Circle, and the Focus may be at least 150 miles distant. As the Focus is approached the Barometer will fall to 29.20 inches at 100 miles distant; to 28.40 at about 50 miles distant, and to 28.00 at about 30 miles distant. At or near the Focus itself it falls as low as 27.00 inches sometimes

DIAGRAM OF THE STORM CIRCLE IN NORTH LATITUDE.

Fig. 18.



RULES TO AVOID THE FOCUS

Turn your back to the Wind, and your Left hand will point to the Focus.

Hurricane Wind.	Bearing of the Focus.	When the Path is to the W.N.W.	When the Path is to the N. E.
Wind at East.	Focus South.	Heave to on the Port Tack.	See the remarks above.
" N. E.	" S. E.	do. do.	Heave to on the Port Tack.
" North.	" East.	Run 50 m's to the S'd, and heave to.	do. do. do.
" N. W.	" N. E.	Heave to on the Port Tack.	do. do. do.
" West.	" North.	do. do. do.	do. do. do.
" S. W.	" N. W.	do. do. do.	do. do. do.
" South.	" West.	do. do. do.	Get a little to the E'd if possible,& heave to.
" S. E.	" S. W.	do. do. do.	Run 50 miles to the N. W., and heave to.

HURRICANES IN SOUTH LATITUDE

The Hurricanes in the South Atlantic Ocean commence near the Southern limits of the S. E. Trade Wind, to the Eastward of the Island of Mauritius, and pursue a course to the Westward. They are generally expected in the months of February or March. The diameter of these Meteors vary from 150 to 300 miles, and their rate of progression is from 12 to 30 miles an hour. The distinctive features of these Hurricanes are, that the wind blows in a circle, around a focus, from left to right (or the right-handed way as seamen call it), consequently the Rule for finding the focus of the Hurricane in South Latitude is to turn your back to the Wind, and the right hand will point to the centre. Those in the Bay of Bengal and China Seas being in North Latitude, revolve the left-handed way, same as in the North Atlantic. So that in meeting one of these Hurricanes, it must be considered, in the first place whether the Ship is in North or South Latitude, and then to act accordingly. If the Ship is in South Latitude, the rule is to heave to on the Starboard Tack, with her head towards the Focus; and supposing the Wind at East, the right hand will point to the Focus bearing North. The Ship would then be on the Southern verge of the Storm Circle, and as the Wind veers to the Southward she will luff up and bow the sea. The Barometer acts in a similar manner as before stated.

DIAGRAM OF THE STORM CIRCLE IN SOUTH LATITUDE.

Fig. 19.

RULES TO AVOID THE FOCUS.

Turn your back to the Wind, and your Right hand will point to the Focus.

Hurricane Wind.	Bearing of the Focus.	When the Path is to the W. S. W.		When the Path is to the S. E	
Wind at West.	Focus bears South.	Heave to on the Starboard Tack.		Heave to on the Starboard Tack.	
" N. W.	" " S. W.	do	do	do	do
" North.	" " West.	do	do	do	do
" N. E.	" " N. W.	do	do	Run 50 miles to the S. W. and heave to.	
" East.	" " North.	do	do	Heave to on the Starboard Tack.	
" S. E.	" " N. E.	Run 50 miles to N. W. and heave to.		do	do
" South.	" " East.	Heave to on the Starboard Tack.		do	do
" S. W.	" " S. E.	do	do	do	do

NOTE. The Hurricanes in the South Atlantic, after leaving the Latitude of 80° S. recurve to the S. E. A Ship meeting these Hurricanes in a higher Latitude would be in their direct path, when she has the Wind at N. E., because on turning your back to the Wind, the right hand will point to the Focus bearing N. W., and its path being S. E will overtake her unless she gets out of its way by running off 50 miles to the S. W.

REMARKS ON HURRICANES.

The following remarks on handling a Ship in a Hurricane, may be found useful: When a Ship is approaching the locality of Hurricanes, the Barometer should be carefully watched, and when it has fallen rapidly from about 30 inches to 29 20, the Ship is then on the verge of a Storm Circle. At the same time the weather will appear threatening, with heavy, bluish-looking clouds in the sky. At other times, it sets in with small rain, and the Wind increases gradually. Now is the time to consider which side of the Storm Circle the Ship is on, from the direction in which the Wind is then blowing, by the rules already given for that purpose.

The most severe Hurricanes, especially those in the Indian Ocean and China Seas, generally give notice of their approach by the rapid falling of the Barometer about an inch, when no other indications in the sky are visible, at from 12 hours to 48 hours before the verge of the Storm reaches the Ship. And in this case no time should be lost in preparing the Ship to encounter it, by sending down on deck all the light spars and rigging, and the studding-sails out of the tops, rigging in the flying-jib and standing-jib booms, securing the boats and hatchways, and the sails (which are furled to the yards) with double gaskets, because after the Hurricane sets in, the violence of the Wind is so great that it will be found impossible for men to go aloft or to do any work whatever. Upon the same principle the Ship's place in the Storm Circle should be ascertained as soon as possible, and arrangements made for her safety by running out of its path, if necessary, before the wind has increased to that degree that no sail can withstand, or to heave to on the proper tack.

Instances have been known of Ships getting into the Storm Circle, and been obliged to scud before the Wind under bare poles, and changing their Course as the Wind veered, and have been kept scudding round the Focus for several days together, and only got liberated after the Meteor had spent itself, and found themselves several hundreds of miles to the Westward of where they had entered it.

A Transport Ship, with troops on board, from Ceylon, bound to the Island of Mauritius, fell in with one of those Hurricanes on the 26th of March. At midnight the Barometer had fallen to 28.90. Wind blowing hard at West. And the captain, not being acquainted with the theory of storms, the Ship was kept on her course to the S. S. W. 50 miles, and next day the centre of the Hurricane burst upon her, and threw her completely on her beam ends. All three masts went by the board, and she righted a little. The wreck of the masts alongside knocked off her rudder, and caused her also to leak badly; and so severe was the Hurricane and sea that the men were frequently washed from the pumps, the Ship laying all the time in the trough of the sea, and her decks were continually swept. For three days this Hurricane continued, and during all that time the hatches had to be kept carefully closed to prevent her going down. And when the storm abated so that the hatches could be raised a little, 14 of the soldiers were found dead by suffocation from the want of fresh air in the hold.

Now there is not a shadow of a doubt but this was caused by the ignorance of the captain, in allowing the Ship to stand on to the S. S. W. 50 miles, after the Barometer had fallen to 28.90, and which placed her right in the centre of the Hurricane.

By referring to the Diagram for South Latitude, it will be seen that with the Wind at West, the Ship would be on the Northern verge of the Storm Circle, and the rule applied, of turn your back to the Wind and the right hand points to the centre. The right hand in this case points to the South, and which was the course the vessel steered for 50 miles, which brought her into the centre of the Hurricane. Now it may be pointed out how she not only could have escaped all this disaster, but actually to have made a fair wind out of part of this Hurricane, as follows: Suppose her to have run off E. N. E. or East with her Westerly Wind, until she raised her Barometer to 29.20, which she would have quickly done. She might then have hauled gradually to the Southward as the Wind veered to the North and N. E., and thus pass round behind or to the Eastward of the storm, and as the Meteor was advancing at the rate of perhaps 30 miles an hour to the W. S. W. it would have soon passed her locality.

At all events, by sacrificing say 150 miles, by running out of her course to the Eastward, she would have sooner got clear of it and without damage. Or by heaving to at once with her head to the Southward on the starboard tack, when the Barometer had fallen to 29.30, she would then have been on the outer verge of the Storm Circle, and allowed the storm to pass by her.

The path of the Hurricanes in the N. Atlantic Ocean being near the coast of America, the same advantage (that is, to get behind the storm) is not always practical for the want of sea room to perform the necessary evolutions in. But supposing a case of a Ship falling in with a Hurricane to the Eastward of the West India Islands, when bound to the Northward. The Barometer has fallen rapidly to 29 inches. Wind at West Under close reefs. Apply the rule, turn your back to the Wind, and the left hand will point to the focus bearing North, in the very direction the vessel is steering.

On referring to the Diagram for North Latitude, it will be perceived that the Ship is on the Southern verge of the Storm Circle, and the barometer at 29 inches would place her within 60 miles of its centre. Now, as before observed, if she has sea-room, she may not only escape the effects of the storm, but make a fair Wind out of part of this Hurricane by running off to the Eastward with her Westerly Wind, until the Barometer rises, which it will soon do, to 29.20. She may then haul gradually to the Northward as the Wind veers to the S. W. and South, and thus continue on her course.

A Ship falling in with a Hurricane off the coast of the United States, its path being then to the N. E., the same difficulty occurs again, that is, the want of sea-room. But suppose a case. A Ship bound to the S. E. has the Barometer fallen rapidly to 29 inches. Wind at N. E. Under close reefs. Now turn your back to the Wind, and the left hand will point to the Focus bearing S. E., distant about 60 miles, and in the very direction the Ship is steering, and 60 miles more of a run, will plunge her right into its centre.

On referring again to the Diagram for North Latitude, it will be perceived that the Ship is on the North-western verge of the Storm Circle, and to escape its effects and turn part of it into a fair Wind, run off to the S. W. with this N. E. Wind, until the Barometer rises to 29.20, which it will soon do, and then haul gradually to the S E. as the Wind veers to N. and N W., thus passing round behind the Meteor

The distance which a Ship would require to run (at right angles to her course) before she raised the Barometer to 29.20, would probably be about 100 miles, and which would take her 10 hours to perform, at the rate of 10 knots an hour. But she would soon make up the lost time when the wind veers so that she can regain her proper course.

Had she been hove to in the first case when the Barometer fell to 29 inches, with her head to the Northward, on the Port tack, the Meteor would have passed to the Northward of the Ship on its path towards the W. N. W., and the Wind as usual would have veered to the S. W. and South. and she would then luff up and bow the sea, but would be kept perhaps two or three days in the storm.

And in the second case, by heaving to under the same circumstances. the storm would pass to the Southeastward of the ship, on its path towards the N. E.; and the Wind veering to the North and N. W., she would luff up as before, but would also be kept 2 or 3 days in the storm laid to.

THE CONSTRUCTION AND USE OF MERCATOR'S CHART.

As the surface of the Globe is round, while that of the paper is flat, every chart exhibiting any extent of surface is necessarily an artificial construction, or, as it is called, projection of the real state of things.

The Charts used in navigation are those on Mercator's Projection, because on this alone the track of a Ship always steering the same course appears a straight line ; and thus all calculations respecting the Latitude and Longitude of a Ship steering a course which cuts all the Meridians at the same angle, are reduced to the utmost simplicity.

On Mercator's Chart all the Meridians are parallel and the degrees of Longitude are all equal, and of the same length throughout, as a degree of Latitude is on the Equator. The degrees of Latitude are unequal, being extended at each Latitude beyond their proper lengths, in the same proportion as the degrees of Longitude are diminished on the Globe towards the Poles.

The miles of Latitude are consequently increased towards the Poles, so that in the Latitude of 60° a degree of Longitude will measure 30 of these miles only, and near the Poles 1 mile of Latitude is equal to a degree of Longitude.

TO CONSTRUCT A CHART ON MERCATOR'S PROJECTION.

Having first determined the limits of the proposed Chart, that is, the number of degrees of Latitude and Longitude it is to contain, and the degree of each it is to commence from, take out the Meridional parts from Table III, corresponding to each degree of Latitude within the intended limits, and find the difference between the Meridional parts of each succeeding degree, or every fifth degree (if the scale is small.) Reduce the difference of the Meridional parts into degrees by dividing them by 60. Draw a line at the bottom margin of the paper, to represent the parallel of the least Latitude, on which lay off the proposed number of Degrees of Longitude, taken from a scale of equal parts, or the space to be occupied by the Longitude can be divided into equal parts. Draw another line at the top margin parallel to the bottom one, and divide it also into the like number of equal parts. This top line or parallel of Latitude must be drawn at a distance from the bottom one equal to the Meridional Difference of Latitude between the extreme Latitudes, taken from the scale of Longitude, which must previously be graduated to Degrees and Minutes.

Take the Meridional Difference of Latitude between the least Latitude and the next fifth degree, from the graduated scale of Longitude, and lay it off on both sides from the parallel of least Latitude upwards, and draw the parallel of Latitude line for that degree. In like manner lay off the next fifth degree, and draw its parallel of Latitude, and draw the Meridians through every fifth degree of Longitude at top and bottom.

Draw Compasses, showing the Rhumb-lines at convenient places on the Chart, and the principal points of the coasts are then laid down according to their Latitude and Longitude, and the coast-line filled in by hand. The variation of the Compass, and other matters that are usually inserted, are then introduced.

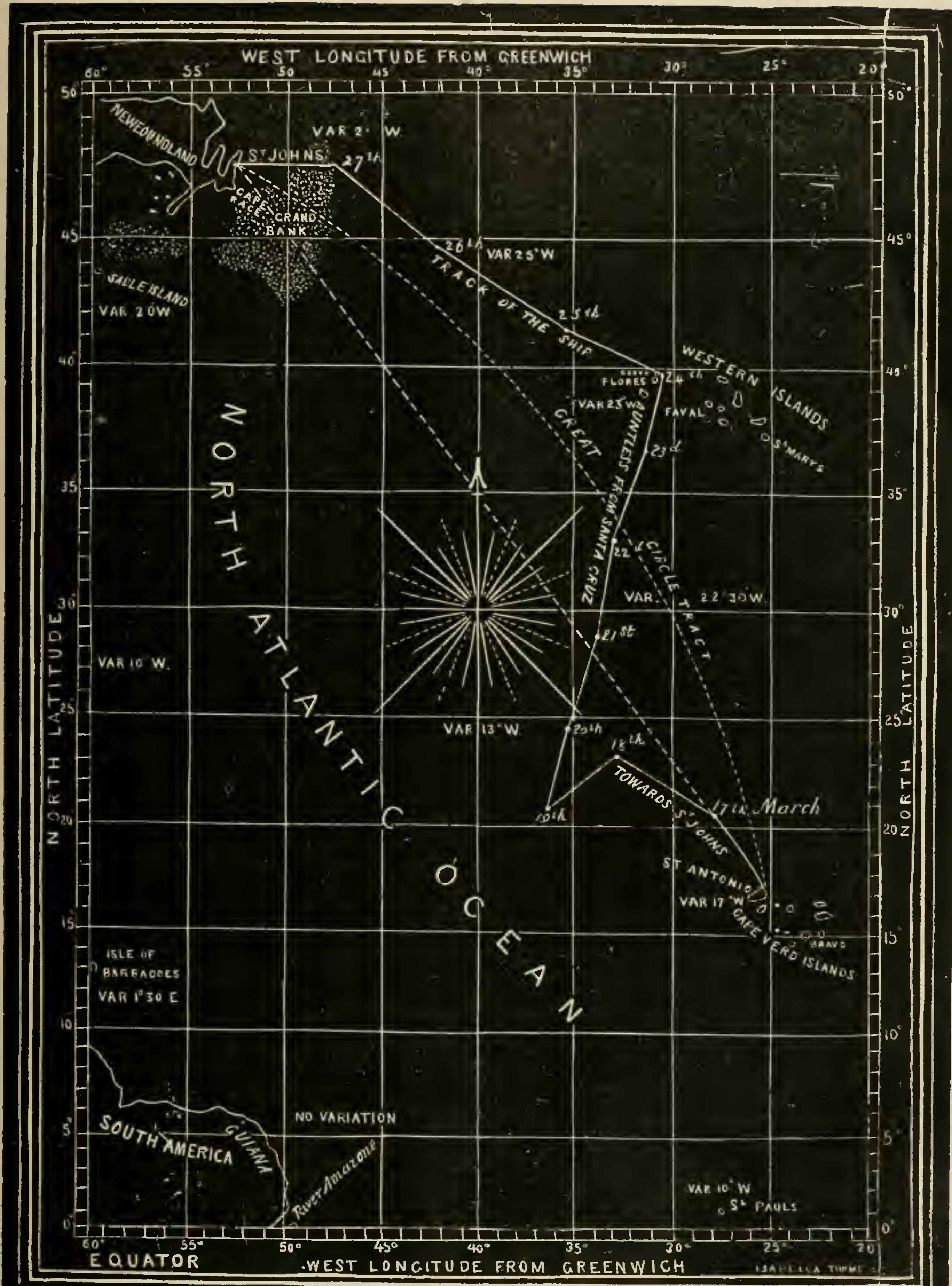
EXAMPLE.

Required to construct a Chart, extending from 29 degrees West Longitude to 60 degrees West Longitude from Greenwich, and from the Equator to 50 degrees North Latitude.

Take out the Meridional parts for every fifth degree with their Difference as follows :

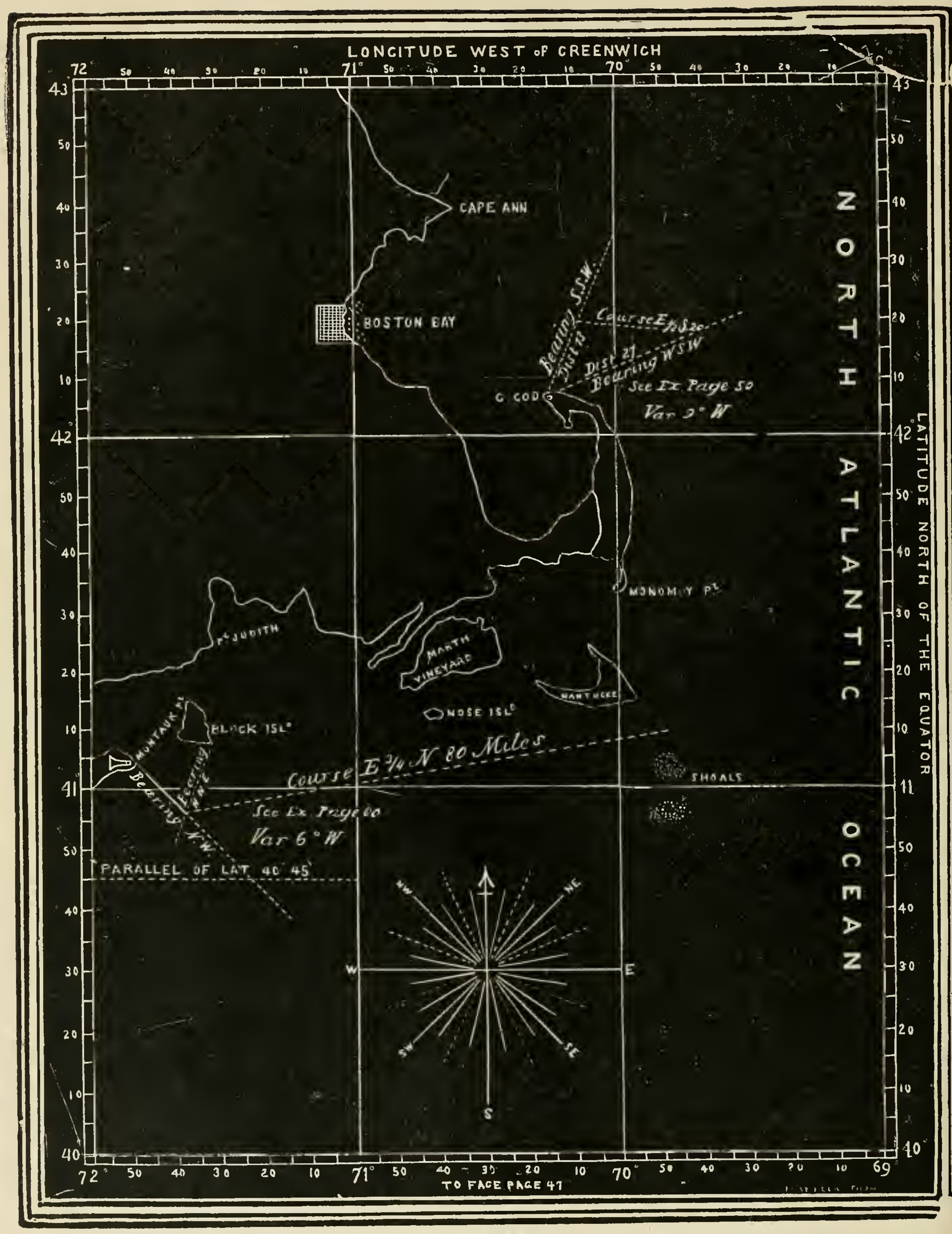
Latitudes.	Merid. Parts.	Differences.		
5°	300	300	—	5° 0′
10	603	303	—	5 3
15	910	307	—	5 7
20	1225	315	—	5 15
25	1550	325	—	5 25
30	1888	338	—	5 38
35	2244	356	—	5 56
40	2623	379	—	6 19
45	3030	407	—	6 47
50	3474	444	—	7 24

Divide the bottom line into 40 equal parts, which will represent the Degrees of Longitude on the Equator. Form a Scale of miles 60 to the Degree; take the first Difference 5° 0′ in the Compasses, and lay it off from the Equator on both sides, and draw the parallel of 5° ; from this parallel lay off the next Difference 5° 3′, and so on



TO FACE PAGE 46

Fig. 20.



LONGITUDE WEST OF GREENWICH
NORTH ATLANTIC OCEAN
LATITUDE NORTH OF THE EQUATOR
CAPE ANN
BOSTON BAY
C. COD
Bearing S.S.W.
Dist 17
Course E ½ S 20
Dist 21
Bearing W.S.W.
See Ex Page 50
Var 2° W
MONOMOY PT
PT JUDITH
MARTHA VINEYARD
NANTUCKET
NOSE ISLD
BLOCK ISLD
MONTAUK PT
Course E ¾ N 80 Miles
SHOALS
Bearing N.W.
See Ex Page 60
Var 6° W
PARALLEL OF LAT 40° 45'
NW
NE
W
E
SW
SE
S
TO FACE PAGE 47

Fig 21

TO CONSTRUCT A PARTICULAR CHART ON A LARGE SCALE.

When the Chart does not commence at the Equator, but is to serve for a portion of a coast contained between two parallels of Latitude on the same side of the Equator, draw a line at the bottom margin of the paper, to represent the least parallel of Latitude.

Divide the given inches to the Degree, (according to the scale required,) into 60 equal parts, which will represent miles of Latitude.

Now enter the Traverse Table with the least Latitude as a Course, and find the length of a Degree of Longitude in that parallel; that is, take 60 minutes of Longitude in the Distance Column, and in the Latitude Column will be found the length of the Degree of Longitude, in miles.

Take this length of the Degree of Longitude in the dividers from the scale of miles of Latitude, and lay off on the bottom margin line as many Degrees of Longitude as required in the Chart, and divide each into 60 equal parts, and draw Meridians at each side.

Enter Table III., and take out the Meridional parts for each Latitude, beginning with the least Latitude, and take the Differ. between that and the next greater. Take this Meridional Difference of Latitude in the dividers from the graduated Scale of Longitude, and lay it off on each Meridian from the bottom margin line, or least parallel of Latitude, and draw the next greater parallel of Latitude. From this last parallel of Latitude lay off the Meridional Difference of Latitude between that and the next, and draw the next parallel of Latitude, and so on, to the extent required. Divide the greatest parallel of Latitude, at the top, into the same number of Degrees and Minutes of Longitude as at the bottom margin, and draw Meridians through each Degree of Longitude, and number the Degrees of Longitude (whenever the Latitude is North of the Equator, and the Longitude West from Greenwich,) from Right to Left, and vice versa.

When the Chart is to be bounded by Parallels of Latitude on different sides of the Equator, to the extent of a few Degrees only, the Degrees of Latitude and Longitude being of the same length, we first draw the Equator and lay off the Degrees of Latitude (according to the scale required) North and South of it, and draw the Parallels of Latitude. The Degrees of Longitude on the Equator are then made of the same length, and the Meridians drawn as before. This is called a Plane Chart, and can only be thus constructed near the Equator. Having thus drawn and graduated the Parallels of Latitude and the Meridians of Longitude, the Latitudes and Longitudes of places are laid down, and the coast-lines sketched by hand. Rocks and shoals are then inserted, with the depth of water at low water, spring tides, the setting of the tides, the times of high water, full and change, variation of the compass, &c.; and one or more Compasses are inserted in the most convenient parts of the Chart.

EXAMPLE.

Required to construct a Chart between the Latitudes of 40° and 43° North and the Longitude of 69° and 72 West from Greenwich, on a Scale of 2 inches to the Degree of Latitude. (See Fig. 21.)

Draw a line at the bottom margin of the paper to represent the parallel of 40°, take 2 inches from the Plane Scale and divide it into 60 equal parts, representing miles of Latitude. Enter the Traverse Table with Latitude 40° as a Course, and 60 miles of Longitude in the Distance Column. Then in the Latitude Column opposite will be found 46 miles, the required length of a Degree of Longitude in that parallel of Latitude. Now take this 46 miles in the dividers, from the two inch scale, and lay off 3° of Longitude, divide them into 60 miles each, and draw a Meridian line at each side. Enter Table III., and take out the Meridional parts for each Latitude, beginning with the least, as follows:

Lat.........40°	Merid. Parts........2623	
" 41	do. 2702	Diff.........79′—1° 19′
" 42	do. 2782	" ....80—1 20
" 43	do. 2863	" ....81—1 21

Now take 1° 19′ in the dividers, from the Scale of Longitude, and lay it off on the Meridian lines from the parallel of least Latitude, 40°, and draw the parallel of 41°. In like manner, from the parallel of 41° lay off 1° 20′, and draw the parallel of 42°, and 1° 21′ laid off will give the parallel of 44°. Divide this last parallel of Latitude into Degrees and Minutes of Longitude, the same as the parallel of 40° at the bottom margin, and draw the Meridian lines. Divide the Degrees of Latitude into 60 miles each, and number the Degrees of Longitude from Right to Left, because the Longitude is West from Greenwich.

Lay off the Latitudes and Longitudes of the most prominent parts of the Coast, and fill in the Coast line by hand, &c.

THE USE OF MERCATOR'S CHART.

TO PRICK OFF THE SHIP'S PLACE ON THE CHART.

Lay the edge of the parallel ruler along the nearest parallel of Latitude line, and move one of its sides until its edge is over the Degree and Minute of Latitude required, and as near as possible to the required Longitude. Draw a pencil line, which will represent the Ship's parallel of Latitude. Take the Longitude with a pair of dividers from the scale, one foot being on the nearest less Meridian, and the other at the Degree and Minute required. Then with one foot on that Meridian, extend the other along the Ship's parallel of Latitude, and mark the spot, which is the Ship's place required.

Or, lay the edge of the parallel ruler along the nearest less Meridian line, and move one of its sides until the edge is over the Degree and Minute of Longitude required, and transfer the same to the Ship's parallel of Latitude. Draw a pencil line, and at the intersection of these two lines will be the Ship's place. (See Chart, Fig. 20, page 46.)

EXAMPLE.

Lay off the Ship's position on the Chart, Latitude 19° 30′ N. and Longitude 42° W.

The nearest less parallel of Latitude is 15°; a ruler on this, and moved up to Latitude 19° 30′ on the Graduated Scale, gives the Ship's parallel of Latitude. Then with one foot of the dividers on the nearest less Meridian of 40° on the Scale of Longitude, and the other extended to 42°, transferred to the Ship's parallel of Latitude, points out the Ship's place.

This is done at least once every day at noon, and being connected together with a pencil line, shows the Ship's track on the Chart from day to day.

TO SHAPE A COURSE ON THE CHART.

Lay the edge of the parallel ruler over the Ship's place and the place she is bound to. Move the ruler over the Chart until its edge is placed over the centre of the nearest Compass, which will give the True Course. Then, if the variation of the Compass is Westerly, it must be allowed to the Right hand of this True Course, but if Easterly, to the Left hand of the True Course, will give the Course required to steer by Compass.

EXAMPLE 1.

A Ship in Latitude 19° 30′ and Longitude 42° W., is required to shape a Course by Compass to St. Antonio, one of the Cape Verde Islands. (See Chart, Fig. 20, page 46.)

Lay the Ruler over the Ship's place and that of the Island, and move the edge of it over the centre of the nearest Compass, gives the True Course E. ¾ S. The variation of the Compass being 1¼ points Westerly, which, allowed to the Right hand, gives the Compass Course required E. S. E.

EXAMPLE 2.

Required the Course to the mouth of the River Amazon from the same position.

Lay the ruler over the Ship's place and that of the River Amazon, and refer it to the centre of the Compass as before, will give the True Course S. S. W. The Variation being ½ point Easterly, which allowed to the Left hand gives the Compass Course required S. by W. ½ W.

TO MEASURE THE DISTANCE BETWEEN TWO PLACES ON THE CHART.

When the places lie nearly North or South of each other, their Difference of Latitude is the Distance required. Extend the feet of the dividers to the places, and refer this extent to the Scale of Latitude between the parallels, and count the number of Degrees and Minutes contained, which multiplied by 60 (and taking in the odd Minutes) will be the Distance required.

EXAMPLE 1.

Required the Bearing and Distance of St. Mary, one of the Western Islands, from St. Antonio, one of the Cape Verde Islands, both Islands being on the same Meridians.

Answer.—The True Bearing is North, and 2 points Westerly variation allowed to the Right hand gives the Bearing by Compass N. N. E. The extent of their Distance in the dividers, and applied to the Scale of Latitude from the parallel of 17° 12′ N. to 36° 59′ N., contains 19° 47′, which multiplied by 60 gives the True Distance 1187 miles.

When the places lie nearly East or West, or on the same parallel of Latitude, extend the feet of the dividers between the places, and refer this extent to the Scale of Latitude, holding the centre or joint of the dividers directly over their parallel of Latitude, so that each foot may reach to equal distances from it. Count the number of Degrees and Minutes contained between the feet of the dividers, which multiply by 60, (and taking in the odd Minutes) will be the Distance required. But if the Distance is too great for the dividers, take, say 10° from the scale (5° on each side of the parallel of Latitude) find how many times this extent of 10° can be obtained between the places. Then contract the dividers and measure the remainder, holding the centre of the dividers over the parallel of Latitude as before, and count the number of Degrees and Minutes they contain. Add this to the number of tens of degrees already measured, which multiplied by 60 (and taking in the odd Minutes) will give the Distance required.

EXAMPLE 2.

Required the Bearing and Distance of the Island of Barbadoes from the Isle of Brava, one of the Cape Verde Islands, in nearly the same parallel of Latitude.

Answer.—The True Bearing is W. ½ S., and ½ a point Westerly variation allowed to the Right hand, gives the Compass bearing W. ½ N. The distance being too great to be measured at one time, take 10° in the dividers, 5 on each side of the parallel of Latitude, and with one foot of the dividers on Brava, it will take 3 times this extent, or 30°, to reach near to Barbadoes. Then the remainder of the distance taken in the dividers, will be found to measure 4°. Total 34°; which multiplied by 60, gives the Distance, 2040 miles.

When the places lie obliquely, neither being in the same Latitude or Longitude.

Find the Middle Latitude between the places. Take the distance between them in the dividers, and refer it to the graduated Scale of Latitude, holding the centre or joint of the dividers directly over the Middle Parallel of Latitude, so that each foot may reach to an equal distance from it, and count the Degrees and Minutes contained in the dividers, and proceed as before. But if the Distance be too great to be taken in the dividers, take an equal number of degrees on each side of the Middle Parallel of Latitude, and proceed as in the last Example.

EXAMPLE 3.

Required the Bearing and Distance of St. John's, Newfoundland, from St. Antonio, one of the Cape Verde Islands

Answer.—The True Bearing is N.W. ½ N., and 2 points of Westerly variation allowed to the Right hand, gives the Compass bearing N. by W. ½ W. The Middle Parallel of Latitude is 32°. Take 10° in the dividers, that is, 5 on each side of 32°, from the Scale of Latitude, and with one foot on St. Antonio, 3 times this extent, or 30°, will reach short of St. John's. The remainder of the Distance taken in the dividers, middled again at 32°, will give 9° more, or 39°, which multiplied by 60, gives the Distance required, 2340 miles. (See Chart, Fig. 20, page 47.)

THE COURSE AND DISTANCE GIVEN, TO FIND THE LATITUDE AND LONGITUDE IN.

Allow the variation on the Compass Course steered to the Left hand, if the variation is Westerly, but to the Right hand if Easterly, will give the True Course. Lay the edge of the parallel ruler over the centre of the nearest Compass on this Course, and transfer it to the Ship's place of departure, and draw a pencil track. Take the Distance run from the Scale of Latitude, middled on the Middle Parallel of Latitude the Ship has sailed in, and lay it off on the track, which will be the Ship's place. Take the Distance in the dividers between it and the nearest less Parallel of Latitude line, and refer it to the Scale of Latitude, will give her Latitude in. In like manner, take the Distance between the Ship's place and the nearest less Meridian line, and refer it to the Scale of Longitude, will give her Longitude in.

EXAMPLE.

A Ship from Barbadoes sails N. E. by Compass 300 miles. Variation of the Compass ½ a point Easterly Required her Latitude and Longitude in.

Answer.—The True Course is N. E. ½ E.; the variation being allowed to the Right hand, because it is Easterly, and the Distance, 300 miles, or 5°, taken in the dividers, from the Scale of Latitude, to the Northward of the Parallel of Barbadoes, and laid off on this N. E. ½ E. Track, will give the Ship's place. The nearest less Parallel of Latitude line is 15°. A parallel ruler laid on this line, and moved up to the Ship's place, and then referred to the Sale of Latitude, will give her Latitude in, 16° 20′ N. The nearest less Meridian line is 55°, and the Difference in like manner referred to the Scale of Longitude, gives her Longitude in, 55°40′ West. Or the Latitude may be ascertained by taking the Difference between the Ship's place and the nearest less parallel of Latitude, 15°, in the dividers, and applying it to the Scale of Latitude, gives her Latitude in, 16° 20′. And in like manner the Longitude is found by taking the Difference between the Ship's place and the nearest less Meridian line, 15°, in the dividers, and applying it to the Scale of Longitude, gives the Longitude in, 55° 40′ W.

USE OF THE COASTING CHART

To find the Ship's Position from the Latitude Observed and the Bearing of the Land by Compass

RULE.—Place the edge of the ruler along the nearest less Parallel of Latitude line, and move it up to the required one on the Scale of Latitude, and draw a pencil line, which will be the Ship's Parallel of Latitude. Correct the Compass bearing by allowing the Variation as before directed, which will give the True Bearing of the object. Place the edge of the ruler over the centre of the nearest Compass, and transfer this True Bearing to the object by moving the ruler until its edge is placed over it, and draw a pencil line, and where this line cuts the Ship's Parallel of Latitude is the Ship's place. By this means her Longitude in and Distance off the object is ascertained.

EXAMPLE.

A Ship observed her Latitude to be 40° 45′ N. At the same time Montauk Point Light House bore by Compass N. W. ¾ N. Variation ¾ point Westerly. Required her Distance off the Point and her Longitude in. (See Chart, Fig. 21, page 47.)

Answer.—Having drawn the Parallel of Latitude line of 40° 43′ N., allowing the variation on the Compass bearing, gives the true bearing N. W. A line drawn in that direction from Montauk Point intersects the Parallel of Latitude and gives the Ship's place. Her Distance off being 30 miles, and her Longitude in 71° 22′ W.

To find the Ship's Position from the Cross Bearing of two Objects on the Land.

RULE.—Take the Bearings by the Compass, and correct them for the Variation, as before directed, which will give the True Bearings. Place the edge of the ruler over the centre of the nearest Compass, and transfer this True Bearing to the objects. Draw pencil lines from each,, and where they cross each other is the Ship's place.

EXAMPLE.

Montauk Point bore N. W. ¾ N., and the East end of Block Island N. N. E. ¾ E. Variation ¾ point Westerly. Required the Distance off each object, and the Latitude and Longitude in.

Answer.—The True Bearing of Montauk Point is N. W. and Block Island N. N. E. The former is 11 miles, and the latter 14 miles distant from the Ship. Latitude in 40° 56′ N. and Longitude in 71° 40′ W.

Having the Ship's Correct Position from Cross Bearings, to Shape a Course along Shore, or to clear a Shoal, or other Danger. (See Chart, Fig. 21, page 47.)

RULE.—Place the edge of the ruler over the Ship's place, and in a direction which will lead the Ship clear of danger, move the ruler along and place its edge over the centre of a Compass, which will give the True Course. Then, if the variation is Westerly, allow it to the Right hand of this True Course, will give the Compass Course required to steer; but if the variation is Easterly, allow it to the Left hand of the True Course.

EXAMPLE.

Required to shape a Course from the position found by Cross Bearing in the last Example, so as to pass clear through midway between Nantucket and its Shoals, and the Distance to run until abreast of the New South Shoal.

Answer.—The True Course to pass midway is E. ¾ N. The variation ¾ of a point to the Right gives the Compass Course, East. The Distance to the South Shoal in the dividers, and middled on the Parallel of Latitude, 41°, gives the Distance off, 80 miles.

The Latitude by Observation and Soundings given, to find the Ship's Position.

RULE.—Place the ruler on the nearest Parallel of Latitude line, and move it up to the required Latitude, and draw a pencil line, which will represent the Ship's Parallel of Latitude. Then where the Soundings obtained are found to agree with that laid down in the Chart, is the Ship's place.

EXAMPLE.

A Ship, in the Parallel of Latitude of Neversink by observation, 40° 23′ N., Sounded in 30 fathoms water. Required her Longitude in and Distance off.

Answer.—Her Longitude in at the time of Sounding was 72° 20′ W., and her Distance off the High Land of Neversink was 76 miles.

To find the Distance by two Bearings of the same Object having the Course and Distance Run between them.

RULE. Take the Bearing by the Compass, and note the time by watch, and after the first Bearing has been altered at least 3 points, take a second Bearing and note the time by watch. Ascertain the True Course the vessel has made, and the Distance run in the interval between the Bearings. Allow the variation on the Compass Bearings, and find the True Bearings, which lay off on the Chart as in the former examples, and draw pencil lines. Lay the ruler over the Course made good, and take the Distance run in the dividers. Move the edge of the ruler up on the two lines, until the points of the dividers reach to both lines at the edge of the ruler, and draw a pencil line, and the result is the Ship's Distance off the object at the time of each Bearing, and also her Latitude and Longitude in at those times.

EXAMPLE 1.

At 8 A. M., Cape Cod bore by Compass S. S. W. ¾ W., and at 10 A. M. it bore W. by S. ¼ S. Course steered E. by S. ¼ S. Rate of Sailing 10 knots an hour Variation ¾ of a point Westerly. Required the Ship's Distance off at the time of both Bearings

Answer.—The first Bearing S. S. W. ¾ W. Corrected for variation is S. S. W. The second Bearing W by S. ¼ S., corrected is W. S. W., and laid off on the Chart: then the Course steered E. by S. ¼ S., corrected for variation is E. ½ S., and the Distance run in the interval, 20 miles, applied to the Ship's track drawn across the two lines of Bearings. gives her Distance off at 8 A. M., 13 miles, and her Distance off at 10 A. M. 27 miles. (See Chart, Fig. 21, page 47.)

EXAMPLE 2.

At 6 P. M. Barnegat Light came in sight, bearing by Compass S. W. by W. Ship sailed on a S. by W. ½ W Course, at the rate of 8 knots an hour, with a two knot tide in her favor until 7 30 P. M., when the same Light was observed to bear N. W. by W. Variation ½ a point Westerly. Required her distance off at the time of both Bearings.

Answer.—The Bearings corrected are S. W. ½ W. and N. W. by W. ½ W. The True Course S. by W., and the Distance run in the interval of 1½ hours is 12, to which add 3 for the effect of the Tide, making 15 miles. The projection of this case on the Chart by the above rule gives her Distance off Barnegat at 6 P. M. 15½ miles; and at 7 30, 10½ miles. See Fig. 17, page 33.)

EXAMPLE 3.

At 5 A. M. Neversink Light Houses bore by Compass W. by S. ½ S. Ship then sailed on a S. ½ W. Course, at the rate of 5½ knots an hour, until 7 A. M., when the same object bore N. W. by N. Required the Ship's Latitude and Longitude in at the time of both Bearings.

Answer.—The Variation of ½ point allowed, gives the True Bearings W. S. W., and N. W. ½ N. The True Course South. and the Distance run in the interval of 2 hours, is 11 miles. This projected on the Chart in like manner as the last example, gives the position of the Ship at 5 A. M., Lat. 40° 26′ N., Lon. 73° 51′ W.; and at 7 A. M., Lat. 40° 15′ N., and Lon. 73° 51′ W.

EXAMPLE 4.

At noon the N. W. end of St. Anthony (one of the Cape Verde Islands) bore S. E. by E. by Compass. Ship then sailed on a South Course by Compass at the rate of 10 knots an hour, until 4 P. M., at which time it bore N. E. by E. The Variation here being 1¼ points Westerly. Required the Latitude and Longitude of the Ship at the time of both Bearings.

Answer.—The True Bearings are E. by S. ½ S. and N.E.½N. The True Course S. by E. ½ E., and the Distance run in the interval of 4 hours is 40 miles. This projected on the Chart in like manner as the last, gives the Ship's position at noon, Latitude 17° 23′ N., Longitude 25° 59′ W; and at 4 P. M. Latitude 16° 45′ N., Longitude 25° 46′ 40″ W.

NOTE.—These two last examples are very useful when it is required to find the Ship's exact position when altitudes are taken for the purpose of verifying the Chronometer from time to time during the voyage, and in ascertaining its error on Greenwich Mean Time and daily rate, and which will be found fully explained at page 155.

SOUNDINGS

The Soundings marked on the Chart are those at low water spring tides, and the depth is noted in fathoms (or in feet in some of the harbor plans), and the nature of the bottom inserted.

As the Ship's place on the Chart can be determined by the Latitude observed and the Soundings laid down in that parallel of Latitude, it may also be determined within certain limits by a systematic manner of Sounding on approaching the land in foggy weather or in dark stormy nights, which is always a proper precaution, however correctly the reckoning may have been kept, because near the shore the Ship is under the influence of either Tides or Currents, which may, in the course of a few hours, set her considerably out of her proper course.

To obviate this, *take Soundings early* (when Soundings can be obtained), say at noon. The Ship's position by observation being then marked on the Chart, the Soundings as laid down at the Ship's place may be compared with the depth obtained from Sounding. This may be taken as a point of Departure. Then the Course and Distance sailed, say every 4 hours, projected on the Chart, may be verified by the Soundings at the end of every 4 hours. and in the event of thick weather setting in (as is often the case in making the land) any deviation from the proper Course and Distance allowed, may be at once detected. Even although the vessel retains her proper Course, it gives greater confidence in the Reckoning, and does away with all doubt and anxiety on the subject.

But, as before observed, this system of Sounding must be commenced *early*, so that the various Soundings obtained may be compared with each other, and also with those laid down on the Chart, from which a judgment may be formed of the Ship's place from the track of Soundings she has passed over.

Single Soundings taken without any reference to each other, are seldom of any use, and only tend to perplex the subject, except when the Latitude is known, or when the Ship comes suddenly into shoal water

REMARKS ON SOUNDING WITH THE LEAD.

There are two Leads used for Sounding, the Hand Lead, weighing 14 pounds, and attached to about 25 fathoms of line, and the Deep-Sea Lead, weighing 28 or 30 pounds, and attached to 100 fathoms or more of line wound on a reel, and a small Lead of 5 or 6 pounds is sometimes used in shoal water. The lower end of these Leads have a hole in which a lump of tallow is inserted, for the purpose of adhering to the bottom of the sea and bringing up a portion of it for examination. This is called Arming the Lead.

The Hand Lead is only used in shallow water, and the Leadsman standing in the main channels, throws it as far forward as he can, swinging it once or twice over his head if necessary, to give it increased force, and endeavoring to draw the line tight from the Lead at the instant the Ship, by her progress, places him directly over it. The hand Lead descends about 10 fathoms in the first 6 seconds, hence when the vessel is going fast it is often difficult to get Soundings, unless her way is deadened.

The line is marked as follows: Blue at 3, White at 5, Red at 7, Leather at 10, Blue at 13, White at 15, Red at 17, and 2 knots at 20 fathoms. These numbers are called Marks, and the intermediate ones Deeps. For example: In obtaining 7 fathoms, the Leadsman calls out, "By the Mark seven." In 8 fathoms, "By the Deep eight." The fathom is divided into a half and quarters. 7¼ fathoms are called "and a quarter seven," 7½ fathoms "and a half seven." 7¾ fathoms "a quarter less eight."

In heaving the Deep-Sea Lead, it is carried forward to the weather cat-head, (and sometimes to the lee cat-head if the Ship is making much leeway.) The line being passed forward to windward and outside of all, the Ship's way is then reduced, if necessary, and the Lead dropped, and as soon as it is felt to strike the bottom the line is hauled in a little and the bottom struck again. The mark at the surface of the water is then examined and the depth of water ascertained, allowing for the streaming of the line, caused by the vessel's drift when hove to, and which sometimes amounts to 10 fathoms to the 100 of line run out.

In Sounding in deep water in small vessels, which drift to leeward rapidly upon losing their way, it is best to drop the Lead before the headway ceases, and to cause the vessel to gather stern-way, so as to pass over the Lead, which will thus have descended through a considerable depth perpendicularly.

The deep-sea line is marked at each 10 fathoms by the corresponding number of knots. and with a single knot at each five fathoms. The error in Sounding is generally in excess, because the line can rarely be stretched straight from the Lead.

A Lead-line should be well stretched and thoroughly wetted before it is measured and marked, because it has a tendency to shrink up on being used; and it should afterwards be verified from time to time, to ascertain whether the marks remain correct.

Soundings on board of Steam vessels may be made with more accuracy than on board of Sailing vessels; because they can be kept stationary while the line is running out by the aid of their wheels.

Many inventions have been tried from time to time to obviate the inconvenience of rounding the Ship to when under a press of sail for the purpose of Sounding. And amongst them may be mentioned as the best, Massey's Lead, Burt's Buoy and Nipper, and Ericcson's Lead.

Massey's Lead registers the depth of water descended through, by wheel-work, set in motion by a fly acted on by the water as it descends. But in great depths this fly is liable to be crushed.

In Burt's Buoy and Nipper, the line being rove through a spring-catch in the buoy, the Lead is dropped (and the buoy afterwards) into the water. The line then continues to run through the catch till the Lead reaches the bottom, or is checked by a pull, when the catch firmly seizes the line attaching the buoy to it at the depth descended through it by the Lead.

Ericcson's Lead measures the depth of water by the space into which the air, (contained in a glass tube and reservoir within the Lead,) is condensed by the pressure of the water. The depth is indicated on a graduated scale by the height to which the water rises in the tube.

These instruments require a great deal of care and circumspection in their management. For instance, by raising and lowering them alternately, they will be made to show the depth in excess, and they must be lowered gradually to the surface of the water. Moreover, they are all liable to get out of order in stormy weather, which is the very time they are most wanted. From these considerations, they have not come much into use amongst merchant vessels, the commanders of which preferring the old and safe method of sounding by the Deep-Sea Lead and Line, and which is more to be relied on in cases of emergency.

In thick blowing weather, when a Ship is approaching the Coast, common prudence would dictate that she should be under easy sail; and by the exercise of a little seamanship, Soundings can always be obtained sufficiently accurate to ensure the vessel's safety, from the use of their old and familiar friend the Deep-Sea Lead and Line

NAUTICAL ASTRONOMY.

DIAGRAM OF THE SOLAR SYSTEM, SHOWING THE PLANETARY ORBITS ROUND THE SUN.

Fig. A.

EXPLANATION OF THE FIGURE.

The Arrows show the direction in which they revolve round the Sun in the centre

No. 1. Orbit of Mercury.	No. 4. Orbit of Mars.
" 2. " of Venus.	" 5. " of Jupiter.
" 3. " of The Earth and her Moon.	" 6. " of Saturn.

The Solar System is that in which our Earth is placed, and in which the Sun is supposed to be fixed in the centre, with several bodies, called Planets, similar to our Earth, revolving round him at different distances from him and from each other, and which shine by the light borrowed from the Sun.

The fixed Stars are supposed to be Suns which shine by their own light, and situated in the heavens at such an immense distance from our system that it is found impossible to measure, or the human mind to conceive it.

While the Earth and Planets are thus revolving round the Sun, from West to East, they have also a motion round their own axis in the same direction, and which, in the case of the Earth, produces our day and night.

Although to a spectator placed in the Sun, the Planets would appear to move in due order about him from West to East, yet to a spectator on the Earth their apparent motions appear to be very irregular. Sometimes they appear to move from West to East, and then to stand still. Then they seem to move from East to West, and after standing some time they again move from West to East, and so on continually. This is easily detected by noticing the relative positions of a Planet and a fixed Star in the heavens on a certain night, and then again at an interval of a few nights after. This is caused by the Earth not being in the centre of the system.

That is the real state of the case. But in conformity with the impression on the mind of the spectator, that the heavenly bodies appear to rise in the East and set in the West, (which in reality is caused by the Earth's motion on its axis in a contrary direction,) and in treating of Nautical Astronomy as applied to the purposes of Navigation, we suppose the Earth to be placed in the centre of the Universe, (See Fig. 1, page 56,) and that the Sun and all the other heavenly bodies revolve round it. This supposition accords with the senses of the spectator, which greatly simplifies the whole matter, and the conclusions arrived at come to the same thing.

DESCRIPTION OF THE PLANETS: THEIR MAGNITUDE AND DISTANCE FROM THE SUN

The Sun is the great centre of our System, and is 890,000 English miles in diameter, and he turns once round on his axis from West to East in 25 days 10 hours.

There are upwards of 17 Planets which revolve around the Sun as a centre, but many of these are invisible to the naked eye. Some of them have satellites or moons, which revolve round them, and being attracted to it, they are carried round the Sun along with the Planet, as in the case of our Earth and Moon.

Out of all this number of Planets and Moons, only 5 can be made serviceable in the Practice of Navigation at Sea, viz: Venus, Mars, Jupiter, Saturn, and the Moon. Mercury being always too near the Sun is seldom seen on account of the sunlight, and the others are too small or too remote, and shine with such a feeble light that they can only be seen and distinguished by using good telescopes on shore.

The path which the Planets describe round the Sun is called their Orbits. Mercury and Venus are called Inferior Planets, because their orbits are within that of the Earth, while the Earth, Mars, Jupiter, and Saturn are called Superior Planets, because their orbits include that of the Earth.

Mercury is a small Planet; his diameter being only 3.200 miles. His distance from the Sun 37 millions of miles, and he performs his revolution in his orbit in 87 days 23 hours.

Venus is the brightest of all the Planets. Her diameter is 7,687 miles. Her distance from the Sun 69 millions of miles. and she performs her revolution in her orbit in 224 days 17 hours. On being viewed through a telescope she appears horned sometimes, like our Moon. When this Planet is in the Western part of her orbit she rises before the Sun, and is then called the Morning Star. When in the Eastern, she shines after sunset, as the Evening Star.

The Earth is the next Planet in the system, the mean diameter of which is about 7,913 miles. (See Description of the Earth at page 2d.) Its distance from the Sun is 95 millions of miles, and its period of revolution in its orbit, 365 days 6 hours nearly, or one year, which produces the change in our seasons, and turning on its axis in 23 hours and 56 minutes, produces our day and night.

The Earth is attended by a satellite or moon, whose diameter is 2,161 miles, and her distance from the centre of the Earth is 240,000 miles. She goes round her orbit in 27 days 8 hours; but reckoning from change to change, in 29½ days, and she turns round on her axis in the same time, but always presents the same side to the Earth. And as she shines by the reflected light of the Sun, she appears differently according as she is situated with regard to him. When she is on the same side, her dark side is turned towards the Earth and is then invisible. This is called New Moon. When she is on the opposite side, her light side is turned towards the Earth. It is then said to be Full Moon.

Mars is the next Planet to the Earth. His Diameter is 4,189 miles. His distance from the Sun is 144 millions of miles. He performs his revolution in his orbit in about 687 days, and turns on his axis once in 24 hours 40 minutes. Mars may be easily distinguished from the other Planets, by his red appearance, which is supposed to be caused by his dense atmosphere.

Eleven small Planets revolve between the orbits of Mars and Jupiter, but as they are of no service to Navigation, it is useless to describe them.

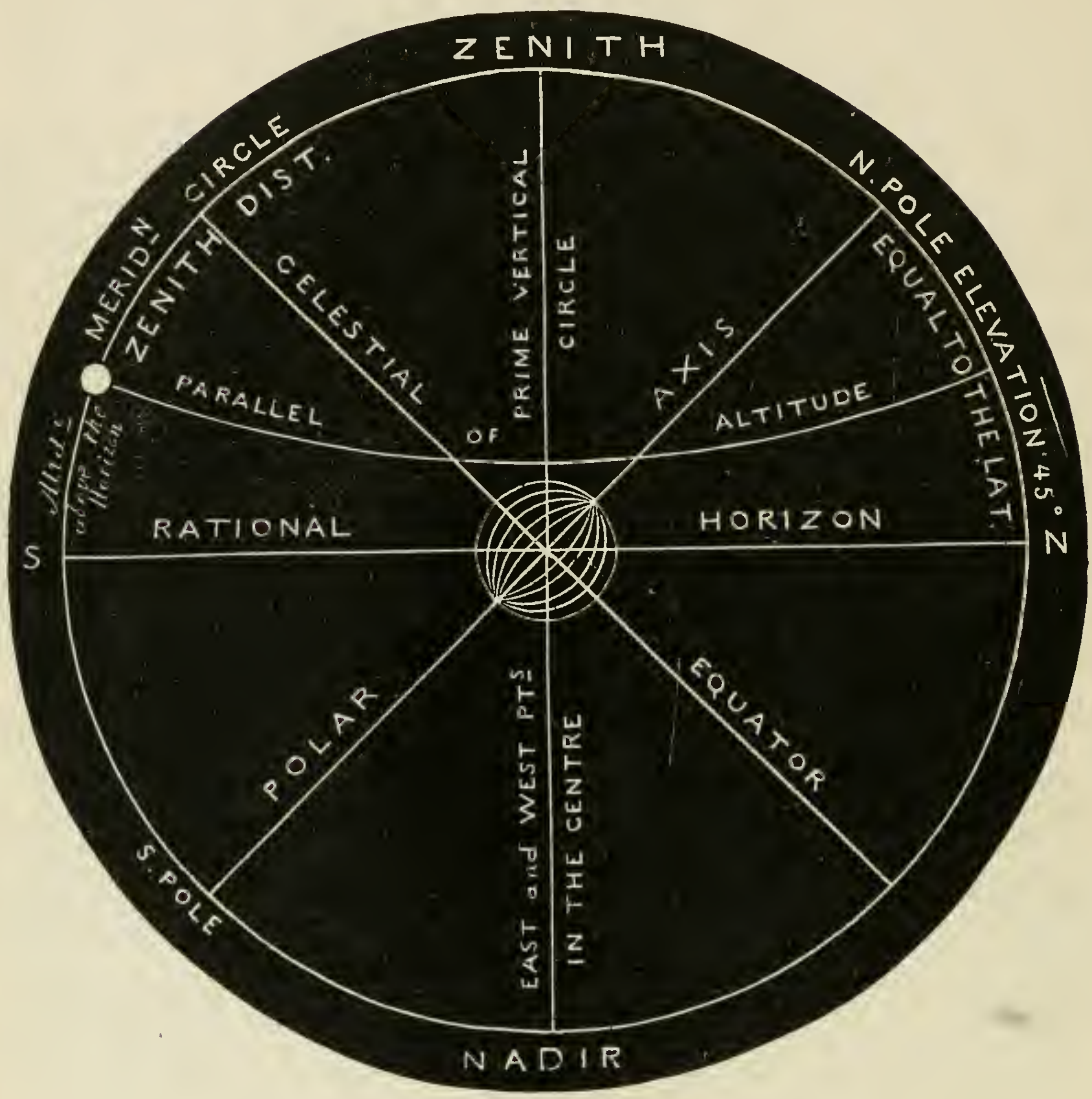
Jupiter is the next and largest of all the Planets, and is easily distinguished by his peculiar magnitude and light. His diameter is 89,170 miles. His distance from the Sun 494 millions of miles He performs his revolution in his orbit in 4,332½ days, or 12 years nearly, and he turns on his axis once in 9 hours and 56 minutes. This Planet is attended by 4 satellites or moons, but is invisible to the naked eye. In viewing Jupiter through a telescope, these moons make a beautiful appearance, together with the belt over his equator, supposed to be caused by the swiftness of his diurnal motion, in drawing his clouds and vapors into that form.

Saturn is the remotest of all the Planets which are useful in Navigation, and may be distinguished by his pale and feeble light. His diameter is 79,042 miles. His distance from the Sun is about 900 millions of miles. He performs his revolution in his orbit in 29 years 167 days, and turns on his axis once in 10 hours 16 minutes, and is attended by 7 moons. This Planet is different from all the others when viewed through a telescope, being furnished with a broad double luminous ring, which appears intended to increase the quantity of light received from the Sun, and which, on account of his vast distance from that body must be very feeble.

DIAGRAM OF THE SPHERE,

Drawn on the Plane of the Meridian in 45° North Latitude.

Fig. 1.



The Spectator is supposed to be situated at a great distance East of the Earth, and looking towards the West, having North on the Right and South on the Left.

TO CONSTRUCT THE FIGURE.

Take 60° from the line of Chords on the Plane Scale, and describe a circle, which will represent the Circular Dome of the Heavens, and from the centre draw a lesser circle, which will represent the Earth in the centre of the Sphere. Draw a horizontal line through the centre, which will cut the Earth in two halves, and represents the Rational Horizon. Draw another line perpendicular to it, which will divide the Heavens into four equal parts of 90° each. This line or circle is called the Prime Vertical, and passes through the East and West points in the centre. The top or point overhead is called the Zenith, which is 90° from the Rational Horizon; and the bottom or point under foot is called the Nadir, also 90° from the Rational Horizon.

Take 45° from the line of Chords, and with one foot of the dividers on the Right hand of the Horizon, lay it off upwards, and draw a line from thence through the centre, will represent the Elevated Pole of the Heavens and the Earth's Polar Axis. At 90° from the Pole draw the Celestial Equator through the centre also, and it will be perceived that the Poles of the Heavens coincide with the Poles of the Earth, and the Celestial Equator coincides with the Equator of the Earth.

Take 21½° from the line of Chords, and with one foot of the dividers on the Left hand of the Horizon, lay it off upwards, will be the Sun's place on the Meridian to the South of the spectator. This is called the Celestial Meridian, and passes through the Poles of the Heavens. Lay 21½° off in like manner to the Right; then take 21½° from the line of semi-tangents on the Plane Scale, and lay it off from the centre upwards, and through these three points describe a circle, which is called a Parallel of Altitude, and which in this case is the Parallel of the Sun's Meridian Altitude, and is always measured from the Rational Horizon. Parallels of Altitudes are parallel with the Horizon.

DEFINITIONS.

This relates to finding the place of the Ship on the surface of the Earth from observations of the heavenly bodies.

To the spectator at the surface of the Earth the heavens appear to form a vault, or the upper half of a hollow sphere, of which he is the centre. The Earth itself, or the ground or Sea on which he stands, occupying the lower half. And supposing the North Pole Star to represent the Elevated Pole of the heavens, or the polar axis of the Earth extended to the heavens, that part of it which is situated 90° from the Polar Star will be the Celestial Equator, or the Great Circle which passes round the heavens from East to West, the half of which only is above the horizon of the spectator, unless he is standing on the North Pole of the Earth; then the Celestial Equator would extend around and coincide with his horizon, and the North Pole Star would then be seen directly over head. At the South Pole, the Celestial Equator would also be in the horizon, and the North Polar Star under his feet. From which it is easy to imagine circles drawn in the heavens corresponding to those drawn on a terrestrial globe.

A spectator conceives himself standing on the surface of the globe, with his feet toward the centre. Now, suppose he were to descend to the centre, and the upper half of the Earth, or globe, to be cut off horizontally, that is, parallel with the horizon, the surface of the lower half globe so exposed, and being produced on all sides to meet the concave Celestial sphere, is called the Rational Horizon. Every point of the Earth's surface has, therefore, a different rational horizon. But all these horizons meet in the centre of the Earth. (See Fig. 1.)

Celestial observations taken at the surface, are reduced to the centre of the Earth; therefore the observer is supposed to be at the centre of the Earth. This is necessary in the case of the Moon, because she is near the Earth, and the Sun, and some others. But the fixed Stars being at such an immense distance from the Earth, its magnitude is nothing in comparison, so that the space between the centre, and the surface, or the Earth's semi-diameter, would produce no change whatever in the places of the Stars in the heavens. Therefore, in drawing figures for general purposes, the Earth is considered as a mere speck in the centre of the Sphere, and its magnitude entirely neglected.

The Zenith is the point vertically over the spectator's head, and distant 90° from the rational horizon at every point.

The point opposite the Zenith, or under the spectator's feet on the other side of the centre, is called the Nadir.

The Pole of the heavens is the point which remains fixed, while the rest of the Celestial surface seen above the horizon appear to revolve. That Pole which is above the horizon, is called the Elevated Pole.

The Celestial Equator is a great circle passing round the heavens, at 90° distance from the Poles, in the same plane as the Earth's Equator.

The Celestial Meridian is a circle passing through the Poles of the heavens, in the same plane as the Terrestrial Meridian.

Circles of Altitude are circles passing through the Zenith, and vertical at the place of the observer, and are measured from the Horizon towards the Zenith.

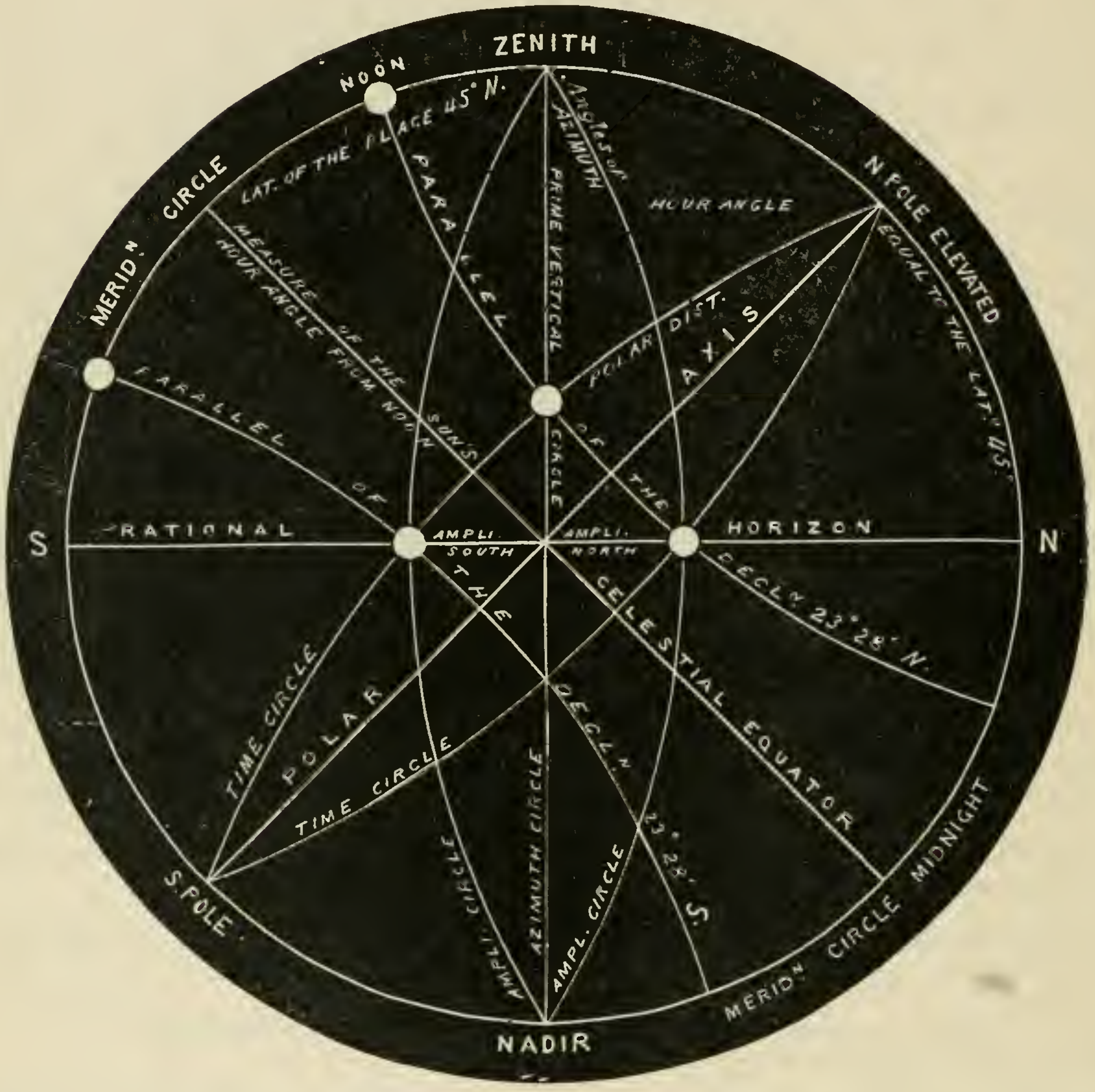
The Prime Vertical is the vertical circle passing through the East and West points in the centre, and appears as a straight line.

Zenith Distance is the distance of any heavenly body from the Zenith. The Zenith Distance is therefore the Difference between the Altitude and 90°.

DIAGRAM OF THE SPHERE.

Drawn on the Plane of the Meridian in 45° North Latitude.

FIG. 2.



In this Figure the Earth is supposed to be a mere Point in the Centre, and the Spectator situated at a great distance to the Eastward of it.

TO CONSTRUCT THE FIGURE.

Construct this figure in the same manner as in the preceding one. Then take 23° 28′ (the extent of the Sun's Declination North or South of the Equator) from the line of Chords, and lay it off on both sides of the Celestial Equator on the Meridian Circle, and take the same quantity, 23° 28′, from the line of Semi-tangents, and lay it off on both sides of the Equator on the Earth's axis. Then through these three points on each side of the Equator describe a Circle, which will be the Sun's Parallels of Declination North and South of the Equator. Suppose the Sun on the Prime Vertical, in the one case, having North Declination, and in the Horizon, in the other case, having South Declination. A Circle drawn from the Poles through these two points, will be the Time Circle, and which will cut the Equator at right angles. Take the Distance between it and the Meridian Circle, will give the measurement of the hour angle from Noon on the line of semi-tangents backwards 67°, or 4 hours 28 minutes. The Sun being on the Prime Vertical in the one case, and rising or setting in the other.

The Sun being on the Prime Vertical Circle, which in this case is also his Azimuth Circle, and which cuts the horizon at right angles, is measured on the horizon, towards the Polar side of the Meridian Circle, and in this case measures 90°, on the line of semi-tangents.

A Circle drawn from the Zenith to the Nadir, through the Sun's place in the horizon, is called the Amplitude Circle, and which cuts the horizon at right angles. The Distance between it and the centre, or the East and West points, measured on the line of semi-tangents, gives the Amplitude, 34°, North, in the one case, because the Declination is North, and South in the other case, because the Declination is South.

DEFINITIONS.

The Declination of a Heavenly Body is the portion of the Meridian contained between the Equator and the body. It is reckoned from the Equator, and is therefore either North or South. (See Fig. 2.)

Parallels of Declination are circles parallel to the Equator. Thus Declination is reckoned from the Celestial Equator, as Latitude on the surface of the Earth is reckoned from the Terrestrial Equator, and as both these circles are in one and the same plane, Declination and Terrestrial Latitude correspond.

Polar Distance is an Arc of the Meridian contained between a Celestial body and the Pole, or the Angular Distance of a body from the Pole. When the Latitude and Declination are of the same name, the Polar Distance is the difference between the Declination and 90°, because the distance from the Pole to the Equator is 90°. When the Latitude and Declination are of contrary names, the Polar Distance is the sum of the Declination and 90°.

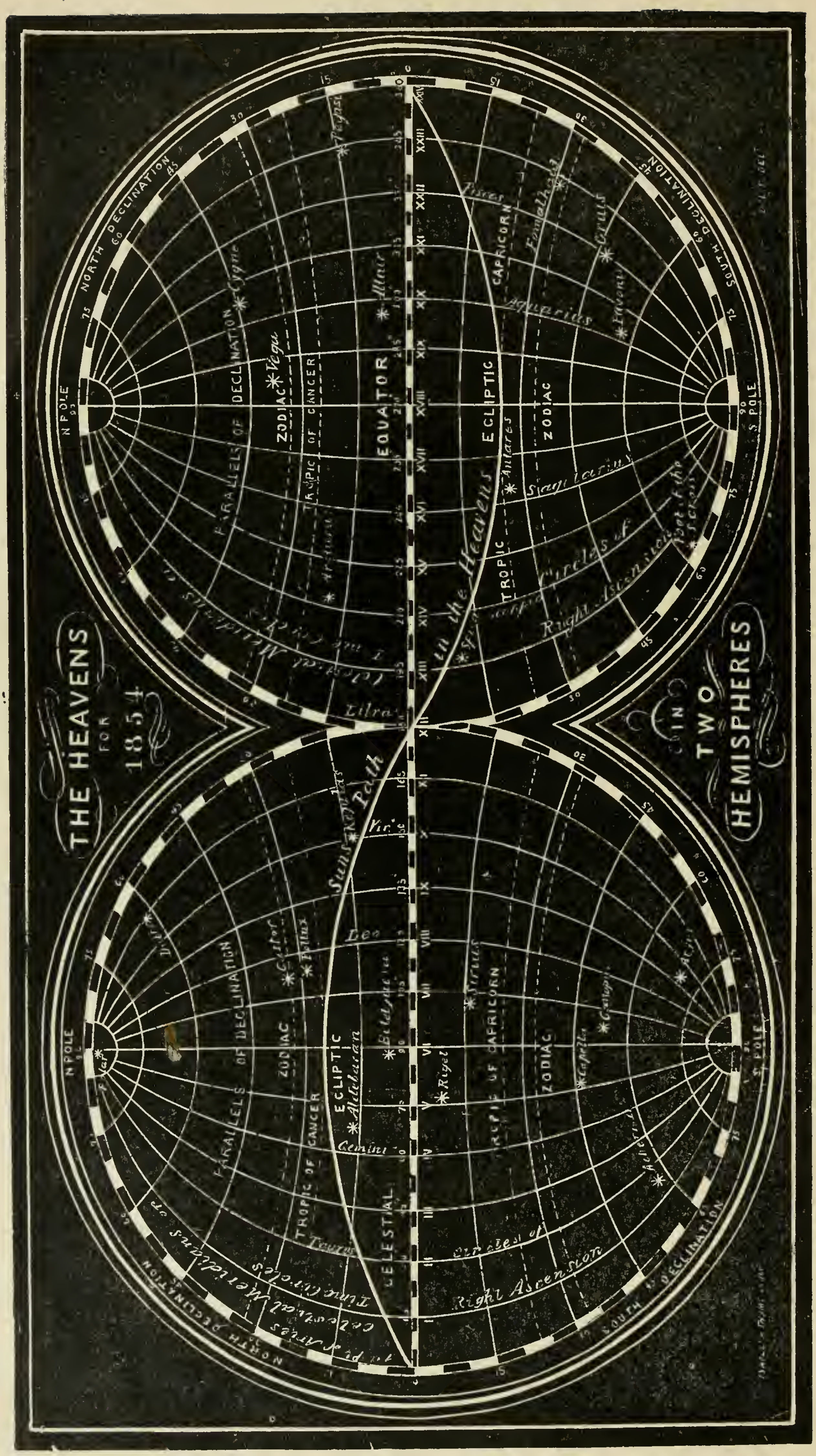
The Azimuth of a Celestial body is an Angle at the Zenith contained between the Meridian Circle of the place of the spectator and the Circle of Altitude passing through the body. It is reckoned to begin from that part of the Meridian Circle which is on the Polar side of the Zenith, that is, from the North in North Latitude, and from the South in South Latitude. The Supplement or Difference between it and 180° is frequently used for convenience, and reckoned from the opposite point. The Azimuth is measured by an Arc of the Horizon contained between the Meridian Circle of the place and the Circle of Altitude of the body, towards the East in the Morning and the West in the Afternoon. The Ship's Course is the Azimuth of the Ship's head, and reckoned from the North or South. So also is the bearing of an object its Azimuth.
When a body is on the Prime Vertical its Azimuth is 90°.

The Amplitude of a body is an Arc of the Horizon contained between a Celestial body at rising or setting, and the Prime Vertical Circle, or the East and West points. Amplitude is reckoned from the East or West towards the North when the Declination of the body is North, and towards the South when the Declination is South.

The Latitude, or Distance of the observer from the Terrestrial Equator, is measured on the Celestial Sphere and is the Distance of his Zenith from the Celestial Equator. When the object is to the South of the observer, his Zenith is to the North of the body, and is called North Zenith Distance. When the object is North of the observer, his Zenith is to the South of the body, and is called South Zenith Distance. Therefore, when the Declination and Zenith distance are of the same name, their sum is the Latitude of that name; and when of contrary names their difference is the Latitude of the same name as the greater of the two.

The Elevation of the Pole above the Horizon is equal to the Latitude of the place, and the Altitude of the uppermost point of the Equator on the Meridian is equal to the Co-Latitude, or the difference between the Latitude and 90°. By noting this, and also that the Equator passes through the East and West points, it is easy, in looking towards the Heavens, to figure in the mind, roughly, the position of this circle. This is often found useful in identifying a Star by means of its Declination, which is measured from the Equator.

The Hour Angle of a Celestial body is an Angle at the Pole contained between the Meridian Circle of the place and the Celestial Meridian or Time Circle, which passes through the body, and cuts the Equator at right angles, and is measured by an Arc of the Equator contained between the Meridian Circle of the place and the Time Circle which passes through the body, and in the case of the Sun gives the apparent time from noon, or his distance from the Meridian. reckoned at the rate of 15° to the hour.
Thus in figure 2d we have the Co-Altitude, Co-Latitude, and Polar Distance; three sides of a Spherical Triangle given to find the Angle at the Pole, which is measured on the Equator.
The Hour Angle is thus measured on the Celestial Equator, in the same way as Longitude is measured on the Terrestrial Equator.


THE HEAVENS
FOR
1854
IN
TWO
HEMISPHERES
N POLE
S POLE
NORTH DECLINATION
SOUTH DECLINATION
PARALLELS OF DECLINATION
ZODIAC
TROPIC OF CANCER
EQUATOR
ECLIPTIC
TROPIC
CAPRICORN
TROPIC OF CAPRICORN
CELESTIAL
Vega
Altair
Cygni
Pegasi
Pisces
Aquarius
Antares
Sagittarius
Libra
Vir.
Leo
Castor
Pollux
Aldebaran
Rigel
Sirius
Gemini
Taurus
Canopus
Achernar
Sun's Path in the Heavens
Circles of Right Ascension
Celestial Meridians or Time Circles

DEFINITIONS

The path on which the Sun appears to move, or the great Circle which he seems to describe in the Heavens, is called the Ecliptic.

The Ecliptic is divided into twelve Signs, or portions of 30° each, called the Signs of the Zodiac, which term means a space or belt of 8° wide on each side of the Ecliptic, in which the older discovered Planets and the Moon appeared to move, and to which they were confined. The Signs, taken in the order in which the Sun moves through them, that is, in the contrary direction to the apparent diurnal motion, are as follows:

♈ Aries, (The Ram.)	♎ Libra, (The Balance.)
♉ Taurus, (The Bull.)	♏ Scorpio, (The Scorpion.)
♊ Gemini, (The Twins.)	♐ Sagittarius, (The Archer.)
♋ Cancer, (The Crabs.)	♑ Capricornus, (The Goat.)
♌ Leo, (The Lion.)	♒ Aquarius. (The Water Bearer.)
♍ Virgo, (The Virgin.)	♓ Pisces, (The Fishes.)

Besides this perpetual motion from West to East, the Sun is always changing his Declination, which varies between 23° 28′ N., and 23° 28′ S., and he crosses the Equator twice in one year, namely: about the 21st of March, he is then entering the first point of Aries, and commences the Astronomical Year, and proceeds into North Declination. He crosses again about the 22d of September, and is then said to be in Libra, and proceeds into South Declination.

When the Sun crosses the Equator, he rises and sets at 6 o'clock in all parts of the world. At these times, therefore, the days and nights are everywhere equal.

The Sun attains his greatest North Declination about the 21st of June; he is then in the Tropic of Cancer; and his greatest South Declination about the 22d of December; he is then in the Tropic of Capricorn.

Since it is Summer on that side of the Equator on which the Sun is, and Winter on that side on which he is not, the Seasons in South Latitude are reversed.

The Common or Civil Year, as most convenient for the affairs of life, includes the succession of the seasons. It is therefore the interval in which the Sun leaves any Parallel of Declination, and returns to it again, and is called a Tropical Year. Its length, that is, the average length of a number of such years, is 365 days 5 hours 48 minutes 6 seconds of Common or Mean Time. The beginning of this Tropical Year commences on the 1st of January.

Declination being the Distance of any Heavenly Body, North or South, of the Celestial Equator, it is used in determining the position of the Fixed Stars, exactly as Latitude is used in determining places on the Earth's surface.

Right Ascension of a Celestial Body is an Arc of the Celestial Equator included between the first point of Aries and the Celestial Meridian of the body, and is reckoned from West to East. Circles of Right Ascension are drawn from the Poles through the body, and cutting the Celestial Equator at right angles.

The Celestial Equator is divided into 360° of Right Ascension, which, at the rate of 15° to the hour make also 24 hours of time. Thus Right Ascension is reckoned on the Celestial Equator, exactly as Longitude of places on the Earth is reckoned on the Terrestrial Equator. The first point of Aries being used as a first Meridian, and from which the Right Ascension of all the Heavenly Bodies are reckoned in hours and minutes, the same as the first Meridian of Greenwich is used to reckon the Longitude from, in Degrees and Minutes.

Right Ascension is therefore used in determining the places of the Heavenly Bodies, and is their distance in time from the first point of Aries.

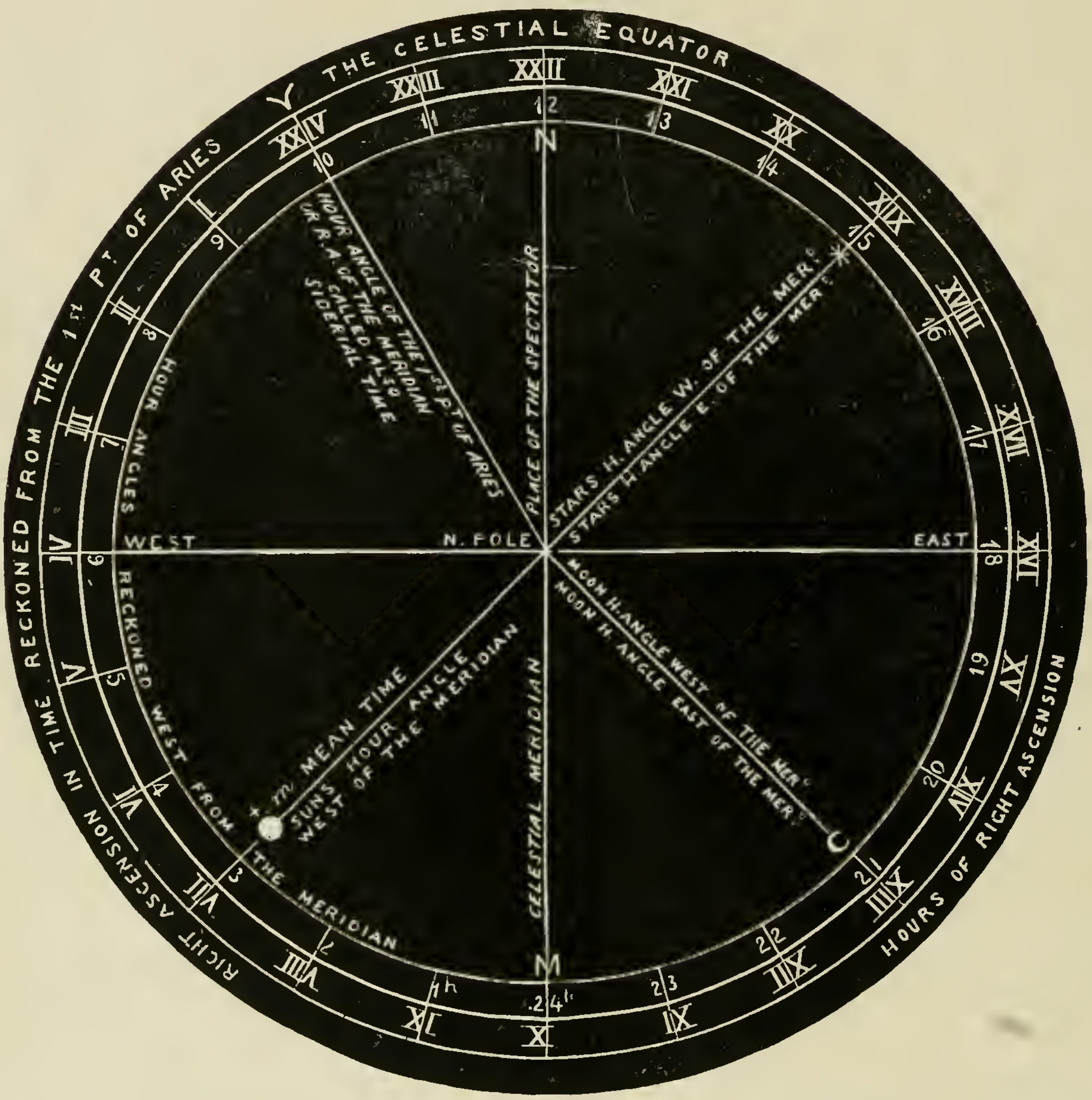
Sidereal Time begins when the first point of Aries is on the Meridian, and is counted through the 24 hours, till the same point returns again, which is called a Sidereal Day, and consists of 23 hours 56 minutes 4 seconds of Common or Mean Time.

The Hour Angle of the first point of Aries is the Right Ascension of the Meridian.

DIAGRAM,

Showing the Motion of the Heavenly Bodies round the Pole, drawn on the Plane of the Celestial Equator

FIG. 4.



In this Figure the Spectator is supposed to be standing on the North Pole, facing toward the South, having East on the Right hand and West on the Left.

TO CONSTRUCT THE FIGURE.

Take 60° from the Chords and describe a circle which will represent the Celestial Equator. Draw a perpendicular line to represent the Meridian. Make ♈ the first point of Aries, and mark the Hours of Right Ascension round the Equator from Right to Left, according to the progression of the Heavenly Bodies, which is, from East to West. Mark the Sun, whose Right Ascension from the first point of Aries is VII h. Then the Sun's Hour Angle West of the Meridian at M is 3 hours.

The first point of Aries having passed the Meridian 7 hours before the Sun, the Sun's Hour Angle added to it gives X h. as the Right Ascension of the Meridian, or, as it is called, the Sidereal Time, which commences when the first point of Aries is on the Meridian, and is counted through the 24 hours, until it again comes to the same Meridian.

Suppose a Star, whose Right Ascension is XIX h., which has passed the opposite Meridian at N., its Hour Angle is 15 h., counted from the Meridian round by the West, which, together make 34 h., from which subtract 24 h., gives X h. for the Right Ascension of the Meridian; or, if counted to the Eastward, its Hour Angle from the Meridian is 9 h. Subtracted from XIX (its Right Ascension) gives the same.

Suppose the Moon's Right Ascension to be XIII, and her Hour Angle 21 h., which together make 34, from which subtract 24 hours, gives the Right Ascension of the Meridian as before, X h. Or the Moon's distance from the Meridian to the East being 3 h., subtracted from her Right Ascension, gives the same.

From the above figure it will be perceived that the Celestial bodies in their diurnal motion in the Heavens are continually forming Angles with the Meridian around the Pole from West to East, caused by the rotatory motion of the Earth on its axis, contrary to their motion in Right Ascension, which is from East to West, and which is caused by the Earth revolving round the Sun.

All Hour Angles, which are differences of Right Ascension of the Meridian and that of a Celestial body, may be considered as portions of Sidereal Time. The interval of time in which a body describes an Hour Angle, depends on the rate at which its Right ascension changes.

The Earth's motion round its axis being perfectly uniform, becomes the real standard of a uniform measure of time. But as any Star passes the Meridian nearly 4 minutes earlier every night, the beginning of the Sidereal Day has no connexion with that of the common, or Civil Day, as determined by light and darkness

The Hour Angle of the Sun, reckoned always Westward from the Meridian. is Apparent Time. Thu when the Sun's Meridian has passed over 45° of the Celestial Equator to the Westward of the meridian of the place, it is said to be 3 hours Apparent Time.

The interval between the Sun's passing the Meridian on one day and the next, or the apparent Solar Day, is not always of the same length, the difference being sometimes half a minute between one day and the next. But the time for general use must unite the two advantages of being regulated by the Sun and of being perfectly uniform. The mean, or average day of 24 hours, must therefore be an average taken of all the days in the year. That is, such a day as the Sun would regulate if he moved uniformly in Right Ascension, or the time a Solar Clock would show, when set at 0 hours, 0 minutes, 0 seconds, at the instant the Sun was on the first point of Aries, and keeping uniform time until his return to the same point, would again show 0 hours, 0 minutes, 0 seconds.

This average day is called the Mean Solar Day, and the time thus regulated, is called the Mean Time.

The Sun being generally either behind or in advance of the position which he would have occupied if he had moved uniformly, Apparent Time is in general either fast or slow of Mean Time. The correction for this irregularity, that is, the Difference between the Sun-Dial and the Solar Clock, is called the Equation of Time. Mean Time is, therefore, deduced from Apparent Time, by applying the correction for the Equation of Time taken from the Nautical Almanac.

Suppose ○ to be the place of the Sun, in Fig. 4, at 3 P. M. Apparent Time, and *m* the place he would be if he moved uniformly. Then the space between ○ and *m*, is the Equation of Time, and *M m*, the Mean Time from Noon. The Equation is here additive to Apparent Time, as is the case from January to March, and from July to August.

Referring to Fig. 4 again. While the Sun and Aries revolve, the Sun moves contrary to the diurna rotation, or is always increasing his Right Ascension by nearly 1° a day. The complete revolution of ♈ constitutes a Sidereal Day, that of ○ an Apparent Solar Day, and that of *m* a Mean Solar Day.

After 24 Sidereal hours, the Sun has still to describe about 1°, or one 360th of 24 Sidereal hours, or 4 sidereal minutes. Thus the Solar Day is longer than the Sidereal Day by about 4 minutes. The Mean Solar day being divided into 24 hours, the Sidereal Day is 23 hours, 56 minutes, 4 seconds of such a day.

Since the Sun passes over 15° of the Circle in one Mean hour, he arrives at the Meridian of a place 15° West of *M* one hour *after* he has passed *M*, that is, at one o'clock of the time at any place, or all places of which *N M* is the Meridian. In like manner, he passes a Meridian 15° East of *M* one hour *before* he arrives at *M*, that is, when the time at *M* is 11 o'clock in the forenoon, or 23 hours after the noon of the day before.

Thus the beginning of the day, and therefore the hour of the day at one place differs from that of another place by the difference of Longitude of the places. The time at the Easternmost of the two being in advance of, that is, greater than the time at the other. Hence, when the Mean Time at two places at the same instant are known, their Difference of Longitude is determined, and also the relative positions of their Meridians.

The Civil Day is dated from Midnight, and the 12 hours are computed twice over. The Astronomical Day is dated from Noon, and runs through the 24 hours. Civil Time is converted into Astronomical Time by diminishing it by 12 hours.

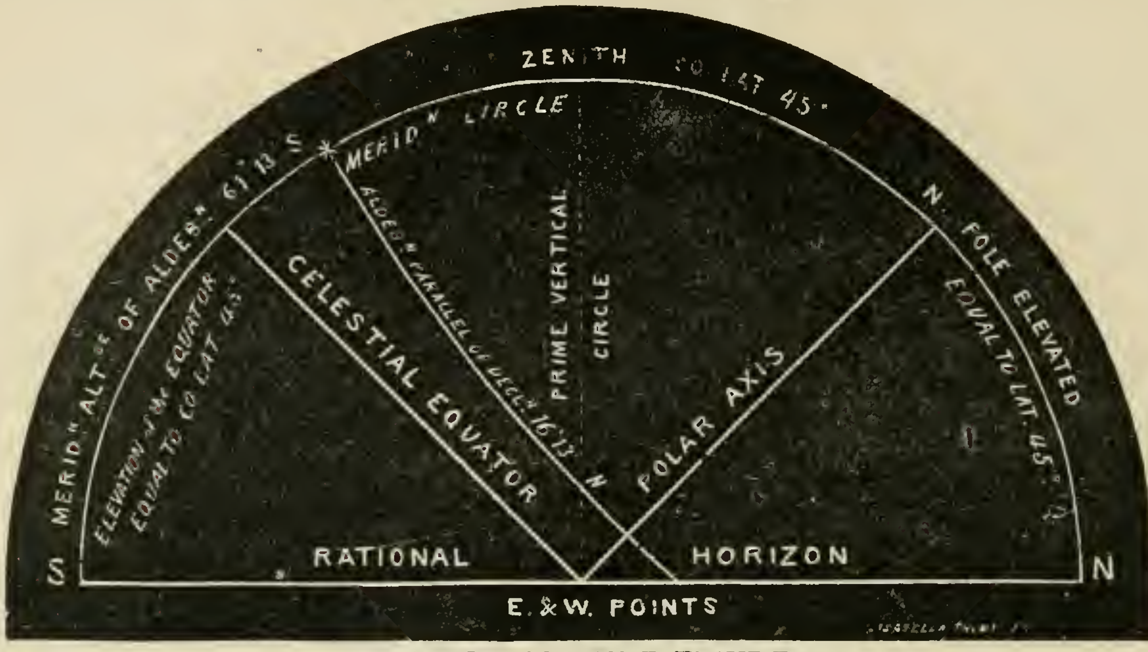
DIAGRAM.

Showing the method of finding the Stars in the Heavens from their Meridian Altitudes.

Find the Meridian Altitude of the Star Aldebaran in the Latitude of 45° North

Fig. 5.

Drawn on the Plane of the Meridian.



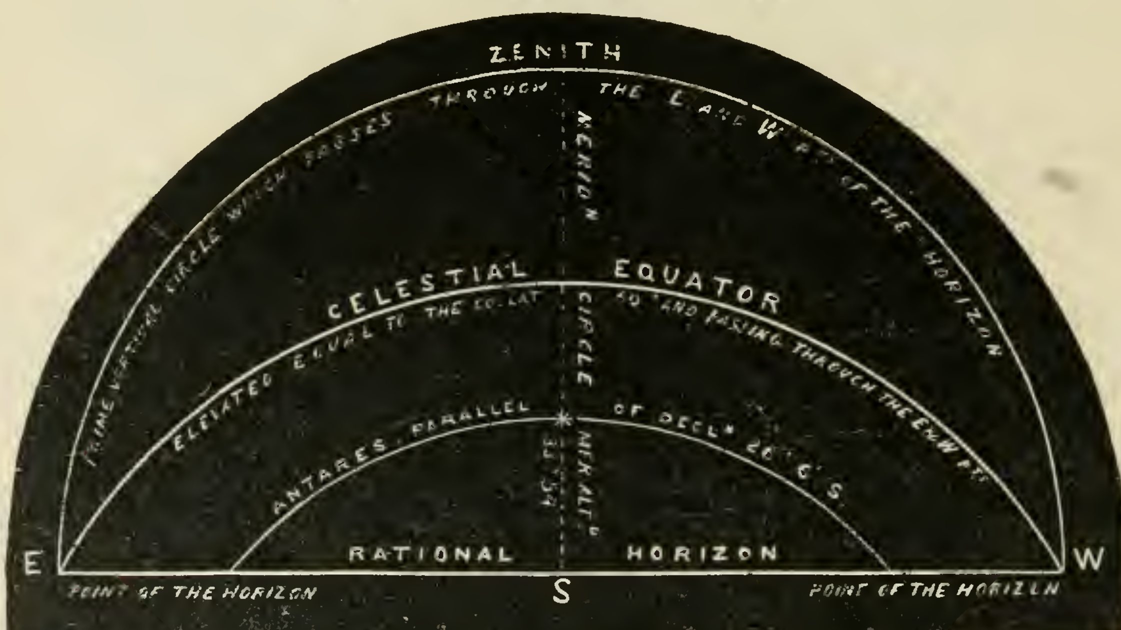
TO CONSTUCT THE FIGURE.

With the Chord of 60 describe a semi-circle, and draw the Horizontal and Prime Vertical lines at Right Angles to each other. Elevate the Polar Axis equal to the Latitude of 45° N., and draw the Equator at Right Angles to it. Lay off the Star's Declination, 16° 13′, on the Meridian to the North of the Equator, which will be the place of the Star, and its Distance measured from the Horizon, is the Altitude required. Now, as the Elevation of the upper end of the Equator above the Horizon, is equal to the Co-Latitude of the place, which is North, and the Declination of the Star being also North, their Sum is the Meridian ltitude of the Star, 61° 13′, South of the observer, because his Latitude is North.

Find the Meridian Altitude of the Star Antares in the Latitude of 30° North.

Fig. 6.

Drawn on the Plane of the Prime Vertical.



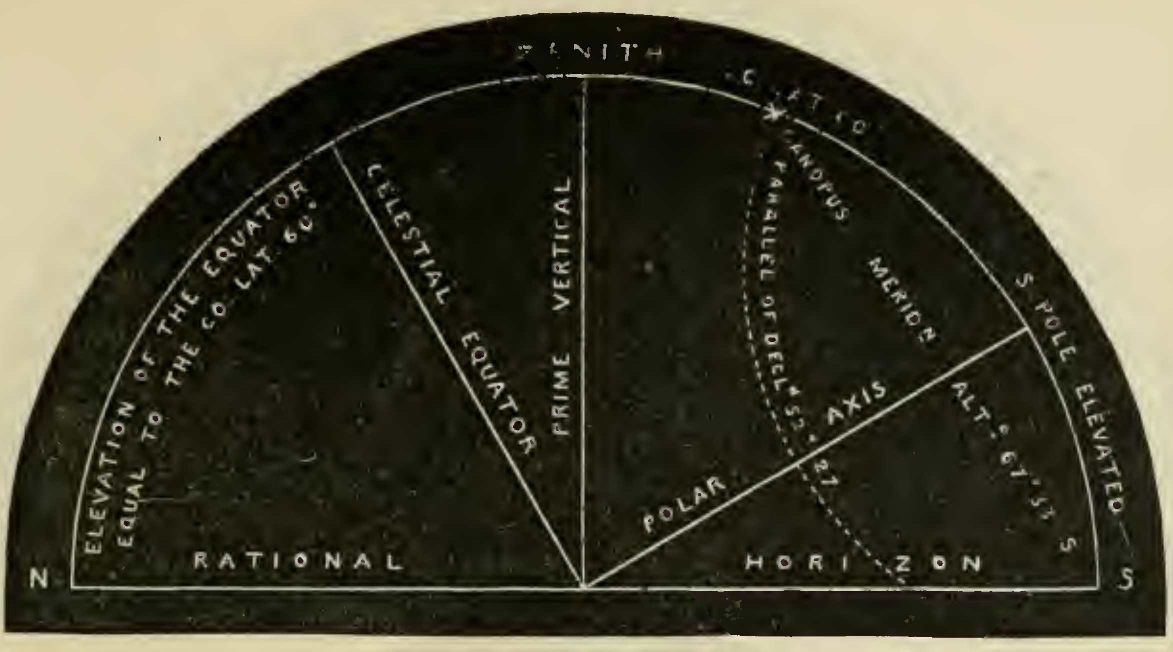
TO CONSTRUCT THE FIGURE.

With the Chord of 60°, describe a semi-circle as before, which will represent the Prime Vertical Circle Draw the Rational Horizon line, and at right angles to it from the centre, draw the Meridan line or Circle. The Spectator is now facing the South. The Prime Vertical Circle passes through the East point of the Horizon on the Left, and through the West point of the Horizon on the Right.

The Elevation of the Celestial Equator above the Horizon being equal to the Co-Latitude, take 60° the Co-Latitude) from the line of semi-tangents, and lay it off on the Meridian line. Then through this point, and the East and West points of the Horizon, draw the Celestial Equator. From the line of semi-tangents take the Star's Declination, 26° 6′ South, (measured from 60° backwards,) and lay it off from the Equator towards the South point of the Horizon on the Meridian line, and draw the Parallel of Declination parallel to the Equator. Then where it crosses the Meridian line is the Star's place, and its Altitude above the Horizon is 33° 54′ South, measured on the line of semi-tangents; and where the Parallel of Declination cuts the Horizon shows the places of the Star's rising and setting.

Find the Meridian Altitude of Canopus, in the Latitude of 30° South.

Fig. 7.



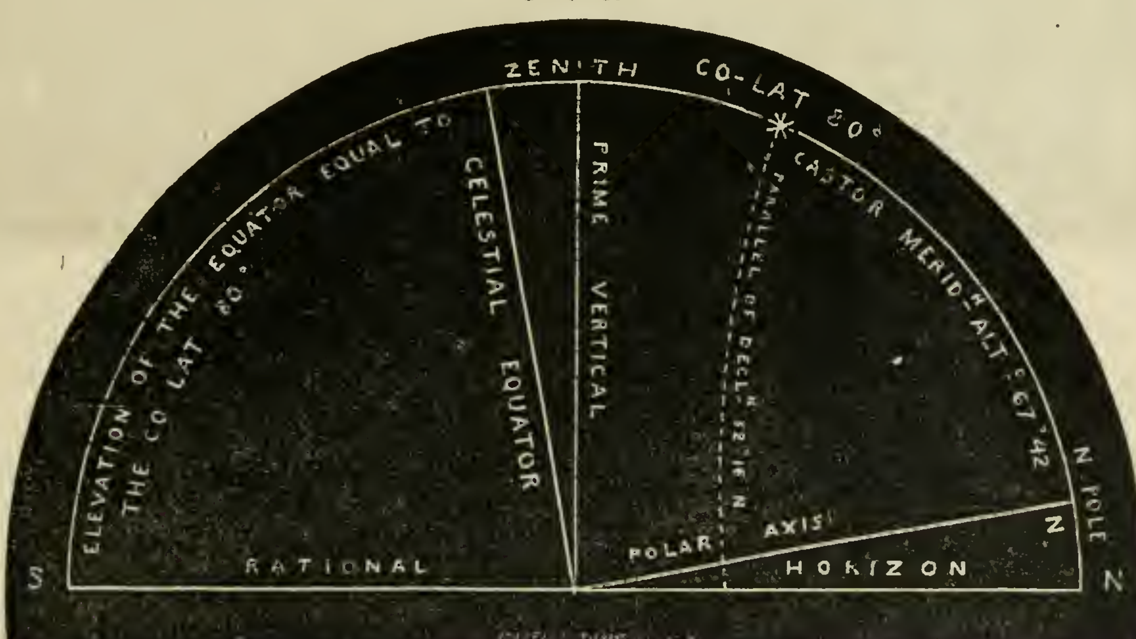
TO CONSTRUCT THE FIGURE.

Having drawn this Figure as in Figure 5, elevate the Polar Axis equal to the Latitude of 30° South, and draw the Equator at Right Angles to it. From the Equator, lay off the Star's Declination, 52° 27′, on the Meridian towards the South, which will be the place of the Star, and its distance from the nearest Horizon is its Meridian Altitude South.

In this case, the elevation of the upper end of the Equator above the Horizon being equal to the Co-Latitude of 60° South, and the Declination of the Star 52° 27′ South, both of the same name, their Sum 112° 27′ exceeds 90°, must be subtracted from 180°, gives the Meridian Altitude of the Star 67° 33′, reckoned from the South point of the Horizon.

Find the Meridian Altitude of Castor in the Latitude of 10° North

Fig. 8.



TO CONSTRUCT THE FIGURE.

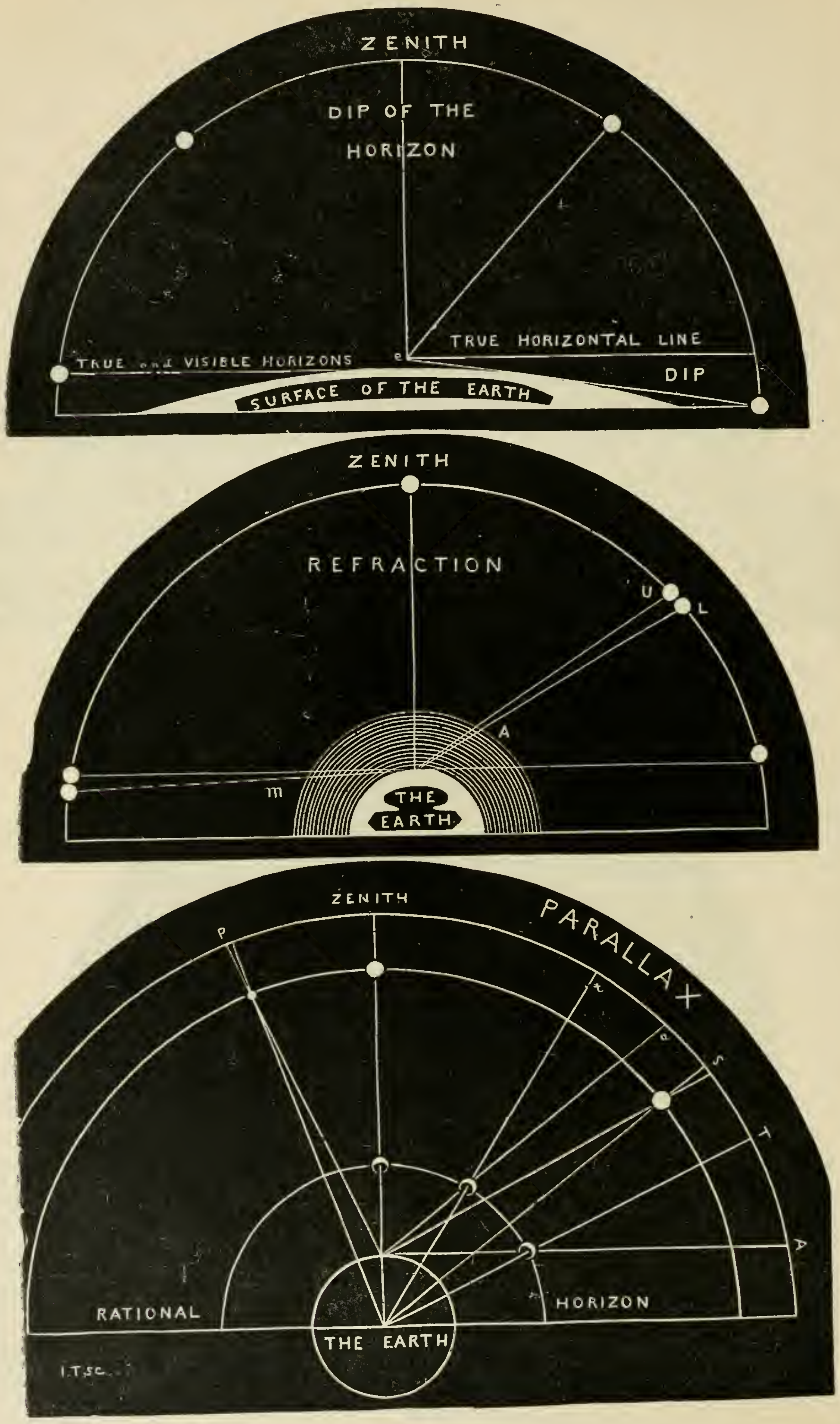
Elevate the Polar Axis equal to the Latitude of 10° North, and draw the Equator at right angles to it rom the Equator lay off the Declination of the Star, 32° 18′, on the Meridian towards the North, which will be the Star's place. Then its distance from the nearest Horizon is its Meridian Altitude.

In this case, the Sum of the Co-Latitude 80° North, and the Star's Declination 32° 18′ North, is 112° 8′, which exceeds 90°, must be subtracted from 180°, gives the Altitude 67° 42′ North.

Thus having the computed Altitude of any Star on the Meridian, the Star itself is found by setting the index of the instrument to this Altitude and facing towards the South or the North, as the case may be, and the Star will be seen on the Horizon.

On referring to Figure 4, the time at which the Stars pass the Meridian is easily computed by subtracting the Sun's R. Ascension from the Star's R. Ascension, (increasing the latter by 24 hours, if necessary), will be the apparent time of its Meridian passage. For example: Suppose a Star, whose R. A. is XIX h in Fig. 4; the Sun's R. A. same time is VII h · the difference 12 h or Midnight is the time the Star passed the Meridian at N

FIG. 9.


ZENITH
DIP OF THE HORIZON
TRUE HORIZONTAL LINE
VISIBLE HORIZONS
TRUE
e
DIP
SURFACE OF THE EARTH
ZENITH
REFRACTION
U
L
A
m
THE EARTH
ZENITH
PARALLAX
P
S
T
A
RATIONAL
HORIZON
THE EARTH

CORRECTIONS OF THE ALTITUDES OF THE HEAVENLY BODIES OBSERVED AT SEA

Dip of the Horizon is the Angle through which the Sea Horizon appears depressed, in consequence of the elevation of the spectator's eye above the Sea level.

Suppose the observer's eye to be at *e* (in the figure for Dip of the Horizon) and a perpendicular line drawn to his zenith. Then a line drawn at right angles to it will be the True Horizontal Line. But his eye being elevated above the Sea, his vision extends over the curvature of the Earth's surface, in the direction of the Visible Horizon, or the dividing line between the Sea and Sky. And as the Altitudes of all Heavenly Bodies are measured to this line, it is evident that the Altitudes so obtained are too great by the amount of the angle of the Dip of the Horizon contained between the True and the Visible Horizons. The distance of the Sea Horizon from the observer is about 6 miles when the eye is elevated 30 feet above the Sea; and if it were possible to observe an Altitude with the eye at the surface of the Sea, as at S, there would be no correction required for Dip, because the True and the Visible Horizons are in the same line and the Rational Horizon is considered to be also on the same line.

The Dip of the Horizon at different elevations is given in Table V for that purpose, and is always subtractive from the observed Altitude.

Refraction.

The rays of light proceeding from a Heavenly Body when not in the zenith, in traversing the Earth's atmosphere, become bent or refracted more and more, on approaching the surface of the Earth towards the perpendicular, which causes all the bodies to be seen above their true places in the Heavens consequently the observed Altitudes are too great by the amount of the Refraction. The rays of light proceeding from the Sun at L (in the figure for Refraction), entering the atmosphere at A, becoming bent upwards as it proceeds, the spectator sees the object at U, and the difference between the True and the Apparent places of the Sun is the amount of Refraction. The Refraction is 0 at the zenith, because the rays of light penetrate directly downwards, and are not bent out of their course. At the Horizon the Refraction is about 34′, because the rays of light enter the atmosphere obliquely, so that all bodies, (except the Moon), when on the Horizon, are raised that much above their true place. In the figure the lower ☉ appears in his true place *below* the Horizon, but the rays of light entering the atmosphere at *m* are bent upwards or refracted, and the ☉ is seen above his true place *in* the Horizon. Refraction diminishes as the Altitudes increase from the Horizon to the Zenith, and the correction for Refraction is given in Table IV for that purpose, and is always subtractive from the observed Altitude.

Parallax.

As before observed, the Earth is considered as a mere point in the centre of the Sphere, as regards the Stars, which are situated a great distance from it, but with respect to the Sun, Moon, and Planets, the Earth's semi-diameter must be taken into consideration in measuring the Altitudes of these bodies, especially the Moon, which is the nearest to the Earth. Parallax, therefore, is the depression of a Heavenly body, in consequence of its being seen from the surface instead of from the centre of the Earth, and the nearer any Heavenly body is to the Earth, the greater is the Angle of Depression

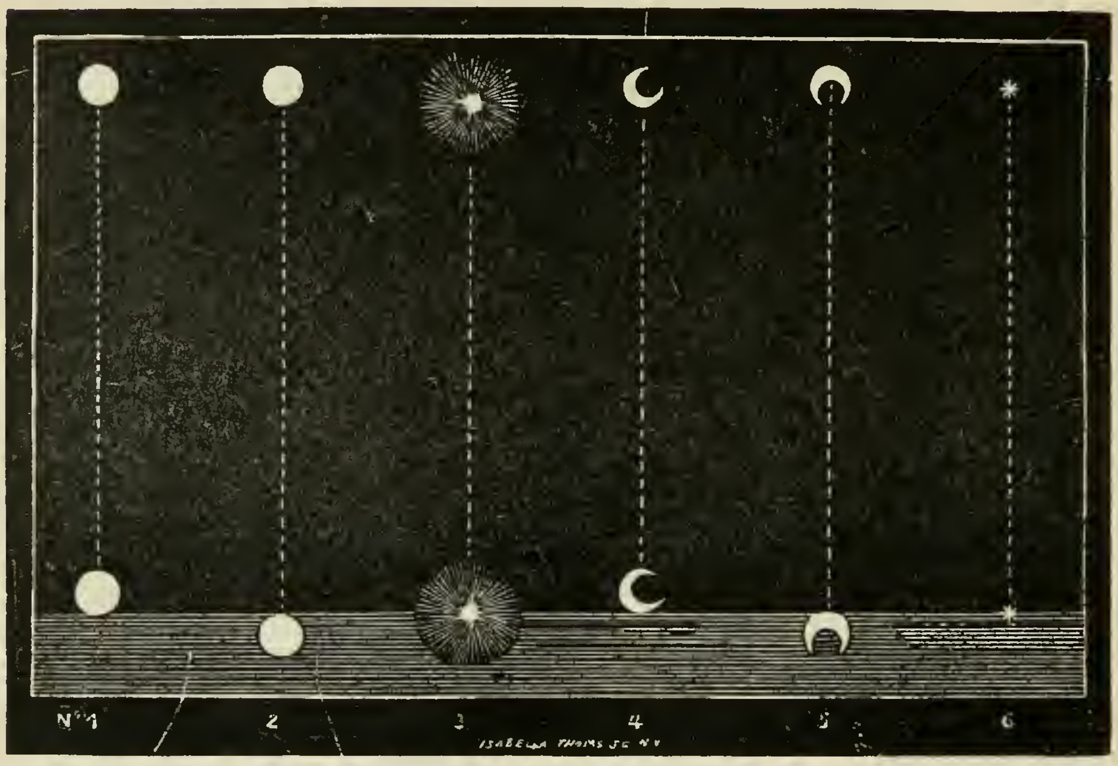
The Moon, to an observer at the surface, would appear to be situated in the Heavens at A, (in the figure for Parallax), but to an observer at the centre, her place would be at T, her true place in the heavens; and the difference between the two places is called her Horizontal Parallax, and which is always greatest at the Horizon. Again, to an observer at the surface, the Moon would appear at *a*, but to an observer at the centre of the Earth she would be at *t*, her true place in the Heavens. The difference between these two places is called her Parallax in Altitude. The Sun and Planets being at a greater distance from the Earth have only a very small parallax. S and P represent the Parallax of the Sun and Planet. When a body is in the Horizon its Parallax is greatest The Sun's Parallax is only 9″, while the Moon's Parallax is above 1° sometimes. But when a body is in the Zenith its Parallax is 0, because it is seen in the same line from the centre as from the surface as at Z. The Sun's Parallax in Altitude is given in Table VI.

The Moon's Horizontal Parallax, which is in perpetual change, and the Parallax of the Planets, are given in the Nautical Almanac.

DIAGRAM,

Showing the Manner of Measuring the Altitudes of the Heavenly Bodies at Sea, and the Correction for Semi-diameter.

FIG. 10.



This figure represents the different methods of observing the Altitudes of the Sun and Moon by bringing their upper or lower limbs in contact with the Horizon.

No. 1 is an Altitude of the Sun's lower limb brought in contact with the Horizon. This is the usual method practised at Sea, being the most simple and correct mode of doing it. His semi-diameter added gives his observed Central Altitude.

No. 2 is an Altitude of the Sun's upper limb brought in contact with the Horizon. This is only resorted to in the event of the lower limb being hidden by clouds. His semi-diameter subtracted gives his observed Central Altitude.

No. 3 is an Altitude of the middle of the Sun brought down to the Horizon. This kind of observation is only used when his limbs are so ill-defined, in consequence of the sky being overcast, as in the case when he shines through a rain-cloud, that no observation can be made with them; the body of the Sun, however, may be visible. By a little practice this method may be turned to a good account in finding the Latitude of the Ship, in the room of a better. At all events, it is more to be trusted to than the Latitude by Dead Reckoning. In this case no semi-diameter is allowed, because the Central Altitude is observed.

No. 4 is an Altitude of the Moon's lower limb brought in contact with the horizon. In this case the Moon's semi-diameter added, gives her observed Central Altitude.

No. 5 is an Altitude of the Moon's upper limb brought in contact with the Horizon. This is necessary when her horns are turned downwards, and in this case, her semi-diameter subtracted gives her observed Central Altitude.

No. 6 is an Altitude of a Star or Planet bisected on the Horizon. This gives its observed Central Altitude.

The semi-diameter of the Sun is given in the Nautical Almanac throughout the year. His greatest semi-diameter is 16′ 18″, at the time the Earth is nearest to the Sun, in December; and his least is 15′ 45″, at the time the Earth is farthest from the Sun, in June. But in dealing with Altitudes, we generally allow 16′ as his mean semi-diameter throughout the year.

The Moon's semi-diameter is also given in the Nautical Almanac for the nearest noon and midnight at Greenwich, because it changes very rapidly, her greatest being about 16′ 48″, and her least about 14′ 43″, so that it is necessary to take it from the Almanac when great accuracy is required. But in general the mean of the extremes, which is about 16′, is taken as the Moon's semi-diameter.

The Stars and Planets require no correction of the Altitude for semi-diameter.

INSTRUMENTS OF NAUTICAL ASTRONOMY.

DESCRIPTION, ADJUSTMENTS, AND USE OF THE QUADRANT AND SEXTANT.

These are instruments for measuring angles between two objects, by bringing the reflected image of one of them in contact with that of the other seen direct. They are also necessary for observing Altitudes of the heavenly bodies at Sea, where the spectator has no fixed point of reference except the horizon. (See Fig. 10.)

On Shore this fixed point is obtained by means of the Artificial horizon, when the Sea horizon is obstructed by the land.

The Quadrant contains an Arc of more than 45°, or the eighth part of a Circle; but on account of the double reflection it measures a few degrees more than 90°. The Arch, or Limb, is divided into degrees, and numbered from Right to Left. These are subdivided into 3 parts of 20 minutes each, which are again subdivided into single minutes, by means of a scale at the end of the Index. The Index is a flat brass bar that turns on the centre of the instrument. When moved forward in measuring Altitudes the screw behind clamps it to the limb, and the tangent screw is then used to make the contact.

The Nonius is a scale fixed to the lower part of the Index bar, and is sometimes called a Vernier. This is a portion of an Arc having the same centre, and divided into one part more than an equal portion of the Arc itself, and is used for making more minute divisions on the Arch, which may be best explained by the following

EXAMPLE.

Suppose a division on the Arch to be one-third of 1°, or 20′, and the Vernier to be equal in length to 19 divisions, or 380′, and divided into 20 equal parts, then each of the divisions on the Vernier is one-twentieth of 380′, that is 19′, and therefore the difference between one division on the Arch, or 20′, and one on the Vernier, is 1′.

Now, suppose the beginning of the Vernier at 0 to coincide with the beginning of the Arch at 0, then the first of the dividing lines of the Vernier falls short of the first dividing line of the Arch by 1′. Therefore, if these lines are made to coincide, the Vernier must be advanced 1′, and to make the next dividing line or 2 on the Vernier, coincide it must be advanced again, and so on until the division of 20′ on the Arch is all gone through. Hence, for an angle *on* the Arch, the number of divisions counted on the Vernier before the coincidence is arrived at, is the number of minutes to be added to the division of the Arch next behind the 0 on the Vernier. For an angle *off* the Arch, it must be read from the opposite *end* of the Vernier

TO READ OFF AN ALTITUDE.

Look at the 0, or beginning of the Vernier, and ascertain how many degrees and divisions it has passed on the Arch, counting the first division 20′, the second 40′, and then look along the divisions, or lines, on the Vernier until one of them is found to coincide with a division, or line, on the Arch, which being counted from the 0, or beginning of the Vernier, towards the left, is the number of minutes to be added to that division on the Arch which is the nearest to the right of the 0 on the Vernier, and which will be the Altitude required.

In some Quadrants the Vernier is divided into 40 equal parts, and the Angles can then be read off to half minutes, or 30″

TO ADJUST A QUADRANT.

To Set the Index Glass Perpendicular to the Plane of the Instrument.

Move the Index to about 45° on the Arch, and holding the instrument in a horizontal position, face upwards, look obliquely into the Index Glass, and ascertain if the true and reflected images of the Arch are in the same straight line; if so, the Glass is adjust. But if the reflection seems to droop from the Arch itself, the Glass leans back; if it rise upwards, the Glass leans forward. The position is rectified by the screws on the back.

To Set the Horizon Glass Parallel to the Index Glass.

Set the 0 on the Vernier at 0 on the Arch, and clamp the Index; hold the instrument vertically, and look through the sight-vane at the horizon, or any other well-defined and distant object. Then, if the reflected and the true horizons appear in the same straight line, the Glass is adjust. But if the horizons do not coincide, use the lever on the under side of the instrument until they are made to do so. This adjustment ought to be tried before and after every observation.

To Set the Horizon Glass Perpendicular to the Plane of the Instrument.

Having previously made the above adjustment, incline the instrument on one side as much as possibl Then, if the horizon seen through the sight-vane continues to form one unbroken line, the Glass is adjust. But if the reflected horizon appears to separate from that seen direct, then the Glass wants rectifying. If the face of the instrument is upwards, and the reflected Sea appears higher than the real Sea, you must slacken the screw before the Horizon Glass and tighten that behind it. But if the reflected Sea appears lower, the opposite screws must be used. Care must be taken in this adjustment to loosen one screw before the other is screwed up, and to leave the adjusting screws tight. Some instruments have their adjusting screws differently constructed, but a little practice will soon enable a person to adjust them.

The graduation of the Arch should commence at a certain point. When this is not the case, the Index Error, as it is called, must be measured.

The point at which the graduation of the Arch is supposed to begin, is that at which the Index stands when the mirrors, or glasses, are parallel, as is the case when the image of a distant object is seen to coincide with the object itself. The Index Error, therefore, is merely the error of the place of the beginning of the divisions, and affects all angles alike.

TO FIND THE INDEX ERROR

By the Horizon.

Hold the instrument vertically, and make the image of the horizon coincide with the horizon itself, as accurately as possible

Then, if the 0 on the Vernier stands at the 0 on the Arch, there is no Index Error. Suppose it stood at 2′ on the Arch, that is, to the Left of the 0 on the Arch, then the Index Error is that much subtractive, but if it stands at 2′ off the Arch, that is, to the Right of the 0 on the Arch, then it is that much additive to all angles taken by the instrument.

By the Sun.

If the instrument has no Shade for the Horizon Glass, take the opportunity when the Sun is veiled over by thin clouds, and use them as a substitute for Shades. Hold the instrument vertically, and look through the sight-vane directly at the Sun, and make the reflected sun cover the one seen direct. Then if the 0 on the Vernier stands at 0 on the Arch, there is no Index Error. Otherwise it is found as before explained.

For the purposes of adjusting an instrument, objects should be used which are at least 1 mile distant; because at a nearer object the distance between the glasses produce a sensible parallax, and the coincidence does not take place

MANNER OF MEASURING ALTITUDES WITH THE QUADRANT

To Observe the Sun's Altitude at Sea.

Set the index at 0, and put down a screen or shade before the Index Glass. Hold the instrument in a vertical position, and direct the sight through the sight-vane and Horizon-Glass to that part of the horizon which is directly under the Sun. Now move the Index onwards with the left hand, and the image of the Sun will appear to descend towards the horizon. Give the instrument a slow motion from side to side, round the line of sight, and the Sun will appear to sweep the horizon, and it must be made just to touch it at the lowest part of the arch. This gives the Observed Altitude of his lower limb. It is best to commence the observation some time before the Meridian Altitude is expected, and to continue observing until his greatest Altitude is obtained, unless the watch has been previously regulated and the apparent time at the ship known.

This last Altitude is sometimes near enough, but for accuracy, having made a rough contact as above, put in the telescope, previously set to distinct vision by looking through it at the horizon, and the tube may be marked at the proper focus of the observer's eye. The image being now magnified, the contact is made more correctly. Clamp the Index, and make the contact perfect by turning the Tangent Screw. This is the method generally used in taking Altitudes for time.

The Tangent Screw should be kept nearly middled when not in use, and the contact should be made in the centre of the field of view of the telescope.

To Observe the Altitude of a Star.

Turn up the sight-vane or unship the telescope. Set the Index at 0, and direct the sight to the star, and look with both eyes, as close to the sight-vane or color of the telescope as possible, and move the Index onwards, when the reflected star will be seen to descend, and which must be followed by the eye until it finally reaches the horizon. Now give the instrument a slow motion from side to side, round the line of sight, and the Star will appear to sweep the horizon, which it must be made to touch at the lowest part of the arch

To find any particular star on the Meridian, the readiest way is to compute the Meridian Altitude, (See pages 64 and 106) and set the Index to it. Then with both eyes, as before observed, look towards that part of the horizon indicated, and the proper star will be seen on or near it. Continue to observe it, until it tains its greatest Altitude. By this means it is impossible to mistake the star, because no other can be on the Meridian at that time.

The Altitude of Planets

May be observed in the day time, even when the Sun is considerably above the horizon, for though they are invisible to the naked eye, they may readily be found by computing their Meridian Altitude, (see page 104), and set the Index to it. Screw in the telescope, and direct the sight to the true North or South points of the horizon at the time it passes the Meridian, and the Planet will be plainly seen on or near it.

To Observe an Altitude of the Moon.

The same directions may be followed as given for the stars, to bring her down to the horizon, and the telescope afterwards used in making the contact. But sometimes, when she is faintly seen, it is better to use both eyes without the telescope. Her upper limb must be observed when her horns are downwards, and care must be taken, in making the sweep for the horizon, that her limb just touches it at the lowest part of the arch.

The best time for making observations of the Moon and Stars is at twilight, for then the horizon is distinctly visible; but in cloudy weather at night long dark shadows are sometimes projected on the sea, which, in the case of the Moon, renders it difficult to ascertain the real horizon under her.

THE SEXTANT

The Sextant is constructed upon the same principle as the Quadrant, and contains an Arc of more than 60° of a circle, but on account of the Double Reflection, it measures Angular Distances of more than 120°. The Arch or limb is divided into degrees, and the degrees into 6 equal parts of 10′ each. The Vernier is generally cut to 10″, for the purpose of minute readings, which is thus explained: Suppose a division on the Arch to be $\frac{1}{6}$ of 1° or 10′, and the Vernier to be equal in length to 590 of such divisions, or 9° 50′, but divided into 600 equal parts. Then each of the divisions on the Vernier is $\frac{1}{600}$ part less than the 591 divisions on the Arch. Therefore the difference between one division on the Arch and one on the Vernier is 10″. As the Vernier contains 600″, it is divided into 10 equal parts or minutes, and the minute into 6 equal parts of 10″ each.

Now suppose the ⇕ or beginning of the Vernier, and the 0 or beginning of the Arch to coincide; then the first of the dividing lines of the Vernier fall short of the first dividing line of the Arch by 10″. If we make these lines coincide, we advance the Index and Vernier 10″. Again, to make the second dividing line of each to coincide, we must move the Vernier to 20″, and so on to 30″, 40″, 50″, and then to 1′. Therefore to make 1′ on the Vernier coincide with 1′ on the Arch, we must advance the Index or Vernier 1′. Hence for an angle *on* the Arch the number of divisions counted on the Vernier before we arrive at a coincidence is 10″, 20″, &c., to be added to the division of the Arch next behind the ⇕ or to the right of the beginning of the Vernier. For an angle *off* the Arch we must read from the opposite end of the Vernier and from left to right.

The scale on which these divisions are marked is generally made of silver, and in consequence of their minuteness a magnifying glass must be used in reading them off, which is fixed to the Index bar for that purpose.

The Adjustment of the Sextant is done in exactly the same manner as that described of the Quadrant The only addition is the following:

To set the Line of Sight of the Telescope parallel to the Plane of the Instrument.

This is a very important matter, because when the Inverting Telescope is used, as in the case of measuring the Lunar Distance, any defect in this adjustment causes a considerable error in the measurement of the angle, and always makes it *too great*.

Place the two wires of the Inverting Telescope parallel to the plane of the instrument. Select two distant objects about 120° apart from each other, such as two stars, or the Sun and Moon, and make an exact contact at the lower wire, or that nearest the instrument. Now move the instrument so as to throw the image in contact upon the upper wire. If the contact is still perfect, (the images continuing the same in the middle of the field), the adjustment is perfect; but if they have separated, the object end of the telescope *droops towards* the plane of the instrument; if they overlap, it *rises from* the plane of the instrument. The position of the telescope is rectified by the screws in the collar.

The adjusting screws are never to be touched, except from necessity, and then with the greatest possible caution.

When two screws work against each other, care must be taken in tightening one to loosen the other if necessary.

The sides of the colored glasses are sometimes not exactly parallel, and the shades may cause an error in the angle. It is, therefore, prudent to find the error of each shade or combination of shades from actual trial.

TO FIND THE INDEX ERROR BY MEASURING THE SUN'S DIAMETER.

The Index Error of an instrument being merely the error of the place of the Beginning of the divisions when all the Mirrors or Glasses are perfectly adjusted, and it affects all angles alike.

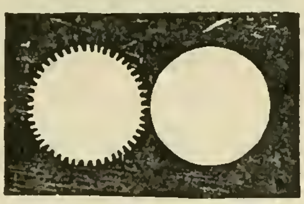
To Measure the Sun's Diameter.

Screw in the Inverting Telescope and adjust it to direct vision; turn up the proper Shades, place the ‡ on the Vernier, about 40′ to the Right of 0, on the Arch, and clamp the Index. Then, holding the instrument horizontally, bring the direct and reflected Suns in exact contact by the use of the tangent screw, and read off the minutes and seconds, counting from the opposite or Left end of the Vernier, which call *off* the Arch.

Next place the ‡ of the Vernier about 40′ to the Left of 0, on the Arch, and make the contact of the two Sun's as before, and read off the minutes and seconds in the usual way, which call *on* the Arch, and set it under the first reading; then half the difference of the two readings will be the Index Error, which is additive to all angles taken with the Sextant, when the Reading to the Right of 0 is greater than the Reading to the Left of 0, but subtractive when the reading to the Left is the greatest. If the two readings are equal there is no Index Error to the instrument. The direct and reflected Suns will appear through the Inverting Telescope thus:

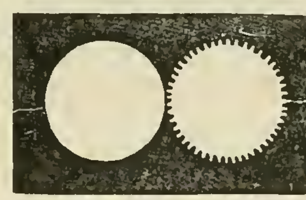
When the Vernier is to the Right of 0 *on the Arch.*

Reflected Sun. Direct Sun.



When the Vernier is to the Left of 0 *on the Arch.*

Direct Sun. Reflected Sun.



Suppose the following Observations were taken to determine the Index Error:

EXAMPLE 1.

1st Jan., 1854. Reading........off 31′ 55″
do.......... on 33 15
)1 20
Index Error............. 0′ 40″ Sub.

Because the reading *on* the Arch is greater than the reading *off*.

EXAMPLE 2.

31st Jan., 1854. Reading......... off 33′ 40″
do............ on 31 20
)2 20
Index Error...... .... 1′ 10″ Add.

Because the reading *off* the Arch is greater than the reading *on*.

When both Readings are *on* the Arch, (which can only happen when the Index Error exceeds half a degree,) the Index Error is the Mean of the two, and subtractive, but when both Readings are *off* the Arch, the Index Error is the mean of the two additive.

To prove that the contacts were made correctly, add the Readings together and divide their Sum by 4, and the quotient should be equal to the Sun's semi-diameter as given in the Nautical Almanac for the above days of the month.

In Example 1, the Sum of the Readings is 65′ 10″
Which divided by 4 gives the Semi......16′ 17″.5.

In Example 2, the Sum of the Readings is 65′ 00″
Which divided by 4 gives the Semi..... 16′ 15″

These agree nearly with that given in the Almanac, namely, 16′ 18″ on the 1st, and 16′ 15″.7 on the 31st. It may, therefore, be presumed that the contacts were correctly made.

In this manner the error of each colored glass, or Shade, may be found by first measuring the Sun's diameter at the time when there is a thin veil of clouds over his disc, (which will answer the purpose of Shades,) and ascertain the Index Error as in the above Examples (without using any Shade.) Then to measure it again, using, say, the Green Shades. If these two measured diameters agree, the Green Shades are correct. If they do not, then their difference is the error of the Green Shades, which must be applied to the Index Error, when they are used. In like manner, the Red Shades, or any combination of Red and Green, may be proved by using them in measuring the diameter, and afterwards comparing them with that which was measured without the Shades.

USE OF THE SEXTANT.

To Observe the Angular Distance between the Sun and Moon.

When the Distance between them is considerable, find their approximate distance in the Nautical Almanac, corresponding to the Greenwich Time of the observation, (by simply turning the Ship's Longitude into Time, by Table XXVI., and adding it to the Time at the Ship in West, or subtracting it in East Longitude.) Now set this approximate distance on the Sextant, turn up one or more of the Shades before the Index Glass, according to the brightness of the Sun. Screw in the Plane Tube into its collar. Then, holding the Sextant (with its face upward when the Sun is to the Right hand of the Moon, or downward when the Sun is to the Left,) with its Plane in the line of Sight of the two objects, and direct the Sight to the Moon, and the Sun's image will be seen near to it. Make the contact roughly. Take out the Tube and screw in the Inverting Telescope, and adjust it to distinct vision, placing the wires parallel to the Plane of the instrument. Raise the Telescope (by the screw behind) to the transparent part of the Horizon Glass. Then, directing the Sight through the Telescope to the Moon, holding the instrument as before directed, make the contact perfect by means of the tangent screw, at the same time moving the Sextant round the axis of the Telescope, by which means the Sun will appear to pass slowly by the Moon, and the contact be more accurately made. Observing always that the point of contact of the limbs should be as near the centre of the field of the Telescope (that is, in the middle between the four wires) as possible.

Reading off the Angle.

Ascertain the nearest degree on the Arch to the Right of the ‡, or the beginning of the Vernier, then the nearest division of the degree on the Arch. Then look along the Vernier, and ascertain which line coincides with the line on the Arch, then the minutes to the Right of where the coincidence takes place must be added to the division of the degree, and the seconds are counted to the Left of the nearest minute on the Vernier up to the place of coincidence.

EXAMPLE,

Of finding the Approximate Central Distance between the Sun and Moon.

February 7th, 1854. At 8 hours 20 minutes A. M., Sea Time, in Longitude of 70° 0′ West. Required the Approximate Central Distance of the Sun and Moon.

Time of Observation......	8h. 20m. A.M.	The Distance in N. A. at Noon is..........	117° 47′ 51″	West.
Add......	12h.	And at IIIh................	119 8 28	
From the preceding Noon	20h. 20m.	The Moon's Motion in 3h. is................	1° 20′ 37″	Increasing.
Long. 70° in Time........	4h. 40m.	G. T. being 1h. from Noon, or equal to ⅓ of it ...	26′ 52″	
	25h. 00m.	Which added to the Distance at Noon......	117° 47′ 51″	
Subtract....	24h.	Gives the required Distance at 8h. 20m. A.M.	118° 14′ 43″	
Greenwich Time, Feb. 7th	1h. 00m.			

Now put this on the Arch of the Sextant as follows: Advance the Index until the ‡ on the Vernier has passed the stroke of 118°, and also the first division, or 10′, of the adjoining degree on the Arch. Then look along the Vernier, and make the 5′ on it coincide with one of the divisions on the Arch. The instrument will then have on it 118° 15′, or even 118° is near enough for the purpose of bringing the objects into the field of view. Accuracy is not, therefore, required when the Sun is used. After bringing the nearest limbs in contact, screw in the Telescope, and proceed as directed. In this case, the Sun being to the Right of the Moon, (in North Latitude.) the instrument is held with its face upwards, in the line of Sight, and the Telescope directed to the Moon, when the Sun will appear inverted, or on the Left of the Moon.

In South Latitude, by direct view, the Sun will be on the Left of the Moon, and the Sextant must be held face downwards, and the Sight directed to the Moon.

TO OBSERVE THE DISTANCE BETWEEN THE MOON AND A STAR.

Turn the Ship's Longitude into time by Table XXVI, and add it to the time at the Ship in West Longitude, or subtract it in East, will give the approximate time at Greenwich. Look into the Nautical Almanac amongst the Lunar Distances, against the day of the month, and find the given Star's distance from the Moon corresponding to this Greenwich time. Put this distance on the Arch of the Sextant. Turn up one of the green shades before the Index-glass; then holding the plane of the instrument in the line of sight between the Moon and Star, with its face upwards when the Moon is to the Right of the Star, or downwards when the Moon is to the Left of the Star. Direct the sight through the ring of the collar towards the Star, (without using the Telescope), and the Moon's image will be seen near the Star. Move the Index so as to bisect the Star on the bright limb of the Moon. Now screw in the Inverting Telescope, and adjust it to distinct vision, and make the contact perfect by means of the tangent screw, at the same time moving the Arch of the Sextant slowly up and down, by which motion the bright limb of the Moon will appear to pass the Star, and the contact be more accurately made, and which should always be done as nearly as possible in the centre of the field of the telescope. The angle being read off will give the observed distance between the Star and the Moon's bright limb.

In the Nautical Almanac, headed Lunar Distance, the Sun, Stars, and Planets are marked according as they are East or West of the Moon. By attending to this and having the approximate distance on the Arch of the Sextant corresponding to the Greenwich time, any Lunar Star may be easily found by a person otherwise unacquainted with the stars in the heavens, because no other one in that direction will correspond to it in distance.

EXAMPLE

Of Finding a Lunar Star.

January 31st, 1854, at 10h. 25m. P. M., Sea Time, in Longitude 60° 0′ W. Required the approximate distance between the Moon and the Star Aldebaran

Time of Observation....	10h 25m	Distance of Aldebaran at Midnight	85° 38′ 38″	East of the Moon.	
Long. 60° W. in time....	4	Do. do. XVh....	83 53 59		
Greenwich time Jan. 30th	14h 25m	Moon's motion in 3 hours.........	1° 44′ 39″	Pro. Log...	2355
	12	G. Time past Midnight.........	2h 25m	Pro. Log..	0939
Past Midnight...........	2h 25m	Pro. of Dist. to be subtracted.....	1° 24′ 18″	Pro. Log..	3294
		From the Dist. at Midnight.......	85 38 28		
Which gives the Star's Distance from the Moon		....	84° 14′ 10″	at 10h 25m P. M.	

It is necessary to be as exact as possible in finding the approximate distance between the Moon and a Star, for very often it is the only security we have for employing the right star. Now put 84° 14′ on the Arch, as follows: Advance the Index until the ⨏ on the Vernier has passed the Stroke for 84°, and also that of the first division or 10′ of the adjoining degree. Then look along the Vernier and make 4′ on it coincide with some line on the Arch, which will be the required distance. The Star being East or to the left of the Moon (in North Latitude), the Sextant must be held with its face upwards in the proper line of sight, and the sight directed through the collar in the direction of the Star. Then if it be the right Star it will appear on the face of the Moon. Bring it in contact with her bright limb, screw in the Inverting Telescope, and the contact is then made perfect by the tangent screw as before directed.

In South Latitude the same Star will be to the right of the Moon, and the Sextant must be held face downwards, and as a general rule the sight must be directed to the dimmest object, and the brightest brought to it

REMARKS ON MEASURING THE LUNAR DISTANCE.

Of the Inverting Telescope.

On account of all the objects seen through this Telescope being inverted, and the difficulty of keeping them in the field of view in consequence of the motion of the Ship at Sea, which is extremely puzzling for a learner, because when the instrument is not held steady they always appear to go out of view on the wrong side. This however can only be remedied by practice and by shifting the instrument in the opposite direction to what he would do if they were seen direct. We are obliged to submit to this annoyance, because of the superior power derived from the Inverting, to what could be obtained from a Direct Telescope, of the same length. Besides, the cross parallel wires, which are so useful in the Inverting Telescope, could not be used in a common one.

Of the Common Telescope.

Those who find a difficulty in observing with the Inverting Telescope may find a good substitute in the Common one. For although its power is not so great, if the contact is made as near as possible in the centre of the field, by a little practice a very fair result may be obtained, if distances are observed East and West of the Moon, and the mean of the Longitudes taken.

The Proper Place of the Ship for taking the Observation,

Is as near as possible to the midships of the vessel, because there her motion is the least felt, and when she rolls heavy going before the wind, if the yards were braced forward a little it would help to keep her steady until the observation is completed.

The observer should place himself firmly in a corner, and sit or lie down on the deck, whichever is most convenient, so that the least bodily effort may be required to steady himself. The following method I have found of great utility, which does not require the tangent screw to be touched at all, when the contact takes place, consequently both hands can be used to hold and steady the instrument, and the whole attention is directed to the time of the contact. It also does away with what is called the springing of the Index Bar, (after the contact is made with the tangent screw), which is the case even in the best instruments:

NEW METHOD OF MEASURING THE LUNAR DISTANCE.

When the Distance is Increasing (which may be known by inspecting the N. A.), and the Near Limbs to be Observed,

Set the Index of the Sextant so that the objects may overlap each other a little, and watch for the instant when the Moon, by her motion in the heavens, brings the limbs in contact. Note the time and read off the angle. Advance the Index 1′, and then watch as before for the contact. Now, as the Moon advances to the Eastward in the heavens at the rate of about 1′ in two minutes of time, this will give time to read off the angles and to note down the observation. Then having advanced the Index another 1′, proceed as before, until the required number of distances are observed.

Distance Increasing, and the Far Limb of the Moon to be Observed.

By advancing the Index 1′, the Star will appear separated from the Moon's Limb. The contact is then watched for, and the observation made in the same manner as the above.

Distance Decreasing, and the Near Limbs to be Observed.

Set the Index so that the limbs may appear a little separated, and watch for the contact taking place. Note the time and read off. Then set back the Index 1′, and watch the contact as before. Note the time and read off, and so on.

Distance-Decreasing, and the Far Limb to be Observed.

By setting back the Index 1′, the Star will appear to overlap the Moon's Limb. Watch for the contact as before, and in the same manner as the last. By this means the Moon is made to measure her own distance, and all that is required to be done is to note the time of the contact

For further remarks on measuring the Lunar Distance, see page 163

THE ARTIFICIAL HORIZON.

When an observer has not the advantage of a Sea Horizon for the purpose of measuring Altitudes of the heavenly bodies, or when, for instance, the Ship is in port and the Sea Horizon obstructed by the land around, he is obliged to use an Artificial one, and which is used for finding the Latitude of the place, and also for rating the Chronometer, &c. (See Fig. 11, page 78.)

An Artificial Horizon is variously constructed, but the general principle, is to produce a perfectly level surface. The most simple is that of a pool of water on a calm day, or a basin containing water. But the most common in use is a trough filled with quicksilver, and protected from the wind by a roof, in which are fixed two glasses, ground perfectly plane and parallel.

Another kind has a plate of glass in the trough, which, when the quicksilver is poured in, floats on the surface, and a roof is not required. But these kind of instruments are troublesome, in having to pour in and out the quicksilver every time they are used. Besides, there is a scum or film gathers on the surface of the fluid. This, however, may be prevented from running into the trough, by holding the bottle bottom up, while it is poured out.

Tar, Treacle, and Oil have been tried for this purpose, but they do not give satisfaction; especially when exposed to the strong heat of the Sun, because the fluidity varies from unequal expansion.

The best and cleanest kind of Horizon is a brass circular box, of about 5 inches in diameter, supported on three screw legs, having a thick plate of glass glazed into its rim. The under surface of this glass is unpolished, and a space left between it and the bottom, this space being nearly filled with spirits of wine, leaving a small portion vacant, so as to produce an air bubble, and which bubble, by the use of the screws is brought under the centre of the glass. This centre must be ascertained from actual trial, and marked, so that the bubble can always be placed under it. The strong heat of the Sun will cause the spirits to expand, but a screw plug is fixed at the side, which can be taken out, and a small bell-shaped funnel put in its place to receive the surplus spirits caused by expansion. This instrument, together with a pocket Sextant, will form a portable Observatory, valuable to those who may have occasion to travel much inland.

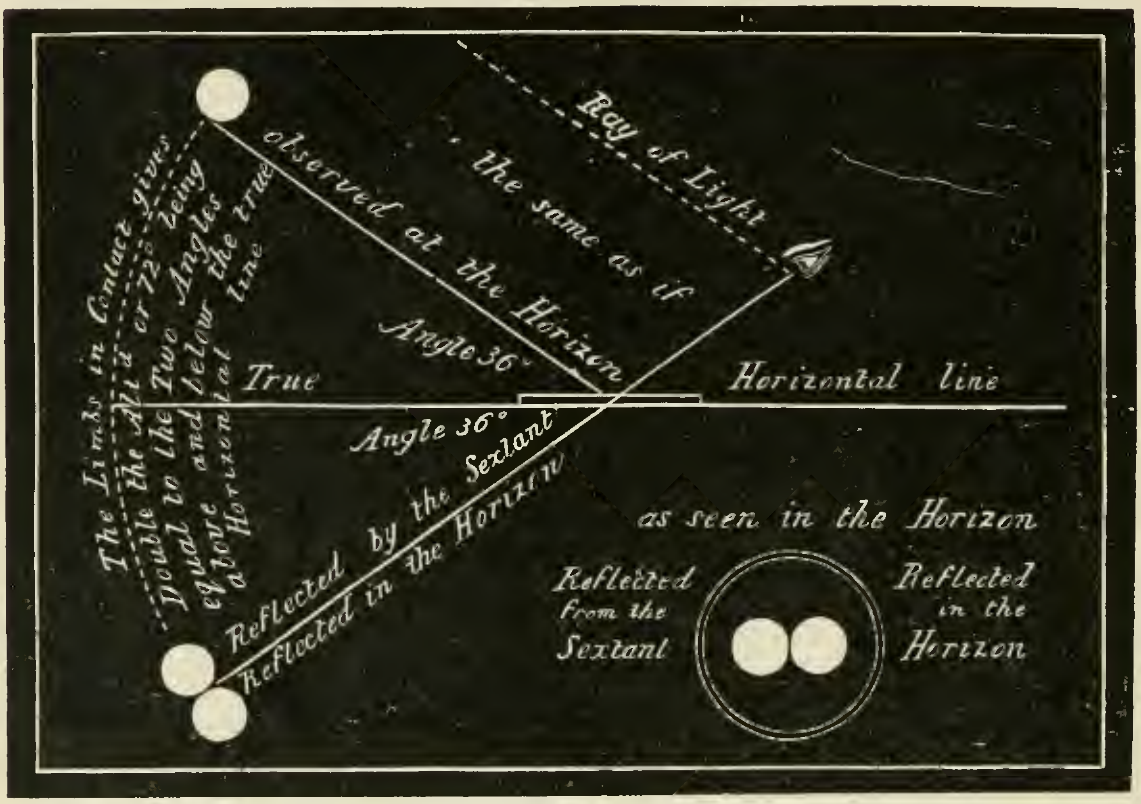
When one of these instruments is used, it must be placed on firm ground, and the observer, facing towards the Sun, walks backwards until he sees the direct image of the Sun reflected on the surface of the Artificial Horizon. Then, turning down the Shades over both the Index and Horizon Glasses of the Sextant, he directs his sight through the Collar of the Telescope at the reflected image in the Artificial Horizon, at the same time advancing the Index Bar, when the reflected image *from* the Sextant will appear to descend. He now brings the lower limb of this Sun in contact with the upper limb of the direct Sun already seen. The Telescope is then screwed in and the observation made. It is thus necessary to bring the limbs in contact, before using the Inverting Telescope, as a security against using the wrong limbs.

The Image of a heavenly body reflected from the surface of a fluid at rest, appears as much below the true horizonal line as the object itself appears above it. The Angular Distance, measured between the object and its image, is, therefore, *Double the Altitude.* And in halving the Angle shown by the instrument. we halve at the same time all the errors of the observation.

DESCRIPTION AND USE OF THE ARTIFICIAL HORIZON.

The following DIAGRAM *will illustrate the Method of Observing Altitudes with an Artificial Horizon*

FIG. 11



In taking Altitudes for Time, the Sun will appear to rise or fall with double the velocity he would otherwise do, when observed with the natural horizon.

When the Sun is rising, the observer is obliged to approach nearer to the Artificial Horizon, according as the Altitude increases. On the other hand, when the Sun is falling, he is obliged to increase his distance from it, according as the Altitude decreases. And when the Sun's Altitude is at 12°, or 14°, it becomes difficult to keep sight of the images reflected in the Horizon, and with Altitudes below this, it is generally impracticable, on account of the slanting direction of the Sun's rays.

An Altitude of the Sun, or other heavenly body, may be obtained by this instrument to the extent of 60°; that is, to 120° by reflection, this being generally the limits of the Scale on the Arch of the Sextant. In Low Latitudes, therefore, it is often impossible to observe with the Artificial Horizon any heavenly body whose Altitude exceeds 60°, unless we use a Sextant of superior power.

The Latitude may, however, be obtained near the Equator, by choosing a Star of the first magnitude, which has great North or South Declination, and whose Meridian Altitude is less than 60°. In computing the Meridian Altitude of a Star, for the purpose of observing with the Artificial Horizon, we have only to double the computed Altitude found by the Rule at page 66, and place it on the Arch of the Sextant. Face towards the Star, and walk backwards until the Star's image appears reflected in the Horizon. Then direct the sight through the Collar of the Telescope of the Sextant at the Horizon, and, holding the instrument vertically, the two Stars will be seen in contact with or near to each other, (at the time of its Meridian passage.) They are now brought in contact, and kept so until the greatest Altitude is obtained. This gives security that the right Star has been observed.

In observations taken with this instrument, it must be remembered that no Dip is to be allowed for, as in the case of using the Sea Horizon. (See pages 92, 131, and 159, for Observations with this Instrument.)

THE CHRONOMETER.

The Chronometer is a superior kind of Watch, constructed so as to keep as near as possible a Uniform or Mean Time. It is set generally to the Mean Time at Greenwich, and its Daily Rate ascertained, that is, what it is gaining or losing on this Uniform or Mean Time. This instrument is of great value to the Navigator, principally in determining the Longitude at Sea, and other useful purposes in Navigation, because if the Mean Time at Greenwich (where the Longitude is reckoned from) be known from consulting the Chronometer, and the Mean Time at the Ship be known from observation at the same instant of time, this difference of time turned into degrees and minutes at the rate of 15° to the hour of Time, is the Longitude of the Ship.

The following remarks will be found useful in managing this instrument:

When a Chronometer is received on board, it should be screwed down in a safe and proper place, at a distance from all iron substances, and where it is not likely to receive any sudden shock or jerk, and there it must remain during the voyage, and wound up regularly every morning *before breakfast*.

In winding, the key should be turned steadily, and about half a turn taken each time, and it should be wound close up. After winding, it should be examined, and if close up, the Index Hand on the face of it will stand at 0. Ascertain, also, that it has not stopped after being wound up.

When a Chronometer is wound up after running down, it is set agoing by giving it a small horizontal circular motion.

When a Chronometer stops it generally alters its Rate.

The hands of a Chronometer must not on any account be touched, either before or after it is set agoing The proper way to set it to Greenwich Time is as follows: Look at what hour, minute and second the hands of the Chronometer has stopped at, and note it down. Turn the Ship's Longitude into Time, and subtract it from that Time if the Longitude is West, or add it to that Time if the Longitude be East, and the result is the computed Mean Time at the Ship. Now have your Watch previously regulated to the exact Mean Time at the Ship found by observation, and when the hands of the Watch arrive exactly at this computed Mean Time at the Ship, set the Chronometer instantly agoing. If the Longitude of the Ship be correct, then the Chronometer will show the same Greenwich Mean Time as before it stopped

For example: Suppose the Chronometer to have stopped at 10 h. 20 m. 10 sec. Ship's Longitude by account being 65° W., or 4 h. 20 m., subtracted from 10 h. 20 m. 10 sec., leaves 6 h. 0 m. 10 sec. Now, having had the Watch regulated in the afternoon to the mean time at Ship, I wait until the hands of the Watch show 6 h. 0 m. 10 sec., and then set the Chronometer instantly agoing.

Again: Suppose the Chronometer to have stopped at 5 h. 40 m. 20 sec. The Ship's Longitude by account being 110° 20′ East, or 7 h. 21 m. 20 sec. This added to 5 h. 40 m. 20 sec, produces 13 h. 1m. 40 sec., or 1 h. 1 m. 40 sec. past Noon for the computed Mean Time at the Ship. Now, having had the Watch previously regulated in the morning to Mean Time at the Ship, I wait until the hands of the Watch come to 1 h. 1 m. 40 sec. and then set the Chronometer instantly agoing.

In taking the time from the face of the Chronometer, the Second Hand is first noted, then the Minute Hand, and lastly the Hour Hand.

Any common Watch which has a Second Hand will do for taking the time when making observations, but it must be compared with the Chronometer, both before and after the Observations are made, and its Rate, if any, allowed for.

EXAMPLE.

Suppose the Chronometer showed........	11h.	20m.	10sec.	Again the Chronometer showed...	11h.	30m.	15sec
And at the same time the Watch showed..	8	10	0	Watch showed..................	8	20	5
The Difference is called the Comparison..	3h.	10m.	10sec.	Comparison....................	3h.	10m.	10sec

In this case the comparison must be added to the Mean of the Times shown by the Watch when the Altitudes were observed, which will give the time by Chronometer when the Altitudes were observed, just the same as if the time of each Altitude had been noted from the face of the Chronometer. In comparing the Watch with the Chronometer, the best method is to wait until the Second Hand of the Watch comes to 60 seconds, which completes the minute, and at that instant note the number of seconds which the Hand of the Chronometer shows, and then the minute and the hour.

It will also save some trouble if the Altitudes are taken at the instant the Second Hand of the watch has completed the full minute. This serves as a check on the measured change of the Sun's Altitude in one minute of time, and which is uniform (See the Table on page 100.)

REMARKS ON THE CHRONOMETER.

Chronometers, when sent on board of Ships, are provided with a Certificate of their Error; that is what they are fast or slow of Greenwich Mean Time on a certain day of the month, and also their Daily Rate, that is, what they are gaining or losing on *Mean Uniform* Time. Consequently, the Greenwich Time can easily be computed for any subsequent period of time, by multiplying the Daily Rate by the number of days elapsed, and applying it to the original Error. And if Chronometers always kept a uniform steady Rate they would answer every purpose required of them. But unfortunately, they do not always keep a steady Rate, at least not the Rate given in the Certificate, or the *Shore Rate*, as we call it. For it is found by experience that after Chronometers have been placed on board Ships their Rates change, caused, no doubt, by the magnetic action of the iron on board the vessel on the steel work of the Watch, and also by the change of temperature in the weather during the voyage. And as this is difficult to remedy on board a merchant vessel, it becomes necessary to find the *Sea Rate* at the earliest convenient opportunity, and to verify it from time to time during the voyage. The method of doing this will be found in its proper place under the head of Rating the Chronometer at Sea. (See page 155.)

This method is simply to ascertain the Error of the Chronometer on Greenwich Mean Time when the Ship is in sight of land, the position of which is well laid down. And the difference in the Error ascertained at one place and the next, divided by the number of days elapsed between the observations, is the *Sea Rate*. Or, when the Ship is in port, and the Sea Horizon visible, the Rate may be found by comparing it with M. Time. Or the Artificial Horizon may be used on shore, the times of the Altitudes being taken by a Watch, which, as before explained, must be compared with the Chronometer, both before and after the observations are made, and its Rate (if any) allowed. Rating Chronometers by the Artifical Horizon is a more correct method than by the Sea Horizon, because of the haze and change of Dip, which sometimes effects the latter.

When there are several Chronometers on board a vessel, the one which keeps the most uniform Rate is taken as a standard one, and with which all the others are compared. The cause which alters the Rate of one Chronometer may likewise alter the Rate of another, so that the agreement of any number of Chronometers cannot be admitted as evidenee of the truth of the time which they show. One good Chronometer, in the hands of a competent person to manage it, is sufficient for almost any voyage.

THE AZIMUTH COMPASS.

The Azimuth Compass is of a superior construction to the Steering Compass, and is particularly adapted for observing Bearings.

It is fitted with vertical Sight Vanes for the purpose of observing objects elevated above the horizon. In one of these Vanes there is a long and very narrow slit, and in the other is an opening of the same kind, but wider, and having a wire up and down the middle of it exactly opposite to the slit.

The Card is similar to those of the Steering Compass, with this difference only, that a circular ring of silvered brass, divided into four times 90°, or 360°, circumscribes the card.

To Observe the Sun's Amplitude.

Turn the Compass Box, until the Vane containing the magnifying-glass is directed towards the Sun, and until the bright speck or rays of the Sun (collected by the magnifying-glass) falls upon the slit in the other Vane. If the Card vibrates considerably at the time of observation, take the middle between the extreme vibrations for the Observed Amplitude.

Or the sight may be directed through the dark glass towards the Sun, which must be bisected by the wire in the other Vane.

A common spare Steering Compass may be made a very good substitute when a Ship is not furnished with an Amplitude Compass, (and which is frequently the case), as follows: Place the Compass Box as near the Binnacle as possible, and in such a position that the Sun at Rising or Setting may be seen over it. Now take a Plane Scale or a thin straight-edge, and place it over the centre of the Card in the direction of the Sun. Look along the edge of the Scale and see that the far end of it points to the Sun's centre. Then the point, or fraction of a point of the Compass, which is under the edge of the Scale, will be the Observed Amplitude, which must always be reckoned from the East or West points towards the North or South.

The observation should be made when the Sun's lower limb appears somewhat more than his semi diameter above the horizon, because, on account of the Refraction of the atmosphere his centre is then really in the horizon.

To Observe the Sun's Azimuth.

In observing the Azimuth of the Sun his Altitude is required to be taken at the same instant of time with a Quadrant, in order to obtain his True Azimuth.

Raise the magnifying-glass to the upper part of the Vane, and move the box, with the magnifying-glass, to the Sun, until the bright speck falls on the other Vane, or on the line on the horizontal bar. The divisions being then read off will be the Sun's Magnetic Azimuth.

If the Card vibrates considerably at the time of observation, take the middle between the extreme vibrations.

The Azimuth is counted generally from the North point of the Compass in North Latitude, and from the South point of the Compass in South Latitude. Towards the East in the morning, and towards the West in the afternoon.

But sometimes, for convenience sake, it is counted from the South in North Latitude, and from the North in South Latitude.

In high Latitudes, the Sun's Azimuth may be observed at Noon at the instant he is on the Meridian, that is, when he is true South or North, and the difference between that and the Azimuth bearing by Compass gives the magnetic variation at once.

But to do this it is necessary to have the Watch previously regulated to Apparent Time at the Ship, so that the Sun's Azimuth may be observed at the instant the Watch shows 12 o'clock, because the Sun then is *True* South in North Latitude, and *True* North in South Latitude. And supposing the Bearing by the Azimuth Compass to have been South also, there would, in that case, be no variation. On the other hand, if the Bearing by the Azimuth Compass was S. 22° 30′ W., then there would be that amount of Magnetic Variation Westerly. But if the Bearing of the Azimuth Compass had been S. 22° 30′ E., there would be that amount of Magnetic Variation Easterly.

INSTRUMENTS USED IN NAVIGATION.

DESCRIPTION AND USE OF THE THERMOMETER.

Fahrenheit's Thermometer is used on board of Ships for the purpose of registering the temperature of the Ocean at the surface, and also the temperature of the Air on the open Sea. The Zero, or commencement of the Scale, begins at 32°, or the Freezing-point, and is counted upwards and downwards, according as the column of mercury expands or contracts. When the temperature or heat increases it rises, but when the temperature decreases, or, (which is the same thing), the cold increases, it falls, and the degree opposite th top of the mercury is the reading required. When it is below 32° it is said to stand so many degrees below the Freezing-point; and during the Winters in the Arctic or Polar regions, the mercury itself freezes from the intense cold.

The Thermometer is a most useful instrument in giving warning of the Ship's approach to Ice in thick foggy weather. This is simply done by drawing a bucket of water from alongside and plunging the Thermometer into it at regular intervals in the day, during the voyage, and the readings noted down. And, when it is found that the temperature of the water has fallen, on approaching a locality where Ice may be expected to be fallen in with, the observations should be repeated every few minutes. And should the mercury in the tube keep sinking, you may conclude that the Ship is approaching Ice, and the precaution should be taken at once to shorten sail. For if it be in the Winter season, and the Thermometer has fallen to 34°, she will then be only half a mile off the Ice. If in the Summer season, and the Thermometer has fallen to 42°, she will then be about the same distance off, and on a nearer approach the glass will fall still lower. But when the Ship has passed the Ice, the Thermometer will gradually rise again.

In the month of June, near the Bank of Newfoundland, the Thermometer had fallen suddenly from 48° to 42°. Ship was then running with Studding-sails set on both sides, in very thick weather. They were immediately taken in and the Courses hauled up, when the white glare of an immense Iceberg was seen right ahead, and she had to be hauled to the wind in order to pass clear to the windward of it at less than a quarter of a mile distant; so that by a timely reference to this useful instrument the Ship was rescued from imminent danger.

The temperature of the Ocean is higher in deep water, than it is in shoal water near the land, or on banks. Hence, a Ship on approaching land, or on Soundings, the Thermometer falls from 2° to 6°, except on a high bold shore with deep water close to it, when it is not so apparent. The difference of temperature on and off the Banks of Newfoundland is 5°.

Currents in the Ocean coming from high Latitudes have their water colder than those which come from low Latitudes, which accounts for the variation in the temperature of the surface water, out on the open Sea

On a Ship entering the Eastern edge of the Florida stream, the water will be found to be from 5° to 8° warmer, and after crossing it and leaving its Western edge, the adjoining Sea will be found that much colder, and when she gets on soundings, several degrees colder still. So that a careful observer will always be warned of his approach to the coast of the United States of America, by consulting this useful instrument in thick weather, when no Celestial observations can be obtained.

The Plate of the Thermometer should be made of Ivory or Metal, so that the tube will be less liable to break, and it should be fixed in a square metal box, the bottom of which, as high as the mark 30°, should be water-tight, so that in examining the degree of temperature, the bulb may be kept immersed in the water The remainder of the length should be open in front, with only two or three cross bars to ward off any accidental blow. It would be better to have a spare one also, fixed up in some safe part of the ship, in the shade, out of the wind, and in as dry a place as possible, to register the temperature of the air, while the other may be used for the water.

DESCRIPTION AND USE OF THE BAROMETER.

The Barometer is used on board of Ships for the purpose of foretelling the state of the weather. By the pressure of the Atmosphere acting on a column of Mercury, contained in a glass Tube, which has a Scale attached to it, marked in inches, and a sliding Vernier, the top of which being set at the height of the Mercurial column, gives the measurement in inches, and hundredth parts of an inch. In North Latitude it stands highest with N. E. winds, and lowest with S. W. In South Latitude it stands highest with S. E. winds, and lowest with N. W.

About the commencement of a Storm, in North Latitude, from the S. W., with rain, the Barometer begins to fall, and continues to fall as the Storm increases; and when it stops and begins to rise, the rain will soon cease, and a shift of wind to the Northward may be expected; but it may continue to blow hard until the Barometer rises to 30 inches.

In South Latitude, N. W. winds bring rain, with a falling Barometer; but it rises with Southerly winds. If it rises slowly and gradually, good weather may be expected to follow; but if it rises rapidly, the weather will continue unsettled and stormy.

In general, before a heavy fall of snow or sleet, the Barometer falls very low, and the wind commences to blow from the quarter in which it generally stands the highest in fine weather, and after the fall of snow it rises rapidly.

But there are many curious exceptions to these general rules; for I have seen the Barometer steady at 30 inches, with the wind blowing hard at S. W., with heavy rain falling for several days together, Ship being then in a high Northern Latitude. But the secret of this turned out to be, that an Easterly wind was at hand, which followed the S. W. wind, and continued blowing for several weeks afterwards.

The never-failing sign of bad weather is, when daylight breaks *high* over head, and the clouds to leeward look *heavy* and *near*; also, when the Sun rises or sets with a lurid red glare. These appearances should be taken in connexion with the action of the Barometer, before a proper opinion can be formed of the kind of weather that may be expected to follow.

The Barometer generally stands about 30 inches in the fine serene weather experienced in the Tropics, except between the Trade Winds, when it falls a little during the rainy weather which prevails there. But, if it falls *rapidly* near the Northern or Southern limits of the Trade Winds, (that is, between the Latitudes of 20° and 30°,) down to 29.50, there is a Hurricane at hand, and by referring to the Diagrams of the Storm Circle, at pages 43 and 44, measures must be taken at once for the safety of the Ship, where it will be perceived that with the Barometer at 29.50, the Ship will be about 150 miles distant from the Focus, when it falls to 29.20, 100 miles off; to 28.40. 50 miles off; and at the Focus itself it will stand at 27 inches. When the Ship increases her distance *from* the Focus the Barometer will rise; so that it is a most valuable instrument in the locality of Hurricanes.

THE ANEROID BAROMETER.

This instrument is constructed so that the pressure of the Atmosphere acts upon a metalic spring, connected with a vacuum, and turns a hand to the Right, answering to the rising of the Barometer, and to the Left when it is falling. It has a round face, similar to a Chronometer, and the Inches are marked on it and counted in the same manner as the Mercurial one. This instrument is very sensitive and exact, very superior to the old ones, which are sometimes difficult to read off, on account of the Mercury plunging up and down in the tube, when the Ship has violent motion.

I have used this instrument myself for some years, and in a great many instances it has given me warning of a coming Hurricane more than 24 hours in advance. It is also more portable, and can be hung up, or placed any where about a Ship's cabin, or in a place where it would be inconvenient to swing a Mercurial one.

NAUTICAL ASTRONOMY.

Having thus given a short description of the principal instruments used in Navigating a Ship, we now proceed to find the Ship's place on the Ocean from Astronomical Observations, and commence with finding the Latitude from the Meridian Altitude of the Sun. The Correct Declination of the Sun must be found at the time of Observation, as follows:

The Sun's Declination, found in Table X, to the nearest minute, is calculated for every Noon at Greenwich, for several years in advance, and which will answer for every fourth year afterwards, by applying a small correction found in the adjoining Table; or it may be taken from the Nautical Almanac.

When the Ship is on the Meridian of Greenwich, no correction is required, and the Declination standing against the day of the month may be taken out and applied at once, because it is Noon at the Ship and Noon at Greenwich at the same instant of time. But when a Ship is on a Meridian to the Eastward or Westward of Greenwich, that is, when her Longitude is East or West from Greenwich, the Declination must be corrected for the Change of Declination corresponding to the Longitude in time; because when it is Noon at the Ship, in 15° East Longitude, it wants 1 hour of being Noon at Greenwich, and when it is Noon at the Ship, in 15° West Longitude, it would be 1 hour past Noon at Greenwich. This correction amounts to a considerable quantity when the Longitude is great, and when the Sun changes his Declination rapidly in the months adjoining March and September.

RULE

For Correcting the Sun's Declination at Noon.

Enter Table XI with the Longitude at the side column and the Declination at the top, and the angle of meeting points out the correction to be applied, according to the precepts at the bottom of the Table.

EXAMPLE 1.

Required the Sun's Correct Declination on the 1st of March, 1854, at the end of the Sea Day, in the Longitude of 80° West.

The Sun's Declination, March 1st, at Greenwich, at the end of the Sea Day, or the beginning of the day in the Nautical Almanac, by Table X, is	7° 35′ S.
Correction for the Declination in Table XI, for Longitude 80° West, is ...... Sub.	5
(Because the Long. is West and Declination Decreasing,) Gives the Correct Declination	7° 30′ S.

EXAMPLE 2.

Required the Sun's Correct Declination on the 1st of April, 1854, at the end of the Sea Day, in the Longitude of 90° East.

The Sun's Declination, April 1st, at Greenwich, by Table X, is	4° 32′ N
The Correction for the Declination in Table XI, for Long. 90° East, is 5′.8 ...... Sub.	6
Because the Long. is East and Declination Increasing,) Gives the Correct Declination	4° 26′

NOTE.—The Corrections in Table XI, are expressed in minutes and tenths of minutes, and it is usual in practice that when the tenths exceed 5, we call the minutes one more, but when the tenths are less than 5, they are not used at all. But when greater accuracy is required, multiply the tenths by 6, which will give seconds of Declination.

It may also be remarked here, that the Declinations, or any other quantity found in the Nautical Almanac, are all calculated for Astronomical Time at Greenwich; and that the Astronomical Day begins 24 hours after the Sea Day, and 12 hours after the Civil Day, and is counted through the 24 hours.

Hence the Noon of the Civil Day, (or that used by the generality of mankind,) the Beginning of the Astronomical Day, and the End of the Nautical Day, take place at the same period of time.

There is no reason why this absurd system of keeping Sea Time should be continued; because it is just as easy to keep Civil Time, commencing the day at Midnight, and the Day's Work could still be reckoned from Noon to Noon, as before. The only difference would be, that one half of it would appear in the preceding day's Log, (where it really belongs,) and the other half in the following. Many Logs are now kept on this principle. (See page 195.)

To Correct the Sun's Declination to any Time of the Day.

When the Declination is required at any other time than at the Noon of the Ship, a farther correction is necessary; because, for instance, an observation of the Sun made at 4 hours, either before or after the Noon of the Ship, his Declination must be corrected for the change of Declination in that time.

RULE.

Correct the Declination for Noon as in the foregoing Examples. Then enter Table XI again, with the time from Noon at the Ship in the side column, and the Declination at the top, and the angle of meeting points out the correction in minutes and tenths, to be applied according to the precept at the bottom of the Table.

EXAMPLE. 3.

Required to find the Sun's correct Declination on the 1st of March, 1854, at 8h 10m in the forenoon, Sea Account in the Longitude of 80° West.

The Sun's Declination, March 1st, at Greenwich Noon, by Table X, is.............	7° 35′	S. Decreasing
Correction for Declination, in Table XI, for Longitude 80° West,.............Sub.	5	
(Because the Long. is West, and the Declination Decreasing), gives the Decl. at Noon	7° 30′	S.
Correction for 3h 50m, or the time from Noon, Table XI, is 3′ 8″ =..........Add	4	
(Because the Time was before Noon and Decl. Decreasing.) Correct Decl. at 8h 10m	7° 34′	S.

EXAMPLE 4.

Required to find the Sun's correct Declination on the 1st of April, 1854, at 7h 20m in the forenoon, Sea Account in the Longitude of 90° East.

The Sun's Declination, April 1st, at Greenwich Noon, by Table X, is...............	4° 32′	N. Increasing.
Correction for the Declination, in Table XI, for Long. 90° East, is 5′ 8″.......Sub.	6	
(Because the Long. is East, and the Decl. Increasing), gives the Decl. at Noon......	4° 26′	N.
Correction for 4h 40m, or Time from Noon, in Table XI, is 4′ 5″..............Sub.	5	
(Because the Time was before Noon and the Decl. Increasing.) Cor Decl. at 7h 20m	4° 21′	N.

EXAMPLE 5.

Required to find the Sun's Declination on the 21st of March, 1854, at 5h 20m in the afternoon, Sea Account, in the Long. of 120° West.

March 21st, Sea Account, is March 20th. Declination at Greenwich Noon, Table X, is	0° 10′	S. Decreasing.
Correction for the Declination, in Table XI, for Long. 120° W. is 7′ 8″........Sub.	8	
(Because the Long. is West, and the Decl. Decreasing), gives Decl. at Noon........	0° 2′	S.
Correction for 5h 20m, or the time from Noon, in Table XI, is 5′ 2″...........Sub.	5	
Here the Decl. has changed from S. to N., and the Diff. is the Decl. at 5h 20m. P. M.	0° 3′	N.

Hence, the rule in this case is, that when the Correction Subtractive, exceeds the Declination, the difference is the Declination of a contrary name.

EXAMPLE 6.

Required to find the Sun's correct Declination on the 23d of September, 1854, at 10h 0m, in the forenoon. in Long. 15° 0′ East.

The Sun's Declination on the 23d September, at Greenwich Noon, is..............	0° 3′	S. Increasing.
Correction for the Declination in Table XI, for Long 15° East,................Sub.	1	
(Because the Long. is East, and the Declination Increasing.) Declination at Noon....	0° 2′	S.
Correction for 2h 0m, or the time from Noon, Table XI......................Sub.	2	
(Because the Time was before Noon and the Decl. Increasing.) Correct Decl. at 10h.	0° 0′	Sun on the Equa

To Correct the Sun's Declination to the Greenwich Time of Observation.

RULE

Turn the Ship's Long. into Time by Table XXVI, and add it to the time at the Ship, in West Longitude, or subtract in East. The result will be the Greenwich Time of the observation. If it is before Noon at Greenwich, subtract it from 12h; if afternoon, it is the required Time. Take out the Declination against the day of the month, from Table X. Then enter Table XI with this time from Greenwich Noon, in the side column, and the Declination at the top, and at the angle of meeting will be the required correction, to be applied according to the precept at the bottom of the Table *for Time.*

Suppose, as in Example 3d, the time at Ship to be 8h 10m A. M. Long. 80° W., in time, is 5h 20m, which, added, makes 13h 30m, less 12h, gives 1h 30m, the Greenwich time past Noon, which, with the Declination 7° 35′, gives the Correction 1′ subtractive, and the correct Declination is 7° 34′ S

LATITUDE BY THE MERIDIAN ALTITUDE OF THE SUN.

Latitude is the Distance of a place from the Equator either North or South, and is measured by an Arc of the Meridian contained between the Zenith of the observer and the Celestial Equator. Hence, if the distance of any heavenly body from the Zenith, when on the Meridian, be known, and its Declination found in Table X, that is, the number of degrees and minutes it is to the Northward and Southward of the Celestial Equator, the Latitude may thence be found.

As the Pole round which the Celestial Bodies appear to revolve, remains always in the same fixed place in the heavens, from whatever point of the Earth's surface it is viewed, its elevation at any particular place is always the same, and the Celestial Equator is 90° from it. When the observer changes his Latitude he changes the distance between his Zenith (which moves with him) and the Pole. He therefore changes the Altitude of the Pole above the Horizon, and which is always equal to the Latitude of the place. The position of the Celestial Equator is changed in like manner. (See Figure 12th, next page.)

The simplest and most efficient manner of determining the Latitude is by measuring the Meridian Altitude of the Sun with a Quadrant, at the time he attains his greatest Altitude. It is then Apparent Noon at the Ship.

To Find the Latitude from the Meridian Altitude of the Sun.

RULE.

Read off the Observed Altitude from the Quadrant, and write it down. In practice, three Corrections only are required to be applied to the Sun's Observed Altitude, viz: The Semi-diameter, taken at 16′, the Dip found in Table V, and the Refraction found in Table IV. The Sun's Parallax, being small, is omitted.

If the lower limb be observed, we find his central Altitude by adding the Semi-diameter 16′, and subtracting the Dip and Refraction; or by subtracting the Dip and Refraction from 16′, and adding the balance, which comes to the same thing.

In Table IX, the balance of all the corrections may be taken out at once by inspection, as follows Enter the Table, with the Observed Altitude, at the side, and the height of the eye above the Sea, in feet, at the top, and at the angle of meeting will be the Correction required in minutes and tenths, and which is always *additive* when the lower limb is observed. When the tenths amount to more than .5, we call the minutes 1′ more, but if less than .5, we throw them away, and the result is the True Central Altitude. But if greater accuracy be required, multiply the tenths by 6, will give seconds of Altitude.

If the Sun's upper limb be observed, the whole of the Corrections are to be subtracted, which will give the True Central Altitude.

If the Sun's centre itself be observed, as in figure 10, No. 3, the Semi-diameter is not required to be allowed for. In that case, the Dip and Refraction together, *subtracted*, will give the True Central Altitude.

Subtract the Sun's True Central Altitude from 90°, will give the Zenith Distance. Then if the Sun bear South when on the Meridian, mark his Zenith Distance North, and if he bear North, mark his Zenith Distance South.

Take out the Sun's Declination from Table X, and correct it for the Longitude of the Ship by Table XI Write it down under the Zenith Distance, and mark it North or South, as named in Table X; or, if taken from the Almanac, in the page containing the day of the month.

Then if the Zenith Distance and Declination be both North or both South, their *sum* is the Latitude of that name. But if one be North and the other South, their *difference* is the Latitude of the same name as the *greater* of the two.

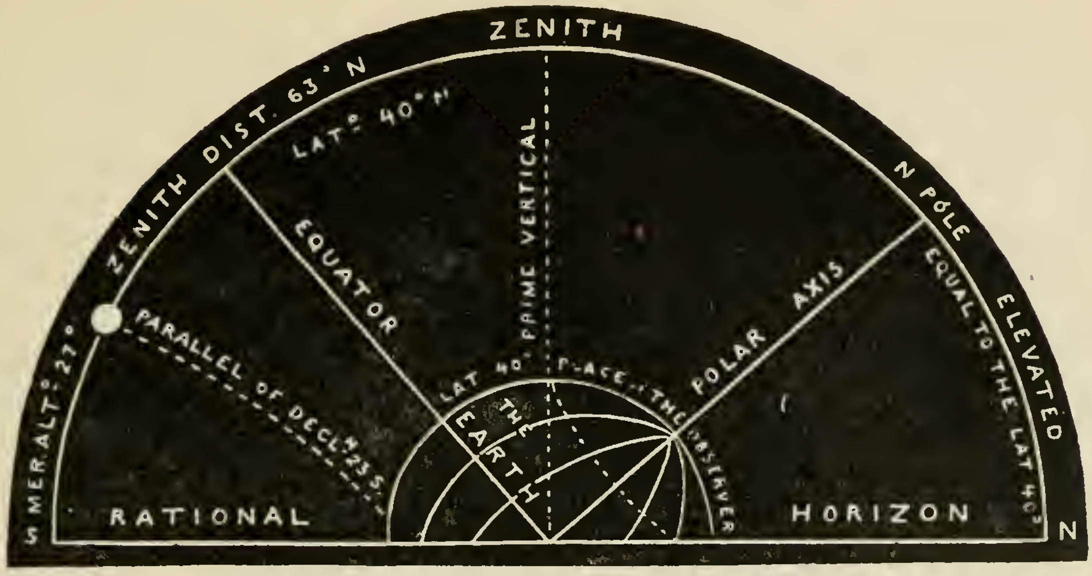
NOTE. When the horizon under the Sun is obstructed by land, the Correction for Dip must be taken from Table VIII, when at less distance from the Shore than 6 miles.

EXAMPLE 1.

January 1st, 1854. In the Longitude of 80° West, the Meridian Altitude of the Sun's Lower Limb was observed to be 26° 52′, bearing South, Index Error 2′, subtractive Height of the eye above the Sea, 18 feet. Required the Latitude in.

Projection of the Meridian Altitude.

Fig. 12.



Rule.—With the Chord of 60° describe a semi-circle, to represent the concave Arch of the heavens, and draw the Rational Horizon. Lay off the Sun's Altitude, 27°, on the Left. Take the Declination, 23° S., in the dividers, (from the line of Chords,) and with one foot in the Sun's place, extend the other towards the Zenith, (because the Declination is South) which will mark the place of the upper end of the Equator on the Meridian Circle. Now draw the Equator through the centre and the Polar Axis at right angles to it. Mark the Zenith at 90° from the horizon, and draw a line from it through the centre, and where it cuts the Earth's surface is the place of the Observer. His Latitude is measured on the Meridian, and is the Distance of his Zenith from the Celestial Equator, which, on the line of Chords, measures 40°, and the Elevation of the North Pole, 40° above the horizon, is equal to the Latitude of the place. Hence the Distance of the Observer from the Equator of the Earth, which is 40°, is his Latitude North.

By Computation.

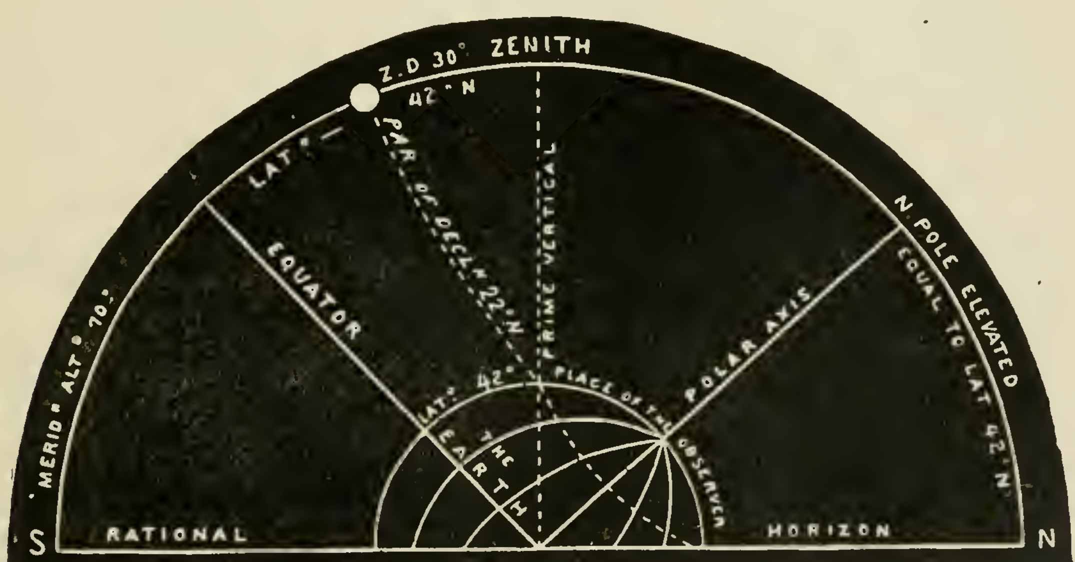
Sun's Observed Altitude, Lower Limb.........26° 52′ S.	
Semi-diam., add,......16′ Index Error, Sub.... 2	Sun's Declination, Jan. 1st, Table X,..........23° 1′ S.
Dip. 4, Ref. 2=Sub... 6′ 26° 50′	Correction Table XI, Long. 80 W........Sub. 1
Balance of Corr......10′,.................Add.. 10	Corr. Declination at Noon of the Ship........23° 0 S.
Sun's true Central Altitude......27° 0′	
90 0	
Zenith Distance................63° 0′ N	
Correct Declination.............23 0 S.	
Latitude in......................40° 0′ N.	

EXAMPLE 2.

June 1st, 1854. In the Long. of 90° E., the Meridian Altitude of the Sun's Lower Limb was observed to be 69° 45′, bearing S., Index Error 3′, additive. Height of the eye above the Sea, 20 feet. Required the Latitude in.

Projection of the Meridian Altitude.

Fig. 13.



Rule.—Proceed, as in the last Example, to draw the figure. Then lay off the Sun's correct Altitude, 70° on the left. Take the Declination, 22° N., in the dividers, and with one foot in the Sun's place, extend the other downwards, (because the Declination is North,) which will mark the upper end of the Equator. Now draw the Equator and the Polar Axis as before. A line drawn from the Zenith, let fall on the Earth's surface, and through the centre, will be the place of the Observer, and his Latitude is the Distance of the Celestial Equator from his Zenith, which measures 42° on the line of Chords, and the Elevation of the Pole is equal to the Latitude.

Finding the Latitude by the Meridian Altitude of the Sun.

BY COMPUTATION.—(*See Example 2.*,

Sun's Observed Altitude, Lower Limb... ....69° 45′ S.
Semi-diam........16′ Index Error,...... Add.. 3
Dip. 4, Ref. 0, Sub. 4 69° 48′
Balance of Corr.....12 Add..... 12
Sun's true Central Altitude........ 70° 0′
90 0
Zenith Distance.................... 20° 0′ N.
Sun's Correct Declination............ 22 1 N.
Latitude in....................... 42° 1′ N.

Declination, June 1st, 1854, Table X,.. . 22° 3′ N
Corr. in Table XI, Long. 90° E.— .Sub.. 2
Sun's Corr. Dec., Noon of Ship.......... 22° 1 ′N

EXAMPLE 3.

July 22d, 1854. In Long. 25° West, the Meridian Altitude of the Sun's Lower Limb was 89° 1′ South. Height of the eye, 18 feet. Required the Latitude in.

Obs. Alt. Sun's Lower Limb ....89° 1′ S.
Corr. found in Table IX.,...........Add.... 12
True Central Altitude........ 89° 13′
90 0
Zenith Distance.... ... .0° 47′ N.
Declination, Table X, 22d July, 20° 19′ N. }
Corr., Table XI, Long. 25°, ..Sub... 1 } 20 18 N.
Latitude in................ 21° 5′ N.

EXAMPLE 4.

July 23d, 1854. In Long. 27° W., the Meridian Altitude of the Sun's Lower Limb was 88° 4′ N. Height of the eye, 18 feet. Required the Latitude.

Obs. Alt. Sun's Lower Limb.............. 88° 4′ N
Correction, in Table IX..............Add.. 12
True Central Altitude........ 88° 16
90 0
Zenith Distance............ 1° 44 S
Declination, Table X, July 23d, 20° 7′ N. }
Corr., Table IX, Lon. 27° W., Sub...1 } 20 6 N
Latitude in................ 18° 22′ N

EXAMPLE 5.

Aug. 7th, 1854. In Long. 112° W., the Meridian Altitude of the Sun's Lower Limb was 74° 27′ North. Required the Latitude in.

Obs. Alt. Sun's Lower Limb............. 74° 27′ N.
Corr. from Table IX, ... Add... 12
True Central Altitude........74° 39′
Zenith Distance..............15° 21′ S.
Declination, Table X, 7th Aug., 16° 28′ N. }
Corr., Table XI, Lon. 112° W., Sub...5 } 16 23 N.
Latitude in................. 1° 2′ N.

EXAMPLE 6.

Aug. 8th, 1854. In Long. 140° East, the Meridian Altitude of the Sun's Lower Limb was 72° 46′ N. Required the Latitude.

Obs. Alt. Sun's Lower Limb..............72° 46′ N.
Correction, Table IX,...............Add.. 12
True Altitude.............. 72° 58′ N
Zenith Distance............ 17° 2′ S.
Declination, Aug. 8th, Table X, 16° 11′ }
Corr., Table XI, for Lon. 140° E., ..Add.7 } 16 18 N.
Latitude in................ 0° 44′ S.

EXAMPLE 7.

March 20th, 1854. In Longitude 160° W., the Meridian Altitude of the Sun's Lower Limb was 32° 58′ N. Required the Latitude.

Obs. Alt. Sun's Lower Limb............... 32° 58′ N.
Correction, Table IX,.............. Add.. 10
True Central Altitude........ 33° 8′
Zenith Distance............ 56° 52′ S.
Declination, Table X, March 20th, 0° 10′ S. }
Corr., Table XI, Lon.160° W.,Sub..0 11 } 0 1 N.
Latitude in................ 56° 51′ S.

EXAMPLE 8.

March 21st, 1854. In Long. 175° E., the Meridian Altitude of the Sun's Lower Limb was 40° 20′ N. Required the Latitude.

Obs. Alt. Sun's Lower Limb was........... 40° 20′ N
Correction, Table IX,...............Add.. 11
True Altitude............... 40° 31′
Zenith Distance... .. .. 49° 29′ S.
Declination, Table X, March 21st, 0° 14′ N. }
Corr., Table XI, Lon. 175° E., Sub. 12 } 0° 2′ N
Latitude in................ 49° 27′ S.

In the above Examples the height of the eye above the Sea is supposed to be about 16 or 18 feet, which answers very well for vessels of common size; but in very large Ships the height of the eye will be considerably above that. On the other hand, in small vessels the height of the eye will be much less than 16 feet above the Sea. The Dip, found in Table V, or the height of the eye, in Table XI, must be regulated accordingly.

FINDING THE LATITUDE BY THE MERIDIAN ALTITUDE OF THE SUN.

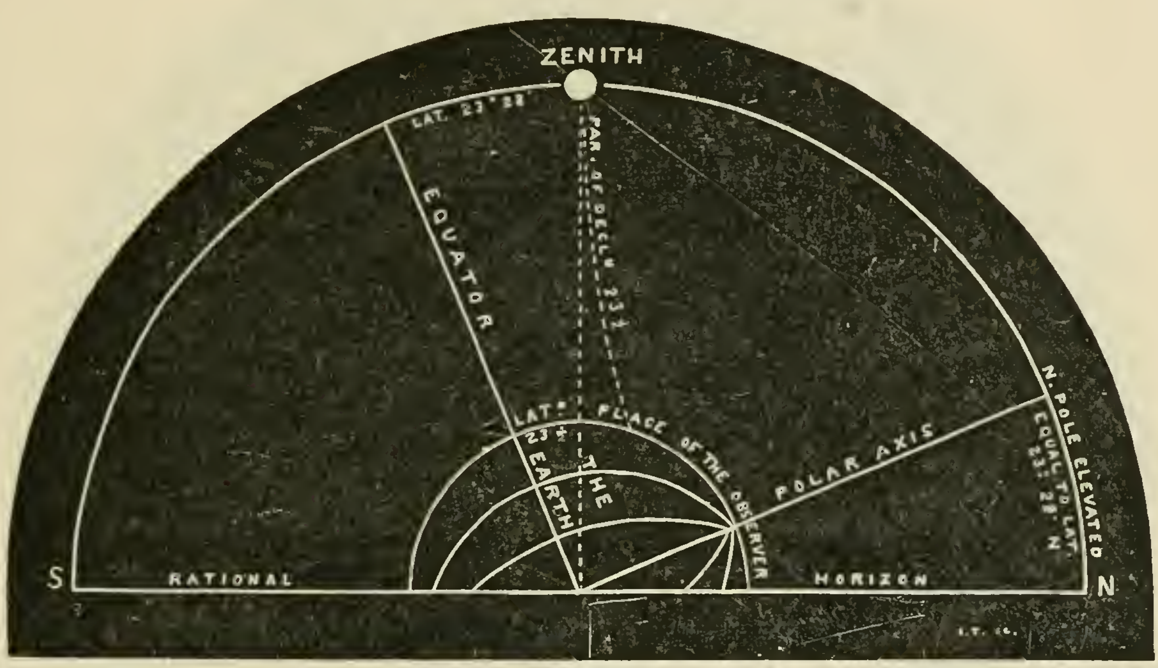
When the Sun's True Central Altitude is 90°, he is in the Zenith, and the correct Declination for the day is the Latitude of the same name as the Declination.

When the Declination is 0° 0′, the Zenith Distance is the Latitude of a contrary name to the Bearing of the Sun when on the Meridian.

When the Zenith Distance and Declination are equal, but of contrary names, the Ship is on the Equator.

When the Sun is in the Zenith, and his Declination 0° 0′, the Ship is on the Equator, which the following Diagram will show.

FIG. 14.



In this Figure, the Sun appears in the Zenith, and his Declination at the same time being 23° 28′ N. from the Equator, *is* the Latitude of that name, and which is equal to the elevation of the Pole above the Horizon. Now suppose the Sun to be on the Equator, then his Zenith Distance would be 23° 28′ N., which is also the Latitude. Again: Suppose the Equator to coincide with the Zenith; then both North and South Poles would appear in the Horizon, and which is the case when the Ship is on the Equator. Again: if the Sun has, say 23° 28′ S. Declination, his Zenith Distance in this case would be 23° 28′ N., which being equal and of contrary names, the Ship would be also on the Equator.

When the Sun is in the vicinity of the Zenith, it is often difficult to observe his Altitude, in consequence of not knowing on which side of it he will pass the Meridian. But if the Watch be previously regulated to Apparent Time it will be found of great service in indicating the exact time, that is, 12 o'clock, when the Sun will be on the Meridian, because his motion is then very quick, and he requires to be carefully watched to obtain his proper Altitude. It may, however, be obtained to nearly 90° in this way, by the exercise of a little care.

It is nevertheless advisable to verify the Latitude so obtained, by an observation of a Planet or a Star taken at twilight, when the Horizon is distinctly seen, and for which there are good opportunities to be found during the fine serene weather in the tropics.

To Find the Latitude by Observing the Sun's Centre.

When the Sun shines through watery clouds his limbs may not be distinctly visible, but a good observation may still be obtained by bringing his middle down to the Horizon. (See page 68, Fig 10.) The observation is then worked as follows:

EXAMPLE 9.

Observed Meridian Alt. of the Sun's Centre...	10° 10′	N
Dip 4, Refraction 5, ...Sub.	9	
Sun's True Central Altitude..................	10° 1′	
Zenith Distance.............................	79° 59′	S.
Declination, June 21st,......................	23 27	N.
Ship off Cape Horn, Latitude in............	56° 32′	S

EXAMPLE 10.

Observed Merid. Altitude of the Sun's Centre.	60° 14′	S.
Dip 4, Refraction 1,.......... ....Sub.	5	
Sun's True Central Altitude.................	60° 9′	
Zenith Distance.........	29° 51′	N.
Declination, December 21st,.................	23 27	S.
Latitude in................................	6° 24′	N

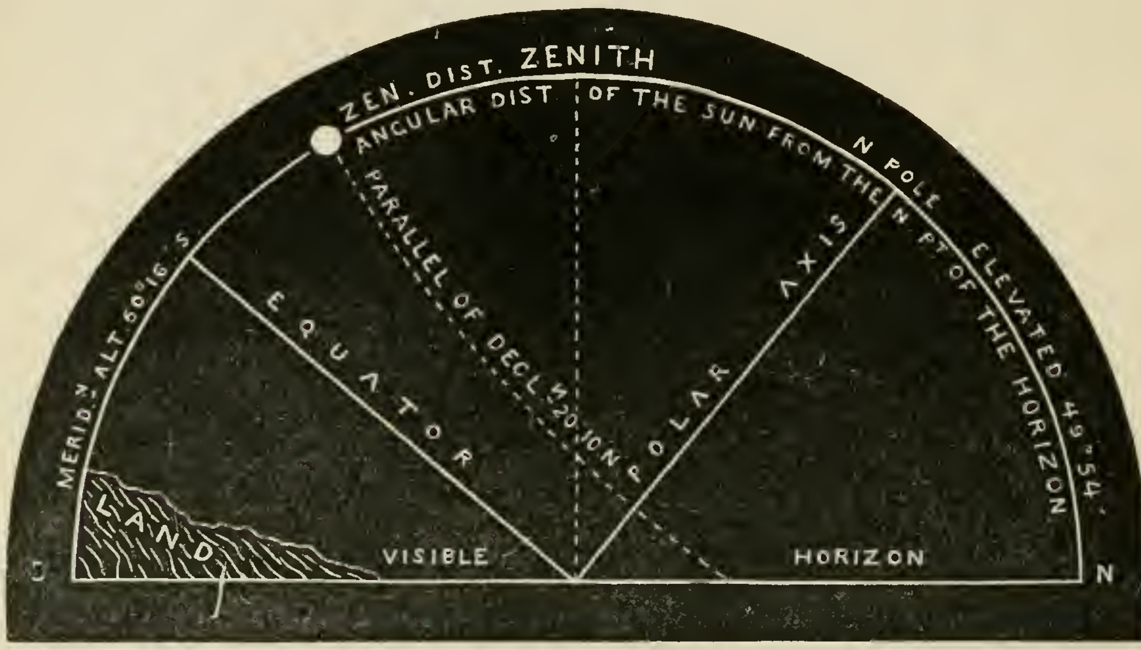
TO FIND THE LATITUDE FROM A BACK OBSERVATION WITH A SEXTANT

RULE.

Bring the Lower Limb of the Sun in contact with the Back Horizon, and subtract the Angle so obtained from 180° 0′, which will give the Meridian Altitude of the Upper Limb Subtract the difference between the Dip and the Semi diameter, (usually taken as 12′), and the result is the True Central Altitude. In this case, no Correction for Refraction is required, because the Sextant can only measure about 120° of an Angle, the supplement of which is 60° of an Altitude, (for which no Correction for Refraction is required in Practice at Sea.) This method is useful in low Latitudes when the Horizon under the Sun is obstructed by the land.

DIAGRAM OF A BACK OBSERVATION.

FIG. 15.



EXAMPLE 11

The Angle of the Sun's Lower Limb from a back Observation with a Sextant, was 119° 32′ on the Meridian, the observer facing towards the North. The correct Declination at the same time was 20° 10′ N. Required the Latitude.

Observed Angle Sun's Lower Limb..........	119° 32′ N.
Subtract from..............................	180 0
Sun's Meridian Altitude, Upper Limb......	60° 28′ S.
Semi-diameter 16′ and Dip 4′, subtract Corr.	12
Sun's True Central Altitude...............	60° 16′
Subtracted from 90°, gives the Zenith Distance	29° 44′ N.
Correct Declination........................	20 10 N.
Latitude in................................	49° 54′ N.

EXAMPLE 12.

The Angle of the Sun's Lower Limb from a Back Observation with a Sextant was 100° 25′ on the Meridian, the observer facing towards the South. The Correct Declination at the same time was 22° 15′ N. Required the Latitude.

Observed Angle Sun's Lower Limb..........	100° 25′ S.
Subtract from..............................	180
Sun's Meridian Altitude, Upper Limb.......	79° 35′ N
Semi-diameter 16′ and Dip 4′, subtract Corr.	12
Sun's True Central Altitude...............	79° 23′
Subtracted from 90°, gives the Zenith Distance	10° 37′ S.
Correct Declination........................	22° 15′ N
Latitude in................................	11° 38′ N

To Find the Latitude from an Altitude by the Shore Horizon

When the Ship is less than 6 miles from the Shore under the Sun, when on the Meridian, his Lower Limb is brought down to the line which divides the Sea and Land, and a Correction for Dip taken from Table VIII, to be used in the room of the Dip usually taken from Table V.

EXAMPLE 13.

With the Bearing of the Land find the Distance off, by some one of the Rules given at pages 32 and 33, or by the Soundings on the Chart.

Suppose the Distance off shore to be 1 mile, and the Observed Altitude to be 60° 11′ S; height of the eye 18 feet: Correct Declination 20° 10′ N. Required the Latitude.

Observed Alt Lower Limb to the Sea Line....	60° 11′ S.
Semid. 16′, Dip at 1 mile, Tab. VIII, is 11′, Add Diff.	5′
Sun's True Central Altitude................	60° 16′
Subtracted from 90°, gives Zenith Distance....	29° 44′ N.
Correct Declination.........................	20 10 N.
Latitude in..................................	49° 54′ N.

EXAMPLE 14.

Find the Distance off shore from the Bearing of the Land, as before directed, and the correct height of the eye above the Sea level.

Suppose the distance off shore to be ½ a mile, and the Observed Altitude to be 79° 35′; height of the eye 25 feet; Correct Declination 22° 15′ N. Required the Latitude.

Observed Alt. Lower Limb to the Sea Line...	79° 35′ N
Semid. 16′, Dip at ½ m., in Tab VIII, is 28′ Sub. Diff.	12
Sun's True Central Altitude................	79° 23′
Subtracted from 90°, gives the Zenith Dist....	10° 37′ S
Correct Declination.........................	22 15 N
Latitude in..................................	11° 38′ N

TO FIND THE LATITUDE FROM A MERIDIAN ALTITUDE BELOW THE POLE

When the difference between the Declination of a body and 90°, or the Polar Distance, is less than the Latitude of the place, and they are both of the same name, the object comes to the opposite Meridian without setting, and passes that Meridian below the Pole. If the Altitude be then observed, the Latitude may be found as follows :

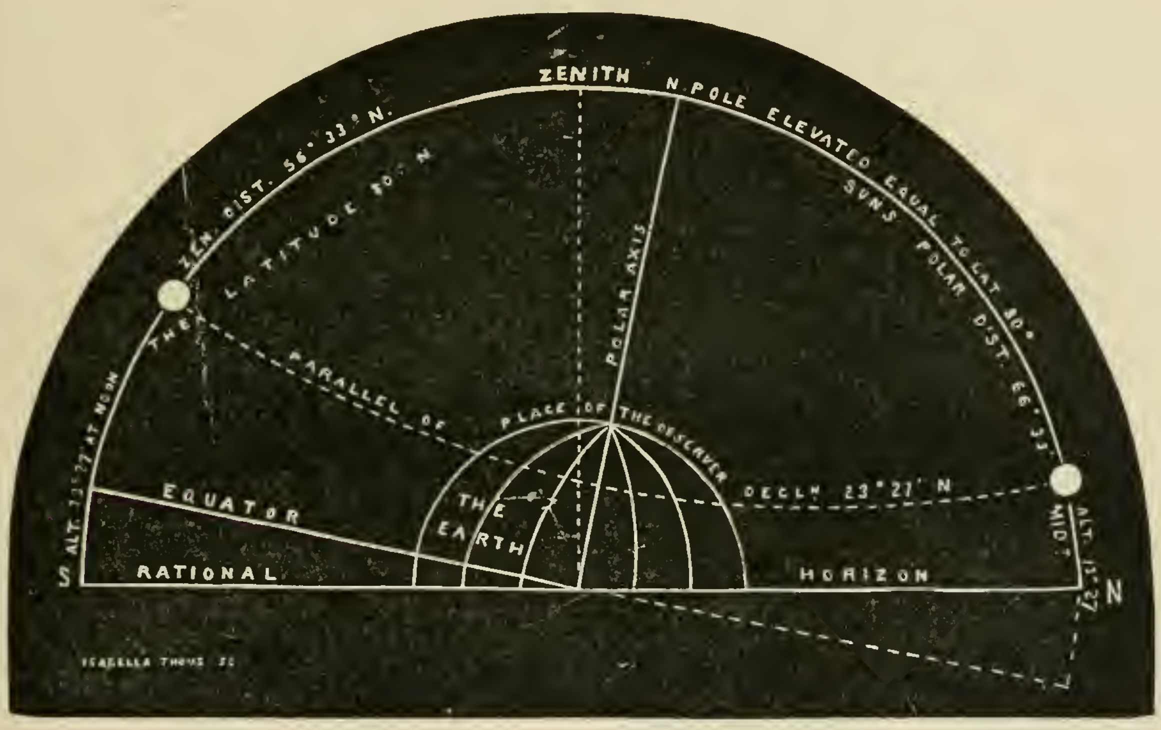
Rule.—Correct the Observed Altitude as usual, and to the true Central Altitude, add the Difference between the Declination and 90°, or the Polar Distance. The Sum will be the Latitude of the same name as the Declination.

In High Latitudes, in the Summer time, the Sun does not set for many days, and the Latitude may be obtained from his Meridian Altitude twice in the 24 hours ; that is, at Noon and Midnight.

DIAGRAM

Of the Meridian Altitude Below the Pole.

Fig. 16.



In this Figure the true Meridian Altitude of the Sun at Noon **is 33° 28′ South, and which, worked out** in the usual manner, gives Latitude 80° 0′ North, (on the coast of Spitzbergen,) and the Latitude from the Meridian Altitude at Midnight, is found as follows :

EXAMPLE 15.

June 21st, 1854. Sea Time at Midnight on the coast of Spitzenbergen, the Merid. Altitude of the Sun's Lower Limb was observed to be 13° 17′ N. Height of the eye, 6 feet ; Long. in, 17° East. Required the Latitude in.

Obs. Alt. Sun's Lower Limb		13° 17′ N.
Correction, Table IX, to be added		10
True Central Altitude........		13° 27′
Declination, June 20th,........	23° 27′ N.	
Corr. for Long. 17° East	0	
Corr. 12h. past Noon..........	0	
Correct Declination............	23° 27′	} = 66° 33′ N.
Subtract from	90 0	
Latitude in.................		80° 0′ N.

EXAMPLE 16.

May 16th, 1854. Sea Time at Midnight the observed Merid Altitude of the Sun's Lower Limb was 8° 53′ N Height of the eye, 15 feet. Ship off Verlugen Hook, in Long. 16° 50′ East. Required the Latitude in.

Obs. Alt. Sun's Lower Limb..................		8° 53′ N
Correction, Table IX, to be added		6
True Central Altitude.........		8° 59′
Declination, May 15th....	18° 51′ N.	
Corr. for Long. 16° 50′ East,. Sub..	1	
Corr. for 12h. past Noon ....Add.	7	
Correct Deliuation...... ...	18° 57′	} —71° 3′ N
Subtract from.............	90 0	
Latitude in................ ..		80° 2′ N

Note.—This Rule applies likewise to the Polar and other Stars, which have great North Declination, examples of which will be found at page 109 ; and it must be understood that although the foregoing Examples and Diagrams of Nautical Astronomy are generally constructed for North Latitude, and the North Pole elevated above the horizon, by reversing the figure, that is, by elevating the South Pole, the Rules are the same, only substituting South for North. The Spectator is then supposed to be situated at a great distance to the Westward of the Earth and facing towards the East, having South on his Right and North on his Left.

FINDING THE LATITUDE ON SHORE BY THE ARTIFICIAL HORIZON.

When the Sea Horizon is obstructed by the Land, the Latitude may be found by an Artificial Horizon on shore, (a description of which is given at pages 78 and 79,) in places where the Sun's Meridian Altitude does not exceed 60°; because in observing with this instrument, the angle is doubled, that is, 60° of Altitude would require an angle of 120° on the Arch of the Sextant, and the Arch of common Sextants do not extend much beyond 120°.

RULE.

Bring the Limbs of the Sun in contact, and when he has attained his greatest Altitude read off the angle, to which apply the Index Error of the Sextant, and take half the angle for the Meridian Altitude of his Lower Limb, to which add the Sun's semi-diameter, and subtract the Refraction, will give his true Central Altitude. The Latitude is then found in the usual manner.

EXAMPLE 17.

Jan. 20th, 1854. At New York the observed Angle of the Sun's Lower Limb in the Artificial Horizon, on the Meridian, was 57° 57′ 20″ S., the Index Error of the Sextant being 2′ subtractive. Required the Latitude

Obs Angle Sun's Lower Limb.........	57° 57′ 20″ S.
Index Error........Sub..	2 0
Apparent Angle.........	57° 55′ 20″
Half the Angle is the Sun's Mer. Alt....	28° 57′ 40″ S.
Sun's semid., N. A...Add.	16 17
App. Central Altitude ...	29° 13′ 57″
Refraction, Table IV, Sub.	1 41
Sun's True Central Alit...	29° 12′ 16″
Sub. from 90°, gives the Zen. Distance..	60° 47′ 44″ N.
Sun's Dec., Jan. 20th, N.A., 20° 7′ 38″ S. * Cor. for Lon. 74° W., in Table XI, ... Sub. 2.6=2 36	20 5 2 S.
Latitude of New York....	40° 42′ 42″ N.

EXAMPLE 18.

March 30th, 1854. At Valparaiso Fort the observed Angle of the Sun's Lower Limb in the Artificial Horizon, on the Meridan, was 105° 44′ 10″ N., Index Error of the Sextant being 1′ 30″, additive. Required the Latitude.

Obs. Angle Sun's Lower Limb.......	105° 44′ 10″ N
Index Error........Add	1 30
Apparent Angle........	105° 45′ 40″
Half the Angle is the Sun's Mer. Alt..	52° 52′ 50″
Sun's semid., N. A...Add	16 2
Apparent Central Alt....	53° 8′ 52″
Refraction, Table IV, Sub.	43
True Central Alt	53° 8′ 9″ N.
Sub. from 90°, Gives the Zenith Dist...	36° 51′ 51″ S
Sun's Dec., March 30th...3° 45′ 22″ N. Corr. for Lon. 72° W., in Table XI, Add 4′.5, or 4 30	3 49 52 N
Latitude of Valparaiso Fort,	33° 1′ 59″ S

EXAMPLE 19.

June 21st, 1854. At the North Cape of Europe the observed Angle of the Sun's Lower Limb in the Artificial Horizon, on the Meridian, was 84° 5′ 36″ S. No Index Error in the Sextant. Required the Latitude.

Obs. Angle Sun's Lower Limb	84° 5′ 36″ S.
Half the Sum is the Sun's Mer. Alt.......	42° 2′ 48″
Sun's semi-diam., N. A......	15 46
Sun's App. Altitude	42° 18′ 34″
Refraction, Table IV......	1 2
Sun's True Central Alt....	42° 17′ 32″S.
	90 00 00
Zenith Distance..........	47° 42′ 28″N.
Declination, June 21st. No Corr. required.	23 27 32 N.
Latitude of the North Cape,	71° 10′ 0″N.

EXAMPLE 20.

Sept. 1st, 1854. At Antipodes Island, in Lat. 49° 35′ S., Lon. 179° 2′ E., the observed Angle of the Sun's Lower Limb, on the Meridian, in the Artificial Horizon, was 63° 21′ 10″ N. No Index Error. Required the Latitude.

Obs. Angle Sun's Lower Limb.........	63° 21′ 10″ N
Half the Angle is the Sun's Mer. Alt....	31° 40′ 35″
Sun's semid., N. A....Add.	15 53
Sun's App. Altitude......	31° 56′ 28″
Refraction, Table IV, Sub	1 33
Sun's True Central At.....	31° 54′ 55″ N
Sub. from 90°, Gives the Zenith Dist.....	58° 5′ 5″ S
Sun's Dec., Sept.1st, N.A. 8° 19′ 18″ N. Cor.Long.179° E.,Ta.XI.Add 11	8 30 18 N
Latitude of Antipodes Island..	49° 34′ 47″ S.

NOTE.—In correcting the Declination, the Civil Time is used in the above Examples; that is, the Noon of the Civil day corresponding to the Beginning of the Astronomical day. The Latitude found in this manner is more correctly obtained than by the Sea Horizon.

* The Correction for the Declination in Table XI being in minutes and tenths of a minute, by multiplying the tenths by 6 we get seconds of Declination

By one Altitude of the Sun and the Time from Noon.

It frequently happens that the Meridian Altitude of the Sun is lost, in consequence of cloudy weather coming on, and that he may be visible both before and after he passes the Meridian. In either case, if an Altitude be then observed, and the Apparent Time at the Ship known, the Latitude may still be found as correct as at Noon.

To facilitate this computation, a Table has been constructed so that the required Logarithms can be taken out by inspection, for the purpose of finding the number of Minutes of Altitude which the Sun has to rise, when the observation is made before Noon, or what he has fallen, when made in the Afternoon. In both cases this Correction is *additive* to the Sun's Observed Altitude, which will give his Meridian Altitude, or what it would have been if observed at that place.

Table XV, in Five parts, is given for this purpose, and explained as follows:

PART I

Contains the Logarithm of the Hour Angle, or the time from Noon, and extends to 64 m. 30 sec. This being sufficient for the common purposes of Navigation, and within which the observation must be made according to the limits given in Part V, (except in a very high Latitude in the Winter months, and where few Ships frequent.) This part is entered, with the minutes and the nearest seconds, from Noon, and opposite to it stands the Logarithm, to which annex the Index found at the top of the table.

PART II

Contains the Logarithm of the Latitude by the Dead Reckoning, and the Sun's Declination when they are of the *same* name. The Latitude extends to 60°, and the Declination to 23°. This part is entered with the Latitude by Dead Reckoning at the side, and the Declination at the top. The Angle of meeting points out the required Logarithm. When the minutes of the Latitude and Declination amount to nearly half a degree, take out the nearest Logarithm preceding and the nearest Logarithm following it, add them together and take their half sum for the required Logarithm.

PART III

Contains the Logarithm of the Latitude and the Declination, when they are of *contrary* names, and is entered in the same manner as the other.

PART IV

Contains the Sum of the Logarithms of the time from Noon, and that of the Latitude and Declination, opposite to which stands the required correction, to be *added* to the observed Altitude.

PART V

Contains the limits of the Time from Noon, at which the Observation can be relied on. It is entered with the Declination at the top, (according as it is of the *same* or of *contrary* names to the Latitude), and the Latitude at the side, and the angle of meeting points out the time from Noon, at which the observation should be made, and it must not greatly exceed this time, especially near the Equator. And it will be perceived by this Part, that in low Latitudes the Observation must be made nearer to Noon than in high Latitudes. This table is, therefore, of the greatest utility in high Latitudes; and where, also, it is oftenest required, on account of the stormy weather which generally prevails there, when the Meridian Altitude can seldom be obtained.

This method of finding the Latitude will, therefore, be found very useful when an Altitude can be obtained near Noon, (but which is generally considered by seamen as useless after their Meridian Altitude has been lost), and although a Ship at Sea is almost continually changing her time, if the time of the Observation be noted by a good watch, which may have been regulated previously to Apparent Time at the Ship, then the difference of Longitude made in the interval since it was last regulated, turned into time, and *subtracted* from the time by watch, if the Ship has been sailing West, or *added* to it when sailing East, will give the Apparent Time of the Observation; which, if before Noon, subtracted from 12 hours, will give the time from Noon, A. M.; otherwise it will be the time from Noon, P. M. (See Example 6, page 95.) Or the watch may be regulated by equal Altitudes near Noon, as in Example 5.

But the most correct mode; is, to find the Apparent Time at Ship from the Greenwich Time by Chronometer. The Ship's Longitude being generally known within a few minutes of the truth, which turned into time and applied to the Greenwich Time, furnishes the Apparent Time of the Observation as follows:

To Find the Latitude by one Altitude of the Sun, having the Apparent Time from Noon deduced from the Greenwich Time by Chronometer.

RULE FOR FINDING THE TIME.

Note the Time of the Observation by Chronometer, and find the Greenwich Time by applying its error. Turn the Ship's Longitude in (at the time of the Observation) into Time, and *subtract* it from the Greenwich Time in West Longitude, or *add* it to the Greenwich Time in East Longitude, will give the Mean Time of the Observation at the Ship. To this Mean Time apply the Equation of Time the *contrary* way to what is directed in the precept at the head of the column in the Nautical Almanac for Apparent Time, and the result is the Apparent Time of the Observation at the Ship, which, if before Noon, must be subtracted from 12h, (or from 24h if above 12h,) will give the time from Noon, A. M., otherwise it is the required Time from Noon, P. M.

THE OBSERVATION.

Observe an Altitude of the Sun near the limits of the time from Noon, given in Part 5th, Table XV, and note the Time by the Watch or Chronometer, and find the time from Noon as previously directed. Find the Latitude in by Dead Reckoning to the nearest half degree, and correct the Sun's Declination to the time of the Observation as usual, but to the nearest half degree is enough for the tables.

RULE FOR USING TABLE XV.

Enter Part 1st with the Time from Noon, and take out its Logarithm.
Enter Part 2d when the Latitude and Declination are of the *same* name, or
Enter Part 3d when they are of *contrary* names, and take out the Log. as explained in the preceding page. Add together these two Logarithms, and find their sum in Part 4th, against which will be found the Correction required in Minutes, or Degrees and Minutes, and which must *always* be *added* to the Sun's Observed Altitude, and the result is the Sun's Meridian Altitude, or, what it would have been if observed on the Meridian at the place at which the observation was made.

The Latitude is now found in the usual manner, which will be that of the Ship at the *time* of the Observation and may be brought up to Noon by applying the Difference of Latitude made in the interval.

EXAMPLE 1.

Feb. 25th, 1854, a Ship at Sea in Latitude by Dead Reckoning about 38° N., and Long. 76° 30′ W., by Chro., an Altitude of the Sun's L. Limb was observed to be 41° 44′ S. *P. M.*, and the Greenwich Time by Chro. 5h 53m 57sec. P. M. at Greenwich. Required the Latitude in.

	H. M. S.	
Green. Time by Chro.	5 53 57	Decl. Feb. 25...9° 5′ S.
Ln. 76° 30′ W. in time	5 6 0	Corr. Table XI.. 5
Mean Time at Ship..	47 57	Corr. Decl......9° 0′ S.
Equa. of Time...Sub.	13 16	Equ. of T., N. A., 13m 16s
App. Time from Noon	34 41	= Log. 7.757 Part 1st.
Lat. 38° N., Decl. 9° S..........		..Log. 0.328 Part 3d.
Corr. in Part 4th....	0° 42′	Log. 8.085 Table XV.
Obs. Alt. L. Limb...	41 44 S.	
Meridian Altitude...	42° 26′	
Corr. Table IX...Add	11	
Sun's Central Alt....	42° 37′	
	90 0	
Zenith Distance......	47° 23′ N.	
Correct Declination..	9 0 S.	
Latitude in.........	38° 23′ N. at 35 min. past Noon.	
D. Lat. made since N	5 to the Northward.	
Latitude in.... ...	38° 18′ at Noon.	

EXAMPLE 2

March 15th, 1854, a Ship at Sea, in Latitude 44° 30′ N., by Dead Reckoning, and Long. 60° 30′ W. by Chro., the Sun's observed Altitude was 42° 20′ S., A. M. The Greenwich Time by Chro. was 3h 31m 9sec. P. M. The course to Noon was S. W. true, going 9 knots. Required the Latitude in at Noon.

	H. M. S.	
Green. Time by Chro...	3 31 9	Decl., March 15. 2° 9′ S.
Add.	12 0 0	Corr. T. XI. Sub. 4
For the purpose of Sub.	15 31 9	Correct Decl...2° 5′ S.
Ln. 60° 30′ W. in time.	4 2 0	
Mean Time at Ship...	11 29 9	Equa. Time N. A. 9m 9s.
Equa. of Time...Sub.	9 9	
App. Time at Ship...	11 20 0 A. M.	
Sub. from.	12 0 0	
Time from Noon.....	40 0	Log. ' 881 Part 1st.
Lat. 44° 30′ N., Decl. 2° S.		Log. 0.294 Part 3d.
Corr. in Part 4th	0° 51′	Log. 8 175 Table XV.
Obs. Altitude L. Limb..	42 20 S.	
Meridian Altitude......	43° 11′	
Corr. Table IX.....Add	11	
Sun's Central Altitude..	43° 22′	
Sub. from 90° = Zen. Dist.	46° 38′ N.	
Correct Declination.......	2 5 S.	
Latitude in..............	44° 33′ N. at 40m before Noon	
Course S. W. 6 m. gives D. Lat.	4 to the Southward.	
Latitude in.............	44° 29′ N. at Noon.	

FINDING THE LATITUDE OUT OF THE MERIDIAN.

EXAMPLE 3.

Oct. 20th. 1854. In Latitude by Dead Reckoning about 40° 0′ S., Long. by Chro. 62° E., the Sun's Obs. Alt. was 59° 30′ N., P. M. The Greenwich Time by Chronometer was 19h. 58m. 54s. A. M. The Course since Noon was S. S. E., going 12 knots an hour. Required the Latitude in at Noon.

	H. M. S.		
Green.Time by Chr.,	19 58 54	Dec., Oct. 20...	10° 20′ S.
Lon. 62° E. in time..	4 8 0	Cor., Ta. XI, Sub.	4
	24 6 54	Cor. Dec.....	10° 16′ S.
Subtract....	24 0 0		
Mn. Time at Ship..	6 54	Equa. Time, N. A. 15′ 6″	
Eq. of Time,.. Add..	15 6		

Ap. Time from Noon. 22m.0s. Log 7.362 Part 1st.
Lat. 40° S. and Dec. 10° S. Log 0.480 Part 2d.
Cor. in Part 4th, Add 0° 24′ = Log. 7.842 Table XV.
Obs. Alt.......... 59 30′ N.
Mer. Altitude.... 59° 54′ N.
Corr., Table IX, Add 12
True Altitude.... 60° 6′ N.
Zenith Dist....... 29° 54′ S.
Declination...... 10 16 S.
Latitude in...... 40° 10′ S. at 22′ past Noon.
S.S.E. 4 m. =D.Lat. 4 to the South'd since Noon.
Latitude... .... 40° 6′ S. at Noon.

EXAMPLE 4.

July 5th, 1854. In Lat. by Dead Reckoning about 50 S., and Long. 90° 36′ E. by Chro., the Sun's Obs. Alt. was 15° 47′ N., A.M. The Greenwich Time by Cro. was 17h. 1m. 47s. A.M. The Course to Noon was N.E., going 10 knots an hour. Required the Latitude at Noon.

	H. M. S.		
Green. T'e by Chr.,	17 1 47	Dec., July 5....	22° 49′ N.
Lon. 90° 36′ E. in time,	6 2 24	Cor., Ta. XI, Add	2
M. T'e at Ship, A.M.	23 4 11	Cor. Dec.	22° 51 N
Equa. of time. Sub.	4 11		
Sub. fr. 24h.=Ap.T.	23 0 0	Equa., N. A. ...	4′ 11″

Ap. T. fm Noon.. 1h.0m.0s. Log 8.231 Part 1st.
Lat. 50° S., and Dec. 23° N. Log 0.093 Part 3d.
Cor., Part 4th,. Add 1° 13′ = Log 8.324 Table XV
Obs. Altitude.... 15 47′ N.
Mer. Altitude.... 17° 0′ N.
Corr., Table IX, Add 9
True Altitude .. 17° 9 N.
Zenith Distance .. 72° 51′ S.
Declination...... 22 51 N.
Latitude....50° 0′ S. at 11 o'clock A. M.
Co. N.E. 10 m.=D.Lat. 7 to the Northward.
Latitude....49° 53′ S. at Noon.

EXAMPLE. 5

June 22d, 1854. Ship near the Equator, equal Altitudes were taken to correct the Watch.

Altitude A.M. 66° 4′ N. Time by Watch....11h. 48m.
do. P.M. 66 4 N. do. do. 12 18
Watch is 3 min. fast of Apparent Time.......)24 6
12h. 3m.

Required the Latitude in at the time of the P.M. Altitude.

Time by Watch, P.M.....0h. 18m.
Watch fast of App. Time. 3
App. Time from Noon ...0h. 15m. Log 7.029 Part 1st.
Lat. 0° 0′, Dec.......23° N. Log 0.673 Part 2d.
Corr. Part 4th, ..Add 0 17′ = Log 7.702 Table XV.
Obs Altitude........66 4 N.
Merid. Altitude .... 66° 21′ N.
Cor., Table IX, Add. 12
True Altitude.......66° 33′ N.
Zenith Distance .....23° 27′ S.
Declination.........23 27 N.
Latitude.... 0° 0′

EXAMPLE 6.

Nov. 15th, 1854. In Latitude about 56° 5′ N., Long. 15° W., an Altitude of the Sun was observed in the afternoon to be 14° 7′ S. Time shown by the watch, 1h.8m.46s., which had been regulated in the morning, since which time the Ship had made 64′ of Longitude to the Westward. Required the Latitude in at the time of the Altitude.

Time of Alt. by Watch......1h. 8m. 46s.
* D.Lon. ma. 64′ W. in time, Sub. 4 16
App. Time at Ship, P. M.... 1h. 4m. 30s. Log. 8.294
Lat. 56° N., and Dec..18½ S. .... Log. 0.042
Corr. in Part 4th..Add 1° 14′ = Log. 8.336 Table XV.
Obs. Altitude ....14 7 S.
Merid. Altitude .....15° 21′ S. Dec.....18° 30′ S.
Corr., Table IX. .Add 8 Corr...Add 1
True Altitude.......15° 29′ S. Cor. Dec. 18° 31 S.
Zenith Distance .....74° 31′ N.
Declination.........18 31 S.
Latitude in ....56° 0′ N. at 1h. 4m. P. M

QUESTIONS FOR EXERCISE.

Question 1st.—Dec. 11th, 1854. The Latitude by Dead Reckoning was about 50° 0′ N., and the Longitude by Chronometer 41° 20′ W. An Altitude of the Sun was observed in the forenoon to be 15° 28′ S and the time by Chronometer 13h. 40m. 6s, P. M., which was fast of Greenwich 3m. 20s. The Course until Noon was S. by W., going 8 knots. Required the Latitude at the time of the Altitude and at Noon.

Answer.—Latitude at 10h. 58m., or time of Altitude, was 50° 4′ N., and at Noon, 49° 56′ N.

Ques. 2d.—August 27th. The Latitude by Dead Reckoning was 35° 30′ N., and Long. 75° W. An Altitude of the Sun was observed to be 63° 59′ S. at 20 minutes past Noon, apparent time at the place Ship running to the Northward, going 9 knots. Required the Latitude as before.

Ans—Latitude at 20 minutes past Noon was 35° 27′ N. Latitude at Noon, 35° 24′ N.

* When the Difference of Longitude made in time is East, it must be added to the Time by Watch.

TO FIND THE LATITUDE BY TWO ALTITUDES OF THE SUN, (USUALLY CALLED DOUBLE ALTITUDES,)

Having the Measured Interval of Time between the Observations by the Watch.

This method will be found more simple and useful than the old and tedious methods of Double Altitudes usually given in works of this kind, many cases of which are of very doubtful utility, besides the time spent in working them out.

The principle of this method is simply to find the Sun's Hour Angle at the time the Altitude was observed, which was farthest from the Meridian, and to measure the interval of time elapsed between it and another Altitude observed near the Meridian, by a good Watch or Chronometer. This interval of time being then corrected for the Ship's change of Longitude in time, and applied to the Outer Hour Angle, the difference between them is the Inner Hour Angle, and which is the Apparent Time from Noon. The observation then becomes the same as if only one Altitude had been observed, and the limits are the same as in the last case.

The Time so found is only an approximation, because the Latitude is not known, but it is near enough for this purpose. And as every Navigator, now-a-days, is supposed to know how to find the time at Sea, nothing new is required to be learned. The Rule for finding the time at Sea is given at page 124.

When both Altitudes are Observed in the Forenoon.

RULE.

When the Sun is at a proper distance from the Meridian, or on the Prime Vertical, that is, when he bears nearly true East or West, take an Altitude, and note the time by a good-going Watch, or the Chronometer. Take another Altitude nearer Noon, about the limits given in Part 5th, Table XV, and note the time by the same Watch, and find the Interval of Time elapsed between the observations.

Correct the lesser Altitude by Table IX. Compute the Latitude in by the Dead Reckoning at the tim the lesser Altitude was observed, and also the Sun's Declination, and find his Polar Distance. Then, with the true Altitude, Latitude, and Polar Distance, find the Sun's Outer Hour Angle. If the Ship has been stationary during the Interval, or been sailing due North or South, no correction of the Interval is necessary. But if she has made Easting or Westing, then find the Departure the Ship has made in the Interval, from her true Course and Distance made good, and the corresponding Difference of Longitude. Turn this Difference of Longitude made into Time, by Table XXVI, and *add* it to the Interval if the Ship has been sailing East, or *subtract* it from the Interval if she has been sailing West, will give the correct Interval of Time between the observations; then the Difference between this corrected Interval, and the Sun's Outer Hour Angle, will give the Inner Hour Angle, at the time the greater Altitude was observed, and the result is the Apparent Time from Noon. The Latitude is thence found in exactly the same manner as if only one Altitude had been observed near Noon.

When the Lesser Altitude is Observed Before and the Greater Altitude in the Afternoon.

The Interval is found in the same manner, and the Outer Hour Angle subtracted from it, gives the Inner Hour Angle, which will be the Apparent Time past Noon at the Ship.

*When Both Altitudes are Observed in the Afternoon.**

Take an Altitude near Noon, about the limits in Part 5th, Table XV, and another when the Sun is at a Distance from the Meridian, and find his Hour Angle as before, from which subtract the Interval, will give the Inner Hour Angle past Noon.

*When the Lesser Altitude is Observed After Noon, and the Greater Altitude Before Noon.**

The Interval is found in the same manner, and the Outer Hour Angle subtracted from it, gives the Inner Hour Angle, which will be the Apparent Time from Noon, A. M., at the Ship.

Hence it is easy to ascertain at once whether the observations have been made on the same, or on opposite sides of the Meridian, by comparing the Outer Hour Angle with the Interval of time between the observations. If the Interval be *less*, they must have been taken on the same side, that is, both in the forenoon, or both in the afternoon. If *greater*, they must have been taken on opposite sides of the Meridian, that is, one Altitude has been taken in the forenoon and the other in the afternoon.

* When both Altitudes are observed in the Afternoon, or the Greater Altitude before Noon, and the Lesser Altitude after Noon, the difference of Long. in time made in the interval, should be added *to the interval*, if the course has been Westerly, or subtracted from the interval, if the course has been Easterly.

Examples of Finding the Latitude by two Altitudes of the Sun,

(Usually called Double Altitudes.)

EXAMPLE 1

April 1st, 1854, the Latitude in was 36° 48′ N., and the Long. 60° W. by Dead Reckoning. In the morning, at 7h 28m per Watch, the Sun's Observed Altitude was 20° 10′. Ship then sailed on a True S. E. course, going 9 knots an hour, until 11h 30m per Watch, when another Altitude of the Sun was observed to be 57° 28′ S. Required the Latitude of the Ship at the time of the last Altitude, and at Noon.

Observed Altitude L. Limb	20° 10′	
Corr. Table IX........Add	9	
True Altitude............	20 19	
Latitude...	36 48	Log. 0.09651
P. Distance...............	85 28	Log. 0.00136
Sum....................	142 35	
½ Sum..............	71 18	Log. 4.50598
True Altitude.............	20 19	
Difference..............	50 59	Log. 4.89040
Outer Hour Angle.....	4h 31m 41s =	9.49425
Correct Interval.......	4 4 8	
Inner H. Angle, A. M..	27m 33s	Log. 7.555 Part 1st
Lat. 36½° N., Decl. 4½° N........		Log. 0.481 Part 2d.
Corr. in Part 4th.....Add	0° 37′ =	Log. 8.036 Table XV.
Greater Altitude.........	57 28	
Meridian Altitude.......	58° 5′ S.	
Corr. Table IX..	11	
True Central Altitude...	58° 16′ S.	
From 90° Zen. Dist.....	31 44′ N.	
Corr. Decl. Noon	4 36 N.	
Latitude..............	36° 20′ N. at 27 minutes before Noon.	

	H. M.
Time of Lesser Altitude	7 28
Time of Greater Alt....	11 30
Interval of T. by watch.	4 2
Rate of Sailing...	9 k's
Distance Sailed........	36 m.

Decl. in Table X.......	4° 32′ N
Cor. Ln. 60° W., T. XI, Add	4
Corr. Decl. Noon.......	4 36
Cor. 4h 32′ before N. Sub.	4
Corr. Decl. at 7h 28m...	4 32 N
	90 0
Polar Distance.........	85° 28′

Course S. E. 36 m., Dep. 25.5, D. Long. 32′ in time.	0h 2m 8s Add
Interval of Time by Watch....................	4 2 0
Correct Interval of Time....................	4h 4m 8s

Course S. E., Dist. in 27 min. 4 miles gives D. Lat. to Noon	0° 3′ S
Latitude at 27m before Noon.....................	36 20 N
Latitude at Noon..................................	36° 17′ N

The Watch in this case was 2m 27s fast at time of Greater Altitude.

EXAMPLE 2.

15th March, 1854, In Latitude 44° 42′ N., and Long. 50° W. by Dead Reckoning. In the morning at 9h 10m per Watch, the Sun's Observed Altitude was 25° 8′. Ship then sailed on a True W. S. W. course, going 8 knots an hour, until 1h 11m, per Watch, in the afternoon, when the Sun's Observed Altitude was 42° 30′ S. Required the Latitude in at the time of the P. M. Altitude, and also at Noon.

Observed Altitude L. Limb	25° 8′	
Corr. Table IX........Add	10	
True Altitude...........	25 18	
Latitude...............	44 42	Log. 0.14825
Polar Distance...........	92 9	Log. 0.00031
Sum....................	162 9	
½ Sum.................	81 5	Log. 4.19033
Altitude................	25 18	
Difference..............	55 47	Log. 4.91746
Outer Hour Angle....	3h 21m 6s =	9.25635
Correct Interval.......	3 58 8	
Inner Hour Angle.....	37m 2s	Log. 7.813 Part 1st.
Latitude 44½° N. Decl. 2° S........		Log. 0.293 Part 3d.
Corr. Part 4th........Add	0° 44′	Log. 8.106 Table XV.
Greater Altitude.........	42 30	
Meridian Altitude.........	43° 14′ S	
Corr. Table IX.......Add	11	
True Central Altitude.....	43° 25′ S.	
Sub. from 90° Zenith Dist..	46° 35′ N.	
Decl. Noon 2° 6′, Corr. for 37m Sub. 1.........	2 5 S.	
Latitude.................	44° 30′ N. at 37 minutes past Noon.	

	H. M.
Time of Lesser Altitude	9 10
Time of Greater Alt. 1h 11m add 12h =......	13 11
Interval of T. by watch..	4 1
Rate of Sailing........	8 ks.
Distance sailed........	32m.

Decl. in Table X........	2° 9′ S.
Corr. Lon. 50° W....Sub.	3
Decl. at Noon..........	2 6
Corr. 3h before Noon Add.	3
Decl. at 9h A. M..	2 9
	90 0
Polar Distance.........	92° 9′

Course W. S. W. 32 miles = Dep. 30 = D. Lon. in time.	0h 2m 52s Sub
Interval of Time by watch....	4 1 0
Correct Interval of Time.....	3h 58m 8s

Course W. S. W. 5 miles since Noon D. Lat.	0° 2′
Latitude at 37m past Noon..............	44 30
Latitude in at Noon.....................	44° 32′ N

The Watch in this case was 33m 58s fast at the time of the Greater Altitude.

NOTE. In the 1st Example, 10 miles of an error in the Latitude, in working the Hour Angle, would produce an error in the time of about 9 seconds, and which does not affect the Corr. for Altitude.

In the 2d Example, 10 miles of an error in the Latitude, in working the Hour Angle, would produce an error of 45 seconds in the time from Noon, and an error of only 1′ 30″ in the Correction for Altitude

FINDING THE LATITUDE BY TWO ALTITUDES OF THE SUN,

(Usually called Double Altitudes.)

EXAMPLE 3.

Nov. 30th, 1854, Ship off Cape Horn, in Latitude 56° S., Long. 80° W., by the Dead Reckoning. In the afternoon, at 0h 36m 52s, per Watch, the Observed Altitude of the Sun was 54° 49′ N. Ship then sailed on a True N W. by W. Course, going 10 knots an hour, until 4h 47m 41 sec., by the same Watch, when the Sun's Observed Altitude was 26° 38′. Required the Latitude at the time of the Greater Altitude, and at Noon.

	° ′	
Lesser Altitude Observed..	26 38	
Corr. Table IX........Add	10	
True Altitude............	26 48	
Latitude by Dead Reck....	55 38	Log. 0.24835
Polar Distance...........	68 16	Log. 0.03202
Sum..................	150 42	
½ Sum..............	75 21	Log. 4.40297
Difference.............	48 33	Log. 4.87479
Outer Hour Angle.......4h 55m 41s	= 9.55813	
Correct Interval.........4 15 1		
Time past Noon........	40m 40s	Log. 7.895 Part 1st.
Lat. 56° S., Decl. 22° S............		Log. 0.268 Part 2d.
Corr. Part 4th......Add	0° 50′	= Log. 8.163 *Table XV.*
Greater Alt. Observed..	54 49	
Merid. Alt............	55° 39′ N.	
Corr. Table IX.....Add	11	
True Altitude..........	55° 50′ N.	
Zenith Distance........	34° 10′ S.	
Decl. at Noon..........	21 42 S.	
Latitude..............	55° 52′ S. at 0h 41m past Noon.	

	H. M. S.
Time of Lesser Alt. by Watch......	4 47 41
Time of Greater Alt.	0 36 52
Interval Time by W.	4 10 49
Say...............	4¼ hours
Rate of Sailing......	10 knots
Distance Sailed...	42 miles.

	° ′
Sun's Decl. Nov. 30,......	21 40 S
Cor. Ln. 80° W. Tab. XI Add	2
Decl. at Noon............	21 42 S.
Cor. for 4h 47m past Noon Add	2
Decl. Time of Lesser Alt..	21 44 S.
	90 0
Polar Distance.........	68° 16′

Course N. W. by W. 42 miles } in time. Add 0h 4m 12s
Dep. 35 = D. Lon. = 63... }
Interval of Time by Watch.............. 4 10 49
Correct Interval of Time..................4h 15m 1s

Course N. W. by W. 7 miles. since Noon, gives = D. Lat. 0° 4′
Latitude in at 41m past Noon.........................55° 52 S.
Latitude in at Noon...................................55° 56′ S

And the Watch in this case was 3m 48s slow, at the time of the Greater Alt.

EXAMPLE 4

August 10th, 1854, Ship off the Cape of Good Hope, in Latitude 38° 20′ S., and Long. 20° 10′ E. by the Dead Reckoning. At 11h 28m in the forenoon, the Sun's Observed Altitude was 35° 2′ N. Ship then sailed due East, going 8 knots, until 4h 21m 29s in the afternoon, when the Sun's Observed Altitude was 10° 8′. Required the Latitude in at the time of the A. M. Altitude, and also at Noon.

	° ′	
Lesser Altitude Observed...	10 8	
Corr. Table IX.......Add	7	
True Altitude............	10 15	
Lat. Dead Reckoning.....	38 20	Log. 0.10545
Polar Distance	105 35	Log. 0.01627
Sum....................	154 10	
½ Sum..................	77 5	Log. 4.34934
Altitude...............	10 15	
Difference..............	66 50	Log. 4.96349
Outer Hour Angle..... 4h 11m 29s	= 9.43455	
Correct Interval....... 4 50 5		
Time before Noon.....	38m 36s	Log. 7.851 Part 1st } Table XV.
Lat 38½ S., Decl. 15½ N...........		Log. 0.271 Part 3d }
Corr. Part 4th........Add	0° 46′	Log. 8.122
Greater Altitude Observed.	35 2	
Meridian Altitude........	35° 48′ N.	
Corr. Table IX.......Add	11	
True Altitude............	35° 59′ N	
Zenith Distance...........	54° 1′ S.	
Decl. Noon..............	15 38 N.	
Latitude................	38° 23′ S. at 11h 21m 24s in the forenoon.	

	H. M. S.
Time of Great Alt. by Watch........	11 28 0
Time of Lesser Alt. 4h 21m 29s add 12h	16 21 29
Interval Time by W.	4 53 29
Say..............	5 hours.
Rate of Sailing....	8
Distance sailed.....	40 miles.

	° ′
Decl. Aug. 10th..........	15 37 N
Corr. 20° E. Long....Add	1
Declination Noon........	15 38
Corr. for 4h 21m.....Sub.	3
Decl. Time of Lesser Alt.	15 35
	90 0
Polar Distance..........	105° 35′

Course True East 40 miles = D. Lon. 51′ in time 0h 3m 24s Sub
Interval of Time by Watch................ 4 53 29
Correct Interval of Time................... 4h 50m 5s

Ship's Course having been due East, she is on the same Parallel of Latitude at Noon, 38° 23′

In this case the Watch was 6m 36s fast at the time of the Greater Altitude

NOTE.—In Example 3d, the Lesser Altitude having been observed on the Prime Vertical, an error in the Latitude does not affect the Hour Angle.

In Example 4th, an error of 10′ in the Latitude would produce an error of 29 sec. in working the Hour Angle but which has little or no effect on the correction for Altitude

FINDING THE LATITUDE BY TWO ALTITUDES OF THE SUN

QUESTIONS FOR EXERCISE.

Question 1st.—October 20th, 1854. Ship becalmed in Latitude 50° 9′ N., and Longitude 30° W by Dead Reckoning. In the afternoon at 0h. 34m., per watch, the Sun's observed Altitude, Lower Limb, was 29° 5′ S., and at 2h. 46m. it was 19° 54′. Required the time from Noon, when the greater Altitude was observed, and the Latitude in.

Answer.—The time from Noon, when the greater Altitude was observed, is 0h. 28m. 46s., and the Latitude in at that time was 50° 3′ N.

Ques. 2d.—February 25th, 1854. In Latitude 51° 2′ N., Longitude 45° W., by Dead Reckoning. In the afternoon, at 0h. 33m., the Altitude of the Sun's Lower Limb was 28° 53′ S. Ship then sailed to the Eastward 20 miles, and at 2h. 43m. P. M., it was 19° 44′. Required the error of the Watch, and the Latitude at the time of the greater Altitude.

Ans.—The time from Noon, when the greater Altitude was observed, was 0h. 40m. 11s Watch was 7m. 11s. slow, and the Latitude in 51° 17′ N.

Ques. 3d.—January 6th, 1854. In Latitude 58° 25′ S., and Longitude 138° E., (at Noon, by Dead Reckoning.) At 11h. 2m., A. M., per watch, the Altitude of the Sun's Lower Limb was 52° 13′ N. Ship then sailed on a S. S. W. ½ W. Course, (true,) going 8 knots an hour until 4h. 50m. P. M., when his Altitude was 28° 10′. Required the correct time from Noon, when the greater Altitude was observed, the Latitude in at that time, and the Latitude at Noon, brought on by the Dead Reckoning.

Ans.—The time from Noon, when the greater Altitude was observed, was 1h. 1m. 58s. A. M. Latitude in at that time 58° 30′ S. The Difference of Latitude made to Noon was 7′ S., and the Latitude in at Noon was 58° 37′ S. (*In this case, at the time of the lesser Altitude, the Sun was on the Prime Vertical.*)

Ques. 4th.—August 30th, 1854. In Latitude 12° 43′ S., and Longitude 93° W., Dead Reckoning, at 11h. 45m. 12s., A. M., the observed Altitude of the Sun's Lower Limb was 67° 44′ N. Ship sailed S. W. by W., going 4 knots an hour, until 1h. 15m. 12s., P. M., (both times being noted by the same watch,) when the Altitude was 62° 0′. Required the time from Noon, when the greater Altitude was observed, and the Latitude in.

Ans.—The time from Noon was 0h. 20m. 22s., A. M., and the Latitude observed at that time was 12° 32′ S.

NOTE.—In Low Latitudes, the Lesser Altitude may be taken much nearer to Noon than in High Latitudes; because there the Sun's motion is much quicker, and the Time is more correctly found in Low Latitudes; but in all cases the Greater Altitude should be observed as near to Noon as the limits required in Part 5th, Table XV

Should there happen to be a very great difference between the Latitude so found, and that by the Dead Reckoning at the time of the greater Altitude, the Latitude used in finding the Outer Hour Angle must be corrected accordingly, and the case worked over again, and the Inner Hour Angle found anew, which will give the correct Latitude.

In the above Examples the height of the eye is taken at 16 or 18 feet above the Sea level.

TO FIND THE LATITUDE FROM THE SUN'S CHANGE OF ALTITUDE.

This Table contains the Sun's Change of Altitude in One Minute of Time for every Degree of Latitude

When on the Prime Vertical.

Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.	Lat.	Change of Alt.
°	′ ″	°	′ ″	°	′ ″	°	′ ″	°	′ ″	°	′ ″	°	′ ″	°	′ ″	°	′ ″
1	15. 0	11	14.44	21	14. 0	31	12.52	41	11.20	51	9.27	61	7.16	71	4.53	81	2 22
2	15. 0	12	14.41	22	13.54	32	12.44	42	11.10	52	9.15	62	7. 2	72	4.38	82	2. 6
3	14.58	13	14.37	23	13.48	33	12.35	43	10.59	53	9. 2	63	6.48	73	4.23	83	1.50
4	14.58	14	14.34	24	13.42	34	12.26	44	10.48	54	8.49	64	6.34	74	4. 8	84	1.34
5	14.57	15	14.30	25	13.36	35	12.17	45	10.37	55	8.36	65	6.20	75	3.53	85	1.18
6	14.56	16	14.26	26	13.29	36	12. 8	46	10.26	56	8.23	66	6. 6	76	3.38	86	1. 2
7	14.54	17	14.21	27	13.22	37	11.59	47	10.15	57	8.10	67	5.52	77	3.23	87	0.46
8	14.51	18	14.16	28	13.15	38	11.50	48	10. 3	58	7.57	68	5.38	78	3. 8	88	0.30
9	14.49	19	14.11	29	13. 8	39	11.40	49	9.51	59	7.44	69	5.24	79	2.52	89	0.15
10	14.46	20	14. 6	30	13. 0	40	11.30	50	9.39	60	7.30	70	5. 9	80	2.36	90	0. 0

When the Sun, or any other heavenly body, is on the Prime Vertical, that is, when it bears true East or West, its change of Altitude is then greatest. If its change of Altitude in one minute of time be then measured with a Sextant, to the nearest second, the Latitude corresponding to it will be found in the above Table This method depends entirely upon the accuracy with which the change of Altitude is measured, and cannot be much depended on, even in High Latitudes, where the change of Altitude in one minute of time, between any two degrees, differ the most.

It is merely given here to illustrate the subject. The Table itself, however, will be found useful when we want to know the change of Altitude of any heavenly body when bearing East or West; for instance, in observing Altitudes for Time, it may be used as a check on the difference of the observed Altitudes in a given time, and which should agree with the change of Altitude in one minute of time given in the above Table, according to the Latitude of the place of observation.

But as the heavenly bodies only pass the Prime Vertical above the horizon when the Latitude of the place and the Declination of the body are of the same name, (as in the case of the Sun in the Summer time,) the change of Altitude will be slower when they are of contrary names, and in this case the quickest change will take place when the Altitude is from 5° to 10° above the horizon, but there are always some one or other of the heavenly bodies on the Prime Vertical, which may be observed.

To find the Latitude from the Change of the Sun's Altitude in One Minute of Time.

RULE.

Observe with a Sextant an Altitude of the Sun, when he bears true East or West, and note the full minute by the Watch. Three minutes afterwards, observe another Altitude, at that exact time. Divide the Difference of the Observed Altitudes by the number of minutes elapsed, will give the Change of Altitude in 1 minute of time, with which enter the above Table, opposite to which will stand the Latitude required.

EXAMPLE 1.

The Sun's Change of Altitude in 1 minute, and his bearing East (passing the Meridian to the Southward) given. But neither the Declination nor the Latitude by account known. Required the Latitude in.

T. by Watch.. 5h 20m. 1st Alt..14° 17′ 40″
do. do. .. 5 23 2d Alt..14 52 10

3m. ....)34′ 30″ Diff. of Alt.

Sun's Change of Alt. in 1 minute. 11′ 30″
Which corresponds to Lat.. 40° 0′ N. in the Table.

EXAMPLE 2.

Required to find the Latitude by the Sun's Change of Altitude in 1 minute of time, when on the Prime Vertical, having passed the Meridian to the North of the Observer.

T. by Watch.. 5h.4m. 1st Alt..21° 6′ 20″
do. do. .. 5 7 2d Alt..20 37 23

3m. ....)28′ 57″ Diff. of Alt

Sun's Change of Alt. in 1 minute. 9′ 39″
Which corresponds to Lat..50° 0′ S. in the Table.

The Latitude may be found from the Meridian Altitude of the Moon, upon the same principle as that by the Sun. But as the Moon's Declination changes very rapidly, we must know the exact Greenwich date at which the Observation is made, in order to correct her Declination to that date.

The Moon's Declination is given in the large Nautical Almanacs for every hour of the day at Greenwich and her change of Declination in seconds for every 10 minutes between the hours, so that the Correction can easily be computed.

In the small Almanacs, it is only given for every Noon and Midnight at Greenwich, and we take the proportional part of her change in Declination, corresponding to the hours and minutes past the nearest Noon or Midnight, or enter Table XXIII with the Diff. in 12h at the side, and the time past Noon or Midnight at the top, and take out the Correction.

But if the Longitude of the Ship be not known, the correct Declination cannot be computed, consequently the Latitude cannot be found by the Moon.

Ships, however, which carry good Chronometers, have their Longitude always tolerably correct; hence, the Latitude found by the Moon, in that case, can be depended on, and is sufficiently near the truth for all practical purposes.

The Moon being nearer the Earth than any other heavenly body, her place in the heavens is greatly affected by Parallax; that is, she always appears below her true place in the heavens, by the amount of her Parallax in Altitude. This Correction is given in Table XXV, (and which includes the correction for the Refraction of the Atmosphere), and is always *additive* to the Apparent Altitude.

The Moon's Semi-diameter and Horizontal Parallax is given in the Nautical Almanac for every Noon and Midnight at Greenwich, and are generally taken out for the nearest Noon or Midnight corresponding to the Greenwich date of the Observation.

When the Moon is in the Zenith, she is nearer to the observer than when in the Horizon, by the amount of the Earth's Semi-diameter; hence, her Diameter is augmented, or appears 16″ larger than when in the Horizon. This Correction is given in Table VII, but is seldom used in the practice of finding the Latitude at Sea.

The first thing required to be done is to find at what time the Moon passes the Meridian of Greenwich. in the Nautical Almanac, on the day before the Sea Date, and correct it to the time she passes the Meridian of the Ship; because, as the Moon is constantly advancing to the Eastward in the Heavens, she will pass any Meridian to the Eastward of Greenwich sooner in the day, or a Meridian to the Westward later in the day, by a certain number of minutes. Therefore, in West Longitude we take out the Meridian passage on that and the following day, but in East Longitude, on that and the preceding day, and take their difference, which is the daily variation of the Moon's passing the Meridian. Enter Table XXII with the daily variation at the top, and the Longitude of the Ship in the side column, and at the angle of meeting will be the number of minutes required, which must be *added* to the time of her Meridian passage on the day before the Sea Date, if the Longitude be West, or *subtracted*, if East, will give the Mean Time of her passing the Meridian of the Ship.

This correction may also be found by *adding* 2 minutes of time for every 15° of Longitude which the Ship is to the Westward of Greenwich, to the Mean Time of her passing the Meridian of Greenwich (by the Nautical Almanac), or *subtracting* the same when the Longitude is East, will give the Mean Time of her passage at the Ship.

Here it may be remarked, that as the Watch is generally regulated to Apparent Time at Ship, and is referred to in ascertaining the time to begin the observation, these two times may differ as much as 16 minutes sometimes, and the observation is frequently lost; that is, the Moon has passed the Meridian before the observation has been begun. To prevent this happening, take out the Equation of Time given in the Nautical Almanac, and apply it to the Mean Time of passing the Meridian at the Ship the *contrary* way to what is directed in the precept at the head of the column for Apparent Time, and the result is the Apparent Time of her passing the Meridian at the Ship. Then if the Watch be regulated to Apparent Time at the Ship, it will show the exact time at which the Moon will pass the Meridian, because all the heavenly bodies pass the Meridian at Apparent Time.

Having thus found the Mean Time of the Moon's Meridian passage at the Ship, as directed above·

2. *To Find the Greenwich Date.*

Turn the Ship's Longitude into Time by Table XXVI, and *add* it to the above time, if the Longitude be West, or *subtract* it if the Longitude be East. The Sum or Difference will be the time at Greenwich (usually called the Greenwich Date) when the Moon passes the Meridian of the Ship. But should the sum exceed 24 hours, *subtract* 24 hours from it, and *add* one day to the Greenwich Date. On the other hand, when the Longitude is *subtractive*, and greater than the time of Passing the Meridian, add 24 hours to the latter, for the purpose of *subtraction*, and take one day from the Greenwich Date.

3. *To Correct the Semi-diameter and Horizontal Parallax*

From the Nautical Almanac take out the Moon's Semi-diameter and Horizontal Parallax for the nearest Noon or Midnight corresponding to this Greenwich Date, and correct them if required by Table XXIV, and to the Moon's Semi-diameter add her augmentation found in Table VII. (But this is seldom necessary.)

4. *To Find the Apparent Altitude.*

Add the Difference between the Moon's Semi-diameter and the Dip of the Horizon found in Table V to the Observed Altitude of her Lower Limb, or *subtract* their Sum if the Upper Limb be observed, will give the Moon's Apparent Central Altitude. (See remarks on taking Altitudes at page 71.)

5. *To Find the Moon's True Altitude.*

Enter Table XXV with the Moon's Horizontal Parallax at the top, and her Apparent Altitude at the side, and take out the Correction for her Parallax in Altitude, and which is always *additive* to her Apparent Altitude.

6. *To Correct the Declination by the Large Nautical Almanac.*

To correct the Moon's Declination, taken from the large Nautical Almanac, take out the Declination for the day and hour corresponding to the Greenwich Date. And when there are odd minutes, take out the Diff. of Declination in 10 minutes, found in the side column opposite, and which is expressed in seconds and hundred parts of a second; and when the hundredths are more than 50, call the seconds one more, but if less, throw them away. Multiply the seconds by the odd minutes, and strike off the right hand figure; then divide by 60, will give the Correction in minutes and seconds. If the Declination is increasing, *add* this Correction, but if it be decreasing, *subtract* it.

7. *To Correct the Declination by the Small Nautical Almanac.*

To Correct the Moon's Declination taken from the small Nautical Almanac, take out the Declination for the nearest Noon or Midnight, if the Greenwich Date be exactly at Noon or Midnight; but if not, take it out for the nearest Noon or Midnight preceding, and the nearest Noon or Midnight following, the Greenwich Date, and take their difference, which will be that for 12 hours.

Enter Table XXIII with the difference for 12 hours at the side, and the hour from Noon or Midnight at the top, and take out the Correction. If there are odd minutes, enter the right hand side of the table with the odd minutes at the top and the difference for 12 hours at the side, and take out the Correction. *Add* the *Sum* of these Corrections to the Declination at the preceding Noon or Midnight, if the Declination is increasing, but *subtract* it if decreasing, will give the Moon's correct Declination at the time of the observation.

But when the Declination, taken from the Nautical Almanac, for the preceding Hour or the Noon or Midnight, is decreasing, and the correction *subtractive* exceeds it, the difference is the Declination of a *contrary* name

8. *To Find the Latitude.*

Thus having the Moon's Correct Altitude, and her Correct Declination, the Latitude is found by the same rule as for the Sun's Meridian Altitude. That is: Subtract the True Altitude from 90°, will give the Zenith Distance of a contrary name to the Moon's Bearing. Place the Correct Declination under it. Then if they are both North or both South, their *Sum* is the Latitude of that name; but if one be North and the other South, their *difference* is the Latitude of the same name as the greater of the two

EXAMPLE 1

July 12th, 1854, Sea Time, in the Longitude of 75° W., the Meridian Altitude of the Moon's Lower Limb was observed to be 40° 35′ S. Height of the eye 18 feet. Required the Latitude of the Ship.

July 12th is July 11th, Astronomical Time.		
Moon's Mer. Passage, July 11th,	13h 58m	
On the following day, July 12th	14 56	
Long. 75° W., and daily variation	58m	in Table XXII.
Gives the Correction to be added	0h 12m	
To the Meridian Passage, July 11th	13 58	
Mean Time of the Mer. Passage at Ship	14h 10m	
Long. 75° W. in time ... Add	5 0	
Greenwich Date, July 11th	19h 10m	
Less 12h, gives the time past Midnight	7h 10m	
Moon's Declination at Midnight, July 11th	21° 21′ S.	
Moon's Declination at Noon, July 12th	19 9 S	
Diff. of Declination in 12 hours	2° 12′	and the
Time from Midnight 7h 10m, in Table XXIII = Corr. ... Sub.	1° 18′	
Declination at Midnight decreasing	21 21 S.	
Correct Declination at time of Observation	20° 3′ S	

Mean Time of Mer. Pass. at Ship	14h 10m
Equa. of Time N. A. applied con. way	Sub. 5
App. Time by Watch of Merid. Pass.	14h 5m
Or at 2h 5m in the morning.	
Moon's Hor. Parl. at Mid. July 11th	60′ 0″
Observed Altitude Moon's L. Limb	40° 35′ S
Semid. at Midnight 16′, Dip of the Horizon 4′ } Add Diff.	12
Moon's Apparent Altitude	40° 47′
Corr. for Alt. in Table XXV. Add	44
Moon's True Central Altitude	41° 31′ S
	90 0
Zenith Distance	48° 29′ N
Correct Declination	20 3 S
Latitude in	28° 26′ N

EXAMPLE 2.

April 25th, 1854, Sea Time, in the Longitude of 80° East, the Meridian Altitude of the Moon's Upper Limb was observed to be 67° 36′ N. Height of the eye 21 feet. Required the Latitude of the Ship.

April 25th is April 24th, Astronomical Time.		
Moon's Mer. Passage April 24th,		22h 43m
* Long. 80° E., which, at the rate of 2m to every 15° = Corr.	Sub.	10
Mean Time of the Mer. Pass. at Ship		22h 33m
Long. 80° E. in time	Sub.	5 20
Greenwich Date, April 24th		17h 13m
Less		12h 0
Time past Midnight at Greenwich		5h 13
Moon's Decl. Midnight, April 24th,		0° 51′ S.
Moon's Decl. Noon, April 25th,		2 2′ N.
Diff. of Decl. in 12 hours		2° 53′
And time from Midnight 5h 13m in Table XXIII, Corr.	Sub.	1° 15′
Declination at Midnight decreasing		0 51 S.
Correct Decl. at the time of Observation		0° 24′ N.

Mean Time of passing the Mer. at Ship		22h 33m
Equa. of Time, N. A., applied contr'y way	Add	2
App. Time of the Merid. passage		22h 35m
Less		12 0
App. time by Watch of the Mer. passage		10h 35m A. M.
Moon's Hor. Parl. at Midnight, April 24th		57′ 0″
Moon's Obs. Altitude Upper Limb		67° 36′ N.
Semid. Midnight...15′ 31″; Dip of the Horizon. 4 28	Sub. the Sum	20
App. Altitude		67° 16′
Corr. for Altitude, Table XXV	Add	22
Moon's True Central Altitude		67° 38′ N.
		90 0
Zenith Distance		22° 22′ S
Correct Declination		0 24 N
Latitude in		21° 58′ S

* This Correction is found by adding 2 minutes of Time for every 15° of Longitude which the Ship is to the Westward of Greenwich, to the time of her passage in the Nautical Almanac, or subtracting the same in East Longitude, will give the Mean Time of her passage at the Ship.

Correction of the Declination (used in the above Examples), taken from the large Nautical Almanac

EXAMPLE 1.

Decl., N. A., July 11, 19h.	20° 4′ 44″ S.	Diff. 10m	110″.33
Decl. Decreasing....Sub.	1 50		10m.
Correct Declination	20° 2′ 54″ S.		60)110.0
Correction for 10 minutes			1′ 50″

EXAMPLE 2.

Decl. April 24, 17h.	0° 21′ 3″ N.	Diff. 10m	144 50
Decl. Increasing...Add	3 8		13
Correct Declination	0° 24′ 11″ N.		60)188.5
Correction for 10 minutes			3′ 8″

QUESTIONS FOR EXERCISE.

Question 1.—April 5th, 1854, Sea Time, in Longitude 30° 44′ W., the Meridian Altitude of the Moon's Upper Limb was 75° 15′ S. Height of the eye 18 feet. Required the Latitude of the Ship.

Answer.—Latitude in 40° 58′ N.

Question 2.—April 2d, 1854, Sea Time, the Observed Altitude of the Moon's Lower Limb was 54° 39′ S. in Longitude 60° W. Required the Latitude in.

Answer.—Latitude in 54° 31′ N.

Question 3.—April 13th, 1854, Sea Time, the Observed Altitude of the Moon's Upper Limb was 30° 20′ S. in Longitude 80° W. Required the Latitude in.

Answer.—Latitude in 54° 18′ N.

TO FIND THE LATITUDE BY THE MERIDIAN ALTITUDE OF A PLANET.

The Latitude may be found from the Meridian Altitude of the Planets upon the same principle as that by the Sun and Moon.

Their Declinations are given in the Nautical Almanac for the Noon at Greenwich, for every day of the month throughout the year.

When their Declinations change slowly, they may be taken out for the Noon of the day at once by inspection. But when there is a considerable change in their Declinations between the Noon of one day and the next, we must correct the Declination to the Greenwich time of Observation, in a similar manner as is done in the case of the Moon, except that their Meridian Passage is taken from the Nautical Almanac and used without being corrected, as the Mean Time of their passing the Meridian at Greenwich, is near enough for general practice at Sea.

But to find the Apparent Time, or the Actual Time, they do pass the Meridian by the watch, (regulated to Apparent Time at Ship), the Equation of Time must be applied to the time of passage taken from the Nautical Almanac, the *contrary* way to what is directed in the precept at the head of the column for Equation of Time, in the same manner as it is done in the case of the Moon, so as the Observation may not be lost in consequence of being too late in beginning it.

To Find the Planets in the Heavens when on the Meridian.

RULE.

1. Find at what time a Planet will pass the Meridian in the Nautical Almanac, select one in preference which will be on the Meridian at twilight, because then the Horizon is distinctly visible; or even when the Sun is several degrees above the Horizon, some of them may be observed, though invisible to the naked eye, and they are found as follows:

Apply the Equation of Time, as before directed, to the Mean Time of their passage in the N. A., will give the Apparent Time of their passage at the Ship, and the Watch must be previously regulated to Apparent Time, or its error known.

2. Subtract the Latitude by Dead Reckoning from 90°, and the remainder will be the Co-Latitude. Take out the Declination of *that* Planet from the Nautical Almanac, which passes the Meridian at the proposed time. Then if the Co-Latitude and its Declination are of the *same* name, take their *sum*, but if of *contrary* names, take their *difference*, for the Meridian Altitude of the Planet.

Now put this Computed Altitude on the Arch of the Sextant, and if in the day time, screw in the Inverting Telescope, (otherwise use the Direct one), and look towards the South point of the Horizon when the Latitude is North, and towards the North point of the Horizon when the Latitude is South, and the Planet will be distinctly seen, through the Telescope, on or near it.

But when the *Sum* of the Co-Latitude and Declination exceed 90°, it must be *subtracted* from 180°, and the Planet must be looked for in the North point of the Horizon, in North Latitude, and in the South point of the Horizon in South Latitude.

Bring the Planet in contact with the Horizon, and when it attains its greatest Altitude, read off the Arch, and find the Latitude as follows:

To Compute the Latitude from the Meridian Altitude of a Planet.

RULE

Subtract the Sum of the Refraction and Dip, found in Tables IV and V, from the Observed Altitude, will give the True Altitude, which, *subtracted* from 90°, gives the Zenith Distance of the *contrary* name to the Planet's Bearing. Take from the N. A. the Declination, and correct it if required. Then, if the Zenith Distance and Declination are of the *same* name, their *Sum*, but if of *contrary* names, their *Difference*. is the Latitude of the *same* name as the *greater* of the two

TO COMPUTE THE MERIDIAN ALTITUDE OF THE PLANETS.

EXAMPLE 1.

January 2d, 1854. Sea Time. Required the Apparent Time, and the Altitude at which the planet Venus will pass the Meridian. Ship off the Cape of Good Hope, in Latitude 34° 0′ S., and Longitude 18° 0′ E.

M. Pas. N.A., Jan. 1st,	3h. 15m.	M. Time at Greenwich.
Equ. of Time,..Sub.	4	
M. Pass. at Ship....	3h. 11m.	App. Time P. M.

M. Pas., N.A., Jan. 1st,	3h. 15m.	Dec., N'n, Jan. 1st,	13° 5′ S.
Lon. 18° E. in T., Sub.	1 12	do. Jan. 2d,	12 40 S.
Greenwich Date...	2h. 3m.	Change in 24h..	25′
Lat. of Ship....	34° 0′ S.	Pro. for 2h...Sub.	2′
	90 0	Dec., Jan. 1st,	13° 5′
Cor. Lat........	56° 0′ S.	Cor. Dec....	13° 3′ S.
Dec. Venus.....	13 3 S.		
Compu. Alt.....	69° 3′	of Venus at 3h. 11m. P. M.	

Put this Altitude on the Sextant and look towards the North point of the horizon, (the Latitude being South.)

EXAMPLE 2.

June 7th, 1854. Sea Time. Required the Apparent Time, and the Altitude at which the planet Mars will pass the Meridian. In Latitude 40° 20′ N., and Longitude 75° West.

M. Pas. June 6th, N.A..	6h. 2m.	M. Time at Greenwich
Equa. of Time....Add	2	
M. Pass. at Ship....	6h. 4m.	App. Time, P. M.

M.Pass. N.A., June 6th,	6h. 2m.	Dec., June 6th,	7° 25′ N.
Lon. 75° W. in T., Add	5	do. June 7th,	7 13
Greenwich Date...	11h. 2m.	Change in 24h..	12′
Lat. of Ship....	40° 20′ N.	Pro. for 11h..Sub.	5′
	90 0	Dec., June 6,..	7° 25′ N.
Co-Latitude.....	49° 40′ N.	Cor. Dec.,....	7° 20′ N
Dec. of Mars....	7 20 N.		
Computed Alt...	57° 0′	of Mars at 6h. 4m. P. M.	

Put this Altitude on the Sextant and look towards the South point of the horizon, (the Latitude being North.)

EXAMPLE 3,

April 14th, 1854. Sea Time. Required the Apparent Time, and the Altitude at which the planet Jupiter will pass the Meridian. Ship on the Equator, in Longitude 25° West.

M. Pas. N.A., Ap. 13th,	18h. 24m.	M. Time at Greenwich.
Equ. of Time..Sub.	1	
M. Pass. at Ship....	18h. 23m.,	or 6h. 23m. A. M. by Watch.

M. Pass. April 13...	18h. 24m.	Dec., April 13th,	21° 7′ S.
Lon. 25° W. in T., Add	1 40	do. April 14th,	21 6 S.
Greenwich Date...	20h. 4m.	Change of Dec. 24h.	—1′
		Pro. for 20h. Sub.	— 1
Lat. of Ship 0° 0′ Co-Lat.	90° 0′	Dec., Ap. 13,	21° 7′
Add Dce. of Jupiter....	21 6 S.	Cor. Dec.	21° 6′
	111° 6′		
Subtract from.........	180 0		
Computed Altitude.....	68° 54′	of Jupiter at 6h. 23′ A.M.	

Put this Altitude on the Sextant and look towards the South point of the horizon, (because the Declination is South.)

EXAMPLE 4.

Feb. 2d, 1854. Sea Time. Required the Apparent Time, and the Altitude at which the planet Saturn will pass the Meridian in Latitude 30° 20′ N., and Longitude 76° 30′ W.

M. Pass. Feb. 1st..	6h. 46m.	M. Time at Greenwich.
Equa. of Time..Sub.	14	
Mer. Pass. at Ship...	6h. 32m.	App. Time, P. M.

M. Pass. Feb. 1st....	6h 46m.	Dec., N.A., Fe. 1st.	17° 4′ N
Lon. 76° 30′ W. in T.	5 6	do. Feb. 2d.	17 4 N
Greenwich Date...	11h. 52m.	No Cor. for Dec. required.	
Lat. of Ship....	30° 20′ N.		
	90 0		
Co-Latitude....	59° 40′ N		
Dec. of Saturn..	17 4 N.		
Computed Alt..	76° 44′	of Saturn at 6h. 32m. P. M.	

Put this Altitude on the Sextant, and look towards the South point of the horizon, (because the Lat is North.)

To find the Latitude from the Meridian Altitude of the Planets.

EXAMPLE 1.

Jan. 2d, 1854. Sea Time. The observed Altitude of the planet Venus was 69° 7′ N. in Longitude 18° East. Required the Latitude.

Observed Altitude of Venus............		69° 7′ N.
Dip 4. Ref. 0........................	Sub..	4
True Altitude..............................		69° 3′ N.
Zenith Distance		20° 57′ S.
Declination		13 3 S.
Latitude....................................		34° 0′ S.

EXAMPLE 2.

June 7th, 1854. Sea Time. The observed Altitude of Mars was 57° 4′ S, in Longitude 75° West. Required the Latitude.

Observed Altitude of Mars................		57° 4′ S.
Dip 4. Ref. 1..........................	Sub.	5
True Altitude		56° 59′
Zenith Distance..........................		33° 1′ N
Declination		7 20 N
Latitude		40° 21′ N

EXAMPLE 3.

April 14th, 1854. Sea Time. The observed Altitude of Jupiter was 68° 58′ S., in Longitude 25° West. Required the Latitude.

Observed Altitude of Jupiter............		68° 58′ S.
Dip 4. Ref. 0........................	Sub.	4
True Altitude		68° 54′ S.
Zenith Distance..		21° 6′ N.
Declination		21 6 S.
Ship on the Equator.............		00° 0′

EXAMPLE 4.

February 2d, 1854. Sea Time. The observed Altitude of Saturn was 76° 48′ S., in Longitude 76° 30′ West Required the Latitude.

Observed Altitude of Saturn		76° 48′ S.
Dip 4. Ref. 0	Sub.	4
True Altitude.............................		76° 44′ S
Zenith Distance...........................		13° 16′ N
Declination		17 4 N
Latitude		30° 20′ N

TO FIND THE LATITUDE BY THE MERIDIAN ALTITUDE OF A STAR.

The Latitude may be found by the Meridian Altitude of a fixed Star, upon the same principle as that by the Sun.

1. Table XIX contains the Right Ascensions and Declinations of 24 of the principal Fixed Stars, for the year 1854, and the annual variation or change of the same. So that this Table may serve for future years, by simply multiplying the number of years elapsed by the amount of the annual variation, and applying it according to the sign of addition (+), or subtraction (—), to the Sums taken from the Table.

2. *To Find what Star will Pass the Meridian at any Given Hour of the Day*,

Enter Table XVIII, with the Day of the Month at the top, and follow down the column until we come to the required hour, opposite to which will stand the name of the Star. But as the Meridian passages in this Table are only given for every third day, should the day required be between those which are marked at the head of the column, take it out for the nearest day preceding the required day, and subtract 4 minutes for each intermediate day.

The times shown in this Table are only approximations, but are sufficiently near enough for the purpose of finding the Latitude by the Stars.

By the assistance of this Table, the method of finding the Latitude by the Meridian Altitude of a Star will be greatly facilitated; for when we know at what time, nearly, a Star will pass the Meridian, and the approximate Altitude at that time, there can be no difficulty in making the requisite observation to determine the Latitude. These opportunities occur frequently in the course of a clear night, and may be put in practice by any person otherwise unacquainted with the Stars in the heavens, by reference to the Figures at pages 65 and 66, and the following Rules.

3. *To Compute the Meridian Altitude of a Star.*

Subtract the Latitude by Dead Reckoning, (at the proposed time of observation,) from 90°, will give the complement of the Latitude, or Co-Latitude, of the place of observation. Take out the Star's Declination from Table XIX, and correct it for the years elapsed since 1854. Then, if the Co-Latitude and its Declination are of the same name, take their Sum, but if of contrary names, take their Difference for the Meridian Altitude and the Star will be found in the South part of the heavens when the Latitude is North, and in the North part when the Latitude is South. But when the Sum exceeds 90°, subtract it from 180°; the remainder will be the Altitude, and the Star will be found in the North part of the heavens in North Latitude, and in the South part in South Latitude. (See remarks on taking Altitudes of the Stars, at page 71.)

4. *To Find the Star from its Computed Altitude and Meridian Passage.*

Set the Index of the Quadrant to the Computed Altitude, and at a few minutes before the time of its Meridian passage, direct the sight towards the North or South points of the horizon, as shown above, and the reflected image of the Star will be perceived in the Horizon Glass, upon or near the horizon, which being brought in contact with it, and kept so until it arrives at its greatest, or Meridian Altitude, the angle is then read off the Quadrant.

There is not the least danger of mistaking the Star, as no other will have the same Meridian Altitude at that time. (See remarks at page 71.)

The best time for observing Altitudes of Stars is at twilight, for then the horizon is distinctly visible, and the Latitude may be found as correctly as by the Sun. But in dark nights an error of from 5 to 10 miles in the Altitude may be made, in consequence of the obscurity of the horizon. To obviate this, the Latitude should be found from an Altitude of a Star to the Southward, and another to the Northward, and the half Sum of the two Latitudes thus found will be the correct one This will be further explained in the following Examples.

FINDING THE LATITUDE BY THE MERIDIAN ALTITUDE OF A STAR

The Meridian passages of the Stars shown in Table XVIII, being for Apparent Astronomical Time which commences at Noon, one day before the Sea Day begins, and the hours are counted in succession throughout; so that when Sea Time is used, the Tables must be entered with the date one day less than Sea Time.

If Civil or Common Time is used, the hours less than 12 will be the time past Noon on that day (and which are the same as Astronomical Time.) But when the hours are greater than 12, subtract 12 hours from it, and it will be the time on the morning of the following Civil Day, and which commences at Midnight. Because the Noon of the Civil Day, the beginning of the Astronomical Day, and the end of the Sea Day, takes place at the same period of time.

To Find the Stars in the Heavens from their Computed Altitude.

EXAMPLE 1.

Feb. 28th, 1854, Sea Time, in Latitude by D. R. 40° 10′ N. Required what Star will be on the Meridian at twilight in the evening, and its Computed Altitude.

On referring to Table XVIII, and taking the date one day less, or Feb. 27th, I find the Star Aldebaran will pass at 5h 48m P. M.

Latitude by Dead Reck..40° 10′ N.
Subtract from............90 0
Co-Latitude.............49° 50′ N.
Declination Table XIX...16 13 N.
Computed Altitude......66° 3′. I now set the Index of the Quadrant to this Altitude, and face towards the South, because the Latitude is North. Flatten down the Sight Vane, and using both eyes, the Star Aldebaran will be distinctly seen upon, or near the Horizon.

EXAMPLE 2.

March 1st, 1854, Sea Time, in Latitude by D. R. 38° 10′ N. Required what Star will pass the Meridian at twilight in the morning, and its Computed Altitude.

On referring to Table XVIII, and taking the date one day less, or February 28th, I find that the Star Antares will pass on the 27th, at 17h 40m, from which I subtract 4 minutes, gives 17h 36m, and less 12h gives 5h 36m, the time it passes in the morning.

Latitude by Dead Reck..... 38° 10′ N.
Subtract from............. 90 0
Co-Latitude................ 51° 50′ N.
Declination, Table XIX.... 26 6 S.
Computed Altitude........ 25° 44′. Set the Index to this Altitude, and face towards South in North Latitude, and the Star will be found as before.

EXAMPLE 3.

March 21st, 1854, Civil Time, in Latitude by D. R. 0° 30′ S. Required to find a Star in the evening at twilight.

In Table XVIII, I find that the Star Sirius passes the Meridian at 6h 34m *P. M.*

Latitude by Dead Reck.. 0° 30′ S.
Subtract from.......... 90 0
Co-Latitude............. 89° 30′ S.
Declination, Table XIX.. 16 31 S.
106° 1′
Subtract from..........180 0
Computed Altitude...... 73° 59′ towards the South.

EXAMPLE 4.

March 26th, 1854, Civil Time, in Latitude by D. R 30° 25′ S. Required to find a Star in the morning twilight.

In Table XVIII, I find that the Star Vega passes the Meridian at 18h 20m, on the 24th, from which I subtract 8 minutes, gives 18h 12m, and less 12h gives 6h 12m, its passage in the morning.

Latitude by Dead Reck.. 30° 25′ S.
Subtract from.......... 90 0
Co-Latitude............. 59° 35′ S
Declination, Table XIX.. 38 39 N.
Computed Altitude..... 20° 56′ towards the North.

EXAMPLE 5.

May 2d, 1854, Sea Time, in Latitude by D. R. 20° 0′ N. Required at what Time and Altitude the Star Vega will pass the Meridian.

On the 1st of May, by Table XVIII, Vega passes the Meridian at 15h 59m, or time by Watch at 3h 59m A. M.

Latitude by Dead Reck.. 20° 0′ N.
Subtract from.......... 90 0
Co-Latitude............ 70° 0′ N.
Declination, Table XIX.. 38 39 N.
108° 39′
Subtract from..........180 0
Computed Altitude..... 71° 21′ towards the North.

EXAMPLE 6

June 22d, 1854, Sea Time, Ship on or near the Equator. Required at what Time and Altitude the foot Star of the Southern Cross will pass the Meridian.

On the 21st June, by Table XVIII, it passes the Meridian at 6h 21m in the evening.

Latitude by Dead Reck.. 0° 0′
Co-Latitude............ 90° 0′
Declination, Table XIX.. 62 17 S.
Computed Altitude..... 27° 43′ towards the South because the Declination is South. *The Cross always passes the Meridian erect.*

NOTE.—When the Star's Declination Subtractive is greater than the Co-Latitude, the Star is not above the Horizon of the observer.

TO FIND THE LATITUDE BY THE MERIDIAN ALTITUDE OF A STAR.

RULE.

From the Observed Altitude of the Star, subtract the Dip of the Horizon, and the Refraction, taken from Tables IV and V; or the Sum of these Corrections may be taken out at once from Table XX, by entering it with the height of the eye at the top, and the Observed Altitude at the side, and the Angle of meeting is the required Correction, always *subtractive* from the Observed Altitude, will give the Star's True Altitude, which, subtracted from 90°, gives the Zenith Distance. Then, if the Star bears South, mark the Zenith North, and if the Star bears North, mark the Zenith Distance South.

Take out the Star's Declination from Table XIX, and correct it for the years elapsed since 1854, as before shown, and mark it North or South.

Then, if the Zenith Distance and Declination are of the same name, take their Sum, but if they are of contrary names, take their Difference, for the Latitude, of the same name as the greater of the two.

EXAMPLE 1.

Feb. 28th, 1854, Sea Time, at 5h 48m P. M., the Observed Altitude of the Star Aldebaran was 66° 7′ S. Required the Latitude.

✳'s Observed Altitude........	66° 7′ S.
Corr., Table XX........ } Sub. Height of the eye 16 feet }	4
True Altitude...............	66° 3′
	90 0
Zenith Distance...............	23° 57′ N.
Declination, Table XIX.......	16 13 N.
Latitude Observed...........	40° 10′ N. at 5h 48m P. M.

EXAMPLE 2.

March 1st, 1854, Sea Time, at 5h 36m A. M., the Observed Altitude of the Star Antares was 25° 50′ S. Required the Latitude.

✳'s Observed Altitude......	25° 50′ S.
Corr., Table XX (16 feet) Sub.	6
True Altitude.............	25° 44′
	90 0
Zenith Distance...........	64° 16′ N.
Declination, Table XIX....	26 6 S.
Latitude Observed.........	38° 10′ N. at 5h 36m *A. M.*

EXAMPLE 3.

March 21st, 1854, Civil Time, at 6h 34m P. M., the Observed Altitude of the Star Sirius was 74° 3′ S. Height of eye 18 feet. Required the Latitude.

✳'s Observed Altitude.......	74° 3′ S.
Corr., Table XX..........Sub.	4
True Altitude...............	73° 59′
Zenith Distance.............	16° 1′ N.
Declination, Table XIX.......	16 31 S.
Latitude Observed...........	0° 30′ S. at 6h 34m P. M.

EXAMPLE 4.

March 26th, 1854, Civil Time, at 6h 12m A. M., the Observed Altitude of the Star Vega was 21° 2′ N. Height of the eye 15 feet. Required the Latitude.

✳'s Observed Altitude........	21° 2′ N
Corr., Table XX..........Sub.	6
True Altitude..............	20° 56′
Zenith Distance.............	69° 4′ S.
Declination, Table XIX......	38 39 N.
Latitude Observed..........	30° 25′ S. at 6h 12m A. M.

EXAMPLE 5.

May 2d, 1854, Sea Time, at 3h 59m A. M., the Observed Altitude of the Star Vega was 71° 26′ N Height of the eye 20 feet. Required the Latitude.

✳'s Observed Altitude.......	71° 26′ N.
Corr., Table XX.............	5
True Altitude...............	71° 21′
Zenith Distance............	18° 39′ S.
Declination, Table XIX.......	38 39 N.
Latitude Observed............	20° 0′ N. at 3h 59m *A. M.*

EXAMPLE 6.

June 22d, 1854, Sea Time, at 6h 21m P. M., the Observed Alt. of the foot Star of the Southern Cross was 27° 50′ S. Height of eye 25 feet. Required the Latitude.

✳'s Observed Altitude......	27° 50′ S.
Corr., Table XX...........	7
True Altitude............	27° 43′
Zenith Distance............	62° 17′ N.
Declination, Table XIX....	62° 17′ S.
Ship on the Equator.......	0° 0′ at 6h 21m P. M.

QUESTIONS FOR EXERCISE.

Quest. 1st.—April 2d, 1854, Sea Time, what Star, and at what Time and Altitude will it pass the Meridian about Twilight in the evening, in Latitude 42° 25′ N

Answer.—The Star Castor, April 1st, at 6h 43m, and its Meridian Altitude is 79° 47′ S.

Quest. 2d.—April 2d, 1854, Sea Time, the Meridian Altitude of the Star Castor was observed to be 79° 49′ S., at 6h 43m in the evening. Height of the eye 16 feet. Required the Latitude.

Answer.—Latitude Observed 42° 27′ N.

TO FIND THE LATITUDE BY THE MERIDIAN ALTITUDE OF THE POLE STAR

RULE.

Correct the Observed Altitude for Dip and Refraction by Table XX. Take out the Pole Star's Declination from Table XIX, and correct it for the years elapsed since 1854, and subtract its Declination from 90°, will give its Polar Distance; then the Sum of the true Altitude and Polar Distance is the Latitude, when observed below the Pole, but the Difference between them is the Latitude when observed above it.

To find when the Pole Star passes the Meridian below the Pole, we add half the interval of its revolution, which is 11h. 58m., to the time at which it passes the Meridian above the Pole, found in Table XVIII, and subtract 24 hours from it, if it exceeds that quantity

EXAMPLE 1.

July 2d, 1854. Sea Time. At 6h. 20m. in the evening the Meridian Altitude of the Pole Star (below the Pole) was oberved to be 43° 10′. Height of the eye, 20 feet Required the Latitude.

By Table XVIII, it passes the Merid. at 18h. 26m. A.M.

Obs. Alt. Pole ✱ .	43° 10′	Dec., Table XIX,	88° 32′ N.
Cor., Tab. XX.. Sub.	5		90 00
True Alt........	43° 5′	Polar Dist......	1° 28′
Polar Dist....Add	1 28		
Latitude in.....	44° 33′ N.		

EXAMPLE 2.

July 21st, 1854. Sea Time. At 5h. 9m. in the morning, the Meridian Altitude of the Pole Star (above the Pole) was observed to be 32° 28′. Height of the eye, 16 feet. Required the Latitude.

By Table XVIII, it passes the Merid. at 17h. 9m. A. M.

Obs. Alt. Pole ✱..	32° 28′	Dec., Table XIX,	88° 32′ N
Cor., Tab. XX, Sub.	5		90 00
True Alt.......	32° 23′	Polar Dist....	1° 28′
Polar Dist.. Sub.	1 28		
Latitude in.....	30° 55′ N.		

To Find the Latitude by the Pole Star at any Hour in the Night.

RULE.

To the Sun's Right Ascension, taken from Table XIII, add the time since Noon, when the Altitude was observed The Sum (rejecting 24 hours if it exceeds that quantity) will be the Right Ascension of the Meridian, with which enter Table XXI, and take out the correction, to be applied as directed in that Table, and the Sum, or remainder, will be the required Latitude.

Remarks on Finding the Latitude by the North Pole Star.

This method of finding the Latitude by the Pole Star is only an approximation, and may deviate two or three miles from the truth; but from its extreme simplicity it is well adapted to the practice of Seamen, in cases where an error of a mile or two can be of no material consequence.

If the time at the Ship is not known, that is, if the Watch has not been previously regulated at the time of the Altitude, the Apparent Time at Ship may be deduced from the Greenwich Time by Chronometer, by turning the Ship's Longitude into time, and subtracting it in West Longitude, or adding it in East, will give the Mean Time at Ship, and the Equation of Time applied the contrary way will give the Apparent Time at Ship. In general, a few minutes error in the time will not affect the result.

To Find the North Pole Star Itself

The North Pole Star is easily found in the heavens, from the direction of the two large Stars in the coulter of the Plough, that well-known constellation, which is perpetually wheeling round the Pole of the heavens, so that these two Stars, or Pointers, always point to the North Pole Star as a centre. The Pole Star itself is only a dim object, of the second or third magnitude, and it requires good silvered mirrors in the Quadrant to obtain a tolerable observation, and the glasses should be wiped clean before the observation is commenced. (See remarks on taking Altitudes of the Stars, page 71.)

EXAMPLE 1.

January 21st, 1854. Sea Time. At 8h. 25m. P. M. the Altitude of the Polar Star was observed to be 38° 15′. Height of the eye, 18 feet. Required the Latitude.

✱'s Obs. Alt.....	38° 15′	App. Time at Ship..	8h. 25m.
Cor., Tab. XX, Sub.	5	Sun's R.A. Jan. 20th,	20 9
True Alt........	38° 10′	R. A. Meridian....	28h. 34m.
Cor., Ta. XXI, Sub.	0 53	Less.............	24 0
Latitude in.....	37° 17′ N.	R.A. of Meridian..	4h. 34m.

EXAMPLE 2.

February 11th, 1854. Sea Time. The Greenwich Time by Chronometer being 21h. 30m., in Longitude 60° 0′ W., an Altitude of the Pole Star was observed to be 32° 45′. Height of the eye, 20 feet. Required the Latitude.

✱'s Obs. Alt....	32° 45′	Gr. T. by Chro....	21h. 30m.
Cor., Tab. XX, Sub.	6	Lon. 60° W. in T., Sub.	4 0
True Alt.......	32° 39′	M. Time at Ship...	17h. 30m.
Cor., Ta. XXI, Add	1 18	Eq. of Time.. Sub.	15
Latitude in	33° 57′ N.	App. Time at Ship.	17h. 15m.
		Sun's R.A. Feb. 10th,	21 36
			38h. 51m.
		Less............	24h. 0
		R. A. of Meridian.	14h. 51m.

FINDING THE LATITUDE BY THE MERIDIAN ALTITUDE OF TWO STARS

In the Northern Hemisphere.

In the night time, as before observed, errors in the observed Altitudes of the Stars are liable to be made in consequence of the obscurity of the horizon.

But if we observe one Altitude of a Star to the Southward and another to the Northward, (and although they may both be in error, the one error will balance the other; that is, the Latitude found from the Altitude of both Stars may be erroneous, but if we add the two Latitudes together, their half Sum will be the correct Latitude.

EXAMPLE.

March 19th, 1854. Sea Time. At 10h. 10m. P. M., Apparent Time at Ship, the Meridian Altitude of the Star Regulus was observed to be 64° 7′ South, and at the same time the Altitude of the Pole Star was 37° 57′ North Height of the eye, 18 feet. Required the Latitude.

Obs. Alt. of the ✱ Regulus.	64° 7′ S.	Obs. Alt. Pole ✱..........	37° 57′	App. Time at Ship......	10h. 10m.
Cor., Table XX.....Sub..	5	Cor., Table XX........Sub.	5	Sun's R. A., March 18th..	23h. 51
True Alt...............	64° 2′	True Alt................	37° 52′		34h. 1m
Zenith Dist	25° 58′ N.	Cor., Table XXI.......Add	1 2		24 0
Dec., Table XIX........	12 41′ N.	Lat. by Pole Star.........	38° 54′	R. A. of the Meridian....	10h. 1m.
Lat. by Regulus........	38° 39′ N.	Lat. by Regulus..........	38 39		
		Sum....................	)77° 33′		
The Altitudes were 7½m. too great.		Correct Latitude	38° 46′ 30″ N. at 10h. 10m. P. M		

In the Southern Hemisphere.

There are no Stars near the Pole which will answer the same purpose as the North Pole Star. Consequently, we have to observe the Meridian Altitudes of two Stars in opposite directions, but which do not pass the Meridian at the same period of time. (The difference of their Meridian passages is shown in Table XVIII.) So that the Altitude of the first Star observed must be reduced to the place where the second was observed, by applying the difference of Latitude the Ship has made in that interval of time, by the following simple Rule, and which is founded on the fact that when a Ship sails South she rises all the Stars in that direction, that is, their Meridian Altitudes increase, while those to the North gradually sink, that is, their Meridian Altitudes decrease; and in sailing North, those to the North are raised, while the Stars to the South decline, by a quantity equal to the Difference of Latitude she has made in a given time.

RULE

Enter the Traverse Table with the Course and Distance made good in the interval between the times of the Stars passing the Meridian, and take out the Difference of Latitude made in that interval, and apply it as follows:

Ship sailing South.	Altitude of the first Star observed,	to the Southward,	Add	Difference of Latitude	to it.
		to the Northward,	Sub.	do.	do.	from it.
Ship sailing North.	Altitude of the first Star observed,	to the Northward,	Add	do.	do.	to it.
		to the Southward,	Sub	do	do.	from it

EXAMPLE.

March 13th, 1854. Sea Time. At 12h. 50m. the Meridian Altitude of the foot Star of the Southern Cross was observed to be 61° 47′ South. Ship's Course S. W., (true,) going 10 knots; and at 1h. 48m. the Meridian Altitude of Spica was 66° 35′ North. Required the Latitude.

Mer. Pass. of the Cross....	12h. 50m.	First Obs Alt. S. Cross....	61° 47′ S.	Obs. Alt. of Spica........	66° 35′ N.
do. of Spica.......	13 48m.	Cor. for Diff. Lat.....Add.	7	Cor., Table XX.... Sub.	5
Interval of time..........	0h. 58m.		61° 54′	True Alt............	66° 30′
		Cor., Table XX.....Sub	5	Zenith Dist.............	23° 30′ S
Course S.W., Dist. 10 gives D.Lat. 7′ S.		True Alt................	61° 49′	Dec., Table XIX........	10 24 S.
		Zenith Dist..............	28° 11′ N.	Latitude by Spica.......	33° 54′ S.
		Dec., Table XIX	62 17 S.		
		Latitude by the S. Cross..	34° 6′ S.		
		do. by Spica........	33 54 S.		
		Sum..................	)68° 0′		
		Correct Latitude........	34° 0′ S.	at 1h. 48m. or time of the last Altitude	

The Altitudes in this case have been too great by 6 minutes, and which is generally the case in observing Altitudes of Stars in the night time

FINDING THE LATITUDE BY AN ALTITUDE OF A STAR OUT OF THE MERIDIAN.

The Latitude may be found by an Altitude of a Star out of the Meridian, upon the same principle as the method given at page 94, by the Sun, using the Star's Distance from the Meridian in the room of the time from Noon.

And it is necessary, in this case, (in obtaining a correct result), to compute the Star's Meridian passage, in the room of taking it from Table XVIII.

RULE.

Turn the Ship's Longitude into Time, and add it in West Longitude, or subtract in East, to or from the Apparent Time of Observation, reckoned from the preceding Noon, will give the Greenwich Time, nearly. Or the Greenwich Time may be found at once from the Chronometer. Take out the Sun's Right Ascension from the Nautical Almanac, one day less than the Sea Date, and correct it to the Greenwich Time by multiplying the difference for 1 hour by the time from Greenwich Noon, and add it to the Right Ascension at the preceding Noon, (because it is always increasing.) Take out the Star's Right Ascension, and correct it, if required. Then subtract the Sun's Right Ascension from the Star's Right Ascension, (increasing the latter by 24 hours, if necessary, for the purpose of subtraction), and the remainder will be the correct Apparent Time of the Star's Meridian passage.

The limits of the time from the Meridian passage of the Star, are the same as the time from Noon by the Sun, given in Part 5, Table XV, and the rules for using the Tables are the same as given at page 94.

If the time of the Altitude of the Star is noted by the Watch, it must be previously regulated, or its error on Apparent Time known.

The Chronometer may be used to find the Apparent Time of Observation, as at page 94.

EXAMPLE 1.

Feb. 28th, 1854, Sea Time, in Latitude by Dead Reckoning, about 40° 10′ N., and Longitude 60° W., at 6h 5m P. M., the Observed Altitude of the Star Aldebaran was 65° 43′ S.; height of the eye 18 feet; the Watch showing the correct Apparent Time. Required the Latitude.

Feb. 27th, the Sun's R. A., N. A. Noon.....22h 40m 59s
Time of Obs. 6h 5m; Long. 60° W. 4 0 — Change of R. A. in 1h = 9s × 10h = 1 30
Green. Date. 10h 5m — ☉'s Correct R. A...22h 42m 29s
✳'s R. A. 4h 27m 32s, Increased by 24h..... 28 27 32
✳Aldebaran's Mer. Passage............... 5h 45m 3s
Apparent Time of Observation............ 6 5 0
Time past the Meridian.................. 19m 57s
✳ Past the Meridian 19m 57s, Part 1st.......... Log. 7.279 — Table XV.
Lat. 40° N., ✳'s Decl. 16s N., Part 2d.......... Log. 0.559 — Table XV.
Corr. for Altitude...Add 0° 24′ Log. 7.838
✳'s Obs. Altitude......65 43
Meridian Altitude.....66° 7′ S.
Corr., Table XX...Sub. 5
True Altitude.........66° 2′
Zenith Distance.......23° 58′ N.
Declination...........16 13 N.
Latitude in...........40° 11′ N. at 6h 5m P. M.

EXAMPLE 2.

March 22d 1854, Sea Time, in Latitude by Dead Reckoning about 38° N., and Longitude 45° W., an Altitude of the Star Sirius was observed to be 34° 36′ S., when the Greenwich Time by Chro. was 9h 3m P. M: height of the eye 18 feet. Required the Latitude.

March 21st, Sun's R. Ascen., N. A., at Noon 0h 2m 5s
G. Time of Obs. 9h 3m 0s — Corr. for G. T. 9h × 9s 0 1 21
Long. 45° W. in time.... 3 0 0s — ☉'s Cor. R. A. 0h 3m 26s
Mer. T. at Ship. 6h 3m 0s — ✳'s R. Ascen. 6 38 43
Equa of Time. Sub. 7 15 — ✳'s Mer. Pas. 6h 35m 17s
App. T. at Ship. 5h 55m 45s or T. of Obs. 5 55 45
Time before passing the Meridian......... 39m 32s
Time before Mer. Pass. 39m 32s, Part 1st.................. Log. 7.869 — Tab. XV
Lat. 38° N., ✳'s Decl. 16½° S...., Part 3d.................. Log. 0.268 — Tab. XV
Corr. for Altitude....Add 0° 47′ Log. 8.137
✳'s Observed Altitude...34 36
Meridian Altitude........35° 23′ S.
Corr., Table XX.....Sub 5
True Altitude..........35° 18′
Zenith Distance.........54° 42′ N.
✳'s Decl., Table XIX...16 31 S.
Latitude in.............38° 11′ N. at 5h 56m P. M.

The same Examples as above, worked with the Star's Meridian Passage taken from Table XVIII.

Mer. Passage of Aldebaran, Feb. 27, Tab. XVIII 5h 48m
Time of Observation........................ 6 5
Time past the Meridian..................... 17m
✳ past the Mer. 17m Part 1st...Log. 7.138 — Table XV.
Lat. 40° N., ✳'s Decl. 16° N.., Part 2d.................. Log. 0.559 — Table XV.
Corr. for Altitude 17′..........Log. 7.697

Mer. Passage of Sirius, March 21, Table XVIII. 6h 34m
Time of Observation......................... 5 56
Time before passing the Meridian.............. 38m
Time before Mer. 38m Part 1st...Log. 7.836 — Table XV
Lat. 38° N., Decl. 16½° S. Part 3d. Log. 0.266 — Table XV
Corr. for Altitude 44′ .. ..Log. 8.102

Hence an error of nearly 3 minutes of time in the Meridian Passage of Aldebaran would produce an error of 7′ in the Correction for Altitude.

And an error of 1m 32s of time in the Meridian Passage of Sirius would produce an error of 3′ in the Correction for Altitude.

FINDING THE LATITUDE BY AN ALTITUDE OF A STAR OUT OF THE MERIDIAN.

As the Parts 2d and 3d of Table XV are only calculated for objects whose Declinations do not exceed 25°; therefore, when the Declination of a Star exceeds that quantity, the Logarithm of the Latitude and Declination must be computed as follows:

RULE.

Compute the Meridian Altitude of the body by *adding* its Declination to the Co-Latitude, when they are of the *same* name, or taking their *Difference* when of *contrary* names. Enter Table XXVIII with the Latitude and the Declination, (as if they were Half Sums), and take out *three* figures of these Logarithms with their Indices. Enter Table XXVII, with the Meridian Altitude, (as a Latitude), and take out its Logarithm in like manner, and write under it the constant Logarithm 0.301. *Add* these four Logarithms together, and their *Sum* (rejecting 10's in the Index), will be the Logarithm of the Latitude and Declination required.

EXAMPLE 1.

Required the Logarithm for Lat. 48° 30′ N., and the Declination of the Star Castor 32° 12′ N.

Latitude.......48° 30′ N. as a half Sum....	Log.	4.821
Subtract from...90 0 (Table XXVIII.)		
Co-Latitude.....41° 30′ N.		
✱'s Decl........32 12 N. as a half Sum....	Log.	4.927
Mer. Altitude..73° 42′ S. as a Lat., Table XXVII......	Log.	0.552
Constant....	Log.	0.301
Required Computed....................	Log.	0.601

EXAMPLE 2.

Required the Log. for Lat. 38° 25′ S., and the Decl of the foot Star of the Cross 62° 17′ S.

Latitude....... 38° 25′ S. as a half Sum....	Log.	4.894
Sub. from..... 90 0 (Table XXVIII.)		
Co-Latitude.... 51° 35′ S.		
Decl........... 62 17 S. as a half Sum....	Log.	4.667
113° 52′		
Subtract from...180 0		
Mer. Altitude.. 66° 8′ S. as a Lat., Table XXVII.....	Log.	0.398
Constant.................................	Log.	0.301
Required Computed........................	Log.	0.255

EXAMPLE 3.

March 31st, 1854, Sea Time, Latitude by Dead Reckoning 48° 30′ N., Long. 30° W., the Observed Altitude of the Star Castor was 73° 1′ S., and the Greenwich Time by Chronometer 8h 28m 49s. Required the Latitude.

March 30th, Sun's R. A., in N. A., Noon..			0h 34m 48s
G. T. by Chro.	8h 28m 49s	Cor. for G. T. 8¼h × 9s...	1 16
Lon. 30° W. in time..	2 0 0	⊙'s Cor. R. A..	0h 36m 4s
M. T. at Ship.	6h 28m 49s	✱'s R. Ascen...	7 25 17
Equa... Sub.	4 36	✱'s Mer. Pass...	6h 49m 13s
App. Time...	6h 24m 13s	App. T. of Obs..	6 24 13
Time before the Meridian Passage.........			25m 0s

✱'s Dist. fm. the Mer. 25m, Part 1st, Tab. XV.	Log.	7.473
Lat. 48° 30′ N., Decl. 32° 12′ N., Computed..	Log.	0.601
Part 4th. Corr. for Altitude......Add 0° 41′	Log.	8.074
✱'s Observed Altitude..............73 1		
Meridian Altitude. ....73° 42′ S.		
Corr., Table XX...................Sub. 4		
True Altitude......................73° 38′		
Zenith Distance....................16° 22′ N.		
✱'s Declination....................32 12 N.		
Latitude Observed..................48° 34′ N.		
At 6h 24m 13s P. M.		

EXAMPLE 4.

Jan. 2d, 1854, Sea Time, in Lat. by Dead Reckoning 38° 25′ S., Long. 30° E., the Obs. Alt. of the foot Star of the Southern Cross was 65° 41′ S., and the Greenwich Time by Chro. 16h 2m 40s. Required the Latitude.

Jan. 1st, Sun's R. A., in N. A., Noon.......			18h 47m 6s
G. T. by Chro..	16h 2m 40s	Cor. for G. T. 16h × 11s=	2 56
Long. 30° E. in time....	2 0 0	⊙'s Cor. R. A..	18h 50m 2s
M. T. at Ship..	18h 2m 40s	✱'s R. A.... 12h 18m 31s + 24h = ..	36 18 31
Equa. of T..Sub.	3 51		
App. Time....	17h 58m 49s		
		✱'s Mer. Pass..	17h 28m 29s
		App. T. of Obs.	17 58 49
Time past the Meridian..................			30m 20s

✱'s Dist. from the Mer. 30m 20s, Part 1st....	.........Log. 7.641	Table XV.
Lat. 38° 25′ S., Decl. 62° 17′ S...............	Computed Log. 0.255	
Corr. for Altitude.......Add 0° 27′	Log. 7.896	
✱'s Obs. Altitude..........65 41		
Meridian Altitude...........66° 8′ S.		
Corr., Table XX........Sub. 4		
True Altitude..............66° 4′		
Zenith Distance............23° 56′ N.		
Declination................62 17 S.		
Latitude Observed.........38° 21′ S.		

EXAMPLE 5.

Required the Logarithm for Latitude 10° 0′ S., and the Declination of the Star Dubhe 62° 32′ N.

Latitude 10° 0′ S. as a half Sum	Log.	4.993
Sub. fm. 90 0		
Co-Lat... 80° 0′ S.		
Decl..... 62 32 N. as a half Sum..........	Log.	4.664
Mer. Alt. 17° 28′ S. as a Latitude...........	Log.	0.021
Constant.................................	Log.	0.301
Required Computed......................	Log.	9.979

EXAMPLE 6.

Required the Log. for Latitude 40° 27′ S., and the Declination of the Star Canopus 52° 37′ S.

Latitude 40° 27′ S. as a half Sum.........	Log.	4.881
Sub. fm.. 90 0		
Co-Lat... 49° 33′ S.		
Decl..... 52 37 S. as a half Sum.........	Log.	4.788
102° 10′		
Sub. fm..180 0		
Mer. Alt. 77° 50′ S. as a Latitude...	Log.	0.676
Constant................................	Log.	0.301
Required Computed....................	Log.	0.646

FINDING THE LATITUDE BY TWO STARS, ONE OF THEM OUT OF THE MERIDIAN.

As before observed, a single Altitude of a Star for Latitude, on a dark night at Sea, is always of a doubtful character, in consequence of the obscurity of the horizon; but which may be remedied by observing two Stars on opposite sides of the Meridian. But as no two Stars pass the opposite Meridians at the same period of time, the Ship may have changed her place in the interval of their passing, and a correction must be applied to the first Altitude, to reduce it to the place where the second was observed, (an Example of which is given at page 110.) But when we want to find the Latitude *at once* from the Altitude of two Stars on opposite sides of the Meridian, we observe the Meridian Altitude of one, and directly afterwards observe the Altitude of the other, (not on the Meridian,) and note the time by the Watch or the Chronometer, and reduce it to the Meridian, (as in the Examples on the preceding page.) The limits must be the same as that given in Part 5th, Table XV.

EXAMPLE 1.

February 12th, 1854. Sea Time. In Latitude, by Dead Reckoning, about 40° 9′ S., and Longitude 25° 16′ W., the Meridian Altitude of the Star Spica was observed to be 60° 34′ North, and at the same time the Altitude of the foot Star of the Cross was 66° 10′ South. Greenwich Time by Chronometer, 15h. 34m. 20s. Required the Latitude.

Greenw'h Time by Chr..	15h. 34m. 20s.	
Long. 25° 16′ W. in T...	1 41 4	
Mean Time at Ship....	13h. 53m. 16s.	
Equa. of T., contrary, Sub.	14 32	
pp. Time at Ship....	13h. 38m. 44s.	
Mer. Obs. Alt. of ✳ Spica..	60° 34′	N.
Cor., Table XX.........	4	
True Alt..........	60° 30′	
Zenith Dist.............	29° 30′	S.
Dec. Spica	10 24	S.
Lat. Obs. by ✳ Spica....	39° 54′	S.
do by ✳ S. Cross..	40 6′	S.
Sum...............	½)80° 0′	
Correct Latitude	40° 0′	S.

Feb. 11th, Sun's R. Ascen., N. A.....	21h. 39m. 28s.	..Diff. for 1h....9s.
Corr. for Greenwich Time..... Add	2 20	..Green. Time .15½h.
Sun's Correct R. Ascen............	21h. 41m. 48s.	135
✳ Cross R. A. 12h.18m.31s.×24h.=	36 18 32	5
✳'s Meridian Passage...........	14h. 36m. 44s.	)140
Time of the Observation..........	13 38 44	......Cor. 2m.20s
Time before Mer. Passage........	58m. 0s.	......Log. 8.202
Lat. 40° S., Dec. 62° 17′ S., computed		..................Log. 0.274
Cor. for Alt.......................Add	1° 43′	......Log. 8.476
Obs. Alt. ✳ S. Cross................	66 10	.......Table XV.
Merid. Alt.........................	67° 53′ S.	
Cor., Table XX ....Sub.	4	
True Alt..........................	67° 49′	
Zenith Dist........................	22° 11′ N.	
Dec., S. Cross	62 17 S.	
Lat. by S. Cross...................	40° 6′ S.	

EXAMPLE 2.

March 2d, 1854. Sea Time. In Latitude, by Dead Reckoning, about 40° 30′ South, and Longitude 75° 30′ East, the Meridian Altitude of the Star Sirius was observed to be 66° 14′ North, and at the same time the Altitude of the Star Canopus was 77° 36′ South. Greenwich Time by Chronometer, 3h. 0m. 24s. Required the Latitude.

Gr. Time by Chro......	3h. 0m. 24s.	
Lon. 75° 30′ E. in time.	5 2	
Mean Time at Ship....	8h. 2m. 24s.	
Equa. of T., contrary, Sub.	12 37	
App. Time at Ship....	7h. 49m. 47s.	
Mer. Alt. of ✳ Sirius..	66° 14′	N.
Cor., Table XX ..Su .	4	
True Alt.	66° 10	
Zenith Dist..........	23° 50′	S.
Dec Sirius	16 31	S.
Lat. Obs. by Sirius ...	40° 21′	S.
do. by Canopus.	40 32	S.
Sum	½)80° 53′	
Correct Latitude	40° 26′ 30″	S.

March 1st, Sun's R. A. in N. A......	22h. 48m. 30s.	.......Diff. for 1h... 9s.
Cor. for Greenwich Time .....Add	27	Green. Time..... 3h
Correct R. Ascen.	22h. 48m. 57s.	.......Cor. ....27s.
✳Canopus R.A. 6h.20m.44s. Add 24h.	30 20 44	
do. Mer. Passage	7h. 31m. 47s.	
Time of Obs.	7 49 47	.........(Table XV.)
Time before Mer. Passage	18m. 0s.	...........Log. 7.188
See Example 6th, page 112, of Computing the		..............Log. 0.641
Correction for Altitude ....Add	0° 23′	....Log. 7.829
Obs. Alt. ✳ Canopus	77 36 S.	
Mer. Alt.	77° 59′	
Cor., Table XX ....Sub.	4	
True Alt.	77° 55′ S.	
Zenith Dist........................	12° 5′ N.	
Dec. Canopus	52 37′ S.	
Lat. Obs. by Canopus...............	40° 32′ S.	

NOTE.—The 1st Example given above is not a good case, as the time from the Meridian passage exceeds the limits of the Part 5th, and an error in the time will considerably affect the result.

When there is a choice of Stars, take the one whose Declination is of a contrary name to the Latitude of the place, and which has a low Altitude, because it can be observed farthest from the Meridian, and an error in the time affects it the least. In this case an error of 1 minute in the time would produce an error of 4 minutes in the correction for Altitude; and on reversing the case, that is, observing the Cross on the Meridian, and finding the correction for the Altitude of Spica, an error of 1 minute in time would produce an error of 3 minutes in the correction for Altitude.

FINDING THE LATITUDE BY AN ALTITUDE OF THE MOON OUT OF THE MERIDIAN.

The Latitude may be found by an Altitude of the Moon, taken either before or after she passes the Meridian, within the limits of Part 5th, Table XV, upon the same principle as that by the Sun and Stars, as follows :

RULE.

To Find the Apparent Time of the Observation.

1. Note the Greenwich Time by Chronometer, when the Altitude was observed. Turn the Ship's Longitude into Time. *Subtract* in West or *add* in East Longitude, will give the Mean Time at Ship. Apply the Equation of Time the *contrary* way to what is directed for Apparent Time in the column of the Nautical Almanac, and we have the Apparent Time at Ship at which the observation was made.

To Find the Time of the Moon's Meridian Passage.

2. Take out the Moon's Meridian Passage from the Nautical Almanac, against the day of the month, and correct it by Table XXII, which will give the Mean Time of her passing the Meridian of the Ship, to which apply the Equation of Time the contrary way, as above directed, and the result will be the Apparent Time of her passing the Meridian of the Ship.

To Find the Moon's Distance from the Meridian.

3. Now take the difference between the Apparent Time of her passing the Meridian of the Ship and the Apparent Time of the Observation, with which enter Part 1st, Table XV, as a time from Noon, and take out its Logarithm.

To Find the Correction for Altitude.

4. Correct the Moon's Declination, taken from the Nautical Almanac, to the Greenwich time of the observation by the Rules given at page 102, No. 6, with which, and the Latitude by Dead Reckoning, proceed as before to find the Correction, (as in the case of the Sun and Stars,) to be added to the observed Altitude. The Latitude is then found in the usual way

Sometimes the *Meridian* Altitude of the Moon is lost, in consequence of being too late in beginning the observation. The Latitude may, however, still be obtained as correctly as by the Meridian Altitude, by the above method, if the Longitude of the Ship can be ascertained within a few miles of the truth.

EXAMPLE.

June 3d, 1854. Sea Time. In Latitude, by Dead Reckoning, 49° 25′ North, and Longitude 45° W., the observed Altitude of the Moon's Lower Limb was 56° 29′ South, before her Meridian passage, and the Greenwich time by Chronometer, 7h. 56m. 0s. Height of the eye, 24 feet. Required the Latitude of the Ship.

				☽'s Dec. Noon, 18° 24′ N., June 2d.		
☽'s Mer. Pas., June 2d, N.A.,	5h. 21m.	Green. Time by Chro...	7h. 56m. 0s.	Midnight,....	16 19	
June 3d,.....	6 5	Lon. 45° W. in time...	3 0 0	Change in 12h.	2° 5′	= 1° 22′
Tab.XXII, Lon.45°W.,D.Varia.	44m.	Mn. Time at Ship.....	4h. 56m. 0s.	G. T. from Noon, 8h. in Table XXIII ...		
Gives the correction ...	5m. 0s.	Equa. of Time....Add	2 22			
Mer. Pass., June 2d.....	5h. 21m. 0	App. Time of Obs.....	4h. 58m. 22s.	Dec.. Noon, June 2d......	18 24	
M.Time of M.Pas. at Ship,	5h. 26m. 0s.	App. Time of M. Pass.	5 28 22	☽'s Cor Dec............	17° 2′ N	
Equa. of T., contra. .Add	2 22	Moon's Dist. from Mer..	0h. 30m. 0s.	.........Log.	7.631	Table XV
App. Time of Mer Pas...	5h. 28m. 22s.	Lat. D. R. 49° 25′ N., Dec...	0° 17′ N.	.........Log.	0.367	
		Cor. for Alt..........Add	0 34 =	.........Log.	7.998	
		Obs. Alt. ☽'s L. Limb ...	56 29 S.			
		Mer. Alt.......	57° 3′			
		☽'s semid. 15, Dip 5, Add	10			
		App. Alt...............	57° 13′			
		Cor. for Hor. Par. 55′, Alt. 57°, Table XXV,. Add	0 29			
		☽'s True Alt..........	57° 42′ S.			
		Zenith Distance	32° 18′ N.			
		Correct Dec.	17 2 N.			
		Lat. Observed..........	49° 20′ N. at 5h. 28m. P. M.			

QUESTIONS FOR EXERCISE.

Question.—August 9th, 1854. Sea Time. In Latitude, by Dead Reckoning, about 56° 0′ North, Longitude 75° 30′ West, the observed Altitude of the Moon's Upper Limb was 14° 41′ South, (about 1 hour past the Meridian.) The Greenwich Time by Chronometer being, August 8th, 18h. 52m. 30s. (Height of the eye, 18 feet.) Required the Latitude.

Answer.—Latitude 56° 10′ North. The Apparent Time of observation at Ship was 13h. 45m. 6s. The Apparent Time of the Moon's Meridian Passage. 12h. 45m. 6s., the Moon was 1 hour past the Meridian, and the Correction for Altitude, 1° 6′, and Meridian Altitude 15° 47′ South.

FINDING THE LATITUDE BY AN ALTITUDE OF A PLANET OUT OF THE MERIDIAN.

The Latitude may be found by an Altitude of a Planet out of the Meridian, upon the same principle, and in a similar manner, as that by the Moon.

RULE

To Find the Apparent Time of Observation.

1. Note the time by Chronometer, when the Altitude of the Planet was observed, and from which, deduce the Apparent Time of the Observation, as directed on the preceding page.

To Find the Time of the Planet's Passing the Meridian.

2. Take out the Planet's Meridian Passage from the Nautical Almanac, against the day of the month, as usual, and apply the Equation of Time the *contrary* way to what is directed for Apparent Time, in the column of the Nautical Almanac, which will give the Apparent Time of its passing the Meridian of the Ship.

To Find its Distance from the Meridian.

3. Now take the Difference between the Apparent Time of its passing the Meridian of the Ship, and the Apparent Time of the Observation will be the Planet's Distance from the Meridian in time, the Logarithm of which find in Part 1st, Table XV.

To Find the Correction for Altitude.

4. From the Nautical Almanac take out the Planet's Declination, and correct it to the Greenwich Time of the Observation, in a similar manner as at page 104, with which, and the Latitude by Dead Reckoning, take out the Logarithm from Parts 2d or 3d, Table XV. The Sum of these two Logarithms, in Part 4th, gives the Correction for the Altitude required, which is always additive.

EXAMPLE 1.

Sept. 25th, 1854, Sea Time, in Latitude by Dead Reck. 44° 25′ N., Longitude by Chronometer 65° W., an Altitude of the Planet Jupiter was observed to be 21° 52′ S. (before the Mer. Passage), Greenwich Time by Chronometer, 10h 34m 16s, P. M. Height of the eye 18 feet. Required the Latitude.

Sep. 24th, G. T. of Observation	10h 34m 16s	Mer. Pass. Jupiter.	7h 4m 36s
Long. 65° W. in Time.....Sub.	4 20 0	Equa. of T. Add	8 7
Mean T. at Ship...	6h 14m 16s	App. T. of Pass.	7h 12m 43s
Equa. of Time. Add	8 7		
App. T. at Ship.....	6h 22m 23s	Decl. Jupiter.	22° 44′ S.
App. T. of Passage.	7 12 43		
Time before Mer....	50m 20s	Log. 8.078	Table XV.
Lat. 44° ½ N., Decl. 22° 44′ S........		Log. 0.156	
Corr. for Altitude......Add	0° 59′ =	Log. 8.234	
Obs. Alt. of Jupiter........	21 52		
Meridian Altitude........	22° 51′ S.		
Corr., Table XX. ....Sub.	6		
True Altitude............	22° 45		
Zenith Distance...........	67° 15′ N.		
Declination....	22 44 S.		
Latitude in..............	44° 31′ N. at 6h 23m P. M.		

EXAMPLE 2.

Jan. 29th, 1854, Sea Time, in Latitude by Dead Reckoning, 25° 10′ S., Long. by Chronometer 0° 0′ 0″, an Alt. of the Planet Saturn was observed to be 47°9′ N., (past the Meridian), Greenwich Time by Chronometer 7h 31m 38s, and the height of the eye 18 feet. Required the Latitude.

Jan. 28th, G. T. of Observation...	7h 31m 38s	Mer. Pass. Saturn.	7h 1m 18s
Long. in time......	0 0 0	Equa. of T...	13 16
Mean T. at Ship...	7h 31m 38s	App. T. of Passage	6h 48m 2s
Equa. of Time. Sub.	13 16		
App. T. of Obs. at Ship......	7h 18m 22s	Decl. Saturn	17° 2′ N
App Time of Pass.	6h 48m 2s		
Time past Mer....	30m 20s	Log. 7.641	Table XV
Lat. 25° S., Decl. 17° N............		Log. 0.413	
Corr. for Altitude.......Add	0° 39′	Log. 8.054	
Obs. Altitude of Saturn......	47 9 N.		
Meridian Altitude...........	47° 48′		
Corr., Table XX........Sub.	5		
True Altitude.............	47° 43′ N.		
Zenith Distance............	42° 17′ S.		
Declination...............	17 2 N.		
Latitude in...............	25° 15′ S. at 7h 18m P. M		

NOTE.—In all the preceding Examples, where the Chronometer is used in deducing the Apparent time at Ship, the Difference of Longitude the Ship has made in the interval between the time the Longitude by Chronometer was ascertained, and the time the Altitude of the body was observed for Latitude, must be applied, by the rules in Middle Latitude Sailing, in order to get as near as possible the correct Longitude of the Ship at the time the Altitude of the body was observed; bearing in mind that for every 1′ of error in the Longitude, there will be a corresponding error of 4 seconds in time in deducing the Apparent Time at Ship from it. In general, when sights for Chronometers are taken, both morning and afternoon, the error in the Ship's Longitude, brought on by the Dead Reckoning, will rarely exceed 5 miles. And it will be perceived that in thus finding the Latitude from bodies out of the Meridian, the Chronometer renders valuable assistance in finding the Apparent Time at Ship, at the time the Altitude was observed, when it would be difficult to get it otherwise.

Many of the foregoing Examples of finding the Latitude from the Meridian Altitude of the Stars, are given for Twilight, because the horizon is then distinctly visible, and the observation can be depended on. But it sometimes happens that there are no Stars on the Meridian at Twilight. In that case, if an Altitude be observed at Twilight, either before or after it passes the Meridian, and the time noted by Chronometer, the Latitude is found by the preceding rules as correctly as if its Meridian Altitude had been observed. In the two last Examples, the Planet Jupiter passed the Meridian after darkness had set in, but his Altitude was obtained in good Twilight, 50 minutes before that time. Saturn had passed the Meridian in strong Sun-light, and 30 minutes afterwards, or as soon as he became visible, his Altitude was observed and the Latitude found as above.

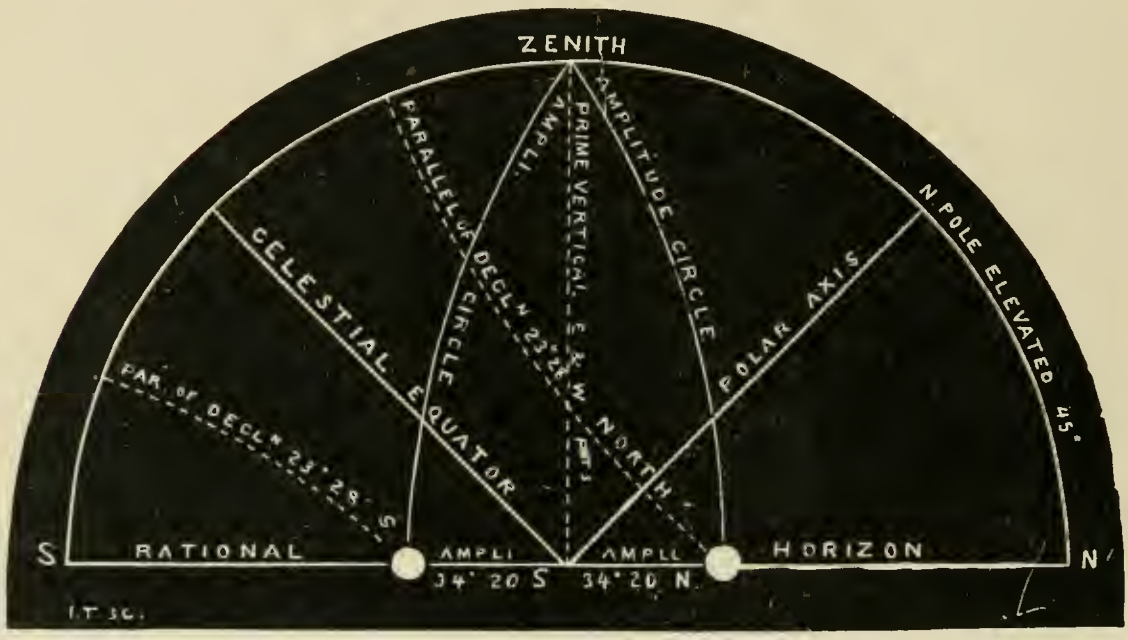
FINDING THE VARIATION OF THE COMPASS BY AN AMPLITUDE

An Amplitude means the Distance of any Heavenly body from the True East or West points of the Horizon at Rising or Setting, and is found by inspection in Table XXXV, by entering it with the Latitude of the Ship at the side, and the Declination of the body at the top, and at the angle of meeting will be the required Amplitude in degrees and minutes, to be called East in the morning and West in the evening, and towards the North or South, according as the Declination of the body is North or South, as the following figure will show :

DIAGRAM

Of an Amplitude in 45° North Latitude.

FIG. 17.



This Figure represents the North Pole of the Heavens elevated above the Horizon equal to the Latitude of the place, and the Celestial Equator at Right Angles to it. The line drawn perpendicular to the Horizon is called the Prime Vertical Circle, and which passes through the East and West points in the centre. The dotted Circles on each side of the Equator are the Sun's Parallels of Declination North and South. The Circles from the Zenith passing through the Sun's place in the Horizon, are called Amplitude Circles, and measure the Sun's Amplitude or Distance from the East or West points of the Horizon.

Hence, it will appear that the Sun and all the other Heavenly Bodies Rise and Set to the Northward of the East and West points, when their Declinations are North, and that they Rise and Set to the Southward of the East or West points when their Declinations are South.

EXAMPLE 1.

June 21st, 1854. Required the Sun's True Amplitude at Rising and Setting, in Latitude 45° N.

Answer.—The Sun's Declination on the 21st of June is 23° 28′ N., with which and the Latitude 45°, the true Amplitude is found in Table XXXV, at Rising, to be E. 34° 18′ N., and at setting W 34° 18′ N.

EXAMPLE 2.

December 21st, 1854. Required the Sun's True Amplitude at Rising and Setting, in Latitude 45° N.

Answer.—The Sun's Declination on the 21st of Dec is 23° 28′ S., with which and Latitude 45°, the True Amplitude is found in Table XXXV, at Rising, to be E. 34 18′ S., and at Setting, W. 34° 18′ S.

EXAMPLE 3.

March 21st, 1854. Required the Sun's True Amplitude Rising and Setting, in Latitude 45° N.

Answer.—The Sun being on the Equator, his Declination is 0° ; he therefore Rises and Sets in the East and West points of the Horizon.

EXAMPLE 4.

Sept. 21st, 1854. Required the Sun's True Amplitude at Rising and Setting, in Latitude 45° N.

Answer.—The Sun being on the Equator, his Declination is 0° ; he therefore Rises and Sets in the East and West points of the Horizon.

NOTE.—All heavenly bodies whose Declinations are 0° 0′, Rise in the True East point of the horizon, and Set in the True West point. Hence, when the Sun's or Moon's Declination is 0° 0′, that is, when they are on the Celestial Equator, and their Bearing be taken by an Amplitude Compass, when Rising or Setting, if they bear by Compass East or West, there is no Magnetic Variation. But suppose the Sun was observed to Set by Compass W. 12° N., that would be the amount of Magnetic Variation *Westerly*. Or, suppose he was observed to Set West 12° S., that would be the amount of Magnetic Variation *Easterly*, and he would rise in the first case E. 12° S., and in the second case, E. 12° N., which would furnish the Variation in the same manner.

FINDING THE VARIATION OF THE COMPASS BY AN AMPLITUDE.

The manner of observing the bearing of the Sun, or other heavenly body, at rising or setting, by an Amplitude Compass, and other remarks connected with the observation, will be found at page 81.

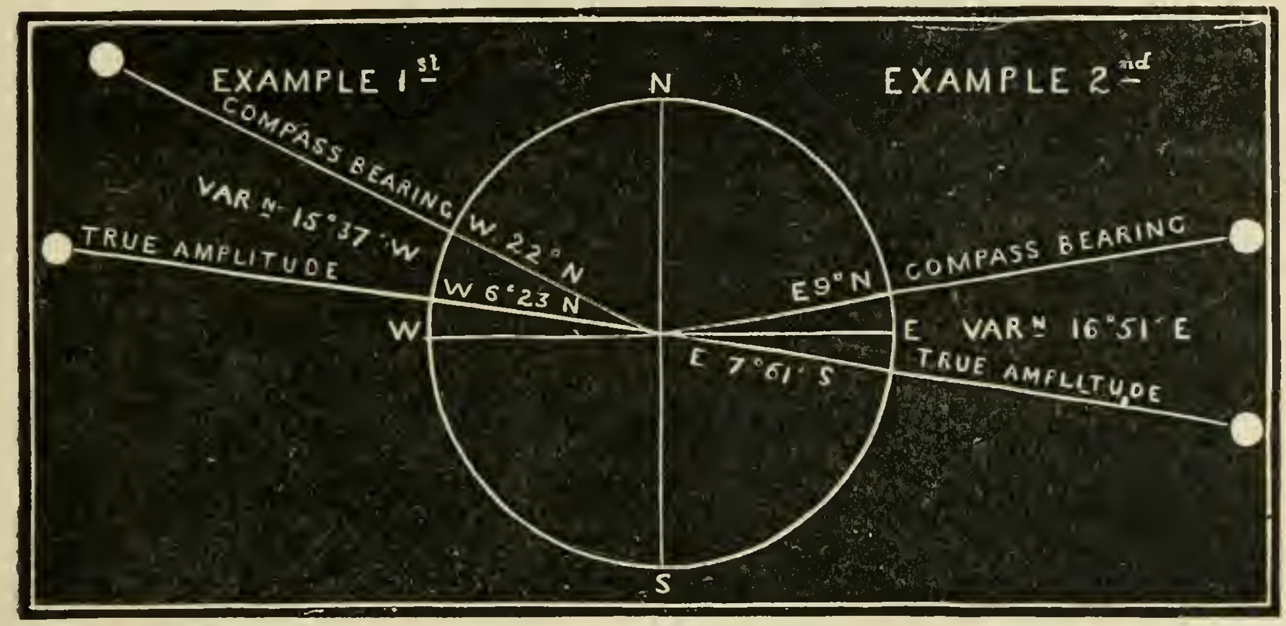
When the Magnetic Amplitude, or bearing of the body by the Compass, and the True Amplitude, are both on the same side of the East or West points, that is, when they are both North or both South, their difference is the Variation of the Compass.

But when one is North and the other South, their Sum is the Variation, and the following Diagram will show whether the Variation is Easterly or Westerly.

DIAGRAM,

Showing Easterly and Westerly Variation

FIG. 18.



EXAMPLE 1.

April 2d. 1854. In Latitude 38° 30′ North, Longitude 52° West, the Sun was observed to Set by Compass W. 22° N. Required the Variation of the Compass.

April 2d, Sun's Declination 4° 55′ N. and Lat.	38° 30′ N.
In Table XXXV, gives the True Ampli...W.	6 23 N.
Sun's bearing by Compass at Setting.....W.	22 0 N.
Magnetic Variation.....................	15° 37′ W.

or 1½ points, (nearly,) Westerly.

EXAMPLE 2.

Oct. 8th, 1854. In Latitude 40° South, Longitude 75 West, the Sun was observed to Rise by Compass E. 9° N. Required the Variation of the Compass.

Oct. 8th, Sun's Declination 5° 52′ S. and Lat.	40° 0′ S
In Table XXXV, gives the True Ampli. E.	7 51 S
Bearing by Compass at Rising......... E.	9 0 N.
Magnetic Variation	16° 51′ E.

or 1½ points Easterly.

Taking the 1st Example, and referring it to the above Figure, it will be perceived that both Amplitudes are to the North of the West Point, their difference is therefore the Variation; and looking towards the Sun's bearing by the Compass, the true Amplitude is on the left of the Compass bearing; the variation is, therefore, Westerly.

In the 2d Example, (and referring it to the same figure,) one Amplitude is on the North and the other on the South of the East Point, and their Sum is the variation.

And looking towards the bearing of the Sun by Compass, the true Amplitude is to the right of the Compass bearing; the variation is, therefore, Easterly.

And in the 1st Example, if we make the Compass bearing coincide with the North point in the above Figure, the true Amplitude will then be on the West side of the North; hence it is called Westerly variation. And in the 2d Example, in like manner, the true Amplitude will be on the East side of the North, hence it is called Easterly variation.

In the above Examples the Latitude used is that brought on from Noon by Dead Reckoning, and the Sun's Declination taken out for the nearest Noon, but if greater accuracy is required, the Declination must be corrected to the time of the observation, by Table XI; but this is seldom necessary at Sea.

QUESTIONS FOR EXERCISE.

Question 1st.—July 3d, 1854. In Latitude 9° 36′ South, the Sun's bearing by Compass at Rising was E. 12° 42′ N. Required the Variation.

Answer.—The True Amplitude is E. 23° 22′ N., and the Variation 10° 40′ Westerly.

Question 2d.—Sept. 21st, 1854. In Latitude 26° 32′ North, the Sun's bearing by Compass at Setting was West 6° 15′ South. Required the Variation.

Answer.—The True Amplitude is W. 1° 7′ N., and the Variation 7° 22′ Easterly.

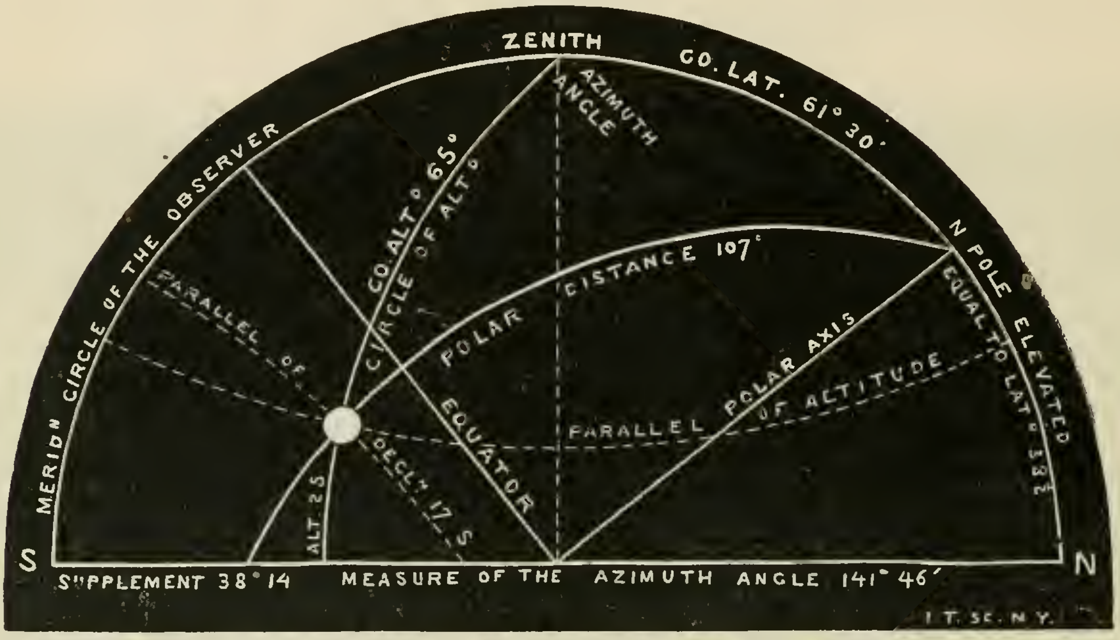
FINDING THE VARIATION OF THE COMPASS FROM AN AZIMUTH.

An Azimuth means an Angle at the Zenith, contained between the Meridian of the Observer and a Circle of Altitude passing through the body.

DIAGRAM

Of an Azimuth in 38½° North Latitude.

Fig. 19.



In this Figure the Sun's True Altitude is 25°, his Declination 17° South, and the Latitude 38° 30′ North; and it will be perceived that the Co-Altitude, or the Sun's distance from the Zenith, the Polar Distance, and the Co-Latitude are given, which form the three sides of an Oblique Spherical Triangle, to find the Angle of Azimuth at the Zenith, which is measured on the Horizon by a Circle of Altitude passing through the body, and cutting the Horizon at right angles. The Azimuth Angle in the above Figure is measured from the North point of the Horizon, because the North Pole of the heavens is elevated, and it contains 141° 46′; but for convenience' sake its Supplement is generally used, that is, what it wants of 180°, and is reckoned from the opposite point of the Horizon, because the Sun is South of the observer in North Latitude, and North of the observer in South Latitude.

RULE.

Correct the Sun's observed Altitude by Table IX. Correct the Sun's Declination by Table XI, and find his Polar Distance by adding the Declination to 90°, when the Latitude and Declination are of contrary names, or taking the difference between it and 90° when they are of the same name.

Then add together the Sun's Polar Distance, his True Altitude, and the Latitude. Take half their Sum, and take the difference between the half Sum and the Polar Distance, which call the difference.

Enter Table XXVII, and take out the Log. Secant of the Altitude, and also the Log. Secant of the Latitude. Enter Table XXVIII, and take out the Log. Co-Sine of the Half Sum and the Log. Co-Sine of the Difference. Add together these four Logs., and their Sum found in Table XXIX, will give an angle in time. Turn this into Degrees and Minutes by Table XXVI, which will be the Angle of Azimuth required. To be reckoned from the South in North Latitude, and from the North in South Latitude; towards the East in the morning, and towards the West in the afternoon.

The Magnetic Azimuth having been observed by the Azimuth Compass, as directed at page 81, at the the time of taking the Altitude. Then the difference between the True Azimuth and the Magnetic Azimuth, (both of which being reckoned from the same Meridian,) is the Variation of the Compass when they are on the same side of the Meridian, that is, both East or both West; but when one is East and the other West, their Sum is the Variation

Finding the Variation at Noon.

In High Latitudes, where the Sun's Meridian Altitude is low, the variation may be found at Noon, from the Magnetic Azimuth observed. But to do this, it is necessary to have the watch previously regulated to Apparent Time at the Ship, so that the Sun's Azimuth bearing may be observed at the instant the watch shows 12 o'clock; because the Sun is then True South in North Latitude, and True North in South Latitude. And supposing the bearing by the Azimuth Compass to have been South also, there would in that case be no variation. On the other hand, if the bearing by the Azimuth Compass was S. 22° 30′ W., then there would be that amount of Magnetic Variation *Westerly;* but if the bearing by Azimuth Compass had been S. 22° 30′ E., then there would be that amount of Magnetic Variation *Easterly.*

EXAMPLE 1.

February 2d, 1854, Sea Time, in Latitude 38° 30′ N., Longitude 60° W., the Altitude of the Sun's Lower Limb was observed to be 24° 50′, and his Magnetic Azimuth S. 16° 0′ E., at about 9h 30m in the forenoon. Height of the eye 18 feet. Required the Variation of the Compass.

Sun's Declination, February 1st, Table X..	17° 6′ S.	Observed Altitude Sun's Lower Limb..	24° 50′
Corr. for Lon. 60° W., Table XI, Subt. 3 } Sub.	1	Corr., Table IX.................Add	10
Corr. for Time before Noon, 2h 30m Add 2 }		Sun's True Altitude.................	25° 0′
Sun's Correct Declination...............	17° 5′ S.		
	90 0		

Sun's Polar Distance	107° 5′			
True Altitude........................	25 0′	...............Log. Secant	Table XXVII	0.04272
Latitude.............................	38 30	...............Log. Secant	Table XXVII	0.10646
Sum..................................	170° 35′			
Half Sum.............................	85° 18′	............Log. Co-Sine	Table XXVIII	3.91349
Difference...........................	21° 47′	............Log. Co-Sine	Table XXVIII	4.96783

Fig. 19, Supplement of the Angle in Time, 2h 32m 57s, Table XXIX......Log 9.03050

Turned into space by Table XXVI, gives the True Azimuth................S. 38° 14′ E.

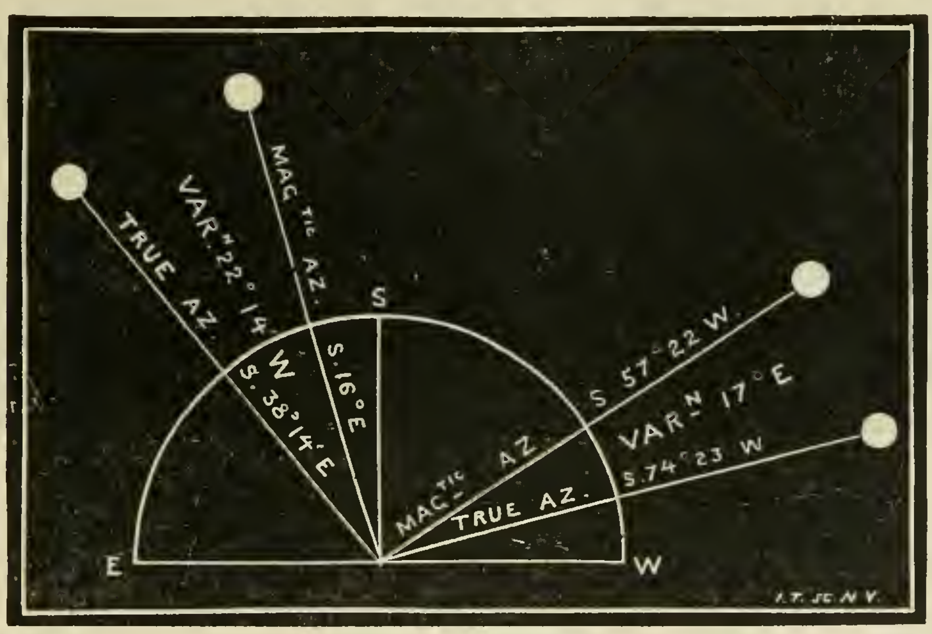
Magnetic Azimuth.........S. 16 0′ E.

Magnetic Variation...........22° 14′ Westerly.

DIAGRAM,

Showing Easterly and Westerly Variation.

FIG. 20.



In the above figure, (to the left), both Azimuths are on the same side of the Meridian, and their Difference is the Variation Westerly, because the True Azimuth is to the Left of the Magnetic Azimuth.

EXAMPLE 2.

April 16th, 1854, Sea Time, in Latitude 40° N., Longitude 120° W., the Observed Altitude of the Sun was 32° 15′ Magnetic Azimuth S 57° 22′ W., at about 3 P. M. Required the Variation.

April 15th, Sun's Declination...............	9° 45′ N.	Sun's Observed Altitude Lower Limb....	32° 15′
Corr., Long. 120° W., Table XI, 7′ } ...Add	10	Corr., Table IX........................Add	10
Corr. for 3h past Noon.........3 }		Sun's True Altitude...	32° 25
Sun's Correct Declination..............	9° 55′ N.		
	90 0		

Sun's Polar Distance...................	80° 5′			
Correct Altitude......	32 25	......................Log. Secant	Table XXVII	0.07357
Latitude..........	40 0	......................Log. Secant	Table XXVII	0.11575
Sum....................................	152° 30			
Half Sum...............................	76° 15′	....................Log. Co-Sine	Table XXVIII	4.37600
Difference...............	3° 50′	....................Log. Co-Sine	Table XXVIII	4.99903

Angle in Time 4h 58m 10s, Table XXIX...............................Log. 9.56435

Turned into space by Table XXVI, gives the True Azimuth..............S. 74° 33′ W.

Magnetic Azimuth..........S. 57° 22′ W.

Magnetic Variation............17° 11′ Easterly

Because on referring to the above figure on the right, we find the True Azimuth is to the Right of the Magnetic Azimuth.

EFFECT OF LOCAL ATTRACTION ON THE SHIP'S COMPASS.

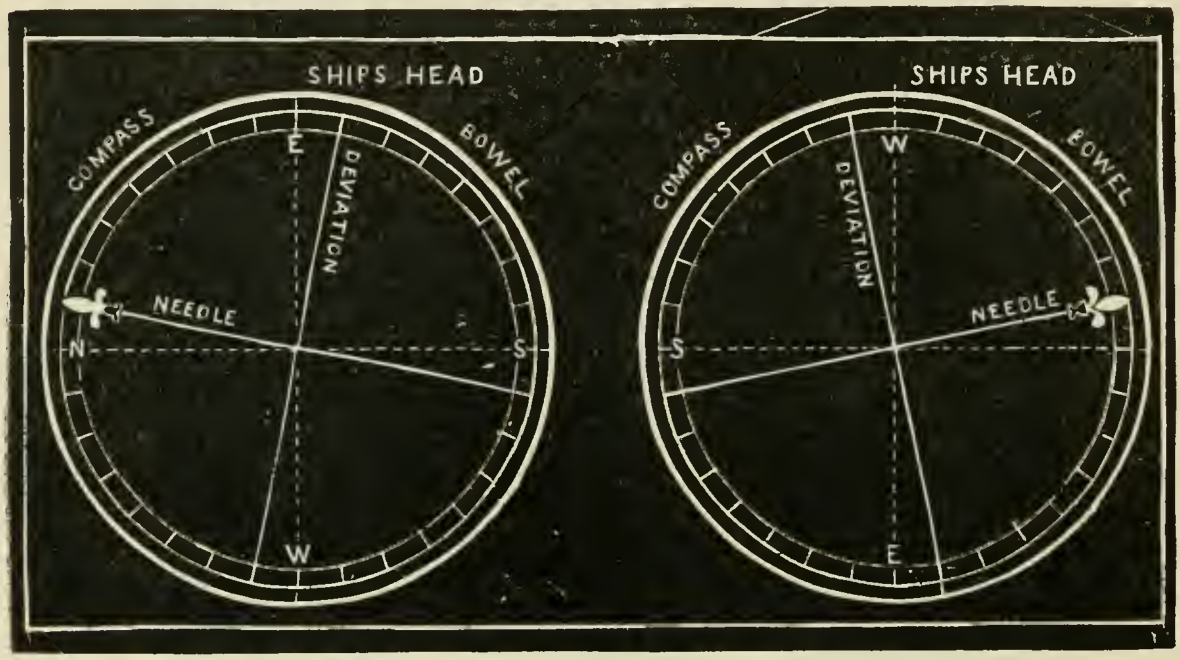
This is a very important matter for investigation, and should be attended to at the earliest possible opportunity, because, in consequence of not knowing that Local Attraction existed on board, many vessels have been wrecked from that very cause.

There being large quantities of Iron now used in the construction of Ships, besides the quantities which they carry to and fro, and stowed in different parts of the vessel as cargo, renders every Ship liable to have her Compasses deranged by Local Attraction. And the general effect which Iron, situated in the forward part of a vessel, has on the Compass, is to draw the North end of the Needle forward in North Latitude, and the South end of the Needle forward in South Latitude, and which the following Diagram will show:

DIAGRAM,

Showing the Effect of Local Attraction.

FIG. 21.



When the Attracting Force is Forward.

In the above figure, the dotted line will show the course intended to be steered, which in the one case is East. But the North end of the Needle being drawn forward from the effect of the Local Attraction, (caused by the Iron forward acting on it), the Ship is actually going E. by S.; and in the other case, steering West, the North end of the Needle being drawn forward in like manner, the Ship is actually going W. by S.

Now suppose the Ship to steer North, the North end of the Needle will point in the direction of the disturbing force, and which being then on the same line as the Magnetic Meridian, no Local Attraction will be perceptible.

Hence, when the Ship's head is at North or South, little or no deviation will be found in the Compass; but when her head is at East or West, or nearly so, the greatest deviation may be expected. The above figure is drawn for North Latitude, but by substituting South for North, it will answer for South Latitude. In that case, the South end of the Needle is drawn forward from the effect of Local Attraction, and in steering East, in the one case, the Ship would actually be going E. by N.; and in the other case, steering West, the Ship would actually be going W. by N.

When the Attracting Force is Abaft.

We have hitherto been considering the case where the Attracting Force is situated forward in the vessel; but it sometimes happens that it is situated abaft the Steering Compass, as in the case of some Steamships, where the Steering Apparatus is placed in the forward part of the vessel; and in this case, on referring to the figure in North Latitude steering East, the North end of the Needle is drawn aft, when the Ship would actually be going E. by N. Again, in steering West, the North end of the Needle being drawn aft, the Ship would actually be going W. by N.

In South Latitude, and supposing the disturbing force to be abaft the Compass, the South end of the Needle is drawn aft, and in steering East the Ship would be going E. by S., and in steering West, she would be going W. by S.

Having thus shown the effect of Local Attraction on board Ship, the most practical remedy derived from experience in this matter, is as follows:

FINDING THE LOCAL ATTRACTION ON BOARD SHIPS AT SEA.

Contrivances to Counteract Local Attraction not to be Depended on.

Many contrivances have been proposed to counteract the Local Attraction on board Ships where it is known to exist, but none of them can be depended upon under all circumstances; especially in merchant vessels, where it is liable to vary at different times, and from the fact that the Poles of the Magnetic Needle change their attracting power on entering the Southern Hemisphere.

Mode of Detecting Local Attraction.

The simplest mode of detecting Local Attraction on the Ship's Steering Compass at Sea, is to observe an Amplitude, that is, to take the bearing of the Sun at rising, by it, as directed at page 81, and find the variation of the compass by the Rules given at page 116, at the time the Ship's head is in a Northerly or Southerly direction by the Compass. Repeat the operation at Sunset, at the time the Ship's head is in an Easterly or Westerly direction. Then, if the variations so found agree within one degree of each other (allowing for a probable error in the observations,) it may be concluded that there is no Local Attraction of any consequence on board.

But if they do not so agree, the difference will be the amount of the Local Attraction which exists on board. Always providing that the variation found when the Ship's head was at North or South, agrees with that laid down on the newest Charts.

By ascertaining the variation from bearings taken by the Steering Compass (or one situated near the Binnacle) with the Ship's head in any given direction, we have the whole amount of the deviation of the Compass from the true Meridian due to the course on which the vessel is then steering. This includes both Variation and Local Attraction, and is the proper quantity to be allowed in correcting the course steered to a True Course. And when the course has been changed, the variation should again be found in like manner, and applied in the room of that taken from the Charts.

Local Attraction may also be detected by the bearing of objects on the Land, when, after allowing the variation proper to the place, they do not agree with the True Bearings. The Steering Compass will also show Local Attraction when the Ship appears to sail within 5 points of the wind on the one tack, and 7 points from the wind on the other.

The Binnacle.

One Steering Compass only should be used, because when there are two near each other, the one attracts the other, and the Binnacle should be constructed so as to prevent improper substances (such as iron) being placed therein.

On Fixing the Standard Compass as a Remedy

When Local Attraction is decidedly known to exist on board, the only proper remedy is to fix up a Standard Compass on some part of the vessel's deck, which shall be free from all Local Attraction. This can only be ascertained from *actual trial*, and in some Ships the Standard Compass requires to be raised 5 or 6 feet, more or less, above the deck. In general, the most convenient place for fixing it. is on the Centre Line of the Quarter Deck, where the true direction of the Ship's head, or the bearing of the land, can at any time be easily ascertained. Observations of Amplitudes or Azimuths should also be made with this Compass, if it be provided with proper sight-vanes, otherwise with the Azimuth Compass on its *site*.

The Course must be shaped by the Standard Compass, and when the Ship's head is exactly in the proper direction by the Standard Compass, note the direction of her head by the Steering one, and which will be the approximate Course required to steer by that Compass, in order to allow for the effect of the Local Attraction, and the difference between the two Compasses is the amount of the Local Attraction on board, (so long as the Ship's head continues in the same direction,) but on changing the Course this difference between the two Compasses will be found to vary according as her head approaches to or recedes from the Magnetic Meridian. When the Ship's head is at North or South they will be found to agree nearly, because the disturbing force is on the same line as the Magnetic Meridian, and the greatest difference will be found when her head is at East or West, as previously explained. Consequently, when it is required to change the Ship's course, she is brought to her proper course by the Standard Compass, and the direction of her head then shown by the Steering one is the approximate course required to steer. The correctness of the Standard Compass may be further verified by taking Amplitudes, &c., with the Ship's head on all the points of the Compass; then, if the variation so found agree with that assigned to the place of observation, and with each other, the Compass is correct. All bearings should be taken with this Compass, and the courses made good by this Compass, when the Ship is close-hauled, must be entered on the Log Board, in the room of those by the Steering one.

FINDING THE TIME AT SEA

It will be necessary here again to premise that there are three different modes of reckoning Time, with respect to the commencement of the day, viz., Civil, Astronomical, and Nautical.

The Civil Day,

Which is that used by the generality of mankind, begins at Midnight and ends at the Midnight following. It is divided into two equal parts of twelve hours each. The first is marked A. M , signifying before Noon, and the latter P. M., or afternoon.

The Astronomical Day

Begins 12 hours after the Civil Day, that is, at Noon, or when the Sun's centre is on the Meridian, and ends at the following Noon; and it is reckoned through the 24 hours, from Noon to Noon; and what are called the morning hours of the common day are by Astronomers reckoned in succession from 12, or midnight, to 24 hours. So that 8 o'clock on the morning of June 5th, Civil Time, is by Astronomers called June 4th, at 20 hours.

The Nautical, or Sea Day,

Commences at Noon, or 12 hours before the Civil Day, and 24 hours before the Astronomical day, and ends at the Noon of the Civil Day, and at the beginning of the Astronomical Day. It is divided into two parts of 12 hours each; the former being marked P. M. and the latter A. M., so that occurrences which happened, for instance, on Sunday, the 10th, afternoon, Civil Time, are entered in the Log as Monday, the 11th, P. M.

Hence it appears that the *Noon* of the Civil Day, the *Beginning* of the Astronomical Day, and the *End* of the Nautical Day take place at the same period of time.

Time, as inferred from observations of the Sun, is denominated Apparent and Mean Solar Time.

Apparent Time,

Is that which is immediately derived from the Sun, either from the middle of the times of his Equal Altitudes, that is at Apparent Noon, or by observing his Altitude at a proper distance from the Meridian

Mean, or Uniform Time,

Is that shown by Clocks, or Watches, which keep a constant, uniform time throughout the year.

The reason of these two different modes of dividing Time is explained in Figure 4, page 62, and is caused by the unequal motion of the Earth in her orbit, combined with the inclination of its axis to the plane of the Ecliptic.

The difference between Apparent and Mean Time is called the Equation of Time, and amounts to over 16 minutes sometimes. It is computed for the Noon at Greenwich, and set down on page 1st of the Nautical Almanac, against the day of the month, throughout the year, and the precept at the head of the column shows whether it must be added to or subtracted from Apparent Time, to obtain Mean Time.

The Greenwich Date,

Or the Mean Time at Greenwich, is referred to, because it is for the Time at this Meridian that the elements of Astronomical calculations (which are in perpetual change) are given in the Nautical Almanac.

The Greenwich Date is therefore always expressed in Mean Time, (unless the contrary is notified,) and it may be defined as being the time at Greenwich, corresponding to any given time elsewhere, and in taking observations at Sea, the Noon at Greenwich is referred to, in order to find on which side of Greenwich Noon the observation has been made

NOTE.—In observing Altitudes for time, the observation should be made when the body is on or near the Prime Vertical, that is, when it bears true East or West; because then, errors in both the Latitude of the observer and of the Altitude observed, produce the least effect on the Hour Angle.

In general, the change of Altitude should not be less than 6 minutes to 1 minute of time. An error of 1 minute in the Altitude would then produce an error of about 10 seconds in time. In High Latitudes, an error in the Latitude produces a great effect on the Hour Angle.

On the other hand, in the Tropics the time can be more correctly determined when the body is at less than an hour from the Meridian than when at several hours from it in High Latitudes.

FINDING THE APPARENT TIME FROM AN ALTITUDE OF THE SUN.

This is one of the most important problems in Nautical Astronomy, and for the solution of which we require to have the Altitude and Polar Distance of the body, and the Latitude of the place of observation, being three sides of an Oblique-Angled Spherical Triangle given, to find the Hour Angle at the Pole, and which is measured on the Celestial Equator, between the Meridian and the Time Circles.

DIAGRAM *of an Hour Angle. Latitude and Declination of the Same Name.*

FIG. 22.

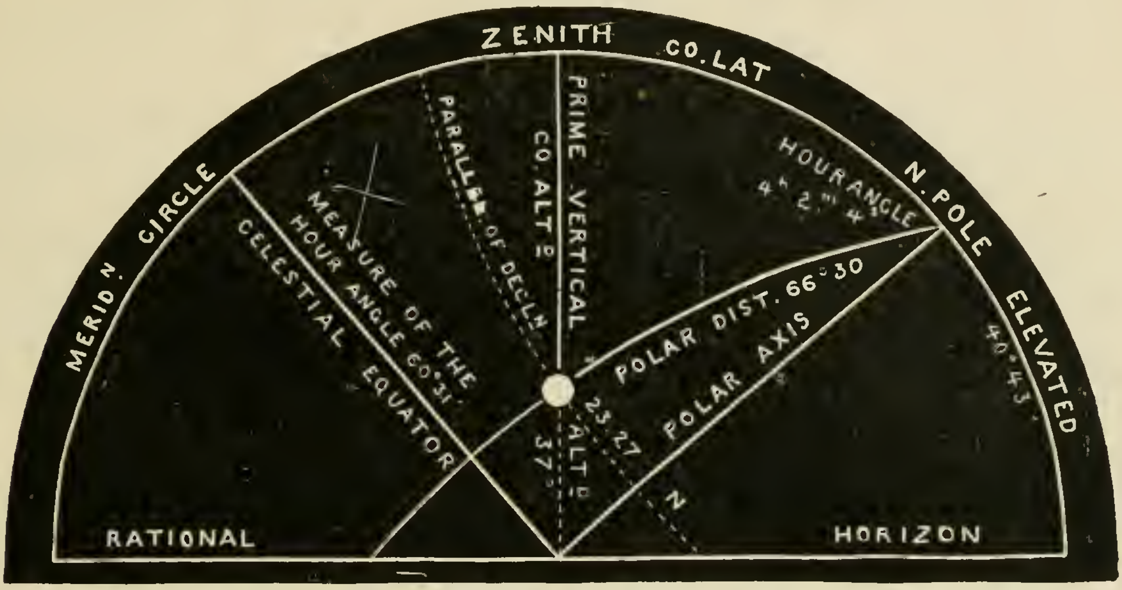
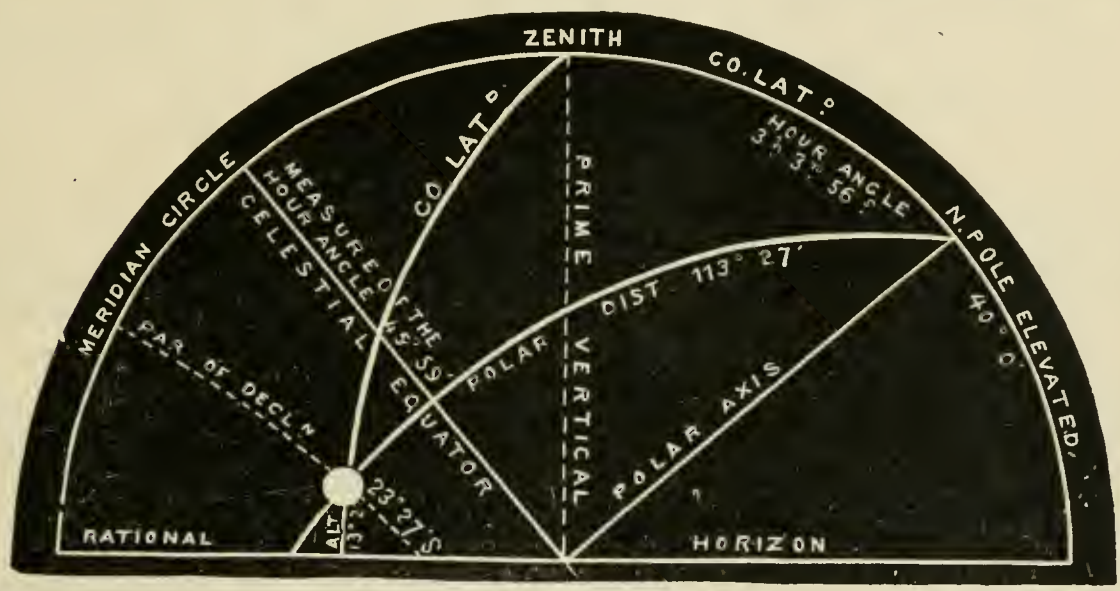


DIAGRAM *of an Hour Angle. Latitude and Declination of Contrary Names.*

FIG. 23.



In Figure 22, the Sun is on the Prime Vertical, the Latitude and Declination being of the same name, the Declination subtracted from 90°, gives the Polar Distance.

In Figure 23, the Latitude and Declination being of contrary names, the Declination added to 90°, gives the Polar Distance.

RULES FOR USING THE TABLES.

1st. *Add* together the Sun's True Altitude, the Polar Distance, and the Latitude of the place of Observation, find the Half Sum, and the Difference between the Half Sum and the Sun's True Altitude.

2d. To the Logs. of the Polar Distance, and Latitude found in Table XXVII, *add* the Logs. of the Half Sum and Difference found in Table XXVIII, and the *Sum* of these four Logs., found in Table XXIX, will give the Sun's Hour Angle, at the *Top* of the Page, and which is also the Apparent Time from Noon, when the Altitude is observed in the *Afternoon*. But when the Altitude is observed in the *Forenoon*, the Apparent Time from the preceding Noon, or Midnight, is found at the *Bottom* of the page.

EXAMPLE 1.

Figure 22. Given the Sun's True Altitude, 37°, Polar Distance, 66° 33′, and Latitude 40° 43′ N. Required the Hour Angle.

Sun's True Altitude........	37° 0′	
Polar Distance............	66 33	....Log. 0.03744
Latitude in...............	40 43	....Log. 0.12036
Sum	144° 16′	
Half Sum	72° 8′	....Log. 4.48686
Sun's True Altitude........	37 0	
Difference	35° 8′	....Log. 4.76003
Hour Angle...............	4h. 2m. 4s.	....Log. 9.40469

EXAMPLE 2.

Figure 23. Given the Sun's True Altitude, 13° 26 the Polar Distance, 113° 27′, and Latitude 40° North Required the Hour Angle.

Sun's True Altitude........	13° 26′	
Polar Distance......... ...	113 27	....Log. 0.03744
Latitude in...............	40 00	....Log. 0.1157
Sum	166° 53′	
Half Sum.................	83° 27′	....Log. 4.05717
Sun's True Altitude........	13 26	
Difference...........	70° 1′	....Log. 4.97302
Hour Angle	3h. 3m. 55s.	. — 9.18339

FINDING THE TIME AT SEA BY THE SUN.

Method of Observing Altitudes for Time.

Hold the instrument with the right hand and the watch in the left; bring the Sun's Lower Limb in contact with the Horizon, and clamp the Index, and at the instant the Second-hand of the watch has completed the full minute, bring the Sun's limb in contact by using the Tangent screw; note the Time by the watch and read off the Altitude, and write them down. When the Second-hand of the watch has again completed the full minute, take the Altitude, &c., as before, and write them down. This may be repeated three or five times. In general, three Altitudes, and their corresponding times, is sufficient. If the difference between the Altitudes, or the Sun's change of Altitude in one minute of time, correspond with each other, it is a guarantee that the Altitudes have been correctly observed; but if they do not so agree, add them together, and divide by the number taken, will give the mean of the Altitudes corresponding to the middle of the times they were taken, which may be taken as the correct observed Altitude

EXAMPLE.

A. M., 21st June, in Latitude 40° North.

Alt. L. Limb....	37° 13′ 0″	Time by Watch,	3h. 58m.
	25 30		3 59
	38 0		4 0
Obs. Altitude...	37° 25′ 30″	Time.......	3h. 59m.

This Altitude has been correctly taken.

EXAMPLE.

P. M., December 21st, in Latitude 40° North.

Alt. of L. Limb....	13° 26′	Time by Watch,	3h. 3m
	19		4
	10		5
Number taken...	3)55		3)12
Obs. Altitude.....	13° 18′ 20″	Time........	3h. 4m

The above Altitudes have not been correctly taken

To Find the Apparent Time, and thence the Mean Time, at Ship.

RULE.

To Correct the Altitude.

1 *Add* the Correction, taken from Table IX, to the Sun's Observed Altitude, will give his True Central Altitude

To Find the Greenwich Date

2. Turn the Ship's Longitude into Time, by Table XXVI, and *Add* it to the Time of the Observation by Watch in West Longitude, or *Subtract* it in East will give the approximate Greenwich Time, which, if before Noon, *Subtract* it from 12h. will give the Time from Greenwich Noon, A. M., otherwise it is the Time from Noon, P. M.

To Correct the Declination.

3. Take out the Sun's Declination from the Nautical Almanac, against the Day of the Month, and the Difference or Change of the Declination in one hour, found in the adjoining column. Multiply this Difference for 1 hour by the Time from Greenwich Noon, and divide by 60, will give the Correction in Minutes and Seconds.

To Correct the Equation of Time.

4 Take out the Equation of Time from the Nautical Almanac in like manner, and the Difference, or Change of Equation in one hour, (which is given in Decimal parts of a Thousand,) found in the adjoining column. Multiply this Difference for 1 hour by the Time from Greenwich Noon, and strike off the Right-hand figure, prefix a Decimal point to the Left of the next two figures, which are now hundredth parts of a second, and the figure to the Left-hand is Seconds of Time, and is the required correction.

For Applying the Corrections for Declination and Equation.

5 Inspect the columns in the Nautical Almanac, and ascertain whether they are Increasing or Decreasing.

Greenwich Time.	Before Noon.	Declination or Equation................	Increasing, Subtract, Decreasing, Add,
Greenwich Time.	After Noon.	Declination or Equation...............	Increasing, Add, Decreasing, Subtract,

to or from the Declination, or the Equation of Time, taken from the page in the Nautical Almanac, will give them Corrected to the Greenwich Time of the Observation.

To Find the Sun's Polar Distance.

6 Subtract the Declination from 90°, when the Latitude and Declination are of the same name, or Add the Declination to 90° when they are of contrary names

FINDING THE APPARENT TIME, AND THENCE THE MEAN TIME, AT SHIP.

To Correct the Latitude to the Time of the Observation.

7. The usual mode of doing this at Sea, is to find the Difference of Latitude the Ship has made in the interval between the time the Sights were taken and Noon, (the correct Latitude having been obtained from the Sun's Meridian Altitude), and applying it to the Latitude Observed, according to the course the vessel has been steering, viz:

Sights taken before Noon, in North Latitude	Sailing North, Subtract Difference of Latitude. Sailing South, Add Difference of Latitude.
Sights taken after Noon, in North Latitude	Sailing North, Add Difference of Latitude. Sailing South, Subtract Difference of Latitude.

Which will give the correct Latitude of the Ship at the time of the Sights. To apply this Rule in South Latitude, we substitute *South* for *North*.

Thus having the Sun's True Altitude, Polar Distance, and the Correct Latitude of the place of Observation, find the Apparent Time by the Rule for using the Tables already given at page 123.

To the Apparent Time apply the Equation of Time as directed in the precept at the head of the column headed Equation of Time, in the Nautical Almanac, by Adding or Subtracting it, and the result is the Mean Time at the Ship.

EXAMPLE 1.

April 30th, 1854, (Noon at Sea), in Longitude by Dead Reckoning 25° 0′ W., the Observed Altitude of the Sun's Lower Limb was 22° 7′. Time by Watch, 7h 6m in the Morning. Ship then sailed on a true N. E. by E. Course, 35 miles, until Noon, when the Latitude observed was 36° 32′ N. Required the error of the Watch on both Apparent and Mean Time.

Obs. Alt...	22° 7′	
Corr., Tab. IX....	10	
True Alt...	22° 17′	
Polar Dist..	75 17	Log. 0.01449
Latitude....	36 13	Log. 0.09324
Sum......	133° 47′	
Half Sum..	66° 54′	Log. 4.59366
Difference...	44° 37′	Log. 4.84656
App. T...	7h 8m 19s	Log. 9.54795
Equa. of Time..	2 53	
Mean T. at Ship.	7h 5m 26s	
T. by.. Watch.	7 6 0	

Watch......0m 34s fast of Mean Time.
And Watch. 2m 19s slow of Apparent Time.

T. by Watch.	7h 6m
Lon. 25° W. in Time..	1 40
Greenwich. Time, A. M.	8h 46m
Subt. from..	12 0
G. T. from Noon....	3h 14m

Decl. 30th April..	14° 45′ 31″ N.
Corr.........Sub.	2 29
Correct Decl.....	14° 43′ 2″
	90 0 0
Polar Distance....	75° 16′ 58″

Diff. for 1h......	46 ″
G. T. from Noon	3¼h
	138 ″
	11
	60)149 ″
Corr.	2′ 29.″

Equa. of Time.....	2m 53s·58
Corr.........Sub.	1 ·06
Correct Equation...	2m 52s·52

Diff. for 1h......	·328
G. T. from Noon..	3¼h
	·984
	82
Corr..........	1′06·6

Course N. E. by E. 35 miles = D. Lat..	0° 19′
Latitude observed at Noon............	36 32 N.
Latitude in at Time of Sights........	36° 13′ N.

Note.—When the Sights are taken in the Morning, we look for the sum of the 4 Logarithms in Table XXIX, and take the time from the *bottom* of the page, and if the figures are found exactly, the Hours are found at the bottom, the Minutes at the right side opposite the Logarithm, and the Seconds in the same column at the bottom of the Table.

But if the Sum of the 4 Logarithms cannot be found exactly, take the nearest *less* Logarithm, and find the difference between it and the given Logarithm, with which enter the adjoining proportional columns, and take out the corresponding Seconds of Time, which must be *subtracted* from the Seconds found at the bottom of the column from whence the nearest less Logarithm was taken, which will be the Apparent Time from the preceding Noon or Midnight.

When the Sights are taken in the Afternoon, the time is taken from the *top* of the Table. And in like manner, we must look for the nearest *less* Logarithm, and find the difference between it and the given one, and the proportional parts for Seconds, found in the adjoining column, must be *added* to the Seconds found at the top of the column, from whence the nearest less Logarithm was taken.

All Hour Angles are taken from the top of the page, and which is also the Apparent Time past Noon by the Sun.

FINDING THE TIME AT SEA BY THE SUN.

EXAMPLE 2.

April 30th, 1854, (Noon at Sea), in Latitude by Observation 36° 32′ N., Longitude 24° 26′ W., the Sun's Observed ltitude was 13° 48′. Time by Watch, 5h 30m in the afternoon, and the Ship had sailed since Noon on a true E. N. E. course, distance 29 miles. Required the Error of the Watch on both Apparent and Mean Time.

Obs. Altitude.....13° 48′	Time by Watch P. M. . 5h 30m 0s	Decl. April 30th. 14° 45′ 31″ N. Diff. for 1h 46″
Corr., Table IX... 8	Lon. 24° 26′ W. in time 1 37 44s	Decl. Increasing, Add 5 22 7h
True Altitude.....13° 56′	Greenh. Time P. M.... 7h 7m 44s	Correct Decl.... 14° 50′ 53″ N. 60)322
Polar Distance.....75 9	Log. 0.01475	90 0 0 Corr......5′ 22″
Latitude..........36 43	Log. 0.09604	Polar Distance.. 75° 9′ 7″
125° 48′		Equation of Time April 30th 2m 53s·58 Diff. for 1h ·328
Half Sum....... 62° 54′	Log. 4.65853	Equation Increasing.....Add 2 ·29 7h
Difference....... 48° 58′	Log. 4.87756	Correct Equation........... 2m 56s·27 Corr.......2·29 6
App. Time...5h 34m 3s	Log. 9.64688	Course E. N. E. 29 miles = D. Latitude 0° 11′
Equa.....Sub. 2 56		Latitude observed at Noon.............. 36 32 N.
Mean Time...5h 31m 7s		Latitude in at time of Sights.......... 36° 43′ N.
T. by Watch...5 30 0		
Watch...... 1m 7s slow of Mean Time, and 4m 3s slow of Apparent Time		

EXAMPLE 3.

March 26th, 1854, (Noon at Sea), in Latitude by observation 12° 21′ S., Longitude 65° 30′ E., the Sun's Observed Altitude was 25° 25′. Time by Watch 7h 47m in the forenoon. Ship had sailed on a N. W. Course, true, 17 miles, since the Sights were taken, until Noon. Required the Error of the Watch on both Apparent and Mean Time.

Obs. Altitude.... 25° 25′		Time by... Watch A. M. 7h 47m	Decl. 26th Mar. 2° 11′ 40″ N. Diff. for 1h. 59″
Corr., Table IX.. 10			Corr.......Sub 8 21 Time fm N. 8½h
True Altitude.... 25° 35′		Lon 65° 3.0′ E. in time.... 4 22	Correct Decl.. 2° 3′ 19″ 472
Polar Distance... 92 3	Log. 0.00028		90 0 0 29
Latitude......... 12 33	Log. 0.01050	G. Time A. M. 3h 25m	Polar Distance 92° 3′ 19″ 60)501″
130° 11′		Sub. from. ...12 0	Corr. for Decl. 8′ 21″
65° 6′	Log. 4.62432	T. fm G. Noon 8h 35m	Equation....5m 50s·02 Diff. for 1h ·768
39° 31′	Log. 4.80366		Corr.....Add 6 ·52 8½h
App. Time.... 7h 47m 9s	Log. 9.43876		Correct Equa..5m 56s·54 ·6144
Equa.....Add 5 57		Course N. W. 17 miles. D. Lat. 0° 12′	·384
Mean Time... 7h 53m 6s		Latitude by Obs. at Noon..... 12 21 S.	Corr. for Equa. 6·52·8
T. by Watch.. 7 47 0		Lat. in at time of Sights..... 12° 33′ S.	
Watch....... 6m 6s slow of Mean Time, and 0m 9s slow of Apparent Time.			

QUESTIONS FOR EXERCISE.

Quest. 1st.—May 12th, 1854, (Noon at Sea). in Latitude Observed at Noon 47° 50′ N., Longitude by Dead Reckoning 50° 30′ W. In the morning the Sun's Observed Altitude was 34° 5′. Time by Watch 8h 6m A. M. The Ship had made 4′ of Diff. Latitude to the Southward since the Sights were taken. Required the Error of the Watch.

Answer.—The Apparent Time is 8h 5m 39s, and Watch fast 0m 21s. Mean Time 8h 1m 47s, and Watch fast 4m 13s.

Quest. 2d.—On the same day as above, in Latitude 47° 50′ N., Longitude 50° 30′ W., in the Afternoon the Sun's Observed Altitude was 10° 14′. Time by Watch 6h 17m′ P. M. The Ship had sailed on a true W. by S. ½ S. Course, 52 miles since Noon. Required the Error of the Watch as before.

Answer.—The Apparent Time is 6h 18m 16s. Watch slow 1m 16s. Mean Time, 6h 14m 23s. Watch fast 2m 37s.

Quest. 3d—June 1st, 1854, (Noon at Sea), in Latitude 39° 25′ S. by Observation, and Longitude 90° E., at Noon. In the Morning the Observed Altitude of the Sun was 12° 15′. Time by Watch 8h 35m A. M. The Ship had sailed on a true S. E. Course, 28 miles, until Noon. Required the Error of the Watch.

Answer.—The Apparent Time is 8h 34m 56s. Watch fast 0m 4s. Mean Time 8h 32m 20s. Watch fast 2m 40s.

NOTE.—In the foregoing Examples, and also those which follow, the height of the eye is supposed to be 18 feet above the Sea level.

Noon at Sea means the end of the Sea Day, and which also corresponds to the beginning of the Astronomical Day and to the Noon of the Civil Day.

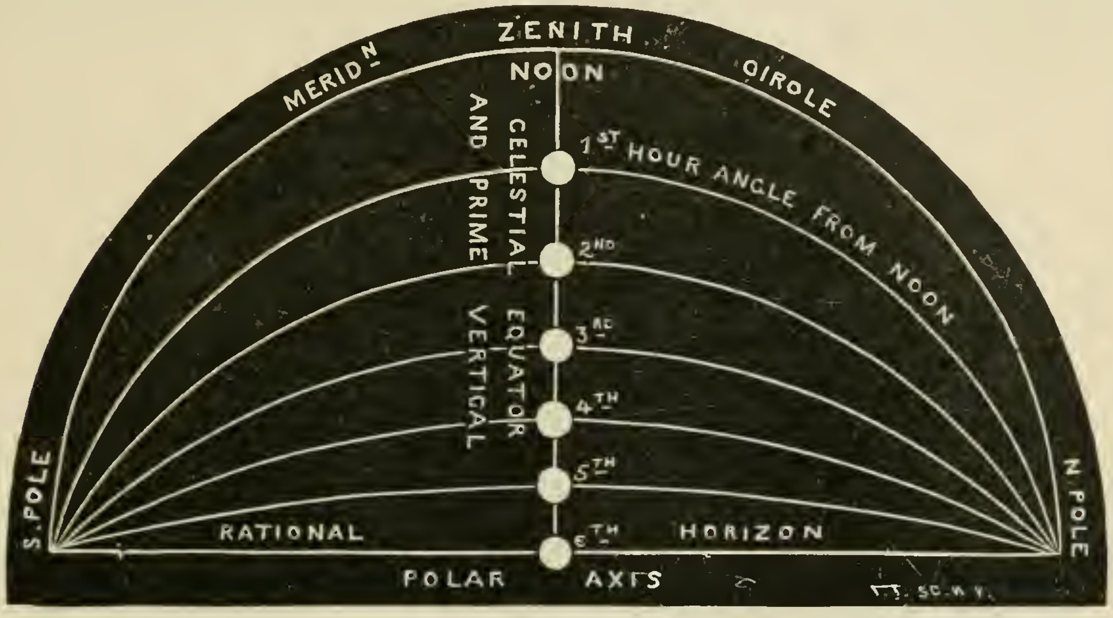
FINDING THE APPARENT TIME AT SEA BY THE SUN, WHEN THE SHIP IS ON THE EQUATOR.

When the Ship is on the Equator, and the Sun is also on the Equator, that is, when his Declination is 0, the Poles of the Heavens are in the Horizon and the upper end of the Celestial Equator is then in the Zenith, and the Sun rises and sets vertically.

DIAGRAM

Of the Hour Angles on the Equator.

FIG. 24.



In this case, the Sun's change of Altitude is 15′ in one minute of Time, or 15° in one hour, throughout the entire day. The time can, therefore, be as correctly found near the Meridian, that is, near Noon, as it can at any other time of the day, and an error in the Latitude, in working out the time, does not affect the result.

It will be perceived by this figure, that when a Ship sails to the Southward, after leaving the Equator, she raises the South Pole of the Heavens, and that in sailing North from the Equator, she raises the North Pole, and that the Polar Distance and Hour Angles are always measured from the elevated Pole. But in this case, both Poles being in the Horizon, and the Sun on the Equator, his Polar Distance 90°, and the Hour Angles, (measured on the Equator), are the same at both Poles.

If we therefore observe the Sun's Altitude at any period of the day, under the above circumstances, and after correcting it in the usual manner, to obtain the True Central Altitude, and then *subtract* it from 90°, we have the Sun's Hour Angle at once, in space, which, turned into degrees and minutes by Table XXVI, will give the Apparent Time at the Ship in the afternoon, and *subtracting* it from 12h, will give the Apparent Time in the forenoon.

EXAMPLE 1.

Latitude and Declination 0; the Sun's Observed Altitude in the forenoon was 74° 48′. Required the Apparent Time at the Ship.

Obs. Altitude L. Limb	74° 48′
Corr., Table IX,	12
Sun's True Altitude	75° 0′
	90 0
Hour Angle in space	15° 0′ = 1h, or 11h A. M.

EXAMPLE 2.

Latitude and Declination 0; the Sun's Observed Altitude was 29° 50′ in the afternoon. Required the Apparent Time at Ship.

Obs. Altitude L. Limb	29° 50′
Corr., Table IX,	10
Sun's True Altitude	30° 0′
	90 0
Hour Angle in Space	60° 0 = 4h 0m P M

This may be verified by the Time Tables, as follows :

Example 1:

True Altitude	75° 0′	
Polar Distance	90 0	Log. 0.00000
Latitude	0 0	Log. 0.00000
Sum	165° 0′	
Half Sum	82° 30′	Log. 4.11570
Altitude	75 0	
Difference	7° 30′	Log. 4.11570
Apparent Time	11h 0m 0s	Log. 8.23140

Example 2:

True Altitude	30° 0′	
Polar Distance	90 0	Log. 0.00000
Latitude	0 0	Log. 0.00000
	120° 0′	
Half Sum	60° 0′	Log. 4.69897
Altitude	30 0	
Difference	30° 0′	Log. 4.69897
Apparent Time	4h 0m 0s	Log. 9.39794

FINDING THE APPARENT TIME WHEN THE SUN IS RISING OR SETTING.

This method is upon the same principle as that of measuring the Hour Angle from the Elevated Pole, but in the room of observing his Altitude above the Horizon with a Quadrant, we observe with a *Spy-Glass* the contact of either of his Limbs with the Horizon at Rising or Setting, and note the time by the watch

RULE

When the Lower Limb is Observed.

Take the *Difference* between the Sun's Semi-diameter, N. A., and the Mean Horizontal Refraction, 34′ 17″, to which *add* the Dip of the Horizon, found in Table V. Call this the Correction.

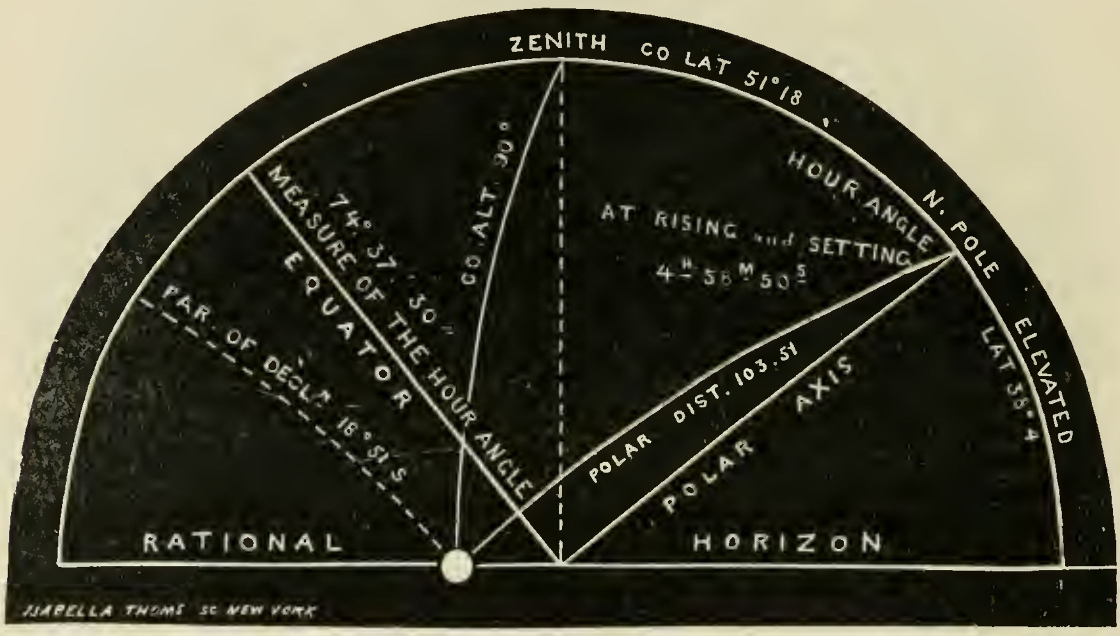
Correct the Declination, and find the Polar Distance, as usual. Also correct the Latitude to the place of Observation by the rules already given.

Add together the Latitude and Polar Distance, from which *subtract* the above Correction. Take half this Sum, to which *add* the same correction and call it the Difference. The Apparent Time is then found by the usual Rule in working the time by Log. Tables.

DIAGRAM

Of the Sun's Hour Angle at Rising or Setting.

FIG. 25.



This figure represents the elements for computing the Hour Angle in the usual manner, being the three sides of an Oblique Angled Spherical Triangle, viz: the Co-Latitude 51° 18′, the Polar Distaace 108° 51′, and the Co-Altitude 90°, to find the Hour Angle at the Pole, and which, measured on the Equator, is 74° 37′ 30″, or, in time, 4h 58m 31s.

EXAMPLE 1.

Jan. 25th, 1854, (Noon at Sea), the Latitude Observed was 38° 0′ N., and Longitude 104° W., at Noon. Ship then sailed N. E. 60 miles, when the Sun's Lower Limb was observed to set at 5h 3m 25s by the Watch. Required its error on Apparent and Mean Time.

Hor. Ref. 34′ 17″, less Par 9″... } 34′ 8″	Time by Watch.... 5h 3m 25s	Sun's Decl. N. A. 18° 57′ 58″ S.	Diff. 1h........ 37″
Sun's Semid. N. A... 16 16	Lon. 104° W in time. 6 56 0	Corr........Sub. 7 24	G. T. past Noon. 12h
Difference........... 17′ 52″	Greenwich Time.... 11h 59m 25s P. M.	Corr. Decl. 18° 50′ 34″	60)444″
Dip of the Horizon... 4 8		90 0 0	Corr........ 7′ 24″
Correction........ + 22′ 0″	Course N. E. 60 miles. 0° 42′	Polar Distance. 108° 50′ 34″	
	Lat. Obs. at Noon.... 38 0′ N.		

Latitude at Sunset................................	38° 42′	Log. 0.10767	
Polar Distance................................	108 51	Log. 0.02394	Equa. of T.. 12m 38.55s Diff. 1h. .554
	147° 33′		Corr...Add 6.65 12
Correction..........................Sub.	+ 22		Corr. Equa. 12m 45 20s Cor..... 6.648
	147° 11′		
Half Sum................................	73° 36′	Log. 4.45077	
Correction..........................Add	+ 22		
Difference................................	73° 58′	Log. 4.98277	
Apparent Time at Ship, past Noon...........	4h 58m 29s	= Log. 9.56515	
Equation of Time.......................Add	12 45		
Mean Time at Ship..........................	5h 11m 14s		
Time by Watch, Sunset......................	5 3 25		
Watch slow of Mean Time..................	7m 49s. and fast of Apparent Time 4m 56s.		

FINDING THE APPARENT TIME WHEN THE SUN IS RISING OR SETTING

RULE.

When the Upper Limb is Observed.

Add together the Horizontal Refraction, 34′ 17″, the Sun's semi-diameter, Nautical Almanac, and the Dip of the Horizon, in Table V. Call this *Sum* the Correction.

Correct the Declination and Latitude as before, and find the Sun's Polar Distance.

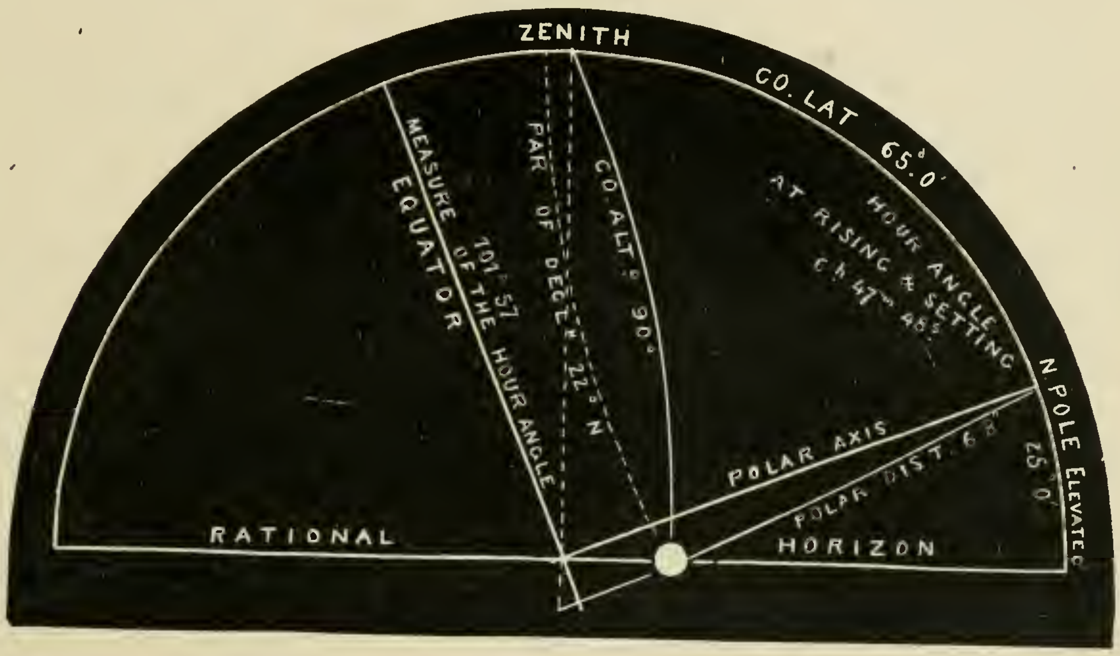
Add together the Latitude and Polar Distance, from which *subtract* the above Correction. Take Half this Sum, to which *add* the same Correction, and call it the Difference.

The Apparent Time is then found by the usual Rule for working the Tables.

DIAGRAM

Of the Sun's Hour Angle at Rising or Setting.

Fig. 26.



This Figure is explained in the same manner as the last, except that the Latitude and Declination being both North, the Sun's Hour Angle exceeds 6 hours when Rising or Setting, and measures 101° 57′ on the Equator, or in Time is 6h. 47m. 48s., which subtracted from 12 hours gives Apparent Time, 5h. 12m 12s. A. M.

EXAMPLE 2

June 1st, 1854. (Noon at Sea.) In Latitude 25° 0′ North, and Longitude 60° East, by Dead Reckoning from the preceding Noon, the Sun's Upper Limb was observed to Rise at 5h. 17m. 0s. by the Watch. Required its Error on Apparent and Mean Time.

H. Ref. 34′ 17″ less Par. 9″,.	34′	8″
Sun's semid., N. A,..........	15	48
Dip of the Horizon..........	4	8
Correction............ †	54′	4″

Time by Watch........	5h.	17m.	0s.
Lon. 60° E. in Time....	4	0	0
Green. Time, A. M.....	1h.	17m.	0s.
Subtract from	12	0	0
Time before G. Noon...	10h.	43m.	0s.

Dec., N. A.,	22°	3′	23″ N.	Dif.	1h. 20″
Corr.,..Sub.		3	40		11h
Corr. Dec..	21°	59′	43″		60)220
	90	0	0	Cor...	3′ 40″
Polar Dist..	68°	0′	17″		

Latitude in at Sunrise.............	25°	0′	....Log. 0.04272
Polar Distance...................	68	0	....Log. 0.03283
Sum	93°	0′	
Correction..... ....Sub.		† 54	
	92°	6′	
Half Sum	46°	3′	.. Log. 4.84138
Correction .... .Add		† 54	
Difference.	46°	57′	....Log. 4.86377
App. Time at Ship at Sunrise.	5h. 12m.	12s.	....Log. 9.78070
Equation of Time.	2	36	
Mean Time at Ship...do.	5h. 9m.	36s.	
Time by Watch	5 17	0	
Watch Fast of Mean Time....	7m.	24s.	and Fast of Apparent Time 4m. 48s.

Equa. of Time....2m. 31s·92		Dif. 1h.	3·80
Corr.....Add.. .	4 ·18		11h.
Correct Equa....	2m. 36s·10	Cor..	4s·18·0

NOTE.—The reason why these Corrections marked thus † are used, will be evident from the fact that when the Sun's Lower Limb touches the Horizon, at Rising or Setting, his centre is actually 22 minutes *below* it. And when his Upper Limb touches it he is a whole diameter, or 32 minutes *more below* it; which together make 54 minutes. This, as before explained at page 67, is caused by the Refraction of the Atmosphere.

This Observation is liable to error, from the unequal Refraction and Mirage at the Horizon. It is, however, very useful, and may be depended on within 20 seconds or 5′ of the truth.

FINDING THE APPARENT TIME FROM EQUAL ALTITUDES OF THE SUN NEAR NOON.

This is a very convenient and simple mode of finding the Apparent Time at Noon, or when the Sun is on the Meridian, that is, at 12 o'clock Apparent Time at the Ship; and as it is independent of Latitude and Declination, and all the other corrections, it is a useful check on the more regular method of finding the time.

This observation can be depended on in Low Latitudes, because the Sun's change of Altitude is very rapid near the Meridian. But in High Latitudes the Sun's change of Altitude near the Meridian is very slow, especially in the Winter months; hence an error in the time of observation, in the latter case, may be committed which may render it worthless.

Besides, the greater the distance of the observer from the Equator, the time from Noon, at which the Altitude is observed, must be greater, (because the correctness of the Time so found depends entirely upon the rapidity with which the Sun rises and falls.) This involves a tedious system of corrections, for the Ship's change of place and the Sun's change of Declination in the interval between the observations, and which is unnecessary labor, because the Time can be found as correctly by one of the Altitudes in the usual manner.

When a Ship sails due East or West in the interval between the Altitudes, in that case it becomes a question of time only. But when she makes much Northing or Southing, it is evident that the same Altitudes will no longer give the correct Middle Time at Apparent Noon. The error in the P. M. Altitude will be equal to the difference of Latitude made in the interval. Therefore the Rule is, when sailing *towards* the Sun, we must increase the A. M. Altitude which is on the Quadrant, by advancing the Index of the instrument equal to the difference of Latitude made in the interval.

But in sailing *from* the Sun, we must decrease the A. M. Altitude by screwing back the Index equal to the difference of Latitude made in the interval; and when the Sun falls to that Altitude in the afternoon. we note the time by the same watch by which the time of the A. M. Altitude was noted.

Limits of the Time from Noon.

The Altitudes should not be taken *nearer* to Noon than in the proportion of *One Minute of Time* for every Degree of Latitude the Ship is North or South of the Equator.

The Observation.

Observe an Altitude of the Sun's Lower Limb according to the above limits before Noon. Note the tim by the Watch, and clamp the Index of the instrument. When the Sun's Lower Limb falls again to the same Altitude in the afternoon, note the time by the watch.

RULE.

Add together the two times, and take their *Half Sum* for the Middle Time. If the Middle Time is exactly 12 hours, the Watch is correct for Apparent Time; because, at the instant of this Middle Time by the Watch, the Sun is on the Meridian and it is Apparent Noon, or 12 o'clock, Apparent Time at the Ship.

But should this Middle Time *exceed* 12 hours, then the *excess* is what the Watch is *Fast* of Apparent Time.

If the Middle Time be *less* than 12 hours, then what it *wants* of 12 hours is what the Watch is *Slow* of Apparent Time. And by applying the correct Equation of Time, in the usual manner, to Apparent Noon, or 12h., we have the Mean Noon at Ship, the difference between which and the Middle Time is the error of the Watch on Mean Time.

EXAMPLE 1.

April 2d, 1854. In Latitude 5° 52′ North, and Longitude 28° West, at 11h. 54m. by the Watch, the Sun's Altitude was 85° 40′ A. M., and at 12h. 20m. by the same Watch, he had fallen to the same P. M. Required the error of the Watch on both Apparent and Mean Time.

Sun's Alt...	85° 40′ A. M.		Time by Watch,	11h. 54m.
	Same P. M.		do. do.	12 20
Equa. of T..	3m. 41s·71	Dif. ·750	Sum....	)24h. 14m.
Corr. ..Sub.	1 ·50	Long. 2h.	Mid. Time,	12h. 7m.
Equa..Add	3m. 40s.	1·50·0	App. Noon,	12 0
Ap. N'u,	12h.0 0		Watch Fast,	0h. 7m.
Mn. N'n,	12h.3 40s.			
Mid. T..	12 7 0			
Watch..	_ 3m.20s. Fast of Mean Time.			

EXAMPLE 2.

April 16th, 1854. In Latitude 30° North, Longitude 45° East, at 11h. 20m. by Watch, the Sun's Altitude was 68° 20′ A. M., and at 12h. 34m. by the same Watch, he had fallen to the same Altitude P. M. Required the error of the Watch on both Apparent and Mean Time.

Sun's Alt...	68° 20′ A. M.		Time by Watch,	11h. 20m.
	Same P. M.		do. do.	12 34
Equa. of T...	0m. 11s·87	Dif. .603	Sum....	23h. 54m
Corr....Sub.	1 ·80	3h.	Mid.Time,	11h. 57m.
Equa...Sub.	0m. 10s.	1.80·9	Ap.Noon,	12 0
Ap. N'n.	12h. 0 0		Watch Slow,	0h. 3m.
Mn. N'n.	11h. 59m. 50s.			
Mid. T...	11 57			
Watch....	2m. 50s. Slow of Mean Time			

NOTE.—It is not necessary to read off the Altitude if the Index of the instrument remains untouched, because we have only to wait until the Sun falls again to the same Altitude in the afternoon, unless the Ship makes much Northing or Southing in the interval, when it must be corrected as above. But to guard against accident, or if the instrument is required for use in the interval, we have only to read it off and write it down, and set the Index to the same Altitude again, ready for the P. M. Altitude, and in case of cloudy weather several Altitudes, and their corresponding times, should be taken before Noon, as a reserve.

FINDING THE TIME ON SHORE FROM ALTITUDES BY THE ARTIFICIAL HORIZON.

As a full description of the method of taking Observations with this Instrument is given at pages 77 and 78, it will only be necessary here to give a few Examples of finding the Apparent Time, and thence the Mean Time, on Shore.

EXAMPLE 1.

March 5th, 1854, at New York, in Latitude 40° 42′ 42″ N., and Longitude 74° 0′ 1″ W., the following Altitudes were observed by an Artificial Horizon in the Morning, to ascertain the Error of the Watch on Mean Time.

Obs. Altitude L. Limb.	24° 14′ 30″	Time by the Watch.	7h 32m 20s	Declination.	6° 3′ 14″ S.	Diff. for 1h	58″
	35 39	....	33 36	Corr. .Sub..	0 29	G. Time past N.	½h
	56 30	....	34 30	Cor. Decl. .	6° 2′ 45″		
	3)106′ 39″		3)100m 26s		90 0 0	Correction	29″
Mean of the Altitudes.	24° 35′ 33″	Mean of the Times.	7h 33m 28s	Polar Dist.	96° 2′ 45″		
Index Error........Sub.	2 0	Lon. 74° W. in time..	4 56 0				
Angle of Double Reflex.	24° 33′ 33″	Mean Time at G...	12h 29m 28s				
Sun's Obs. Alt., L. L...	12° 16′ 46″	Sub..	12 0 0	Equa. of T.	11m 45s·78	Diff. for 1h	·584
Sun's Semid.......Add	16 9	T. past Noon at G..	29m 28s	Corr.. .Sub.	·29	Corr.....	·29·4
Apparent Altitude.....	12° 32′ 55″			Correct Eq.	11m 45s·49		
Refraction........Sub.	4 18						
Sun's True Altitude....	12° 28′ 37″						

Polar Distance........	96 2 45	Log. 0.00245		
Latitude..............	40 42 42	Log. 0.12033		
Sum.................	149° 14′ 4″		Apparent Time of Observation	7h 28m 46s
Half Sum.............	74° 37′ 2″	Log. 4.42370	Equation of Time.........Add	11 45
True Altitude.........	12 28 37		Mean Time..................	7h 40m 31s
Difference............	62° 8′ 25″	Log. 4.94650	Time by Watch..............	7 33 28
Apparent Time...	..7h 28m 46s =	Log. 9.49296	Watch slow.................	0h 7m 3s of Mean Time.

EXAMPLE 2.

October 20th, 1854, at the Cape of Good Hope, in Latitude 34° 22′ S., and Longitude 18° 30′ E., the following Altitudes were observed by an Artificial Horizon in the Afternoon, to ascertain the Error of the Watch on Mean Time.

Sun's Altitude L. Limb.	36° 30′ 30″	Time by Watch	4h 58m 10s	Declination	10° 19′ 47″ S.	Diff. 1h....	54 ″
	36 6 0	....	4 59 20	Corr..Add	3 22		3⅓h
	35 41 10	....	5 0 40	Corr. Decl.	10° 23′ 9″		162 ″
	3)108° 17′ 40″		3)14h 58m 10s		90 0 0		27
Mean of the Altitudes...	36° 5′ 53″	Mean of Times.	4h 59m 23s	Polar Dist.	79° 36′ 51″		13
Index Error.......Add	1 10	Lon. 18° 30′. E. in time.	1 14 0				60)202 ″
Angle of Double Reflex.	36° 7′ 3″					Corr......	3′ 22 ″
Sun's Obs. Alt. L. Limb.	18° 3′ 32″	G. Time P. M..	3h 45m 23s				
Add Semid............	16 6						
Apparent Altitude.....	18° 19′ 38″			Equation of Time	15m 5s·77	Diff. 1h..	·406
Subtract Refraction.....	2 58			Correction...Add	1 ·52		3⅓h
Sun's True Altitude....	18° 16′ 40″			Correct Equation.	15m 7s·29		·1218
Polar Distance........	79 36 51	Log. 0.00717					·203
Latitude..............	34 22 0	Log. 0.08331					·101
Sum.................	132° 15′ 31″					Corr....	1·52·2
Half Sum.............	66° 7′ 45″	Log. 4.60711					
True Altitude.........	18 16 40						
Difference............	47° 51′ 5″	Log. 4.87006					
App. Time at the Place	4h 59m 30s	Log. 9.56765					
Equa. of Time....Sub.	15 7						
Mean Time...........	4h 44m 23s						
Time by Watch........	4 59 23						
Watch...............	15m 0s fast of Mean Time at the place.						

FINDING THE TIME AT SEA FROM AN ALTITUDE OF THE MOON.

The Apparent, and thence the Mean Time, at Ship, may be found by an Altitude of the Moon at a distance from the Meridian.

In the first place we must have the exact Greenwich Date at the time of the observation at the Ship, in order to reduce her Semi-diameter, Horizontal Parallax, Right Ascension, and Declination taken from the Nautical Almanac to that time, and as before stated at Page 101, (in the case of finding the Latitude by the Moon's Meridian Altitude,) if the Longitude of the Ship be not known, *neither the Latitude nor the Time can be found by the Moon.* But in cases where a Ship carries a good Chronometer, the Longitude can at any time be found tolerably correct by applying the Difference of Longitude made by Dead Reckoning to the Longitude last found by Chronometer.

The Moon's Observed Altitude must be corrected as usual, to obtain her centre, and another correction for her Parallax in Altitude, and which is always *additive* to her Apparent Altitude, because she always appears below her true place in the heavens. (See page 67.)

RULES FOR COMPUTING THE VARIOUS CORRECTIONS.

To Find the Greenwich Date.

1st. Turn the Ship's Longitude into Time by Table XXVI, and *add* it to the Mean Time at the Ship, (at the time the observation was made), in West, or *subtract* it in East Longitude, will give the Greenwich Date, *which must be always one day less than the Sea Date.* Or it may be more correctly found by noting the times of the Altitudes by Chronometer, which, after allowing for its error on Greenwich Time, will give the required Greenwich Date.

To Correct the Moon's Altitude.

2d. Take from the Nautical Almanac the Moon's Semi-diameter and Horizontal Parallax, for the nearest Noon or Midnight corresponding to the Greenwich Date. Then if the Moon's Lower Limb be observed, *add* the difference between the Dip of the Horizon and her Semi-diameter to the Observed Altitude. But if her Upper Limb be observed, *subtract* their Sum, will give the Moon's Apparent Central Altitude.

3d. Enter Table XXV with the Apparent Altitude at the side, and the Horizontal Parallax at the top, and take out the Correction, which is expressed in Minutes and tenths of Minutes, and proportion it, if required, for the odd Minutes of Altitude, and the odd Seconds of Parallax. This correction is *always additive*, and will give the Moon's True Altitude.

To Correct the Moon's Right Ascension.

4th. When the large Nautical Almanac is used, and the Greenwich Date, for the full hour, the Right Ascension is found opposite that hour; but when there are odd Minutes, take the Difference between that and the following hour, and apply the proportion of this difference, corresponding to the odd Minutes, to the Right Ascension at the preceding hour, according as it is increasing or decreasing, will give the Moon's correct Right Ascension.

5th. When the small Almanac is used, and the Greenwich Date exactly at Noon or Midnight, take out the Right Ascension found opposite. But when it is between them, take it out for the nearest Noon or Midnight preceding, and the nearest Noon or Midnight following this Greenwich Date, and take their Difference, which will be that for 12 hours, and note the number of Hours and Minutes which the Greenwich Date is past Noon or Midnight. Then say, as 12 hours is to the Difference in 12 hours, so is the Greenwich Time past Noon or Midnight to the required correction, which, applied to the Right Ascension at the preceding Noon or Midnight, according as it is increasing or decreasing, will give the Moon's correct Right Ascension. (See the Note on the next page.)

To Correct the Moon's Declination.

6th. When the large N. Almanac is used, proceed by the rule already given at page 102, No. 6, for correcting the Moon's Declination when on the Meridian.

When the small Nautical Almanac is used, proceed in like manner by Rule No. 7, on the same page, and the result will be the Moon's correct Declination, corresponding to the Greenwich Date.

To Find the Moon's Polar Distance.

7th. When the Latitude and the Moon's Declination are of the *same* name, the Difference between her Declination and 90° is her Polar Distance. But when of *contrary* names, their Sum is her Polar Distance

To Correct the Latitude to the Time of Observation.

8th. Enter the Traverse Tables with the Course and Distance made good, and find the Difference of Latitude the Ship has made since the last Observation for Latitude was obtained, and apply it by the Rule given at page 125, which will give the correct Latitude in

To Find the Moon's Hour Angle.

9th. Thus having the Moon's True Altitude, Polar Distance, and the Latitude of the place, proceed (as with the Sun) to find the Moon's Hour Angle. or her Distance from the Meridian, (which with the Sun is the time from Noon,) this being *added* to the Moon's Right Ascension, if the Moon be to the Westward of the Meridian, or *subtracted* from it if the Moon be to the Eastward, the Sum, or remainder, will be the Right Ascension of the Meridian.

To Correct the Sun's Right Ascension.

10th. Take out the Sun's Right Ascension and the Difference for 1 hour from the Nautical Almanac, multiply this Difference by the Time from Greenwich Noon, and *add* this correction to the Right Ascension, taken from the Nautical Almanac, (because the Sun's Right Ascension is constantly increasing,) will give the Sun's correct Right Ascension.

To Find the Apparent Time at Ship

11th. From the Right Ascension of the Meridian, (increased by 24 hours, if necessary,) *subtract* the Sun's correct Right Ascension, and the remainder will be the Apparent Time.

To Correct the Equation of Time.

12th. Take out the Equation of Time from the Nautical Almanac, and the Difference for 1 hour, and correct it by the Rules given at page 124, will give the correct Equation of Time.

To Find the Mean Time at Ship.

13th. Apply the correct Equation as directed in the precept at the head of the column in the Nautical Almanac, to the Apparent Time, by adding or subtracting it, and the result is the Mean Time at the Ship

EXAMPLE.

March 10th, 1854. At Noon the Latitude observed was 38° 15′ North, Longitude by account 60° 45′ West. Ship had sailed N. E. (true) 40 miles since Noon, when the observed Altitude of the Moon's Lower Limb was 40° 32′ to the Eastward of the Meridian, and the Greenwich Time by Chronometer 9h. 44m. 37s. P. M. Required the time at Ship.

Obs. Alt. ☽'s L. Limb. 40° 32′	Gr. Time by Chro...... 9h. 44m. 37s.	☽'s Dec., Noon. 24° 14′ N.
Semid. 15′, Dip 4..... 11		Midnight. 23 4
Hor. Par. 55′, and.... 40° 43′	Lat. at Noon............ 38° 15′ N.	T. XXIII, Dif. 12h. 1° 10′ } 9h.45m.=0° 56′
Gives Cor., Tab. XXV, 40	Course N. E. 40 miles, D.L. 28	and G. T. from Noon..
☽'s True Alt. .... 41° 23′	Lat. at time of Sights.... 38° 43′	Dec., Noon.... 24 14 N
Polar Dist........... 66 42	....Log. 0.03695	☽'s Cor. Dec...23° 18′N
Latitude............ 38 43	....Log. 0.10777	90 0
Sum .... 146° 48′		☽'s Polar Dist. 66° 42′
Half Sum.......... 73° 24′	....Log. 4.45589	
Difference .... 32° 1′	....Log. 4.72441	☽'s R. A. Noon.. 8h. 12m. 21s.
		Midnight. 8 38 26
☽'s Hour Angle 3h. 38m. 58s.	....Log. 9.32502	Say as 12h.— 26 5s.—9h. 45m.
☽'s R. Ascen... 8 33 53		
R.A. of the Mer.. 4h. 54m. 35s.	Sun's R. A. 23h. 21m. 53s. Dif. 1h. 9s.	* 10.0000
Add 24 0 0	Cor...Add 1 30 10	Pro. Log 12h..1.1761 Table XXXIV
R. A. M. Increa. 28h. 54m. 35s.	Corrected. 23h. 23m. 23s. 90s.	Arth. Co......8.8239
Sun's R. Ascen. 23 23 23		Pro.Log.26m.5 0.8389
App. T. at Ship 5h. 31m. 12s.	Equation.. 10m. 31s·55 Dif. 1h.·665	do. 9h. 45m. 1.2663
Eq. of T...Add 10 25	6·65 10	0.9291
Mean Time.... 5h. 41m. 37s.	Corrected. 10m. 24s·90 6 65·0	Pro. Log...... 0h. 21m. 12s. Cor. for 9h. 45m
		☽'s R.A. at N'n 8 12 21
		☽'s Cor. R.A.. 8h. 33m. 33s.

* The Proportional Logs., Table XXXIV, are very useful for the purpose of performing Rule of three questions; but to make the terms all *additive* we must *subtract* the Pro. Log. of the first term from 10.0000. It is then called the Arithmetical Complement.

But as this Table only extends to 8 hours, we must enter it, (when they exceed that quantity,) with the hours as minutes and the minutes as seconds, &c., &c., as in the above Example, which will be found a much more correct mode than when taken from Tables which are generally constructed for that purpose.

FINDING THE TIME AT SHIP FROM AN ALTITUDE OF A PLANET.

The Time may be found as correctly by an Altitude of a Planet at a distance from the Meridian at twilight, as by the Sun, and the name of the Planet of which the Altitude is observed may be easily ascertained, if we refer to the Diagrams and Rules for finding the Meridian Altitudes of the Stars, at pages 64 and 65. There it will be perceived that the Elevation of the upper end of the Celestial Equator is equal to the Co-Latitude of the place. Now, it is easy to imagine a semicircle in the heavens, (in an opposite direction to the Elevated Pole,) to be elevated equal to the Co-Latitude of the place, and that this semicircle passes through the true East and West points of the Horizon, which will represent the Celestial Equator, and that if the Planet is seen to the North of this semicircle, it must have North Declination, otherwise South, and to note by its bearing whether it is to the Eastward or Westward of the Meridian. Now inspect the Nautical Almanac on that day of the month, and find which of the Planets agree with the above Declination, and find the time of its Meridian passage. If it be observed to the Eastward, it will pass the Meridian *later* than the time of observation, but if it be observed to the Westward, it will have passed the Meridian *earlier* than the time of observation. And bearing in mind that all the heavenly bodies rise and set to the Northward of the true East and West points, when their Declinations are North, otherwise to the Southward of these points when their Declinations are South; and that in High Latitudes, when the Declination is of the same name as the Latitude, the Planets will have a high Altitude, and they pass the Prime Vertical above the Horizon. But when the Latitude and Declination are of contrary names, their Altitudes wil be low, and they pass the Prime Vertical below the Horizon, or set before they reach it.

RULES

For Computing the Corrections.

1st. Find the Greenwich Date by turning the Ship's Longitude into Time, by Table XXVI, and *add* it to the Time at Ship in West Longitude, or *subtract* it in East; or it may be found from the Chronometer, *and to be called always one day less than the Sea date.*

To Correct the Planet's Observed Altitude.

2d. Enter Table XX with the Height of the eye at the top, and the observed Altitude at the side, and take out the correction for Dip and Refraction, which is always *subtractive.*

To Correct the Planet's Declination.

3d. Take out its Declination from the Nautical Almanac for the nearest Noon preceding the Greenwich Date, (except when the Change of Declination is small it may be taken for the nearest Noon of the Greenwich Date,) and also for the Noon of the following day, and take their Difference. Then say, as 24 hours is to the Difference in 24 hours, so is the time past Noon at Greenwich to a proportional part, which applied to the Declination at the preceding Noon, according as it is increasing or decreasing, will give the Planet's Correct Declination.

To Find the Planet's Polar Distance.

4th. When the Latitude and Declination are of the *same* name, the *difference* between the Declination and 90° is the Polar Distance; *otherwise*, their *Sum* is the Polar Distance.

To Correct the Latitude to the Time of Observation.

5th. Find the Difference of Latitude the Ship has made, and apply it to the Latitude last observed.

To Find the Hour Angle of the Planet.

6th. Having thus the True Altitude, Polar Distance, and the Latitude of the place, proceed as with the Sun to find the Planet's Hour Angle, or Distance from the Meridian, (which with the Sun is the time from Noon.)

To Correct the Planet's Right Ascension.

7th. Take out the Right Ascension from the Nautical Almanac for the Noon preceding the Greenwich Date, and also for the nearest Noon following it, and take their Difference; then say, as 24 hours is to the Difference in 24 hours, so is the time past Noon at Greenwich to a proportional part, which applied to the Right Ascension at the preceding Noon, according as it is increasing or decreasing, will give the Correct Right Ascension.

To Find the Right Ascension of the Meridian.

8th. If the Planet be to the Eastward of the Meridian, *subtract* its Hour Angle from its Right Ascension, but if to the Westward of the Meridian, *add* its Hour Angle to its Right Ascension, will give the Right Ascension of the Meridian.

To Correct the Sun's Right Ascension.

9. Take out the Sun's Right Ascension and the difference for 1 hour from the Nautical Almanac, multiply the difference for 1 hour by the time from Greenwich Noon, and *add* this correction to it.

To Find the Apparent Time at Ship.

10. From the Right Ascension of the Meridian, (increased by 24 hours if required,) *subtract* the Sun's correct Right Ascension, and the remainder will be the Apparent Time at Ship.

To Find the Mean Time at Ship.

11. Take out the Equation of Time from the Nautical Almanac, and correct it as usual, and apply it to the Apparent Time, according to the precept at the head of the column, and the result is the Mean Time at the Ship. (*See the Rules at page* 124.)

EXAMPLE 1.

April 7th, 1854 Sea Time. In Latitude 28° 26′ North, and Longitude 70° 0′ West, at twilight in the morning the observed Altitude of the Planet Venus, was 24° 21′ to the Eastward of the Meridian. Greenwich Time by Chronometer, 22h. 16m. 5s. Required the Apparent and Mean Time at Ship. Elevation 16 feet.

Obs. Alt. Venus, 24° 21′
Cor., Tab. XX, Sub. 6
Venus T. Alt... 24° 15′
Polar Dist. 96 7 .Log, 0.00248
Latitude ...... 28 26 .Log. 0.05583
Sum......... 148° 48′
Half Sum .... 74° 24′.Log. 4.42962
Difference .... 50° 9′.Log. 4.88521
Venus H.An. 3h. 52m. 35s.Log. 9.37314
R.Ascen. 22 29 34
R.A. of Mer. 18h. 36m. 59s.
Sun's R. A. 1 3 38
App. Time 17h. 33m. 21s.
Equa.. Add 2 14
Mn. Time.. 17h. 35m. 35s. from Noon,
Subtract .. 12 0 0 [Ap. 6th.
Mn. Time.. 5h. 35m. 35s. from midnight, or on the morning of the 7th April, Civil Time.

Dec. Venus, April 7th...... 6° 7′ S.
Add 90
Polar Distance of Venus... 96° 7′
Ven. R. A. Ap. 6th } 22h.27m.28s.
Ven. R. A. Ap. 7th } 22 29 44
Say as 24h. is to 2m. 16s. so is 22h.16m.
10.0000 by Pro. Logs.
0.8751 P. Log. of 24h., Table XXXIV.
9.1249 Arith. Complement.
1.8999 P. Log of 2m. 16s.
0.9076 P. Log. of 22h. 16m.
1.9324 Pro. Log. Cor.=2m. 6s.
Venus R. A., April 6th. 22h. 27m. 28s.
Correct R. Ascen..... 22h. 29m. 34s.

Gr. Time by Chro........ 22h. 16m. 5s.
Gr Date, April 6th..... 22h. 16m. 5s.
Sun's R. A. 1h. 0m. 18s. Dif. 1h... 9s.
Corr..... Add 3 20 G. T. 22½h.
Corrected. 1h. 3m. 38s. 198
2
60)200
3m. 20s.
Eq. of Time.. 2m. 30s·50 Dif. 1h.. ·725
Cor..... Sub. 16 ·13 22½h.
Correct Eqa. 2m. 14 ·37 1450
1450
181
16·13·1

EXAMPLE 2.

Dec. 6th, 1854. Sea Time. The Latitude at Noon was 38° 10′ South, and the Longitude by Chronometer 92° 50′ East. Ship then sailed S. W. (true) 40 miles, when the Altitude of the Planet Jupiter observed was 36° 10′ to the Westward of the Meridian, at 7h. 15m. by the Watch, at twilight in the evening. Required the error of the Watch on Apparent and also Mean Time, at Ship. Elevation 16 feet.

Jup'r's Obs. Alt. 36° 10′
Cor., Tab. XX, Sub. 5
True Alt.. 36° 5′
Polar Dist. 68 45 .Log. 0.03058
Latitude...... 38 38 Log. 0.10726
Sum .... 143° 28′
Half Sum.... 71° 44′.Log. 4.49615
Difference ... 35° 39′.Log. 4.76554
Jup.'s H.A. 4h. 0m. 29s.Log. 9.39953
R. Ascen. 19 57 15
R.A. of Mer. 23h. 57m. 44′
Sun's R. A. 16 46 47
Ap.T. at S'p, 7h. 10m. 57s.
Eq. of T., Sub. 9 11
Mn. Time, 7h. 1m. 46s.
T. by watch 7 15 0
W. fast M. T. 13m. 14s.

Time by Watch....... 7h. 15m. 0s.
Lon. 92° 14′ E. in time. 6 8 56
Green. Date, Dec. 5th .. 1h. 6m. 4s.
Jupiter's Dec. N'n, Dec. 5th, 21° 15′ S.
90 0
Jupiter's Polar Dist...... 68° 45′
Sun's R. A. 16h. 46m. 36s. Dif. 1h.. 11s.
Correction. 0 0 11
Corrected . 16h. 46m. 47s.
Lat. Obs. at N'n 38° 10′ S. Long..... 92° 50′ E.
Co. S.W. 40=D.L. 28 S. Dep. 28 —D.L. 36 W.
Lat. time sights, 38° 38′ S. Long..... 92° 14′ E.
App. Time at Ship.... 7h. 10m. 57s.
Time by Watch 7 15 0
Watch fast of App. T.. 0h. 4m. 3s.

Eq. of Time. 9m 12s·43 Dif. 1h. 1·049
Correction .. 1 ·04 1
Correct Equa. 9m. 11s·39 1s·049
Ju. R.As. Dec. 5th } 19h. 57m. 13s.
R.As. Dec. 6th } 19 58 4
Say as 24h. is to 51s. so is 1h. 6m.
*9.1249 A. C. P. Log. 24h., Ta. XXXIV
2.3259 Pro. Log... 51
2.2139 Pro. Log... 1h. 6m.
3.6647 Pro. Log. Corr. 0m. 2s.
R. Ascen., Dec. 5th. 19h. 57 13
Correct R. Ascen. ... 19h. 57m. 15s.

* See the Note at page 133, for working by the Proportional Logs.

FINDING THE TIME AT SHIP FROM AN ALTITUDE OF A STAR.

The Time may also be found as correctly by an Altitude of a Star at a distance from the Meridian, twilight, as by the Sun; and the name of the Star of which the Altitude is observed, may be found in like manner as the Planets, by referring to the Diagrams and Rules for finding the Meridian Altitude of the Stars, at pages 64 and 65. The names of any of the Stars, in Table XIX, when observed out of the Meridian, may be found by imagining a point in the heavens, in an opposite direction to the elevated Pole, which is equal in Altitude to the Co-Latitude of the place. This point will represent the Upper part or Elevation of the Celestial Equator. Then suppose a semicircle drawn from thence through the true East and West points of the Horizon, will represent the Celestial Equator.

Then all the Stars seen to the Northward of this semicircle will have North Declination. and those seen to the Southward of it will have South Declination, and it can at once be determined whether the Star observed has North or South Declination. Now estimate its distance in Degrees from this supposed line or Equator, and enter Table XIX, and find which of the Stars corresponds nearest to this estimated Declination.

The bearing of the Star will show whether it be to the Eastward or Westward of the Meridian. Now enter Table XVIII with the day of the month, and find at what time it would pass the Meridian on that day. Then, if the Star be to the Eastward when observed, and it is the proper Star, the Table will give its Meridian passage *later* in the day; but if observed to the Westward, it will give it *earlier* in the day. Thus the Declination and Meridian passage will point out the name of the Star.

And as before stated, all the Stars having North Declination rise and set to the *Northward* of the true East and West points of the Horizon, while those having South Declination rise and set to the *Southward* of the East and West points.

And in High Latitudes, when their Declinations are of the *same* name as the Latitude, their Altitudes are high, and they pass the Prime Vertical, that is, they pass the East or West points above the Horizon. But when the Latitude and their Declinations are of *contrary* names, their Altitudes are low, and they do not reach the East or West points (at rising or setting) when above the Horizon.

RULES

For Computing the Corrections.

1. Turn the Ship's Longitude into Time, and *add* it to the Time by Watch, in West Longitude, or *subtract* it in East, will give the Greenwich Date.

To Correct the Star's Observed Altitude.

2. Take out the Correction from Table XX, and *subtract* it from the observed Altitude, will give the Star's true Altitude.

To Correct the Star's Declination.

3. Take out the Star's Declination from Table XIX, and the annual Variation; multiply this by the number of years elapsed since 1854, and divide by 60, if above 60″, will give the correction in Minutes and Seconds, and apply it according to the sign of *addition* (+) or *subtraction* (—) found in the Table.

To Find the Star's Polar Distance.

4. When the Latitude and Declination of the Star are of the same name, the *Difference* between the Declination and 90° is the Polar Distance, otherwise their *Sum* is the Polar Distance.

To Find the Latitude at the Time of Observation.

5. Find the Difference of Latitude the Ship has made, and apply it to the Latitude last observed.

To Find the Star's Hour Angle.

6 Having thus the True Altitude and Polar Distance of the Star, and the Latitude of the place, proceed as with the Sun to find the Star's Hour Angle, or Distance from the Meridian, (which with the Sun is the time from Noon.)

To Correct the Star's Right Ascension.

7. Take out the Star's Right Ascension from Table XIX, and the annual Variation; multiply this by the number of years elapsed since 1854, and divide by 60, (if above 60s.,) will give the correction, which is always *additive.*

FINDING THE TIME AT SHIP FROM AN ALTITUDE OF A STAR.

To Find the Right Ascension of the Meridian.

8. If the Star be to the Eastward of the Meridian, *subtract* its Hour Angle from its Right Ascension. But if to the Westward, *add* its Hour Angle to its Right Ascension, will give the Right Ascension of the Meridian

To Find the Sun's Right Ascension.

9. Take out the Sun's Right Ascension, and the Difference for 1 hour, from the Nautical Almanac, for the Noon of the Greenwich Date. Multiply the Difference for 1 hour by the time from Greenwich Noon, and divide by 60 (if above 60). This Correction is always *additive.*

To Find the Apparent Time at Ship.

10. From the Right Ascension of the Meridian, (increased by 24 hours, if necessary), *subtract* the Sun's Correct Right Ascension, and the remainder is the Apparent Time.

To Find the Mean Time at Ship.

11. Take out the Equation of Time, and the Difference for 1 hour from the Nautical Almanac, and correct it to the Greenwich Date by the rules at page 124, and apply it to the Apparent Time, according to the precept at the head of the column in the Nautical Almanac, by *adding* or *subtracting* it, and the result is the Mean Time at Ship

EXAMPLE 1.

February 10th, 1854, Sea Time, in Latitude 40° 10′ N., Longitude 68° 20′ W., in the Evening Twilight, the Obs. Altitude of the Star Sirius was 12° 29′ to the Eastward of the Meridian. The Time by Watch was 5h 28m. Required the error of the Watch on both Apparent and Mean Time. Elevation 16 feet.

Observed Altitude of Sirius 12° 29′
Corr., Table XX......Sub. 8
True Altitude............ 12° 21′
Polar Distance.... ......106 31 Log. 0.01830
Latitude................ 40 10 Log. 0.11681
Sum....................159° 2′
Half Sum............... 79° 31′ Log. 4.25995
Difference............... 67° 10′ Log. 4.96456
Sirius's Hour Angle... 3h 48m 40s Log. 9.35962
Sirius's Right Ascen.... 6 38 43
R. Ascen. of the Mer.. 2h 50m 3s
Add. 24 0 0
Increased R. A. M.....26h 50m 3s
Sun's R. Ascen.......21 33 14
App. Time at Ship.... 5h 16m 49s
Equation........Add 14 32
Mean Time at Ship.. 5h 31m 21s

Time by Watch........ 5h 28m 0s
Long. 68° 20′ W. in time 4 33 20
Green. Date, Feb. 9th.. 10h 1m 20s

Sirius's Declination, 1854.. 16° 31′ S
90 0
Polar Distance..........106° 31′

Sirius's Right Ascension, 1854, 6h 38m 43s

Sun's R. A., Feb. 9th 21h 31m 34s Diff. 1h........10s
Add 1 40 10
Correct Right Ascen. 21h 33m 14s 60)100s
1m 40s

Time by Watch.... 5h 28m 0s
Apparent Time..... 5 16 49
Watch fast........ 0h 11m 11s of Apparent Time.

Time by Watch.... 5h 28m 0s
Mean Time........ 5 31 21
Watch slow........ 0h 3m 21s of Mean Time.

EXAMPLE 2.

May 13th, 1854. Sea Time. Ship's position at the preceding Noon was Latitude 37° 44′ S., Longitude 68° 9′ E. She then sailed E. S. E., 120 miles, until 4h 40m A. M., when the Altitudes of Antares was observed 42° 36′, to the Westward. Required the error of the Watch on both Apparent and Mean Time. Elevation 18 feet.

Obs. Alt. of Antares.... 42° 36′
Corr., Table XX...Sub. 5
True Altitude.......... 42° 31′
Polar Distance........ 63 54 Log. 0.04671
Latitude............... 38 30 Log. 0.10646
Sum....................144° 55′
Half Sum............. 72° 28′ Log. 4.47894
Difference............. 29° 57′ Log. 4.69831
Antares's H. Angle 3h 40m 27s Log. 9.33042
Antares' Right A..16 20 24
R. Asc. of the Mer. 20h 0m 51s
Sun's R. Ascen.... 3 17 50
App. Time from previous Noon. } 16h 43m 1s
Sub. 12 0 0
App. T. at Ship.... 4h 43m 1s
Equa. of Time.... 3 58
Mean T. at Ship... 4h 39m 3s
T. by the Watch.. 4 40 0
Watch Fast ..... 0h 0m 52s of Mean Time.

Time by Watch.... 4h 40m
Add. 12 0
From preced. Noon 16h 40m
Lon. 70° 30′ E. in T.. 4 42
G. Date, May 12th.. 11h 58m

Antares's Declination 1854 26° 6′ S
90 0
Antares's Polar Distance... 63° 54′

Antares's R. A., 1854, 16h 20m 24s

Noon previous Lat.........37° 44′ S., and Long.........68° 9′ E
Course E. S. E. 120 mls. D. L. 0 46 S., Dep. 111 = Diff. Long. 141 = . } 2 21 E
Lat. in at Time of Sights...38° 30′ S., Longitude in......70° 30′ E.

Sun's Right Ascension, May 12th, 3h 15m 50s Diff. 1h 10s
Add 2 0 12
Sun's Correct R. A............. 3h 17m 50s 30)120s
2m 0s

Equation of Time. 3m 52s·34 Diff. 1h ·53
Corr ....Add ·63 12h
3m 52s·97 Corr. ·63·6

Apparent Time at Ship.... 4h 43m 1s
Time by Watch........... 4 40 0
Watch Slow .... 0h 3m 1s of Apparent Time

FINDING THE LONGITUDE BY CHRONOMETER.

The Cause of a Ship Losing or Gaining Time.

Having thus given all the most practical methods of finding the Time at Sea, it will be necessary, before proceding to find the Longitude, to premise, that when a Ship sails *Westward* she *loses* Time: that is, the Time shown by the Watch, which was regulated to Apparent Time on the preceding day, will be in advance of that found by observation on the following day. And that when a Ship sails *Eastward* she *gains* Time that is, the Time shown by the Watch, which was regulated to Apparent Time on the preceding day, will be behind that found by observation on the following day.

The Rotation of the Earth is the Cause of the Difference of Time between Places.

The velocity of the Earth's rotation on its axis from West to East, is 360° in 24 hours of time, or at the rate of 15° to the hour, and 1° to every 4 minutes. It is evident that any place that lies Eastward of another place, will come sooner under the Sun, or will have the Sun earlier on the Meridian, consequently the hour of the day will be in advance of the other. On the other hand, any place that lies to the Westward of another place, will be later in coming under the Sun, or will have the Sun later on the Meridian, consequently the hour of the day will be behind that of the other. Thus, at a place, say Greenwich Observatory, situated 74°, or 4h 56m in time, to the Eastward of New York, when it is Noon at Greenwich, it wants 4h 56m of being Noon at New York; and when it is Noon at New York it is 4h 56m past Noon at Greenwich. And at a place, say San Francisco, situated 48°, or 3h 12m in time, to the Westward of New York, when it is Noon at San Francisco it is 3h 12m past Noon at New York, and when it is Noon at New York, it wants 3h 12m of being Noon at San Francisco. Hence the difference of Time between any two places, indicates their difference or Longitude.

Longitude Reckoned from the Meridian of Greenwich.

Longitude is reckoned from a first Meridian, and in this work we use the Meridian of Greenwich as first Meridian, and from which the Longitude is reckoned Eastward 180° and Westward 180°, which together are equal to the circumference of the globe.

On Circumnavigating the Globe, steering West, Ship loses one Day.

Suppose a Ship to sail from Greenwich, with her Chronometer accurately set to Greenwich Mean Time, and steering to the Westward, when she has made 15° of Longitude the Mean Time at the Ship will be found to be 1 hour behind that by the Chronometer. She has therefore lost 1 hour of time. And supposing the Ship to continue her course to the Westward until she reaches the Longitude of 180° W., the Mean Time at the Ship will be 12 hours behind that of the Chronometer, and she will have lost 12 hours in time. The Ship being now in East Longitude, and continuing her course to the Westward, her Longitude decreases, and finally, when she arrives again on the Meridian of Greenwich, (after circumnavigating the Globe) it will be found that the Mean Time at the Ship is 24 hours behind the Mean Time at Greenwich, consequently she has *lost* one entire day on the voyage.

On Circumnavigating the Globe, steering East, Ship gains one Day.

On the other hand, a Ship sailing East from Greenwich, under the same circumstances, when she has made 15° of Longitude, the Mean Time at the Ship will be found to be 1 hour in advance of the Greenwich Time by Chronometer, and she has therefore gained 1 hour of time. And continuing her course to the Eastward until she reaches the Longitude of 180° E., the Mean Time at the Ship will be 12 hours in advance of the Greenwich Time by Chronometer, and she will have gained 12 hours of time. Being now in West Longitude, and continuing her course to the Eastward, her Longitude decreases, and finally, when she arrives again on the Meridian of Greenwich, (after circumnavigating the Globe), it will be found that the Mean Time at the Ship is 24 hours in advance of the Mean Time at Greenwich, consequently she has *gained* one entire day on the voyage.

In Circumnavigating round by the West, one Day is subtracted from the Greenwich Date.

In the case of Circumnavigating, the general practice is, that when on reaching the opposite Meridian to Greenwich, (or the Longitude of 180° W.), in sailing round by the West, into East Longitude, and with the view of making the general rule applicable, which is, that the Greenwich Time should be the *least* in East Longitude, we *subtract* one day from the Greenwich Date, so that when the Ship arrives again on the Meridian of Greenwich, the time at Ship, and the Greenwich Time by Chronometer will coincide.

In Circumnavigating round by the East, one Day is Added to the Greenwich Date.

In Circumnavigating round by the East, the general practice is, that on reaching the opposite Meridian to Greenwich, or the Longitude of 180° E., thence passing into West Longitude, and with the view of making the general rule applicable, which is, that the Greenwich Time should be the *greatest* in West Longitude, we *add* one day to the Greenwich Date, and on the Ship's arrival again on the Meridian of Greenwich, the time at Ship will coincide with the Greenwich Time by Chronometer.

On Ascertaining the Greenwich Time from the Chronometer.

As only 12 hours are given on the face of the Chronometer, it shows only the time after Noon or Midnight, therefore when it is A. M. at Greenwich, by adding 12 hours to it, we have the time since the preceding Noon.

If it shows P. M. at Greenwich, the Noon of the present day will be the preceding Noon at Greenwich, or the beginning of the Astronomical day, which, with the day of the month prefixed, is called the *Greenwich Date.*

To know whether the Time by Chronometer is P. M. or A. M. at Greenwich.

To the Astronomical Mean Time at the Ship (which is found by taking one day from the Sea Date, and counted through the 24 hours), *add* the Ship's Longitude in time in West Longitude, or *subtract* it in East, the Sum or Difference will be the Mean Time at Greenwich. If it be less than 12 hours, the face of the Chronometer will show P. M. at Greenwich; but if the Greenwich Time be more than 12 hours, the face of the Chronometer will show A. M. at Greenwich, to which we must add 12 hours to get the Time from the preceding Noon.

Longitude is the Difference of Time between two Meridians, and how Found.

It will be perceived, from the above remarks that Longitude is merely a question of the difference of Time between two Meridians. If we, therefore, have the correct Mean Time at the first Meridian of Greenwich, shown by a Chronometer, we can at any time find the Longitude of the Ship by simply taking the difference between the Mean Time at Greenwich and the Mean Time at the Ship, found by any of the methods already given in this work, which, turned into Degrees and Minutes, by Table XXVI, is the Ship's Longitude

Then, if the Greenwich Time be *greater* than the time at the Ship, the Longitude is West; but if the Greenwich Time is the *least*, the Longitude is East.

When one of the Times is P. M. and the other A. M. on the same day, we must add 24 hours to that at P M., and take their difference for the Longitude in time.

And when the P. M. and A. M. Times fall on different dates, their difference, counted from their preceding Noons, is the Longitude in Time.

Rate of a Chronometer.

The Chronometer would therefore be a most useful instrument, were it to keep a steady uniform rate throughout the voyage, and nothing more would be required; but as this is seldom the case, (see remarks at Pages 79 and 80), it is necessary that it should be verified from time to time during the voyage, in order to ascertain its error on Greenwich Mean Time, at the place of observation, and its present rate. The manner of doing this will be found at page 155.

Method of Keeping an Account of the Rate.

Calculate the daily error of the Chronometer on Greenwich Mean Time by applying the Rate for each day for several days in advance, and write it on the margin of the Nautical Almanac, each day's error opposite the day of the month. So that the error of the Chronometer can be taken out and applied at once from the same page that the Sun's Declination and Equation of Time are taken from. This will be found a very convenient mode, and save some time and trouble.

To Find the Accumulated Error of a Chronometer, after a lapse of Time.

Multiply the Daily Rate, which is generally given in Seconds and Tenths of Seconds, by the days elapsed since the last Rate was ascertained, and divide by 60, (if it is above 60), will give the accumulated Rate, in Minutes and Seconds. This applied to the original error,

When the Chronometer is
- Fast, and the Daily Rate Gaining, Add,
- Slow, and the Daily Rate Gaining, Subtract,
- Fast, and the Daily Rate Losing, Subtract,
- Slow, and the Daily Rate Losing, Add,

will give the whole error of the Chronometer on Greenwich Mean Time on that day; and it is applied in the same manner as for a common watch, and requires no explanation.

Mode of Observing Altitudes.

In taking Altitudes of any of the Heavenly Bodies, for the purpose of finding the time at the Ship, the times by Chronometer at which they were observed, must be noted, and the Altitudes are then added together and divided by the number taken. The times by Chronometer are in like manner added together, and divided by the number taken. This gives the Mean of the Altitudes, and the Mean of the Times by Chronometer. By this mode we are supposed to obtain a more correct result by taking the Arithmetical Mean of the Altitudes than can be obtained from one Altitude alone. At all events, it prevents mistakes in the readings off. (See also the method given at page 124.)

The Times at which the Altitudes were observed to be taken by a Watch.

As the Chronometer must, on no account, be removed from the place where it has been fixed for the voyage, it may not be convenient to note the time direct from the Chronometer at the time of taking the Altitudes, and in that case we use a Hack or common Watch, furnished with a Second Hand, with which the Times of the Altitudes are taken. It is then immediately afterwards compared with the Chronometer, and their difference noted. This difference being then applied to the Mean of the Times by Watch, at which the Altitudes were observed, will give the Time of the Altitudes by Chronometer. Its error being then applied, we have the Greenwich Time.

The Mean Time at Ship by an Altitude of the Sun is then found in exactly the same manner as that given at page 124, using the Greenwich Time by Chronometer, in making the Corrections, in the room of the approximate Greenwich Time. The following is an example of the whole process, as is usually done at Sea, and both Latitude and Longitude found at Noon.

EXAMPLE 1.

March 6th, 1854 (at the end of the Sea Day), a Ship which sailed from her last port 5 days previously had the following observations in the morning: The Error of her Chronometer on Greenwich Time, March 1st, was 0h 2m 14s fast, and the Daily Rate 2s and 6-10 gaining. Ship sailed N. W. 50 miles until Noon, when the Sun's Meridian Altitude observed was 45° 32′ S., and the Longitude by Dead Reckoning being about 54° W. Required her Latitude and Longitude in at Noon.

Sun's Obs. Altitude L. Limb..	10° 12′		Times by the Watch			7h 11m 24s
	0 22					0 12 30
	0 35					0 13 50
	3)69′					3)37m 44s
Mean of the Altitudes	10° 23′		Mean of the Times by Watch			7h 12m 35s
Corr., Table IX.........Add	7		Comparison Chro. fast of Watch			3 49 54
Sun's True Altitude	10° 30′		Time by Chronometer A. M.			11h 2m 29s
Sun's Polar Distance	95 41	Log. 0.00214	Accumulated Error Fast............Sub.			2 27
Latitude	38 5	Log. 0.10396	Greenwich Time from Midnight			11h 0m 2s
Sum	144° 16′				Add.	12 0 0
Half Sum	72° 8′	Log. 4.48686	Greenwich Date, March 5th			23h 0m 2s
Difference	61° 38′	Log. 4.94445	Mer. Alt. Obs.	45° 32′ S.	Diff. Decl.	1h = 58
Apparent Time	19h 12m 24s	Log. 9.53741	Corr., Table IX..Add	11	Cor. for Ln.	54° W. 3½h
Equation of Time.....Add	11 32		True Altitude	45° 43′		174″
Mean Time	19h 23m 56s		Zenith Distance	44° 17′ N.		29
Greenwich Time	23 0 2		Declination	5 37 S.		60)203″
Longitude in Time	3h 36m 6s = 54° 1′ 30″ W.		Lat. at Noon	38° 40′ N.	Corr.	3′ 23″
Departure made to Noon, 35′ = Diff. Long.	45 0 W.		Course N. W. 50m D. L.	35	Decl	5° 40′ 0 S.
Long. of the Ship at Noon	54° 46′ 30″ W.		Lat. at Sights	38° 5′ N.	Decl.	5° 36′ 37″ S.

To find the Comparison.		Sun's Dec. Noon, March 6th.	5° 40′ 2″ S.	Diff 1h..58″
Time by Chronometer	11h 5m 54s	Corr. 1h before Noon..Add	58	
Time by Watch	7 16 0	Corrected Dec.	5° 41′ 0″	
Comparison Chro. fast of Watch	3h 49m 54s		90 · 0 0	
		Polar Distance	95° 41′ 0″	
To find the Error of the Chronometer.				
Chronometer fast March 1st	0h 2m 14s	Equation of Time	11m 31s ·74	Diff. 1h 60·2
Days elapsed 5, daily rate 2s 6-10 —	13	Corr. 1h before Noon....Add	·60	
Accumulated Error	0h 2m 27s	Correct Equa	11m 32s ·34	

RULE FOR TURNING TIME INTO LONGITUDE BY COMPUTATION.

Turn the Hours into Minutes, and divide by 4. This gives Degrees, Minutes, and Seconds.

Example.—3h 36m 6s is 216m 6s, which, divided by 4, gives 54° 1′ 30″.

RULE FOR TURNING LONGITUDE INTO TIME BY COMPUTATION.

Multiply the Longitude by 4. This turns the Degrees into Minutes of Time (which, divided by 60, gives Hours and Minutes), the Minutes of Longitude into Seconds of Time, and the Seconds of Longitude into Thirds of Time.

Example.—Longitude 54° 1′ 30″, multiplied by 4, gives 216m 6s = 3h 36m 6s.

FINDING THE LONGITUDE BY CHRONOMETER FROM THE SUN'S ALTITUDE.

Referring to the 1st Example, it will be perceived that the Time shown by the face of the Chronometer is 11h 2m. 29s., and the accumulated Error subtracted, would give the Greenwich Time from midnight, 11h. 0m. 2s. The Mean Time at Ship, from the preceding midnight, being 7h. 23m. 56s., their Difference, 3h. 36m. 6s., is the Longitude in time. This mode of reckoning the two times from the same midnight is frequently done at Sea, because it is more convenient than to reckon them from the preceding Noon. The result in either case is the same. The Time from Noon, A. M., in the one case is found by subtracting it from 24 hours, and in the other from 12 hours.

In the Example referred to, the time from Noon is 1 hour, and the difference of the Sun's Declination and Equation of Time for 1 hour, in the column of the Nautical Almanac, is the correction required, to be applied as directed at page 124, No. 7.

RULE

For Correcting the Sun's Declination at Noon of the Ship by the Nautical Almanac.

Multiply the difference for 1 hour by the Longitude in Time, and divide by 60, if required, will give the correction in Minutes and Seconds, to be applied to that taken from the Nautical Almanac, as follows:

In West Longitude and Declination	Increasing, Add, Decreasing, Subtract,
In East Longitude and Declination	Increasing, Subtract, Decreasing, Add,

RULE

To Reduce the Longitude by Chronometer at Time of Sights to Noon.

Take the Latitude in as a Course, and the Departure made in the interval, in the Latitude column, the Difference of Longitude is found in the Distance column. Apply this as follows:

Observation taken in the morning, in West Longitude	Sailing West, Add, Sailing East, Subtract,
Observation taken in the afternoon, in West Longitude	Sailing West, Subtract, Sailing East, Add.

To or from the Longitude by Chronometer, will give the Longitude in at Noon.

By substituting East for West, the same Rule may be applied in East Longitude.

EXAMPLE 2

April 2d, 1854. (End of the Sea day.) The Latitude observed was 30° 37′ North. Ship then sailed S. E. (true) 50 miles, when the following observation was made in the afternoon, the Error of her Chronometer on Greenwich Mean Time, on the 23d of March, was ascertained to be 0h. 9m. 31s. fast, and the daily rate 3s 4-10th losing. Required her Longitude in at time of Sights and Noon.

Sun's Obs. Alt	10° 13′	Times by Watch . . .	5h. 24m. 0s.	
	10 0		25 0	
	9 47		26 0	
	3)30° 0′		3)75m. 0s.	
Mean of the Alt	10° 0′	Mn. of the Times by W . . .	5h. 25m. 0s.	
Corr., Table IX . . . Add	7	Comparison	3 14 48	
True Alt	10° 7′	Time by Chro	8h. 39m. 48s.	
Polar Dist	84° 57′	Log. 0.00169	Accumu. error . . Sub.	8 57
Latitude	30 2	Log. 0.06262	Gr. Date, April 2d.	8h. 30m. 51s.
Sum	125° 6′			
Half Sum	62° 33′	Log. 4.66368		
Difference	52° 26′	Log. 4.89908		
App. Time	5h. 24m. 54s.	Log. 9.62707		
Equation . . . Add	3 35			
Mean Time	5h. 28m. 29s.			
Green Time	8 30 51			
Long. in Time . .	3h. 2m. 22s. = 45° 35′ 30″ W.			
Dep. made since Noon 35′ = Diff. Lon.	40 30			
Long. in at Noon	46° 16′ 0″ W.			

To find the Comparison.

Time by Chro. .	8h. 42m. 48s
Time by Watch,	5 28 0
Comparison . .	3h. 14m. 48s.

Chr. fast, March 23d. .	0h. 9m. 31s.
Days elap. 10. Rate 3s. 4-10th	=34
Accumulated error	0h. 8m. 57s. fast.

Course S. E. 50 miles, D. Lat.	35′ Dep. 35′		
Lat. Obs. at Noon	30° 37′ N.		
Lat. Time of Sights	30° 2′ N.		

Sun's Declina., April 2d . . .	4° 54′ 55″ N.	Dif. 1h.	57″
Correction . . . . Add	8 4	Time from Noon.	8½h
Correct Declination	5° 2′ 59″		456
	90 0 0		28
Polar Distance	84° 57′ 1″		60)484
			8′ 4″

Equation of Time, April 2d. .	3m. 41s·71	Dif. 1h	·750
Correction . . . . Sub.	6 ·37	Time fr. N'n,	8½h
	3m. 35s·34		6·00·0
			375
			6·37·5

NOTE.—The Longitude obtained from Morning Altitudes and brought on to Noon, very seldom agrees with the Longitude obtained from Afternoon Altitudes and reduced back to Noon. This is supposed to be caused by unequal refraction in the Atmosphere, together with errors in the observed Altitudes, errors in the Instruments, and that of an incorrect Latitude used in the computation.

FINDING THE LONGITUDE BY CHRONOMETER FROM THE SUN'S ALTITUDE

EXAMPLE 3.

May 20th, 1854. (End of the Sea day.) A Ship being in South Latitude, and in about 77° East Longitude, in the morning the Mean of several Altitudes of the Sun was observed to be 12° 10′, and the Time by the Watch 8h 10m. 20s., which, on being compared, was found to be fast of the Chronometer 5h 15m 38s, and on the 30th April this Chronometer was found to have been slow on Greenwich Mean Time 0h 5m 10s, and the rate losing daily 4 sec. and 7-10th. Ship then sailed on a S. E. Course (true) 20 miles, until Noon, when the Sun's Meridian Altitude observed was 33° 14′ N. Required her Latitude and Longitude in at Noon.

Sun's Obs. Alt.	12° 10	
Cor., Tab. IX	8	
True Alt.	12° 18′	
Polar Dist.	109 54	Log. 0.02674
Latitude	36 25	Log. 0.09435
Sum	158° 37′	
Half Sum	79° 18½′	Log. 4.26840
Difference	67° 0½′	Log. 4.96405
App. T.	20h 13m 5s	Log. 9.35354
Eq. of T.	3 47	
Mn. Time	20h 9m 18s	
Gr. Time	15 1 26	
Lon. in T.	5h 7m 52	76° 58′ 0″ E.
Dep. made to Noon	14 ..=D.-L. 17′ 30	
Lon. of Ship at Noon		77° 15′ 30″ E.

Time by Watch	8h 10m 20s
Comparison	5 15 38
Face of Chro. A. M.	2h 54m 42s
Accum. Error......Add	6 44
G. T. from Mid.	3h 1m 26s
Add	12h 0 0
Gr. Date, May 19th	15h 1m 26s
Subtract from	24 0 0
Time Before Noon	8h 58m 34s

To find the Comparison.

Time by Chronometer	2h 57m 42s
Time by Watch	8 13 20
Comparison	5h 15m 38s
Chro. Slow, April 30th	0h 5m 10s
Days elapsed 20×4s.7-10th =	1 34
Accumulated Error	0h 6m 44s

Sun's Dec. 20th May	19° 58′ 19″ N.	Diff. 1h	·31″
Correction ....Sub.	4 39	Before Noon	9h
Correct Declination	19° 53′ 40″		60)279
	90 0 0	Correction	4·39
Polar Distance	109° 53′ 40″		

Meridian Altitude	33° 14′ N.	Dif. Dec. 1h=31″	
	11	Long... 77°=	5h
	33° 25′		60)155
Zenith Distance	56° 35′ S.		2′ 35″
Declination	19 56 N.	Dec..	19° 58′ 19
Lat. of Ship at Noon	36° 39′ S.		19° 55′ 44″ N
Course S. E. 20 miles. Dif. Lat.	14		
Latitude at Time of Sights	36° 25′ S.		

Eq. of Time	3m 46s·15	Dif. 1h	·140
Correction...Add	1 ·26	Bef. N.	9h
Correct Eqa.	3m 47s·41	Corr.	1·26·0

EXAMPLE 4.

October 10th, 1854. (End of the Sea day.) Latitude observed at Noon 20° 41′ South, Longitude in by Dead Reckoning 179° 30′ East, at Noon. Ship had sailed N. E. 54 miles since Noon, when the Mean of several Altitudes of the Sun was observed to be 18° 45′. Time by Watch 4h 40m 35s, which, on being compared with the Chronometer, was found to be fast of the Chronometer 0h 14m 22s, and on the 10th of September this Chronometer was slow of Greenwich Mean Time 0h 10m 26s., and gaining 5s. 2-10th per day. Required the Longitude of the Ship at the time of the Sights and at Noon.

Sun's Obs. Alt.	18° 45′	
Correction, Table IX... Add	9	
True Altitude	18° 54′	
Polar Distance	83 29	Log. 0.00282
Latitude	20 3	Log. 0.02715
Sum	122° 26′	
Half Sum	61 13	Log. 4.68260
Difference	42° 19	Log. 4.82816
App. Time	4h 48m 53s	Log. 9.54073
Equation of Time.... Sub.	12 50	
Mn. Time at Ship, Oct. 10th	4h 36m 3s	
Add	24 0 0	
Mn. Time at Ship, Oct. 9th	28h 36m 3s	
Mn. Time at Green., Oct. 9th	16 34 3	
Long. in Time	12h 2m 0 =	180° 30′ 0″ E.
Subtract from		360 0 0
Long. of Ship at time of Sights		179° 30′ 0s W
Dep. made since Noon 38m = D. Long.		40 30
Reckoned from Greenwich		180° 10′ 0″W
Subtract from		360 0 0
Long. of Ship at Noon		179° 49′ 30″ E.

Lat Obs. Noon	20° 41′ S.
Course N. E. 54 miles=Dif. Lat. Sub.	0 38
Lat. at time of Sights	20° 3′ S.

Time by Watch	4h 40m 35s
Comparison	0 14 22
Face of Chron., A. M.	4h 26m 13s
Add	12 0 0
Time by Chronometer	16h 26m 13s
Accum. Error, slow.... Add	7 50
Gr. Date, Oct. 9th	16h 34m 3s
Subtract from	24 0 0
Time Before Noon	7h 25m 57s

Chron. slow, Sept. 10th	0h 10m 26s
Days elaps. 30. Rate 5s 2-10th.	2 36
Accumulated Error	0h 7m 50s

To find the Comparison.

Time by Chronometer	4h 29m 13s
Time by Watch	4 43 35
Comparison	0h 14m 22

Sun's Dec., Oct. 9th	6° 37′ 30″ S.	Dif. 1h=57″
Correction........Sub.	6 58	7⅓h
Correct Declination	6° 30′ 32″ S.	399
	90 0 0	19
Polar Distance	83° 29′ 28″	60)418
		Corr 6′ 58″
Equa. of Time	12m 55s·18	·647
Correction ..... Sub.	4 ·74	7⅓h
Correct Equation	12m 50s·44	4·52·9
		216
		Corr 4·74·6

NOTE.—In the 4th Example the Ship has crossed the Meridian of 180° East, in the interval between Noon and the time the Sights were taken in the afternoon, having passed from East into West Longitude, and if bound to the Eastward, we would add one day to the Greenwich Date. (See page 139.)

EXAMPLE 5.

August 5th, 1854, (end of the Sea day,) a Ship being in North Latitude and about 179° West Longitude. In the Morning the Sun's observed Altitude was 35° 6′, and the Time from the Face of the Chronometer was 8h 39m 22s. (being P. M. at Greenwich,) which was fast of Green. M. T. 0h 30m 35s. Ship then sailed due West 48 miles until noon, when the Sun's Meridian Altitude observed was 76° 11′ S. Required the Ship's Latitude and Longitude in at Noon.

Sun's Observed Altitude......	35° 6′	
Corr., Table IX.........Add.	11	
True Altitude...............	35° 17′	
Polar Distance..............	78 4	Log. 0.01925
Latitude....................	30 30	Log. 0.06468
Sum.........................	138° 51′	
Half Sum....................	69° 26′	Log. 4.54567
Difference..................	34° 9′	Log. 4.74924
Apparent Time..............	20 5° 44′	Log. 9.37884
Equation of Time.......Add	5 43	
Mean T. Ship Aug. 4	20h 11m 27s	
Green. Date, Aug. 4.......	32 8 47	
Longitude in Time........	11h 57m 20s=179° 20′ 0″W.	
Departure made to Noon, 48=Diff. Long.	55 45 W.	
Reckoned West from Greenwich.........	180° 15′ 45″W.	
Sub. from..............	360 0 0	
Long. of the Ship at Noon..............	179° 44′ 15″ E.	

NOTE.—Here the Ship has crossed the Meridian of 180° West, between the time the Sights were taken and Noon, and she is now in East Longitude. We therefore Subtract one day from the Greenwich Date, if the Ship is bound *West*. See page 139.

Time by Chronometer..............	8h 39m 22s	
Chronometer fast of Greenwich......	30 35	
Greenwich Time Aug. 5th...........	8h 8m 47s P M	
Add.	24h 0m 0s	
Greenwich Date Aug. 4th..........	32h 8m 47s	

Meridian Altitude...........76° 11′ S.		Dif. Dec. 41″
Corr...............Add.	12	12h
True Altitude..............	76° 23′	60)492
Zenith Distance............	13° 37′ N.	8′ 12″
Declination...............	16 53 S.	17° 1′ 0 S.
Latitude at Noon..........	30° 30′ N.,	D. 16° 51′ 48″ S.

Sun's Declination..........	17° 1′ 2″ N.,	Dif. 1h 41″
Correction..............Sub.	5 28	8h
Correct Declination.........	16° 55′ 34″ N.	)328
	90 0 0	5′ 28″
Polar Distance.............	73° 4′ 26″	

Equation of Time.....	5m 44s ·64	Dif. 1h 0·258
Corr.....................Sub.	2 ·06	8h
Correct Equation............	5m 42s ·58	2·06·4

EXAMPLE 6

November 28th, 1854, (end of the Sea day,) the Sun's Altitude in the Forenoon was observed to be 50° 25′, when the Face of the Chronometer showed 9h 33m 10s A. M. at Greenwich, and which was correct for Greenwich Mean Time. Ship then sailed E. by N. 31 miles, when the Sun's Meridian Altitude observed was 68° 23′ S. Required the Ship's Latitude and Longitude at Noon.

Sun's Observed Altitude......	50° 25′	
Corr., Table IX.............	11	
True Altitude...............	50° 36′	
Polar Distance..............	68 42	Log. 0.03073
Latitude....................	0 0	Log. 0.00000
Sum.........................	119° 18′	
Half Sum....................	59° 39′	Log. 4.70353
Difference..................	9° 3′	Log. 4.19672
Apparent Time............	9h 44m 9s	Log. 8.93098
Equation..................	11 54	
Mean Time at Ship........	9h 32m 15	from Midnight.
Greenwich Mean Time......	9 33 10	from Midnight.
Long. in Time.............	0h 0m 55s= 0° 13′ 45″ W.	
Departure made to Noon 30=Diff. Lon.	30 0 E.	
Long. in at Noon......................	0° 16′ 15″ E.	

NOTE.—Here the Ship has crossed the Meridian of Greenwich, between the time the Sights were taken and Noon, from West into East Longitude.

Sub. from....................	12h 0m 8s
Greenwich Time by Chro......	9 33 10
Time before Noon............	2h 26m 50s

Sun's Meridian Altitude...........	68° 23′ S.	
Correction..........	12	
True Altitude..................	68° 35′	
Zenith Distance................	21° 25′ N.	
Declination....................	21 19 S.	
Latitude in at Noon............	0° 6′ N.	
Course E. by N. 31 miles D. L......	6—& Dep. 30	
Lat. time of Sights...............	0° 0′	

Sun's Declination..............	21° 19′ 21″ S.	Dif. 26″
Correction...................	1 5	2½
Declination..................	21° 18′ 16″ S.	52
Polar Distance...............	68° 41′ 44″	13
		65″

Equation of Time.............	11m 52s ·4	Dif. ·871
		2½
Correction..................	2 ·17	1742
Equation....................	11m 54s ·21	435
		2 17·7

QUESTIONS FOR EXERCISE.

Quest. 1. July 20th, 1854. In the Morning the Sun's observed Altitude was 33° 19′, when the Face of the Chron showed 9h 28m 40s A. M. at Green., and which was fast 0h 5m 47s S. Ship sailed on a S. S. W. ½ W. Course 32 miles until Noon, when the Lat. Obs. was 26° 27′ N. Required the Long. of the Ship at the time of the Sights and at Noon.
Answer.—Longitude at time of Sights 21° 12′ W., and at Noon 21° 29′ W.

Quest. 2. September 25th, 1854. In the Afternoon the Sun's observed Altitude was 18° 20′. Time by the Chron 3h 7m 38s, being P. M. at Greenwich, and which was fast 0h 7m 2s. The Latitude observed at Noon was 37° 57′ S and the Course was E. N. E. 29 miles since Noon. Required the Long. in at the time of the Sights and at Noon.
Answer.—Longitude at time of the Sights 64° 49′ E., and at Noon 64° 15′ E.

TO CORRECT THE LONGITUDE BY CHRONOMETER AT NOON WHEN THE LATITUDE IS IN ERROR.

In the foregoing Six Examples the Latitude used in computing the time at Ship has been deduced from the Latitude by Observation at Noon, and when the Altitudes are observed in the morning we have in that case to wait until Noon, before the Ship's position can be accurately ascertained.

And as it is sometimes of importance to know the Longitude by Chronometer as soon as possible after the Sights are taken in the morning, within a few minutes of the truth, we have in that case to use the Latitude by Dead Reckoning from the preceding Noon in working the Time, and which may be considerably in error, and as before explained at page 122, greatly affects the Hour Angle. (except when the Sun is on the Prime Vertical.) so that after finding the correct Latitude we have to work it over again.

To save all this trouble Tables A and B, No. XXX., are given for the purpose of correcting the Longitude by Chronometer, brought on to Noon for the effect of an error in the Latitude used in computing the time at the Ship, and all we have to do is to take out the Correction for the Longitude from the Tables, (which is expressed in minutes and seconds) for each mile of Latitude. This, multiplied by the number of miles of error in the Latitude worked with, gives the whole correction to be applied to the Longitude brought on to Noon, and the result is the correct Longitude of the Ship at Noon.

RULE

For Using Table XXX.

Enter Table A with the Latitude worked with at the side, and the Hour Angle at the Top, and at the Angle of meeting take out the Correction.

Enter Table B with the Declination at the Side and the Hour Angle at the Top, and at the Angle of meeting take out the Correction.

When the Latitude and Declination are of the same name, the difference between the Corrections found in Tables A and B is the Correction of Longitude for each mile of Latitude in error. And Note whether the Correction found in Table A be greater or less than that found in Table B.

When the Latitude and Declination are of contrary names the Sum of the Corrections in Tables A and B is the Correction of Longitude for each mile of Latitude in error.

Multiply the Correction for Longitude by the number of miles of error in the Latitude, which will give the whole Correction for Longitude.

To Apply this Correction.

When the Corrections in Tables A and B are *subtractive* and the one found in Table A is *less* than the one in Table B, apply the Correction as follows:

Latitude worked with being too *Small*, *Add* in West Longitude, *Subtract* in East.
Latitude worked with being too *Great*, *Subtract* in West Longitude, *Add* in East.

When the Corrections in Tables A and B are *additive*, and also when the Correction in Table A is *greater* than that in Table B, *Subtractive*, as follows:

Latitude worked with being too *Small*, *Subtract* in West Longitude, *Add* in East.
Latitude worked with being too *Great*, *Add* in West Longitude, *Subtract* in East.

To or from the Longitude by Chronometer, brought on to Noon by the Dead Reckoning, will give the Ship's Correct Longitude by Chronometer at Noon.

EXAMPLES

In Using the Tables.

Lat. worked with 30° 30′ N., H. A. 3h 15m Tab. A	—31″
Dec. 22° 30 N. (same name) H. A. 3h 15m Tab. B	33″
The Diff. is the Corr. for each mile of Lat....	2″
Lat. worked with found to be too small......	10m
Whole Corr. for Long. to be Added..........	20″
Long by Chro. brought on to Noon.....	60° 13′ 30″W.
Corr. Long by Chro. at Noon.......	60° 13′ 50″W.

The Latitude and Declination being of the same name the Difference of the Corrections in the Tables is the Correction Additive, because the Latitude was too small and the Longitude West.

Lat. worked with 50° 10′ N., H. A. 2h 45m Tab. A	1′ 21″
Dec. 23° S. (contrary names) H. A. 2h 45m Tab. B	39″
The Sum is the Corr. for each mile of Lat.......	2′ 0″
Lat. worked with found to be too great........	10
Whole Corr. for Long. to be Subtracted........	20′
Long. by Chro. brought on to Noon........	30° 14′ W.
Correct Long. by Chro. at Noon..........	29° 54′ W

The Latitude and Declination being of contrary names the Sum of the Correction in A and B is the Correction Subtractive, because the Latitude was too great and the Longitude West.

TO CORRECT THE LONGITUDE BY CHRONOMETER AT NOON WHEN THE LATITUDE IS IN ERROR

EXAMPLE 9.

March 6th, 1854. (End of the Sea day.) At about 7h 30m in the morning, the Sun's observed Altitude was 10° 23', and the Greenwich Time by Chronometer 11h 0m 2s, A. M., or 23h 0m 2s, from the preceding Noon. The Latitude in by the Dead Reckoning from the preceding Noon was 37° 53' North. Ship then sailed N. W. (true) 50 miles until Noon, when the Latitude observed was 38° 40' North. Required the Error in the Latitude with which the Time at the Ship was found, and the correct Longitude by Chronometer at Noon.

Sun's Obs. Alt......	10° 23	
Cor., Tab. IX...Add	7	
True Alt...........	10° 30'	
Polar Dist..........	95 40	Log. 0.00213
Latitude	37 53	Log. 0.10278
Sum....	144° 3	
Half Sum.........	72° 2'	Log. 4.48920
Difference.........	61° 32'	Log. 4.94404
H. A. 4h 47m 53s Ap. Time	19h 12m 7s	Log. 9.53815
Equa. of T..Add	11 32	
Mn. T. at Ship.	19h 23m 39s	
Gr. Time.....	23 0 2	
Long. in Time.	3h 36m 23s	Lo. 54° 5' 45"W.
Dep. made to Noon	35'=D. L.	45 0
Approx. Lon. by Chro. at Noon..		54° 50' 45"W.
Cor. from Table XXX.....Sub.		4 12 W.
Cor. Lon. by Chro. at Noon....		54° 46' 33"W.

Agreeing within 3" of the Long. in Example 1st, page 140.

Gr. T. by Chro. A. M..11h. 0m 2s
Add.12 0 0
Gr. Date, March 5th. 23h. 0m 2s

Same as Examp. 1st, page 141.
Sun's Corr. Dec.....5° 40' S.
90 0
Polar Dist...... 95° 40'
Equa. of Time.. 11m 32s

True Course to Noon N. W. 50, D. Lat. 35' N. and Dep. 35 W

Lat. by D. Reckon. at time of Sights...	37° 53' N.
Lat. by D. Reckon. at Noon.........	38° 28
Lat. by Observation................	38 40
Error in the Latitude worked with	12' too small.
Lat. worked with 38° and H. A. 4h 48m in Table A. Corr.	15"
Dec. 5° 40' of (contrary names) H.A. 4h 48m in Tab. B. Corr.	6
Their Sum as the Correction per mile................	21"
Number of miles error in the Latitude..............	12
	60)252"
Whole Correction for Longitude	4' 12"

EXAMPLE 10.

May 20th, 1854. (End of the Sea day.) At about 8 o'clock in the morning, the Sun's observed Altitude was 12° 10', and the Greenwich Time by Chronometer 3h 1m 26s, A. M., or 15h 1m 26s, from the preceding Noon. The Latitude in by the Dead Reckoning from the preceding Noon was 36° 40' S. Ship then sailed S. E. (true) 20 miles until Noon, when the Latitude observed was 36° 39' S. Required the Error in the Latitude used in finding the Time at the Ship, and the correct Longitude by Chronometer at Noon.

Sun's Obs. Alt.........	12° 10'	
Corr., Table IX....Add	8	
True Alt.	12° 18'	
Polar Dist.	109 54	Log. 0.02674
Latitude	36 40	Log. 0.09576
Sum................	158° 52	
Half Sum...........	79° 26'	Log. 4.26335
Difference	67° 8'	Log. 4.96445
H. A. 3h 46m. Ap. T..	20h 14m 0s	Log. 9.35030
Equa. of Time..Sub..	3 47	
Mn. Time at Ship...	20h 10m 13s	
Green. Time.......	15 1 26	
Long. in Time.....	5h 8m 47s	=Long. 77° 11' 45" E.
Dep. made to Noon 14'=D. Long. made.		17' 45" E.
Approx. Long. by Chro. at Noon.......		77° 29' 30" E.
Corr. from Table XXX..........Sub.		14 0
Correct Long. by Chro at Noon......		77° 15' 30" E.

This agrees exactly with the Long. in Example 3.

G. T. by Chro., A. M. 3h 1m 26s Same as Ex. 3d, page 142.
Add 12 0 0 Sun's Dec. cor. 19° 54' N.
Gr. Date, May 19th, 15h 1m 26s 90 0
Polar Dist... 109° 54'
Equation of Time. 3m 47s

True Course to N'n S. E. 20 miles. D. L. 0° 14' Dep. 14

Lat. by D. Reck. at the time of Sights.	36 40
Lat. by D. Reckon. at Noon	36° 54' S.
Lat. by Obs. at Noon..............	36 39 S.
Error in the Latitude worked with	15' too great.
Lat. worked with 37° S. H. A. 3h 46m in Tab. A. Corr.	30"
Dec. 20° N. (con. name) H. A. 3h 46m Table B. Corr.	26
Their Sum is the Correction per mile.........	56"
Number of miles of error in the Latitude......	15
	280
	56
	60)840"
Whole Correction for Longitude........Sub...	14' 0"

NOTE.—When it is of importance to know the Ship's true position at Noon directly the Latitude is observed, Table XXX will be found of great service.

For instance, after Seven Bells we can estimate the Course and Distance the Ship will have made to Noon near enough, so as to work up the day's work and find the Latitude by Dead Reckoning, and also to bring up the approximate Longitude by Chronometer to Noon.

Then the instant the Latitude by Observation is determined, the Error of the Latitude by Dead Reckoning can be found, and the approximate Longitude by Chronometer corrected, as in the above Examples.

This Table will also show at once the effect of an error of one mile of Latitude in producing an error in the Longitude by Chronometer in any given Latitude; and it will be perceived that an error of this kind has the greatest effect in High Latitudes.

TO FIND THE LONGITUDE BY CHRONOMETER AT SUNRISE OR SUNSET.

The method of finding the Time at the Ship from the Sun's Rising or Setting is given at pages 128 and 129, and the same Examples will answer the purpose of finding the Longitude by Chronometer; because we have only to compare the Watch with the Chronometer, and thence find the Greenwich Time at which the Sun rose or set, or the Time may be taken at once from the Chronometer without the Watch. Then the difference between the Mean Time so found at the Ship, and the Greenwich Time by Chronometer is the Longitude in Time.

EXAMPLE 1.—(*See page* 128.)

Jan. 25th, 1854. Latitude in 38° 42′ North, the Sun's Lower Limb was observed to Set, by Watch, at 5h 3m 25s, which, on being compared with the Chronometer, was found to be 7h 7m 11s slow of the Chronometer. The Mean Time at the Ship was found to be 5h 11m 16s, and the error of the Chronometer on Greenwich Mean Time 3m 20s too fast. Required the Longitude of the Ship.

Time by Watch at Sunset...............	5h 3m 25s		
Watch Slow of Chronometer............	7 7 11		
Time by Chron. at Sunset	12h 10m 36s	Green. Mean Time at Sunset, Jan. 25th..	12h 7m 16s
Chron. fast of Greenwich Mean Time......	3 20s	Mean Time at Ship do Jan. 25th..	5 11 16s
Green. Mean Time at Sunset.............	12h 7m 16s	Long. of the Ship at Sunset, 104° 0′ W. =	6h 56m 0s

EXAMPLE 2.—(*Same as at page* 129.)

June 1st, 1854. In Latitude 25° North, the Sun's Upper Limb was observed to Rise at the instant the Time noted on the Face of the Chronometer was 1h 6m 12s A. M. at Greenwich, and which was Slow of Greenwich Mean Time 2m 24s. The Mean Time at the Ship was found to be 5h 9m 36s, the Ship being in East Longitude. Required the Longitude of the Ship.

Time by Chronometer at Sunrise	1h 6m 12s, being A. M. at Greenwich.	
Chronometer Slow of Greenwich Mean Time	2 24	
Greenwich Mean Time from Midnight, June 1st............	1h 8m 36	or May 31st.. 13h 8m 36s
Mean Time at the Ship from Midnight, June 1st............	5 9 36	or May 31st.. 17 9 36
Longitude of the Ship at Sunrise, 60° 15′ 0″ E. =	4h 1m 0s	

As no reflecting instrument is required in this Observation, (we use in its room the common Spy-Glass,) its accuracy, therefore, rests entirely upon the instant of time noted by the Chronometer at which the Sun's Upper Limb at rising, or his Lower Limb at setting, touches the horizon. This is liable to a small error, sometimes, in consequence of unequal refraction and mirage at the horizon. (See Note at page 129.)

The Latitude of the Ship may also be determined by an Altitude of a Star or Planet at twilight, and the Ship's position found as correctly as at Noon, as follows:

Enter Table XVIII with the day of the month, and find what Star will pass the Meridian a few minutes before Sunrise, or after Sunset; or inspect the Nautical Almanac, and find what Planet will pass the Meridian about that time, as directed at page 104, No. 2.

Compute the Altitude, and find the Star as directed at page 106, No. 3, or find the Planet as directed at page 104, No. 3, and observe the Meridian Altitude.

EXAMPLE

Of Finding the Latitude at Sunset by a Star.—(*See Example 1st.*)

January 25th, 1854. (End of the Sea day.) The Latitude at Sunset being required, we look into Table XVIII, and find the nearest Star on the Meridian to be the N. Pole Star, which passes at 4h 37m, and is not visible on account of the Sun-light, but at 5h 15m, or 15m after Sunset, its Altitude was observed to be 40° 13′. We find the Latitude to be 38° 42′ North. (See this method at page 109.)

EXAMPLE

Of Finding the Latitude at Sunrise by a Star.—(*See Example 2d.*)

June 1st, 1854. (End of the Sea day.) The Latitude at Sunrise being required, we first add 12 hours to the Apparent Time at Ship, 5h 12m, which gives the App. Astron. Time, May 31st, 17h 12m, and on referring to Table XVIII, we find that the Star Gruis passes the Meridian at 17h 24m, or 12m after Sunrise, and by computing the Meridian Altitude, and setting the Index of the Quadrant at 17° 20′, the Star will be found at that Altitude in the South point of the horizon at a few minutes before Sunrise, and supposing the observed Altitude to have been 17° 27′, the Latitude in would be 25° 0′ North.

NOTE.—As the change of Altitude of these two Stars, when near the Meridian, is very slow, an error of a few minutes in the time at the Ship will be of no consequence. Hence both the Latitude and Longitude of the Ship may be found by Observation, at Sunrise or Sunset.

FINDING THE LONGITUDE BY CHRONOMETER AT NOON FROM EQUAL ALTITUDES OF THE SUN

The method of finding the Apparent Noon at the ship from Equal Altitudes of the Sun near the Meridian and thence the Mean Noon, is given at page 130, and in finding the Longitude by Chronometer at Noon, we have only to compare the Watch with the Chronometer, and apply the comparison to the middle Time by the Watch, which will give the time by Chronometer at apparent Noon. Or if we Note the time by Chronometer when the Sun's Altitude is the same both before and after Noon, the middle of the times is the time by Chronometer, at apparent Noon, (See Note at the bottom of the page,) to which its error on Greenwich, applied as usual, gives the Greenwich time by Chronometer, when it is Noon at the Ship.

The only Correction necessary in this case is for the Equation of Time, which must be Corrected as usual to the Greenwich Time by Chronometer, and applied as directed in the Nautical Almanac to Apparent Noon, will give the Mean Noon at the Ship. Then the difference between the Mean Noon at Ship and the Greenwich Mean Time by Chronometer is the Longitude in time, which turned into Degrees and Minutes by Table XXVI., is the Longitude of the Ship at Noon.

EXAMPLE 1.—(*See Page* 130.)

April 2d, 1854. (End of the Sea day.) The Altitude of the Sun's L. Limb was observed to be 85° 40′ at a few minutes before Noon. Time by Chronometer 1h 46m 10s P. M. at Greenwich, and when the Sun fell again to the same Altitude in the Afternoon, the Time by Chronometer was 2h 12m 16s, and its Error 3m 33s Fast. Required the Longitude by Chronometer at Noon.

Sun's Observed Altitude...............	A. M. 85° 40′		
do............do.......................	P. M. 85 40		
Equa. of Time April 2d.....	3m 41s ·71	Diff. 1h ·750	
Corr.,.................Sub.	1 ·50	2h	
Correct Equation........ Add	3m 40s ·21	1·50·0	
App. Noon at Ship........	0h 0 0		
Mean Noon at Ship.......	0h 3m 40s		

Time by Chronometer...	1h 46m 10s P. M. at Green.
do.........do.........	2 12 16 do. do.
	½)3h 58m 26s
Time by Chron..........	1h 59m 13s at App. Noon.
Chro. Fast of Green., Sub.	3 33
Green. Mean Time......	1h 55m 40s
Mean Noon at Ship......	0 3 40
Lon. of the Ship in time..	1h 52m 0s = 28° 0′ W. at Noon

EXAMPLE 2.—(*See Page* 130.)

April 16th, 1854. (End of the Sea day.) The Altitude of the Sun's L. Limb was observed to be 68° 20′, Time by the Watch 11h 20m in the Forenoon, and when the Sun had fallen to the same Altitude again in the Afternoon, the time by the Watch was 12h 34m 6s, which on being compared was found to be 3h 0m 23s Fast of the Chronometer, and the Error of the Chronometer on Greenwich Mean Time was 3m 10s too Slow. Required the Longitude by Chronometer at noon.

Sun's Observed Altitude...............	A. M. 68° 20′	
do............do.......................	P. M. 68 20	
Equa. of Time April 16th.....	0m 11s ·87	Diff. 1h ·603
Corr...................Sub.	1 ·81	3h
Correct Equa.............Sub.	0m 10s .6	1·80·9
App. Noon at Ship.......12	0 0	
Mean Noon at Ship.......11h	59m 50s	

Comparison.

Watch Showed..........................	12h 36m 0s
Chronometer Showed....................	9 35 37
Watch Fast of Chronometer..............	3h 0m 23s

Time by Watch.......	11h 20m 0
do.....do..........	12 34 6
	½)23h 54m 6s
Mid. Time by Watch...	11h 57m 3s
Comparison.......Sub.	3 0 23
Time by Chro..........	8h 56m 40s at App. Noon.
Chr. Slow of Green., Add.	3 10
Green. Mean Time.....	8h 59m 50s
Mean Noon at Ship....	11 59 50
Lon. of the Ship in Time.	3h 0m 0s = 45° 0′ E. at Noon

Degree of Dependence.

This method, as before observed at page 130, is most suitable for Low Latitudes ranging to 30° on each side of the Equator. Because when the Ship makes much way, and the interval between the Altitudes is great, the First Altitude will not be equal to the Second, on account of the Ship's change of place of Observation and the Sun's change of Declination. Except when she Sails due East or West, in that case it becomes a question of Time only, and does not affect the result.

NOTE.—But when she makes much Northing or Southing in the interval, it is evident that the same Altitudes will no longer give the correct middle time at Apparent Noon. The Error in the Altitude will be equal to the Difference of Latitude the Ship has made in the interval. For instance, a Ship Sailing South in North Latitude, the P. M. Altitude would be too small, and Sailing North the P. M. Altitude would be too great by the Amount of the Difference of Latitude made in the interval, therefore the Rule is, when Sailing *towards* the Sun, we must increase the A. M. Altitude which is on the Quadrant by advancing the Index of the Instrument equal to the Difference of Latitude made in the interval. But in Sailing *from* the Sun we decrease the A. M. Altitude by screwing back the Index equal to the Difference of Latitude made in the interval, and when the Sun falls to that Altitude in the Afternoon, and the time noted by Watch or Chronometer, the correct middle time is found at Apparent Noon as before. But as this method is much used at Sea in its present form, because of its extreme simplicity and independence of both Latitude and Declination and which, with ordinary caution, it is well adapted for the use of Seamen in detecting any very gross error in the more regular mode of working out the Time at Sea.

FINDING THE LATITUDE BY THE SUN, AND THE LONGITUDE BY CHRONOMETER, BY THE MOON'S ALTITUDE AT NOON.

When the Sun is on the Meridian, his Altitude determines the Latitude, and when the Moon is at a proper distance from the Meridian her Altitude will give the Time at the Ship, and thence the Longitude by Chronometer at Noon.

Or the Moon may be on the Meridian, when her Altitude will give the Latitude, and an Altitude of the Sun at the same time will give the Longitude by Chronometer.

Or Altitudes of the Moon, Planets or Stars taken in like manner will give both Latitude and the Longitude by Chronometer at the same time.

The advantage of this method is that the Latitude being correctly known at the time of taking the Sights for Chronometer, the Altitudes of the object for Time may be taken nearer to the Meridian than otherwise, without producing an Error in the H. Angle, always providing that their change of Altitude be not less than 6′ in one minute of time.

EXAMPLE BY THE SUN AND MOON AT NOON.

March 24th, 1854. (End of the Sea day.) The Latitude observed from the Meridian Altitude of the Sun was 40° 10′ S., and at the same time the Altitude of the Moon's Upper Limb was observed to be 41° 40′ to the Westward of the Meridian, and the Greenwich time by Chronometer was 17h 48m 27s. Required the Longitude in by Chronometer at Noon.

Obs. Altitude ☽'s Up. Limb.....	41° 40′	
Semid. 16′, Dip. 4′..........Sub.	20	
Hor. Parl. 59′ and Altitude.....	41° 20′	
Gives the Corr., Table XXV.....	43	
True Altitude..................	42° 3′	
Polar Dist......................	66 53	Log. 0.03635
Latitude Observed.............	40 10	Log. 0.11681
Sum............................	149° 6′	
Half Sum.......................	74° 33′	Log. 4.42553
Difference.....................	32° 30′	Log. 4.73022
☽'s Hour Angle, West......	3h 34m 37s	Log. 9.30891
☽'s R. Ascen................	20 38 20	
R. Ascen. of the Meridian....	24h 12m 57s	
Sun's R. Ascen.........Sub.	0 12 4	
App. Time at Ship.........	24h 0m 53s	
Equation of Time......Add.	6 31	
Mean T. at Ship, March 23...	24h 7m 24s	
G. M. T. by Chr. March 23....	17 48 27	
Longitude in Time..........	6h 18m 57s	
Longitude of the Ship......	94° 44′ 15″ E. at Noon.	

Equation of Time................	6m 45s ·27	·766
Corr....................Add	13s ·79	18h
Correct Equation.................	6m 31s ·48	13·78·8

Green. Time by Chron., March 23.........	17h 48m 27s	
	12 0 0	
Green. Time past Midnight.............	5h 48m 27s	
Sun R. A. 23d...............	0h 9m 22s	Diff. 1h 9s
Add	2 42	18h
Sun's Cor. R. A.	0h 12m 4s	60)162
Corr......		2m 42s
☽'s Declination March 23d, Mid...........	23° 51 S.	
do March 24th, Noon...........	22 20 S.	
Difference of Declination in............12h	= 1° 31′	
Corr., Table XXIII..................	0° 44′	
Declination at Mid...................	23 51	
Correct Declination.................	23° 7′ S.	
	90 0	
☽'s Polar Distance..............	66° 53′	

☽'s R. A. Mar. 23d ...20h 23m 53s at Mid.
Mar. 24th...20 53 47 at Noon.

Say as 12h is to 29m 54s so is 5h 48m T. from Mid.

Pro. Log. of 12h, Table XXXIV.	1.1761	
Arith. Comp....................	8.8239	
Pro. Log. of 29m 54s...........	0.7796	
Pro. Log. of 5h 48m...........	1.4918	
	1.0953	Corr. 14m 27s
R. Ascen. at Mid......................		20h 23m 53
☽'s Correct R. Ascen.................		20h 38m 20s

Finding the Latitude by a Planet, and the Longitude by Chronometer by the Moon's Altitude at the same time.

QUESTION.

October 3d, 1854. In North Latitude and West Longitude at Twilight in the evening the Meridian Altitude of the Planet Jupiter was observed to be 39° 8′ S. About the time the Altitude of the Moon's L. Limb was 13° 19′ East of the Meridian, and the Greenwich Time by Chronometer, October 3d, 11h 23m 52s P. M. Required the Latitude by Observation and the Longitude by Chronometer.

Answer.—In this case the Correct Altitude of the Moon is 14° 24′, her Polar Distance 102° 28′, her Hour Angle 4h 23m 40s, R. A. 22h 52m 43s, R. A. of the Meridian 18h 29m 3s, the Sun's R. A. 12h 38m 19s, Apparent Time at Ship 5h 50m 44s P. M., and the Mean Time 5h 39m 40s. The Latitude observed 28° 16′ N., and Longitude by Chronometer 86° 3′ West.

Note.—It may perhaps be necessary here to repeat the remarks already made at pages 101 and 104, which is, that the Meridian passages of the Moon and Planets are given in the Nautical Almanac for Mean Time, and which must be turned into Apparent Time by Applying the Equation of Time the contrary way to what we would do in turning Apparent into Mean Time.

In the case of the Planet Jupiter in the above Question he passes the Meridian by the Almanac at 6h 31m. The Equation of Time, 11m, added, gives the Apparent Time 6h 41m, at which he passes the Meridian, or that shown by a Watch regulated to Apparent Time at the Ship. The Moon's Meridian passage is found in like manner.

FINDING THE LATITUDE BY A STAR, AND THE LONGITUDE BY CHRONOMETER, BY A PLANET.

EXAMPLE.

April 2d, 1854. (End of the Sea day.) In North Latitude and West Longitude, the Meridian Altitude of the Star Castor was observed to be 77° 52′ North, and at the same time the Altitude of the Planet Saturn was 37° 53′ to the Westward of the Meridian in the evening twilight, and the Greenwich Time by Chronometer was 10h 58m 10s P. M. Required the Latitude in and the Longitude by Chronometer.

Mer. Alt. ✱ Castor	77° 52′ N.	Obs. Alt. Sat.	37° 53′	
Corr., Tab. XX, Sub.	4	Corr. Tab. XX, Sub.	5	
True Alt.	77° 48′	True Alt.	37° 48	
Zenith Dist.	12° 12′ S.	Polar Dist.	71 50	Log. 0.02221
✱'s Dec. 1854	32° 12 N	Lat. Obs.	20 0	Log. 0.02701
Latitude in	20° 0′ N.		129° 38	
at the time Castor passed		Half Sum	64° 49′	Log. 4.62892
the Merid., or at 6h 40m		Difference	27 1′	Log. 4.65729
P. M.		Sat. H. Angle	3h 41m 50s.	Log. 9.33543
		R. Ascen.	3 47 27	
		R. A. of Mer.	7h 29m 17s	
		Sun's R. A.	0 47 22	
		App. Time	6h 41m 55s	
		Equa. Add	3 33	
		Mean Time at Ship.	6h 45m 28s	
		Gr. M. T. by Chro.	10 58 10	

Long. of Ship 63° 10′ 30″ W. = 4h 12m 42s at 6h 41m 55s [P. M.

G. T. by Chro. Ap. 2d,	10h 58m 10s	Dec. Sat. 18° 10
		90 0
	Polar Dist.	71° 50
Saturn's R. A. April 2d,	3h 47m 15s	
April 3d,	3 47 41	
Say as 24h is to	26s, so is 11h	
to the Correction	0h 0m 12s	
Right Ascen., April 2d.	3 47 15	
Correct Right Ascen.	3h 47m 27s	
Sun's R. A. April 2d.	0h 45m 43s.	Dif. 1h, 9s
Correction. Add	1 39	11h
Correct R. Ascen.	0h 47m 22s	99
Equa. of Time	3m 41s ·71	Dift. 1h. ·75t
Sub.	8 ·25	11
Correct Equa.	3m 33s ·47	·8·25·C

Finding the Latitude in and the Longitude by Chronometer at the same time by Two Stars.

EXAMPLE.

August 22d, 1854. (End of the Sea day.) In South Latitude and East Longitude, the Meridian Altitude of the Star Aldebaran was 63° 26′ North, and at the same time the Altitude of the Star Sirius was 53° 47′ East of the Meridian, at twilight in the morning, and the Greenwich Time by Chronometer was, October 21st, 14h 57m 41s Required the Latitude in and the Longitude by Chronometer.

Mer. Alt. ✱ Aldebaran	63° 26′ N.
Correction, Table XX. Sub.	4
True Altitude	63° 22′
Zenith Distance	26° 38′ S.
✱'s Declination	16 13 N.
Latitude in by Observation	10° 25′ S.

At the time Aldebaran passed the Meridian, Aug. 21st, 18h 18m, or on the morning of Aug. 22d, at 6h 18m.

Green. Time by Chron., Aug. 21st. 14h 57m 41s

Declination Sirius 1854	16° 31′ S.
	90 0
Sirius' Polar Distance	73° 29′

Right Ascension Sirius, 1854. 6h 33m 43s

Sun's R. Ascension, Aug. 21st	10h 0m 54s	Dif. 1h. 9s
Correction Add	2 15	15h
Correct R. Ascen.	10h 3m 9s	60)135
		215

Obs. Alt. of Sirius	53° 47′	
Correction, Table XX. Sub.	5	
Correct Altitude	53° 42′	
Polar Distance	73 29	Log. 0.01834
Latitude Observed	10 25	Log. 0.00722
	137° 36′	
Half Sum	68° 48′	Log. 4.55826
Difference	15° 6′	Log. 4.41582
✱'s H. A.	2h 27m 25s	Log. 8.99950
✱'s R. Ascension	6 38 43	
R. A. of the Meridian	4h 11m 18s	
Add	24 0 0	
	28h 11m 18s	
Sun's R. Ascension	10 3 9	
Apparent Time	18h 8m 9s	
Equation Add	2 50	
Mean Time at Ship	18h 10m 59s	
Green. Time by Chron.	14 57 41	

Lon. of Ship 48° 19′ 30″ E. = 3h 13m 18s, at 6h 8m A. M

Equation, Aug. 21st	2m 58s ·97	Dif. 1h. 610
Correction. Sub.	9 ·15	15h
Correct Equation	2m 49s ·82	9·15·0

Finding the Latitude in by the Moon, and the Longitude by Chronometer, by a Star.

QUESTION.

February 7th, 1854. (End of the Sea day.) In North Latitude and West Longitude, the Meridian Altitude of the Moon's Lower Limb was observed to be 63° 9′ South, and at the same time the Altitude of the Star Regulus was 21° 47′ to the Eastward of the Meridian at about 8 o'clock in the evening, and the Greenwich Time by Chronometer, Feb. 7th. 8h 56m 40s. Required the Latitude in and the Longitude by Chronometer.

Answer.—The Moon's Correct Altitude is 63° 45′ South, her Declination 24° 14′ North, and the Latitude in 50° 29′ North. The Star Regulus' Polar Distance 77° 19′, his H. Angle 4h 44m 51s, his Right Ascension 10h 0m 35s. The Right Ascension of the Meridian 5h 15m 44s, (to be increased by 24h,) the Sun's Right Ascension 21h 25m 6s, the Apparent Time at Ship 7h 50m 38s P. M., the Mean Time at Ship 8h 5m 5s, and the Longitude in by Chronometer 12° 53′ 45″ West.

FINDING THE LONGITUDE BY CHRONOMETER, AND THE SUN'S TRUE AZIMUTH, BY THE SAME ALTITUDE.

This is a very convenient mode of finding the Variation of the Compass, the Sun's True Azimuth being obtained from the same Altitude used in working the time for Chronometer, and which may be practiced every day at Sea, with only the additional trouble of taking the Sun's bearing by the Azimuth Compass at the time the Sights are taken, as directed at page 81, and also the Rule for working an Azimuth at page 118. By this method we have only to take out the Log. Secant of the Altitude as a Latitude, at the top of the page, and the Log. Co-Sine of the Difference between the Polar Distance and the Half Sum, as a Half Sum. The Logs. Secant of the Latitude and Co-Sine of the Half Sum serving for both Hour Angle and Azimuth, and the Angle in Time in the latter case turned into space by Table XXVI, will give the Sun's True Azimuth.

EXAMPLE 1.

July 12th, 1854. (End of the Sea day.) In Latitude 39° 25′ North, Longitude by Dead Reckoning 72° 0′ West, the Sun's observed Altitude in the morning was 35° 38′, bearing by the Azimuth Compass South 81° 30′ East, and the Greenwich Time by Chronometer 0h 48m 43s P. M. at Greenwich. Required the Variation of the Compass and the Longitude in by Chronometer.

Sun's Obs. Alt....	35° 38′		
Corr., Table IX. Add	10		
True Altitude ...	35° 48′	....	Alt... 35° 48′
Polar Distance ..	68 0	Log. 0.03283	P.Dist. 68° 0′
Latitude	39 25	Log. 0.11207	....
Sum...........	143° 13′		
Half Sum	71° 37′	Log. 4.49882	H.Sum 71° 37′
Difference	35° 49′	Log. 4.76730	Diff... 3° 37′
App. Time....	7h 55n 58s	Log. 9.41102	
Equation..Add	5 15		
Mean Time ...	8h 1m 13s		
G. T. by Chro..	12 48 43		
Long. in Time	4h 47m 30s=71° 52′ 30″ W. Long.		

G. Time by Chro. 12h 48m 43s Reckoned from Midnight.

Log. Secant.....	0.09094	Sun's Correct Dec..22° 0′ N.
		90 0
Same Log.	0.11207	Polar Dist.........68° 0′
Same Log.	4.49882	Correct Equa.....5m 15s
Log. Co-Sine	4.99913	
	9.70096=Angle 6h 1m 3s	

Angle 6h 1m 3s in Table XXVI=True Az. S. 90° 16′ E.
Magnetic Azimuth.......................S. 81 30′ E.
Magnetic Variation .... 8° 46′
[Westerly.

EXAMPLE 2.

Sept. 6th, 1854. (End of the Sea day.) In Latitude 36° 6′ South, Longitude by Dead Reckoning 10° 30′ East. the Sun's observed Altitude in the afternoon was 12° 38′, bearing by Compass N. 44° W., and the Greenwich Time by Chronometer 3h 52m 14s P. M. at Greenwich. Required the Variation of the Compass and the Longitude in by Chronometer.

Sun's Obs. Alt....	12° 38′		
Corr., Table IX, Add	8		
True Alt.	12° 46′	....	Alt....12° 46′
Polar Distance...	96 25	Log. 0.00273	P. Dist. 96 25
Latitude........	36 6	Log. 0.09259	....
	145° 17′		
Half Sum.......	72° 39′	Log. 4.47452	H. Sum 72° 39′
Difference	59° 53′	Log. 4.93702	Diff... 23° 46′
App. Time...	4h 36m 13s	Log. 9.50686	
Equa......Sub.	1 45		
Mean Time...	4h 34m 28s		
G. T. by Chro.	3 52 14		
Long. in Time	0h 42m 14s=10° 33′ 30″ East Long		

G. Time by Chro. 3h 52m 14s Past Noon at Greenwich

Log. Secant.....	0.01087	Correct Dec. ... 6° 25′ N
		90 0
Same Log.	0.09259	Polar Dist.... 96° 25′
Same Log.	4.47452	Correct Equa.....1m 45s
Log. Co-Sine....	4.96151	
	9.53949=Angle 4h 48m 24s	

Angle 4h 48m 25s, Table XXVI, True Az. N. 72° 6′ W
Magnetic Azimuth.......... ....N. 44 0 W
Magnetic Variation .... 28° 0′
[Westerly

FINDING THE SHIP'S POSITION AT SEA BY SUMNER'S METHOD

This Method consists in a new use or application of a Single Altitude observed for the Longitude by Chronometer, and is very useful when a Ship is near the Land, especially in high Latitudes, where the weather is generally unsettled and the observations for Latitude uncertain. The method is also best adapted for High Latitudes, because the Sun's change of Azimuth is more rapid there than in Low Latitudes, and the greater the change of Azimuth in a given time the more accurately the Ship's position can be defined.

In the Tropics when the Sun rises, passes the Meridian, and sets Vertically, the Ship's position cannot be found by this method.

Having been in the habit of using this method at Sea for many years, I can testify to its great utility in defining a Ship's place on the Chart, when she is near the Land or a danger, and Captain Sumner deserves great credit in making its value known to Seamen.

I propose here to give a sketch of his method as done in the practice at Sea, which may be found useful to those who have not seen his book, where they will find the whole matter fully explained, and which ought to be in the possession of every practical Navigator.

Explanation of Sumner's Method.

In some cases where the Latitude is not correctly known the Longitude by Chronometer cannot be correctly found, as explained in the Note at page 122 of this work, and it is on this very circumstance, and the having the correct Greenwich Time by Chronometer, that the method is founded.

Suppose an Altitude of the Sun to be observed in the Forenoon, and the Longitude by Chronometer found in the usual manner, the Longitude so found will correspond to the Latitude worked with. The same Altitude worked with another greater or less than the first Latitude, the Longitude so found will correspond to the Latitude worked with in like manner, so that for each point of Latitude, with a given Altitude, there will correspond a certain point of Longitude and no other.

These several points or positions laid off on the Chart in their respective Latitudes and Longitudes, and a line drawn through them, the ship will be somewhere on this line, providing the Chronometer is right and the Latitude assumed is not very greatly in error.

If this line produced passes though any point of Land, the true bearing of this Land from the Ship is shown, and thus, though neither the Latitude nor the Longitude of the Ship is correctly known, yet the true bearing of any place on the Land which lies in the direction of either end of the line joining the two positions is certainly known. A line drawn perpendicular to the above mentioned line, towards the side on which the Sun is, shows the True Azimuth of the Sun.

This is easily understood, because the several Latitudes and Longitudes laid off by means of the same Altitude, constitute a curve of equal Altitude, and the observer in moving so as to keep the Sun at the same Altitude, would keep him always on the bearing at right Angles to the direction of his own motion.

The effect of an error in Altitude is easily shown by considering that the place of any part of the circle of equal Altitude on the Chart moves one mile for each 1′ of error of Altitude, and thus the corrected position of the line will be parallel to that already down, and distant from it the amount of the error of Altitude.

When the coast trends parallel to the line of equal Altitudes, the distance of the Ship from the shore is ascertained, though her absolute place is uncertain, provided always that the Ship is really not far from her supposed Latitude, and that the Chronometer is right.

When a single Altitude is observed near Noon the parallel of equal Altitude is evidently near the parallel of Latitude on which the Meridian Altitude would place the Ship, and the bearing of Land nearly East or West is very nearly ascertained. On the other hand, when the Sun is near the East or West points, the line of equal Altitude lies nearly North or South, and its position in Longitude depends entirely on the Chronometer. Also errors of Altitude affect the Longitude by Chronometer most when near Noon, in which case it can have no influence on the bearing of Land near East or West.

As a Single Altitude gives thus the line on which the Ship is, a Second Altitude gives a second line, except when the Sun is Vertical and has no change of Azimuth. In this case only one line can be projected on the Chart, which will always lie North and South.

The intersection of the second line with the first is the Ship's true place, and the place of the intersection is more decisively marked as the two lines lie more at Right Angles to each other, and as the Sun is perpendicular to each of the said lines at the time the Altitude was observed, from which they were computed, they will cross each other more nearly at Right Angles, when the Sun has the greatest change of Azimuth.

Rule for Working by Sumner's Method.

Having obtained an Altitude of the Sun and the Greenwich Time by Chronometer, compute the Latitude in by Dead Reckoning. Take a Latitude, say 30′, to the Southward of the Dead Reckoning, with which and the True Altitude, and the Sun's Polar Distance, find the Longitude by Chronometer as usual.

Again, take a Latitude, say 30′, to the Northward of the Latitude by Dead Reckoning, and with the same Altitude and Polar Distance find another Longitude in by Chronometer.

Lay off these two positions on the Chart and Draw a pencil line between them, which, extended to any Land in the vicinity, will give the true bearing of that place from the Ship, or if the Land trends parallel with the line it will give the Ship's distance from the Shore. At an hour or two or more after the first Altitude was taken, or when the change of Azimuth exceeds 2 points, take another Altitude, and with the same Latitudes and Polar Distance find two other positions. A line drawn between them will cross the first line, which will be the Ship's true place in Latitude and Longitude by Chronometer.

But if the Ship has changed her place between the Observations, lay off the True Course and Distance Sailed in the interval, from any part of the first line, and through the point so obtained, draw a line parallel to the first line projected, and at the intersection of this line with the second, is the Ship's true place in Latitude and Longitude.

EXAMPLE.

December 10th, 1854. A ship in Latitude, by Dead Reckoning, 37° N., and Running for Cape Henry, at about 8 o'clock in the Morning observed the Sun's Altitude to be 9° 35′, and the Greenwich Time by Chronometer 1h 5m 55s P. M. at Greenwich, and after Sailing W. by S. True 20 miles, a second Altitude was observed to be 27° 10′, Greenwich Time by Chronometer 3h 39m 16s. Required the Bearing of or Distance from the Land in the vicinity, at the time of each Altitude, and also the Ship's Correct Latitude and Longitude in at the time of the last Altitude.

Latitude and Longitude in at the Time of the Last Altitude.

Sun's 1st. Obs. Alt..	9° 35′	G. Time by Chro.	1h 5m 55s
Corr., Table IX.....	7	Add	12 0 0
Sun's True Alt.....	9° 42′	Time from Mid.	13h 5m 55s
Polar Distance.....	112 56	Log. 0.03576	
Latitude..........	36 30	Log. 0.09482	
	159° 8′		
Half Sum........	79° 34′	Log. 4.25790	
Difference........	69° 52′	Log. 4.97262	
	8h 10m 55s	Log. 9.36110	
Equation....Sub.	7 0		
M. Ship Time...	8h 3m 55s	1st position.	
Green. Time....	13 5 55	with Lat. 36° 30 N.	
	5h 2m 0s	=Long. 75° 30 W.	

Lat. in D. R.	37° 0′ N.	Dec.	22° 56′ S.
			90 0
True Altitude......	9° 42′	Polar Dist.	112° 56′
Polar Distance.....	112 56	Log. 0.03576	
Latitude..........	37 30	Log. 0.10053	
	160° 8′		Equ. Sub. 7m 0s
Half Sum.........	80° 4′	Log. 4.23679	
Difference.........	70° 22′	Log. 4.97399	
	8h 14m 55s	Log 9.34707	
Equation....Sub	7 0		
M. Ship Time....	8h 7m 55s	2d position.	
Green. Time.....	13 5 55	with Lt. 37° 30′ N.	time of 1st Alt
	4h 58m 0s	=Long. 74° 30′ W.	

Sun's 2d Obs. Alt..	27° 10′	G. Time by Chro.	3h 39m 16s
Corr., Table IX....	10	Add	12 0 0
True Altitude......	27° 20′	Time from Mid.	15h 39m 16s
Polar Distance....	112 56	Log. 0.03576	
Latitude..........	36 30	Log. 0.09482	
	176° 46′		
Half Sum........	88° 23′	Log. 3.45044	
Difference........	61° 3′	Log. 4.94203	
	10h 35m 49s	Log. 8.52305	
Equation...Sub.	6 58		
M. Ship Time..	10h 28m 51s	1st Position.	
Green. Time....	15 39 16	with Lat. 36° 30′	
	5h 10m 25s	=Long. 77° 36′ W.	

Lat. in by D. R.	37° 0′ N.	Dec.	22° 56′ S.
			90
True Altitude.......	27° 20′	Polar Dist.	112° 56′
Polar Distance......	112 56	Log. 0.03576	
Latitude...........	37 30	Log. 0.10053	
	177° 46′		Equ. Sub. 6m 58s
Half Sum..........	88° 53′	Log. 3.28927	
Difference..........	61° 33′	Log. 4.94410	
	10h 49m 34s	Log. 8.36966	
Equation...Sub.	6 58		
M. Ship Time...	10h 42m 36s	2d position.	
Green. Time....	15 39 16s	with Lat. 37° 30′ N.	
	4h 56m 40s	= Long. 74° 10′ W. at the time of the 2d Alt.	

See the Projection on the Chart, next page.

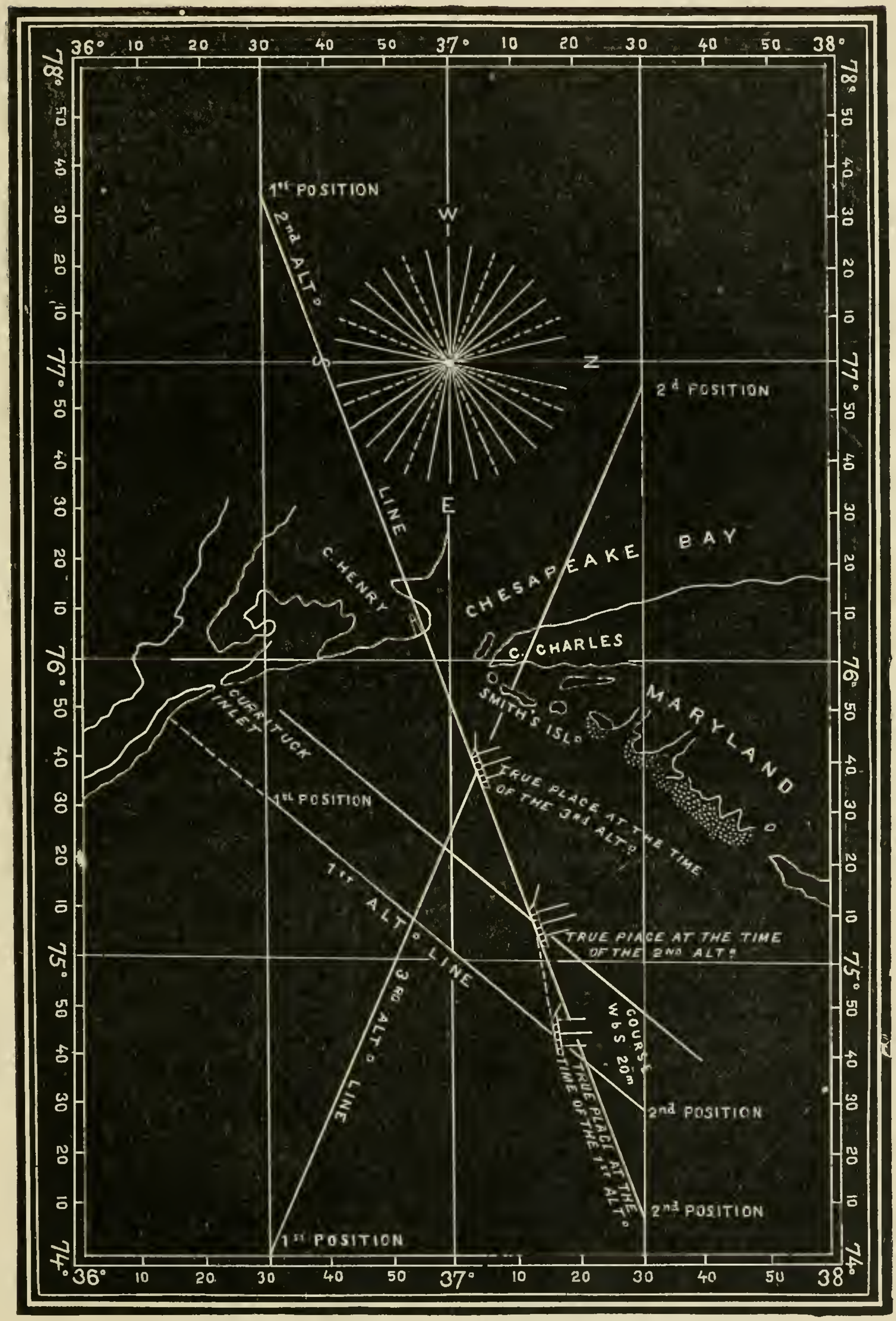
The positions by the first Altitude laid off and the first line drawn between them strikes the Shore about 10 miles to the Southward of Currituck Inlet, hence the true bearing of that part of the Shore is S. W. ½S., and the Coast of Maryland is 38 miles distant in a N. W. direction.

The Positions by the Second Altitude laid off and the second line drawn between them passes through Cape Henry. Hence its true bearing is W. by ¾ S. from the Ship.

The Ship's True Course and Distance W. by S. 20 miles, being now laid off from the first line and a line drawn parallel to it, then where it cuts the second line, is the Ship's True place (at the time of the last Altitude), in Latitude 37° 13′ N. and Longitude 75° 8′ W., and distant from Cape Henry 50 miles.

A line drawn parallel to the Course made in the interval, through the True place of the Ship, back to the first line will show the Ship's place on that line, when the first Altitude was observed, in Latitude 37° 18m N. and Longitude 74° 43′ W. Hence the Ship's Latitude by Dead Reckoning was found to have been 18 miles in Error, or that much too far to the Northward of her proper position, in running for Cape Henry.

FIG. 27.



PROJECTION OF SUMNER'S METHOD ON THE CHART.

FINDING THE SHIP'S POSITION AT SEA BY SUMNER'S METHOD

The Ship's place may be found in the same manner in the Afternoon, should the Latitude not have been obtained from an observation.

The Altitude observed in the Afternoon is worked with the same two Latitudes unless she has made much Northing or Southing in the interval, but the Decl. and Equa. of Time is generally corrected to the time of observation, and two positions are again found, which laid off on the Chart, and a line drawn between them, will give the bearing of the Land or the distance off, as the case may be. The Course and Distance made good in the interval, laid off as before, and another line drawn parallel to the former, will cut the last line projected, at the Ship's true place.

But when the Ship has been sailing in the same direction as the former line it is not necessary to lay off either Course or Distance, because the place of intersection of the two lines as above, will give both.

Thus the Ship's place on the Chart may be found every hour of the Day from Sunrise to Sunset, (See the method at page 128,) if his change of Azimuth be sufficiently rapid to cause the lines projected on the Chart to cross each other at an angle

By this method also the Ship's position may be found every hour of the Night by using the Stars or Planets, that is, finding the Longitude by Chronometer, by them, using two assumed Latitudes as with the Sun. But unfortunately the Horizon is generally so obscured at night that not much dependence can be placed on the Altitudes observed.

In laying off the Course and Distance run in the interval between two Altitudes, when the Ship is in a Tide-way or Current, the Set and Drift of which is known, it can easily be allowed for, by forming a small traverse Table, composed of the true Course and Distance sailed, and the True Set and Drift of the Current. Then the Difference of Latitude and Departure made good will give the Course and Distance made good, which is then laid off as usual.

CONTINUATION OF THE FORMER EXAMPLE.

December 10th, 1854. No observation for Latitude having been obtained, the Ship had been hauled up W. S. W on the bearing of Cape Henry, (from the Altitude which had been obtained about an hour before Noon), and at 1h 30m in the Afternoon another Altitude was observed to be 26° 15′. Greenwich Time by Chronometer 6h 24m 38s, having run in the interval W. S. W. True 25 miles, and been Set by the tide in the same direction 5 miles. Required her true place on the Chart and her Bearing and Distance from the Land in the vicinity.

Sun's 3d Obs. Alt.	26° 15′	G. T. by Chr. 6h 24m 38s
Corr., Table IX...	10	
True Alt.	26 25	
Polar Dis.	112 57	Log. 0.03581
Latitude	36 30	Log. 0.09482
	175° 52′	
Half Sum	87 56	Log. 3.55705
Difference	61 31	Log. 4.94397
	1h 35m 32s	Log. 8.63165
Equa....Sub.	6 54	
M. Ship Time..	1h 28m 38s	
G. T. by Chro.	6 24 38	with Lat. 36° 30′ N.
	4h 56m 0	= Long. 74° 0′ W.

				Sun's Corr. Dec. 22° 57′ S.
				90 0
Same Alt.	26° 25′			112° 57
Polar Dis.	112 57	Log. 0.03581		
Lat......	37 30	Log. 0.10053		
	176° 52		Equa. 7m 1s ·53	Diff. 1h 1·148
Half Sum.	88 26	Log. 3.43680	7 ·46	6½
Diff.....	62° 1′	Log. 4.94600	6m 54s ·7	6·888
	1h 23m 47s	Log. 8.51914		574
Equa...Sub.	6 54			7.462
M. S. T.	1h 16m 53s			
G. T...	6 24 38	with Lat. 37° 30′ N.		
	5h 7m 45s	= Long. 76° 56′ W		

The above positions being laid off on the Chart as before directed, and a line drawn through them, will be found to pass over the Light-House on Smith's Island, near to Cape Charles, and as the Ship has been sailing on the line of bearing of Cape Henry, obtained from the last Altitude, no parallel line is required to be drawn nor Distance laid off in this case, because at the intersection of the two last lines is the true place of the Ship, at the time of the last Altitude.

It now appears from the above that the Light-House on Smith's Island bears from the ship W. N. W. nearly 12 miles, and Cape Henry W. S. W. one 22 miles.

Hence if the Chronometer is right, and the weather clear, these objects will soon become visible from the deck.

RATING THE CHRONOMETER AT SEA.

As Chronometers are frequently found to alter their rates after having been a few days on board, as explained at page 80, they should be verified from time to time during the voyage, or in other words, the Sea rate should be found at every convenient opportunity, which is easily done in the following manner: When a Ship is leaving port, if the weather permit, a set of Altitudes should be carefully taken with a Sextant, and the Times noted by Chronometer, or by the Watch, if found more convenient, in the usual manner of taking Sights, as explained at page 124, or at page 140, and the Sextant should be previously adjusted, and its Index error, if any, applied to the Mean of the Altitudes, (see page 73,) and the same Sextant should be always used for taking the Altitudes for the purpose of rating the Chronometer, so as to insure a uniform result throughout the voyage.

The Ship's position at the time of the Sights must be carefully ascertained from Cross Bearings of objects on the land, by an Azimuth Compass, as directed at page 31, or by the Chart, at page 53. But if Cross Bearings cannot be obtained, run the Ship into the Meridian of any Cape, Light-House, or other object on the land, the position of which is well laid down; that is, get it to bear True North or South, (the variation of the Compass being allowed for in advance, which can easily be done when the Ship is passing it,) and take a set of Altitudes at that instant indicated by the Compass.

The Ship will then be in the Longitude of that place, and her Distance from it is the correction to be applied to the Latitude of the place to find the Latitude of the Ship, according as she is to the North or South of it. In working out the time in this case, we must use the seconds in the computation, and take out the proportional parts of their Logs., and which is easily done by considering what proportion the number of odd seconds bears to a minute, such as 30″ is ½, 20″ is ⅓, or 15 is ¼ of 60″. Then take the difference between the Log. of the nearest preceding minute, and that of the following minute, and apply the corresponding ½, ⅓, or ¼ of this difference to the preceding Log. according as it is increasing or decreasing, or multiply the difference by the odd seconds and divide by 60, will give the proportion required.

The Mean Time at the Ship is found in exactly the same manner, only it is more carefully done. The Ship's Longitude being then turned into Time by Table XXVI, and added to the Mean Time at the Ship, in West Longitude, or substracted from it in East, will give the Greenwich Mean Time of the Observation. Then the Difference between the Greenwich Mean Time so found and the time shown by Chronometer at the time of the Observation, is the error of the Chronometer on Greenwich Mean Time, and is fast or slow accordingly.

The error so found may differ considerably from that given by the Shore rate. However, note the Sea error so found, and the date of the Observation, and at the next favorable opportunity when land is in sight, repeat the observation, and find the error anew. Then, if the two errors have continued the same after the lapse of several days, the Chronometer is running on Greenwich Mean Time, but if the errors differ, then the difference is the amount of what the Chronometer has gained or lost in the interval between the times of Observations, which divided by the number of days elapsed into seconds and tenths of seconds, will give the daily rate gaining or losing accordingly.

EXAMPLE

Of Proportioning the Logs. to the Odd Seconds.

P. Dist.. 98° 20′ 20″	Log. of 98° 20′ is 0.00461	98° 21′ Log. 0.00463	Diff. 2	pro. for 20″ is 1	Additive	=0.00462
Lat.... 36° 10′ 28″	Log. of 36° 10′ is 0.09296	36° 11′ Log. 0.09306	Diff. 10	pro. for 28″ is 5	Additive	=0.09301
H. Sum. 77° 31′ 40″	Log. of 77° 31′ is 4.33477	77° 32′ Log. 4.33420	Diff. 57	pro. for 40″ is 38	Subtract.	=4.33439
Diff. ... 56° 58′ 45″	Log. of 56° 58′ is 4.92343	56° 59′ Log. 4.92351	Diff. 8	pro. for 45″ is 6	Additive	=4.92349

This Example is merely given for the purpose of showing the nature of the proportions of the Logs. required for the odd seconds, and which have a considerable effect on the time when working for the nearest second. In practice we just take the difference between the Logs. as they stand in the Table, and apply the proportions mentally as we write them down. This saves considerable time, and the learner, by a little exercise of his mental powers will soon acquire the habit of doing the same with ease

RATING THE CHRONOMETER AT SEA.

EXAMPLE 1.

March 10th, 1854. A Ship bound out from New York Harbor, observed the following set of Altitudes and Times by Chronometer; her True Position at the same time being found from the bearing of the land, as follows. Required the Error of the Chronometer on Greenwich Mean Time. Elevation 18½ feet.

Sun's Obs. Alt.	10° 15′ 20″	T. by Ch. 0h 16m 24s	
A. M.	10 26 30	0 17 26	
	10 37 50	0 18 28	
	3)79′ 40″	3)52m 18s	
Mn. of the Alt.	10° 26′ 33″	Mn. of Ts. 0h 17m 26s by Chron.	
Index Error. Sub.	2		
Semid. 16′ 7″	10° 24′ 33″		
Dip 4′ 12″, Ref. 4′ 59″ —9′ 11″	Add 6 56		
True Alt.	10° 31′ 29″		
Polar Dist.	94 6 15	Log. 0.00111	
	40 23 40	Log. 0.11827	
	145° 1′ 24″		
	72° 30′ 42	Log. 4.47787	
	61° 59′ 13″	Log. 4.94589	
Ap. T. at Ship	7h 10m 12s	Log. 9.54314	
Equa. Add	10 31		
Mn. T. at Ship	7h 20m 43s		
Long. in Time	4 55 40		
	12h 16m 23s		
Less	12 0 0		
Gr. Mn. Time	0h 16m 23s		

Neversink Light-H. bore W. ¾ N. 4 miles, or True West.
Sandy-Hook Light-House N.W. 7 " or " N.W. ¾ W
The Float Light Vessel N. ¾ E. 3 " or " North.

These Bearings laid off on the Chart gives the Ship's True position at the time of the Sights,
Latitude in 40° 23′ 40″ N. Longitude 73° 55′ W
And the Longitude in Time 4h 55m 40s.

Sun's Dec. at Noon	4° 6′ 30″ S.	Diff. 1h. .¼)59
Correction Sub.	15	15
Correct Dec.	4° 6′ 15″	
	90 0 0	
Polar Distance	94° 6′ 15″	
Equation of Time	10m 31s ·55	Diff. 1h. .¼)665
Correction Sub.	16	·16·6
Correct Equation	10m 31s ·39	

Green. Time of the Observation	0h 16m 23s
Time of the Obs. by Chron.	0 17 26
Chron. Fast of Gr. Mean Time.	1m 3s March 10th.

EXAMPLE 2.

March 25th, 1854. Wreck Hill, in the Island of Bermuda, in Sight, bearing S. 4° W. by Compass, distant 10 miles, and at the same time the Mean of several Altitudes of the Sun was 15° 19′ 25″, Index Error 2, subtractive, Mean of the Times by Chronometer 11h 36m 15s, and the Sun's Magnetic Azimuth bearing S. 78° E. Required the Error of the Chronometer on Greenwich Mean Time, its Rate since leaving New York on the 10th March, and the Variation of the Compass. Elevation 18½ feet.

Time by Chron.. 11h 36m 15s
Reckoned from Midnight.

Bear. of Wreck Hill by Com. S 4° W.
Var. of Com. per Azimuth.... 4 W.
True Bear. S. 10′
Lat. W'k Hill 32° 16′ N. Lon. 64° 55′ W

Sun's Obs. Alt. A. M.	15° 19′ 25″				
Index Error Sub.	2 0				
Semid. 16′ 4″	15° 17′ 25″				
Dip 4′ 12″, Ref. 3′ 22″ —7′ 34″	Add 8 30				
True Alt.	15° 25′ 55″			Log. 0.01595	Lat. of Ship ..32° 26′ N. in T. 4h 19m 40s
Polar Dist.	88 12 22	Log. 0.00021	88° 12′		
Latitude	32 26 0	Log. 0.07365		Log. 0.07365	Sun's Dec., Noon 1° 48′ 7″ N. Dif. 1h. 59
	136° 4′ 17″				Correction....Sub. 29 — 29
Half Sum	68° 2′ 8″	Log. 4.57291	68 2	Log. 4.57291	Correct Dec.... 1° 47′ 38″
Difference	52° 36′ 13″	Log. 4.90007	20° 10′	Log. 4.97252	Polar Dist....88° 12′ 22″
App. Time	7h 8m 45s	Log. 9.54684		9.63503=5h 28m 32s	=True Azimuth S. 82° 8′ E
Equation Add	6 9				Mag. Azimuth S. 78 0 E
Mean Time	7h 14m 54s				Mag Variat'n.. 4° 8′ [Westerly
Long. in Time	4h 19 40				
Green. Mean Time	11h 34m 34s	Days elaps. 15)38s(2s 5-10th ⅓ Daily Rate.			Equa. of T. 6m 8s ·46 Dif. 1h. ·768
Time by Chron.	11 36 15	30	Gaining		Corr...Add 38 ·38·4
Chro. Fast, March 25th,	1m 41s	15)80(5			Corr. Equa. 6m 8s ·84
do. March 10th.	1 3	75			
Accumulated Error...	38s	$\frac{5}{15}$ (⅓			

Hence the Chronometer is this day. March 25th. Fast of Greenwich 0h 1m 41s, and gaining 2s and 5-10th and 1-3d of a tenth per day.

NOTE.—Observations for Rating Chronometers at Sea should be all taken in the morning, or else all in the afternoon, because of the irregularity in the time deduced from the morning Altitudes when compared with those taken in the afternoon. (See the Note at page 141.)

EXAMPLE 3

April 1st 1854. A Ship off Cape Cod, bearing S. 9° W. by Compass 3 miles distant, in the evening observed the Sun's Mean Altitude to be 6° 39' 28". On the Prime Vertical, Index Error 1' 20" Additive, Magnetic Azimuth S. 99° 20' W., and Time by Chronometer 10h 22m 30s. Required the Error of the Chronometer on Greenwich Mean Time and the Magnetic Variation. Elevation 16 feet.

Sun's Obs. Alt.......... 6° 39' 28" Time by Chro. 10h 22m 30s. Bearing of Cape Cod by Compass S. 9° W.
Index Error........Add 1 20 — Magnetic Var'n................ 9 West'ly.
Semid...... 16' 1" — 6° 40' 48" — True Bearing South..Dist. 3' 0" 0
Dip.3' 53" / Ref.7' 36" = 11' 29" — Add 4 32 — Lat. Cape Cod........42° 2' 24 Lon. 70° 3' 18" W
Lat. Ship..42° 5' 24" In time 4h 40m 13s
True Altitude. .... 6° 45' 20" — Log. 0.00302
Polar Distance..........85 18 12 Log. 0.00146 85° 18
Latitude.... ....42 5 24 Log. 0.12955 — Log. 0.12955 Sun's Decl. 4° 31' 49" N. Diff. 1h 58"
134° 8' 56" — Cor.,...Add 9 59 — $10\frac{1}{3}$
Half Sum....... ......67° 4' 28" Log. 4.59055 67° 4' Log. 4.59055 Cor. Dec.... 4° 41' 48" — 9' 59"
Difference..............60° 19' 8" Log 4.93892 18° 14' Log. 4.97763 Polar Dis..85° 18' 12"
App. Time at Ship.....5h 40m 32s=Log. 9.66048 — 9.70075=6h 0m 56s=True Az. S. 90° 14' W.
Equation.........Add 3 52 — Magnetic Azimuth...... S. 99 20' W.
Mean T. at Ship.......5h 44m 24s Eq. of T. 3m 59s ·84 Dif. 1h ·755 — Magnetic Variation........ 9° 6' W'ly
Long in Time.........4 40 13 Corr., Sub. 7 ·80 — $10\frac{1}{3}$
Time at Greeewich....10h 24m 37s Cor. Equ. 3m 52s ·4 — 7·80·2
Time by Chron.......10 22 30

Hence the Chron. is 0h 2m 7s Slow of Green. Mean Time. April 1st, and the Magnetic Variation 9° Westerly and as the Magnetic Variation found by the Azimuth agrees nearly with that known to exist off Cape Cod, it may be concluded that there is no Local attraction in that part of the vessel where the Compass stood when the Bearings were taken.

EXAMPLE 4.

April 21st, 1854. The Isle of Corvo, one of the Azores Islands, in sight bearing S. 24° W by Compass Distant 15 miles, in the evening the Sun's Mean Observed Altitude was 18° 38' 9", Index Error 1' 20" Additive, Time by Chronometer 7h 0m 59s, and the Magnetic bearing of the Sun at Setting was W. 39° 45' N. Required the Error and the Daily rate of the Chron., since leaving Cape Cod on the 1st of April, and the Magnetic Variation. Elevation 18 feet.

Sun's Observed Altitude,... 18° 38' 9" Time by Chron. 7h 0m 59s
Index Error.. ....Add 1 20
Semid.......... 15' 57" — 18° 39' 29" — Bearing of Corvo by Compass........ ..S. 24° W
Dip.... 4' 8" / Ref... 2' 45" = 6' 53" — Add 9 4 — Variation of the Compass............... 24 West'ly.
True Bearing South...Dist. 15' 0
True Altitude.............. 18° 48' 33" — Lat. of Corvo.... .... 39° 41 N. Long. 31 3' W.
Polar Distance.......... 78 3 27 Log. 0.00951 — Lat. of the Ship.......... 39° 56' N. In time 2h 4m 12s
Latitude. .... 39 56 0 Log. 0.11582
136° 48' 0" — Sun's Declination, Noon... 11° 50' 36" N., Dif. 1h—51"
Corr................Add 5 57 — 7h
Half Sum............... 68° 24' 0" Log. 4.56599 — Correct Dec.............. 11° 56' 33" — 5' 57"
Difference............... 49° 35' 27" Log. 4.88163 — Polar Distance........... 78° 3' 27"
Apparent Time at Ship.. 5h 1m 27s=Log. 9.57245
Equation..........Sub. 1 24 — Equa. of Time.............. 1m 20s ·6 Dif. 1h—·514
Mean Time at Ship.......5h 0m 3s — Corr... ....Add 3 ·59 — 7h
Long. in Time.... ....2 4 12 — Correct Equa................ 1m 23s ·65 — 3·59 8
Mean Time at Green.....7h 4m 15s
Time by Chron..........7 0 59 — Lat. 40° and Dec. 12° N. gives True Amp. W. 15° 45' N.
Chr. Slow of G. April 21st 3m 16s — Magnetic Ampli. at Sunset.............W. 39 45 N
Chr. Slow of G. April 1st. 2 7 — Magnetic Variation.. .... 24° Wes'ly
Accumulated Error..... 1m 9s
60
Days Elapsed..... .....20)69m (3s and 4-10th and ½ Daily Rate Losing, and Slow this day 3m 16s
60
20)90m (4
80
$\frac{10}{20}(\frac{1}{2}$

NOTE.—In ascertaining the Ship's position by this method, it is necessary to find the exact amount of Magnetic Variation due to the place, and the Local attraction (if any) due to the Ship (See page 121) previous to the Sights being taken for Chronometer, so that the proper Variation may be allowed on the Compass bearing, for the purpose of indicating the time at which the Object bears True North or South.

An error of this kind will cause an error in the Longitude so deduced, that is, the Ship will not be on the same Meridian or in the Longitude of that place, and the greater the Distance from the Object the greater will be the error caused, and the nearer to the Object the less will be the error from that cause.

RATING THE CHRONOMETER.

EXAMPLE 5

September 7th, 1854. Ship off the Cape of Good Hope. The Magnetic Variation Observed from an Amplitude at Sunrise was found to be 30° Westerly, and when the Lion's Head bore N. 30° E. by Compass, Distant 30 miles, the Sun's Mean Altitude was observed to be 11° 31′ 49″ in the Morning. Time by Chronometer 6h 8m 10s from Midnight. Required the error of the Chronometer on Green. Mean Time. Elevation 18 feet.

Sun's Observed Altitude..	11° 31′ 49″	T. by Chr. 6h 8m 10s
Semid......... 15 55″ } Add	7 17	Reckoned from Mid't.
D. 4′ 8″ R. 4′ 30″ = 8 38 }		
True Altitude..........	11° 39′ 6″	
Polar Distance..........	96 12 2	Log. 0.00255
Latitude................	34 26 0	Log. 0.08366
	142° 17′ 8″	
Half Sum................	71° 8′ 34″	Log. 4.5095
Difference..............	59° 29′ 28″	Log. 4.93528
App. Time at Ship.......	7h 14m 50s	Log. 9.53100
Equa...............Sub.	1 57	
Mean Time at Ship......	7h 12m 53s	
Long in Time.......Sub.	1 13 36	
Green. Mean Time.......	5h 59m 17s	
Time by Chron...........	6 8 10	
Error of the Chron.......	8m 53s	Fast of Green Mean Time this day, September 7th

Bearing of the Lion's Head......	N. 30° E.	
Magnetic Variation..............	30 West'ly.	
True Bearing North 30 miles.		
Lat. Lion's Head..33° 56′ S. Long.	18° 24′ E.	
Lat. of the Ship...34° 26′ S. in Time	1h 13m 36s	
Sun's Dec. Noon..............	6° 6′ 26″ N.	Dif. 1h 56″
Corr..................Add.	5 36	T. fr. Noon 6h
Correct Decl................	6° 12′ 2″	60)336
Polar Distance..............	96° 12′ 2″	5′ 36″
Equa. of Time................	2m 2s ·14	Dif. 1h ·849
Corr..................Sub.	5 ·09	T. fr. Noon 6h
Correct Equ................	1m 57s ·5	5·09·4

EXAMPLE 6

September 30th, 1854. Ship in Sight of St. Paul's Island, in the Indian Ocean, the Variation of the Compass as per Amplitude, being 21° Westerly, and when the centre of the Island bore S. 21° W. by Compass, Distant 25 miles, the Sun's Observed Altitude was 8° 25′ 15″ in the Morning, the Time by Chronometer being 1h 21m 2s, reckoned from Midnight, or 13h 21m 2s from the preceding Noon. Required the error of the Chronometer on Greenwich Mean Time, and its rate since leaving the Cape of Good Hope on the 7th of September. Elevation 19 feet.

Sun's Observed Altitude....	8° 25′ 15″	T. by Chr. 1h 21m 2s
Semid. .... 16′ 1″ } Add	5 38	Reckoned from Midt
Dip. 4′ 15″ R. 6′ 8″ = 10′ 23″ }		
True Altitude.............	8° 30′ 53	
Polar Distance............	87 23′ 56″	Log. 0.00045
Latitude..................	38 22′ 0″	Log. 0.10564
	134° 16′ 49″	
Half Sum..................	67° 8′ 24″	Log. 4.58937
Difference................	58° 37′ 31″	Log. 4.93134
App. Time at Ship.........	6h 36m 13s	= Lg. 9.62681
Equation..............Sub.	9 49	
Mean Time at Ship.........	6h 25m 24s	
Long. in Time........Sub.	5 11 28	
Green Mean Time..........	1h 13m 56s	
Time by Chron............	1 21 2	
Chron. Fast, Sep. 30th......	7m 6s	
Chron. Fast, Sep. 7th.......	8 53	
Accumulated Error..........	1m 47s	
	60	
Days Elapsed.....	23)107s(4s 6-10 and ½	Daily Rate Losing, and this day, Sept. 30th, Fast of Green. M. Time 0h 7m 6s.
	92	
	23)150(6	
	138	
	12(½	

Bearing of St. Paul's Island....	...S. 21° W.	
Magnetic Variation................	S. 21° Wes'ly	
True Bearing South......25 miles.		
Lat. of St. Paul's.... 38° 47′ S. Long.	77° 52′ E.	
Lat of the Ship.... 38° 22′ S. in Time	5h 11m 28s	
Sun's Declination..........	2° 46′ 27″ S.	Dif. 1h 58″
Corr..................Sub.	10 23	T. fr. Noon 10½
Correct Declination.........	2° 36′ 4″	580
	90 0 0	29
Polar Distance..............	87° 23′ 56″	14
		60)623
		10′ 23″
Equa. of Time.............	9m 57s ·32	Dif. 1h ·803
Corr..................Sub.	8 ·63	T fr. Noon 10½
Correct Equa..............	9m 48s ·69	8030
		401
		200
		8·63·1

RATING THE CHRONOMETER ON SHORE.

When a Ship is in Port, and the Sea Horizon visible from the deck, and the Sun is at a proper distance from the Meridian, the Rate of the Chronometer may be found in a similar manner to the foregoing Examples; or the difference of its Error on the Mean Time at the place, ascertained after the lapse of several days, will give its Rate per day. When the Sea Horizon is not visible from the Ship's deck, it may happen that good Sights can be obtained from the Sea-beach. In that case, compare the Watch (with which the Time is intended to be taken) with the Chronometer, before leaving the vessel, and also on the return on board. If the comparisons are the same, then the Watch has no rate, but if they differ, the difference is the error of the Watch in the interval. Hence its rate may be found, (unless the Chronometer has itself a very large rate,) a proportion of which must be applied to the Time by the Watch when the Altitudes were observed.

The elevation of the Observer's eye above the Sea-level must also, in this case, be carefully ascertained, in order to apply the proper correction for the Dip of the Horizon, found in Table V. An Example of doing this is not necessary, as it is worked in the same manner as in the preceding Examples.

By the Artificial Horizon.

The use of this instrument is fully explained at pages 77 and 78, and the manner of finding the Time is given at page 131. It is, therefore, considered unnecessary to give any more Examples of the same, and we proceed to give a case of Rating the Chronometer from the Mean Time at the Place, supposed to have been obtained from either of the above methods.

EXAMPLE 1.

October 3d, 1854. A Ship lying in the Port of Rio Janeiro, her correct position by bearing was Latitude 22° 54 South, Longitude 43° 9′ West. At 8h 30m 25s A. M., Mean Time at the place, a Chronometer showed 11h 33m 12s Required its Error on Greenwich Mean Time.

Mean Civil Time at Rio Janeiro, October 3d.................	8h	30m	25s	
Add....	12	0	0	
Mean Astronomical Time, October 2d	20h	30m	25s	
Longitude of the Ship 43° 9′ W. in Time...............Add....	2	52	36	
Mean Astronomical Time at Greenwich, October 2d	23h	23m	1s	
Astronomical Time by Chronometer, October 2d	23	33	12	
Chronometer Fast of Greenwich Mean Time	0h	10m	11s,	Oct. 3d.

EXAMPLE 2.

Nov. 2d, 1854. At Rio Janeiro, Ship in the same position as before, the Mean Time at the place was 8h 10m 5s A. M., the same Chronometer showed 11h 14m 7s. Required its Error on Greenwich Mean Time, and its Rate since October 3d, at which time it was 10m 11s too fast.

Mean Civil Time at Rio Janeiro, Nov. 2d..................	8h	10m	5s	
Add....	12	0	0	
Mean Astronomical Time, Nov. 1st.......................	20h	10m	5s	
Longitude of the Ship 43° 9′ W. in Time........ Add....	2	52	36	
Mean Astronomical Time at Greenwich, Nov. 1st..........	23h	2m	41s	
Astronomical Time by Chronometer, Nov. 1st.............	23	14	7	
Chronometer Fast of Greenwich Mean Time, Nov. 2d......		11m	26s	
do. do. Oct. 3d......		10	11	
Accumulated Error...		1m	15s	
		60		
Number of days elapsed		30)75(		2s 5-10th Daily Rate gaining
		60		
The Chronometer is this day Fast of Greenwich 11m 26s...		)150(5		
And gaining 2 sec. 5-10th per day.........................		150		
		0		

NOTE.—In East Longitude, the Longitude in Time must be subtracted from the Mean Astronomical Time at the place, to obtain the Greenwich Mean Time; because the Time at Greenwich must always be the least in East Longitude.

FINDING THE LONGITUDE BY CHRONOMETER.

Having thus given all the various methods of finding the Longitude by Chronometer which are of practical utility, and also the manner of Rating the same, both at Sea and on Shore, this part of the subject will be closed by the following Examples for Exercise.

QUESTIONS FOR EXERCISE.

Question 1st.—April 30th, 1854. (Noon at Sea.) In North Latitude, and 24° 30′ West Longitude. in the morning, the observed Altitude of the Sun was 22° 7′. Greenwich Time by Chronometer 8h 46m 10s, reckoned from midnight. Ship then sailed N. E. by E. (True Course) 35 miles until Noon. when the Sun's Meridian Altitude observed was 68° 3′ South. Required the Ship's Latitude and Longitude in at the time of the Sights, and also at Noon.

Answer.—Latitude 36° 13′ N., Longitude 25° 11′ W. at time of Sights, and Latitude 36° 32′ N., Longitude 24° 35′ W. at Noon.

Ques. 2d.—April 30th, 1854. (Noon at Sea.) Latitude observed at Noon 36° 32′ North. In the afternoon the Sun's observed Altitude was 13° 48′. Greenwich Time by Chronometer 7h 7m 15s. Ship had sailed E. N. E. (True Course) 30 miles since Noon. Required the Latitude and Longitude in at time of the Sights, and also the Longitude of the Ship reduced back to Noon.

Ans.—Latitude at time of Sights 36° 43′ N., Longitude 24° 2′ W., and Longitude at Noon 24° 37′ W.

Ques. 3d.—March 26th, 1854. (Noon at Sea.) In South Latitude, and 66° 30′ East Longitude, by account. In the morning the Sun's observed Altitude was 25° 25′. Time by the face of the Chronometer 3h 29m 1s, or which. reckoned from the preceding Noon is, March 25th, 15h 29m 1s Astronomical Time, the Chronometer being 2m 24s fast of Greenwich Mean Time. Ship then sailed N. W. (True) 17 miles until Noon, when the Sun's Meridian Altitude observed was 75° 20′ North. Required the Latitude and Longitude in at the time of the Sights and at Noon.

Ans.—Latitude 12° 32′ S., Longitude 66° 37′ E at time of Sights, and Latitude 12° 20′ S., Longitude 66° 24′ 30″ E. at Noon.

Ques. 4th.—March 10th, 1854. (Noon at Sea.) In North Latitude, and 60° 45′ West Longitude, the Sun's Meridian Altitude observed at Noon was 47° 32′ South. Ship then sailed North East (True) 40 miles, and in the afternoon the Moon's observed Altitude, Lower Limb, was 40° 32′ to the Eastward of the Meridian, and the Greenwich Time by Chronometer was 9h 41m 21s. Required the Latitude and Longitude in at Noon, and also the Latitude and Longitude in at the time of the Moon's Altitude.

Ans.—Latitude observed 38° 14′ N., Longitude 60° 33′ W. at Noon, and Latitude 38° 42′ N., Longitude 59° 57′ W. at the time of Sights.

Ques. 5th.—April 7th, 1854. (Noon at Sea.) In North Latitude, and West Longitude, at twilight in the morning, the Meridian Altitude of the Star Vega was observed to be 79° 51′ North, and at the same time the Altitude of the Planet Venus was 24° 21′ to the Eastward of the Meridian, the Greenwich Time by Chronometer being 10h 15m 55s from midnight, or April 6th, 22h 15m 55s from the preceding Noon. Required the Latitude and Longitude in at the time of the Sights.

Ans.—Latitude observed 2o 26′ N., Longitude by Chronometer 70° 5′ W.

Ques. 6th.—February 10th, 1854. (Noon at Sea.) In North Latitude and West Longitude, at twilight in the evening, the observed Altitude of the Star Sirius was 12° 27′ to the Eastward of the Meridian, and the Greenwich Time by Chronometer was 10h 4m 41s, and at 1½ hours afterwards the Meridian Altitude of the Star Aldebaran was observed to be 66° 16′ South. Ship had sailed on a true S. W. Course 12 miles in the interval. Required the Latitude in by Observation, and the Latitude and Longitude in at time of Sights.

Ans.—Latitude observed by ✱ Aldebaran 40° 1′ N. Latitude in at time of Sights 40° 10′ N., and Longitude 68° 23′ W. at the time of the Sights

Ques. 7th.—A Chronometer which was 10m 14s Fast of Greenwich Mean Time at New York, on the 10th of March, 1854, showed 3h 0m 53s, when the Mean Time at Calcutta was 8h 40m 10s A. M., on the 12th of June, 1854, in Longitude 88° 17′ E., or in Time 5h 53m 8s. Required its Error on Greenwich Mean Time, and its Rate since leaving New York.

Ans.—Its Error on Greenwich Mean Time is 13m 51s. Accumulated Error 3m 37s. The number of days elapsed 94, and its daily Rate 2 sec. 3-10th gaining since leaving New York.

NOTE.—In the above Examples the height of the eye above the Sea-level is supposed to be 17 or 18 feet.

THE LUNAR OBSERVATION

Means the measurement of the Angular Distance of the Moon from certain Celestial bodies, and as the Moon is constantly advancing to the Eastward in the heavens, at the rate of about 1′ in 2 minutes of time, she overtakes and passes all the other Celestial bodies in her progress, they appearing to remain stationary in the heavens.

The Moon's distance from the Sun, and a few bright Stars and Planets, are calculated for the end of every 3 hours, (except during about 6 days at the time of each New Moon,) and given in the Nautical Almanac for the Mean Time at Greenwich. The observation of this distance from any part of the Earth's surface, affords the means of determining the Greenwich Mean Time, the difference between which and the Mean Time at the Ship, is the Longitude in Time. This constitutes a Lunar Observation.

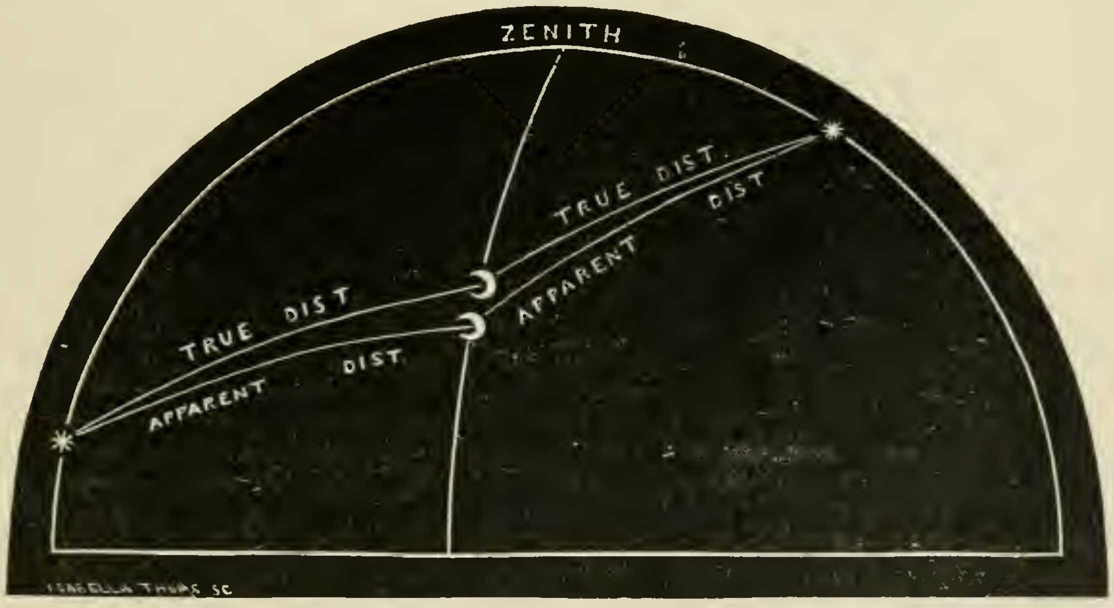
If the distance between the Moon and the other body were the same to the spectator, whether viewed at the surface or from the centre of the Earth, there would be nothing more to do than to measure the distance, (with an instrument,) and to find from the Nautical Almanac the Greenwich Time corresponding to it, and to compare this with the Time at the place. But the Refraction of the Atmosphere has the tendency to *raise* the Sun, a Star, or a Planet, above its true place in the heavens, and the effect of Parallax is to make them appear *lower ;* the latter has, however, very little effect, in consequence of their great distance. (See explanation given at page 67.) On the other hand, the Moon being near the Earth, her Parallax in Altitude is greater than her Refraction, and which causes her to appear *below* her true place in the heavens.

Hence the Apparent Distance between the Moon and the other body differ from the True Distance, as will be seen in the following Diagram.

DIAGRAM,

Showing the Effect of Parallax on the Lunar Distance

FIG. 28.



As the Moon must *always* be *raised*, and the Sun or Star *lowered*, to obtain their true places, the Star to the right in the above Figure being higher than the Moon, it is evident that by raising her the True Distance will be less than the Apparent Distance.

Again, the Star to the left being lower than the Moon, by raising her the True Distance will be greater than the Apparent Distance

And it is evident from the above, that the difference between the True and the Apparent Distances depend almost entirely on the correction of Altitudes.

It is therefore useful to bear in mind, as a check against gross mistakes, that the True and Apparent Distances cannot differ by more than the *Sum of the Corrections of Altitude.* Again, when the Moon's Altitude is equal or less than that of the other body, the True Distance is *less* than the Apparent Distance. But the contrary does not always hold good when the Moon's Altitude is *greater* than the other body

THE LUNAR OBSERVATION

is the only independent method of finding the Longitude which is practical at Sea, and it requires great practice to measure the distance successfully. (See the Use of the Sextant, and the Remarks on Measuring the Lunar Distance, at pages 72 to 76.) And the application of so many small corrections as are necessary, when accuracy is required, even with extraordinary care and some skill, it is scarcely possible to arrive at extreme precision, although the observation may have been made on shore, with the best instruments; and it is recorded by practical surveyors, and other scientific men, entitled to great credit, that the Mean Longitude deduced from several thousands of Lunar Distances, taken equally on both sides of the Moon at one season of the year, have differed from 10′ to 12′ from the Mean Longitude deduced from an equal number of Lunar Distances taken in like manner at a different season of the year.

And from my own experience in observing Lunar Observations at Sea, during the course of many years, I am entirely of the same opinion.

The Lunar Observation is certainly an excellent mode of detecting any very gross error in the Chronometer, and is valuable on that account alone, and also for correcting the Dead Reckoning within certain limits; but I am satisfied that a Chronometer *cannot be rated* by Lunars at Sea, though some authors of Nautical works persist in the contrary opinion.

The most rapid change of distance between the Moon and a body is 1° 48′ in three hours, and the effect of an error of 1′ of distance is 25′ of Longitude, or that of 15″ error of Distance is 6′ of Longitude in the most favorable case.

An error in the observed Altitudes, however minute, also affects the True Distance. Then there are the errors in the Shades or Screens, and the parallelism of the Telescope, all which are explained at page 72 and rules given to correct them; and lastly the errors in the Tables, however small, from which the corrections are taken.

It is usual to take Lunar Distances both East and West of the Moon, and to take the Middle of the Longitudes so found for the True Longitude. This may compensate to a certain extent for some of the errors, but it may nevertheless be several minutes of Longitude from the truth. It is, however, more likely to be correct than either of the others.

From the above facts it would appear that in general the Longitude by a set of Lunar Distances is liable to be in error, even with the greatest care and by the most practical observer. This error may not exceed 10′, and is in general much less; but even this amount of precision is a very valuable acquisition to a Ship on a long voyage, and which may not have had an opportunity of verifying her Chronometer by the sight of land. For, if after several sets of Distances have been taken, both East and West of the Moon, and the Longitude deduced from each set differ considerably from the Longitude by Chronometer, and they all point in the same direction, that is, either all to the Eastward or all to the Westward of the Chronometer, it may be concluded that the Chronometer is in error to the amount of nearly the difference between them. And in the case of a Chronometer thus changing its error and rate, it would be unsafe to trust to it during the remainder of the voyage. And as the following method of observing and working a Lunar Observation may be done with nearly as little time and trouble as that of finding the Longitude by Chronometer, and in the case of the Chronometer breaking down at Sea, the Longitude may be found sufficiently near for all practical purposes by the Lnnar method, bearing in mind that in Low Latitudes the Degrees of Longitude are large, and where an error of a few minutes of Longitude would be most conspicuously seen, the weather is generally clear and fine, and the land may be seen at a considerable distance off.

On the other hand, in High Latitudes the Degrees of Longitude are small, and where an error of a few minutes of Longitude occupy only a small portion of space, or miles of Departure, consequently they would have less effect on the Ship's Distance from the shore than it would in Low Latitudes.

THE LUNAR OBSERVATION.

In taking a Lunar Observation, two assistants may be employed to observe the Altitudes of the objects, while the principal observer is taking their Distance, and a fourth notes the Times of each by a Watch or Chronometer.

The Observation is then written down in the following order. (See page 76.)

June 3d, 1854. In the Afternoon.						Height of the Eye, 18 feet.	
Times by Watch..2h 55m 56s	Sun's Altitude..	49° 45′	Moon's Alt., L. L...	41° 10′	Dist. ☉ and ☽ ..	87° 41′ 20″
2 58 0	do.	49 17	do.	0 32	To the Westward	0 42 20
3 0 4	do.	48 49	do.	0 54		0 43 20
3)8h 54m 0		3)147° 51′		3)96		3)127′ 0″
Mn of the Times..2h 58m 0	Sun's Obs. Alt....	49° 17′	Moon's Obs. Alt..	41° 32′	Mean Obs. Dist..	87° 42′ 20″

When no assistants are at hand, one person may take the whole observation himself; indeed it is more satisfactory to do so than to have to trust to others, because it is very rarely possible that the Altitudes of the bodies can be seized at the instant of taking the Distance. By adopting the following method the observer will be independent of all assistants, and learn by experience to trust entirely on himself in using the instruments with precision.

Being prepared with two Quadrants to measure the Altitudes of the bodies, and a Sextant to measure their Distance, all previously adjusted, (or their errors known,) and a Watch to note the Time. Set the Index of the Sextant roughly to the Approximate Distance. (See page 74 or 75.) Set the Indices of the Quadrants roughly to the Approximate Altitudes of the two bodies. Then, holding the Watch in the hand, or place it where the movement of the second hand can be distinctly seen, take an Altitude of one of the bodies, (generally the one farthest from the Meridian,) at the instant the second hand of the Watch has completed the full minute, and note down the Time and the Altitude of that body opposite. Take up the other Quadrant and observe the Altitude of the other body at the time the second hand of the Watch has completed the next two minutes, and note down the Time and Altitude as before. Now take the Sextant and bring the Limbs of the objects in contact, at the instant the second hand of the Watch has completed the next two minutes, and note down the Time and the observed Distance. Shift backward or forward the Index of the Sextant 1′, (as directed at page 76,) and await the contact; note the Time and Distance down as before. Shift the Index again 1′ in the same direction, and note the time of contact as before, three Distances being sufficient. Take up the Quadrant and observe the Altitude of that body which was last observed, at the completion of the next two minutes, which note down as before, and finish with observing again the Altitude of the first body observed, at the expiration of the next following two minutes. Thus there will be a uniformity of Time between the Observations, which will render it easy to reduce them all to the Mean of the Times at which the Distance of the bodies were observed, as follows:

Form of Writing down the Observation.

June 3d, 1854.	T. by Watch 2h 52m 0s	Alt. of the Sun.......	50° 41′ 0″	Height of the Eye, 18 feet.
	2 54 0	Moon's L. Limb..	40 48 0	
Mn. of Times 2h 58m 0s.	2 55 56	Dist. Sun and Moon..	87 41 20	Sun West of the Moon.
	2 58 0	do.	0 42 20	Mean Distance........ 87° 42′ 20″
	3 0 4	do.	0 43 20	
	3 2 0	Alt. of Moon's L. Limb	42 16 0	
	3 4 0	Alt. of the Sun	47 53 0	

To Reduce the Altitudes to the Mean of the Times that the Distance was Observed.

To Find the Sun's Altitude.

Time of 1st Alt. 2h 52m Alt. 50° 41′ T. 1st Alt. 2h 52m
" 2d Alt. 3 4 Alt. 47 53 Mn. of T's 2 58
Say as 12m is to 2° 48′ So is 6m
6m being half of 12m, and the Difference of Altitude being 2° 48′, the half of which subtract 1° 24′
1st Alt. Obs. (and decreasing) was..............50 41
Sun's Alt. at the Mean of the Times ....49° 17′

To Find the Moon's Altitude.

Time of 1st Alt. 2h 54m Alt. 40° 48′ T. 1st Alt. 2h 54m
" 2d Alt. 3 2 Alt. 42 16 Mn. of T's 2 58
Say as 8m is to 1° 28 so is 4m
4m being half of 8m, and the Difference of Altitude being 1° 28′, the half of which added 0° 44
1st Alt. (increasing) was 40 48
Moon's Alt. at the Mean of the Times ....41° 32′

Hence we have the following Observation:

Mean of the Times by Watch..2h 58m 0s Sun's Alt...49° 17′ Moon's A 41° 32′ Dist. ☉ and ☽ ..87° 42′ 20″

TO FIND THE APPARENT ALTITUDES OF THE BODIES AND THEIR APPARENT DISTANCE.

* Add 12′ to the Observed Altitude of the Sun and Moon, and add their Semidiameter to the Observed Distance

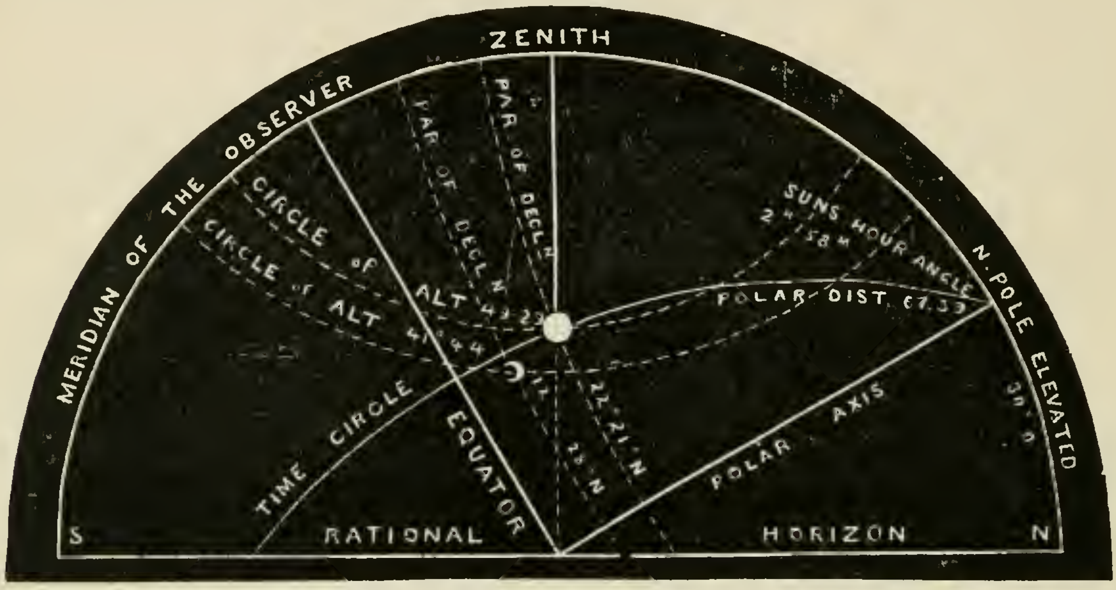
Sun's Obs. Alt. .49° 17′	Moon's Obs. Alt., L. L..41° 32′	Obs. Distance of Sun and Moon.......... 87° 42′ 20″
12	12	Sun's Semid.15′ 48″ ☽'s Aug. Semi. 15′ 21″.Sum 31 9
Sun's App. Alt. .49° 29′	Moon's App. Alt. ....41° 44	Apparent Central Distance.............. 88° 13′ 29″

June 3d, 1854. At 2h 58m P. M., Latitude in 30° North, Longitude, Dead Reckoning, 70° W., the Sun's Declination 22° 21′ North, the Moon's Declination 12° 28′ N., given to Project the Figure.

DIAGRAM OF A LUNAR,

Drawn on the Plane of the Meridian.

Fig. 29.

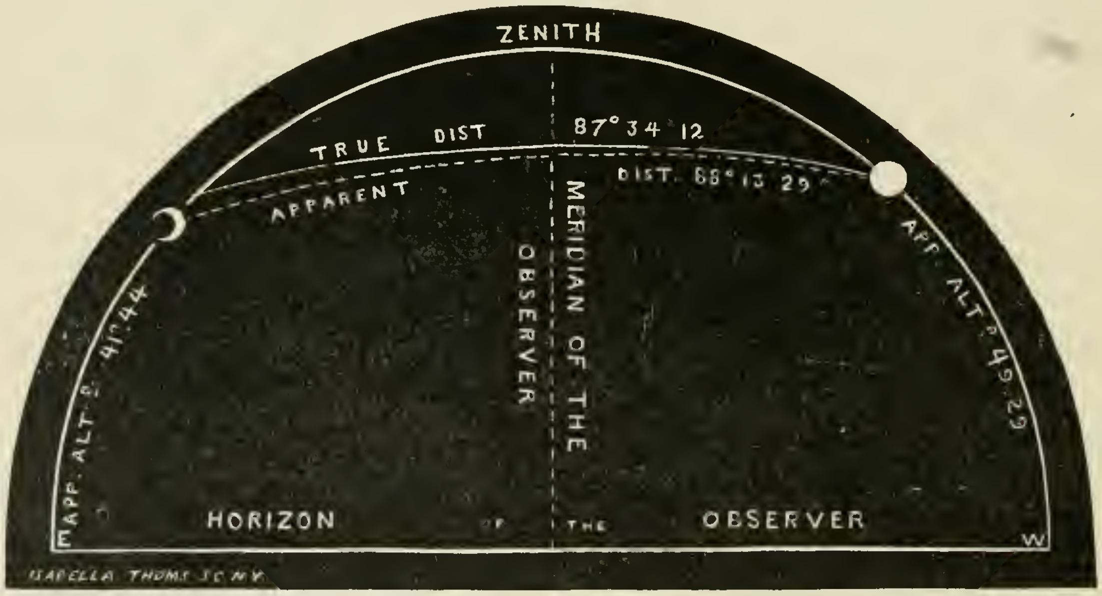


In this Figure the Sun is on the Prime Vertical, to the Westward of the Meridian, and his Hour Angle measured on the Equator gives the Apparent Time of the Observation, 2h 58m P. M. The Moon having nearly the same Hour Angle to the Eastward of the Meridian, appears to a spectator situated at a great distance to the Eastward of the Earth, (which is in the centre,) to be nearly in the same line of bearing, but the following Figure, drawn with the objects facing the spectator, will place them in a better point of view for showing the nature of the case.

DIAGRAM OF A LUNAR,

Drawn on the Plane of the Prime Vertical.

Fig. 30.



In this last Figure both bodies are seen on the Prime Vertical, East and West of the Meridian, their Altitudes are laid off from the line of Chords, and their Apparent Central Distance measures on the scale 88° 13′ 29″. Now, it is evident that by raising the Moon (which the correction for Parallax does) we bring the Moon nearer the Sun, while the correction for Refraction increases the Distance by lowering the bodies; but as the former has more effect than the latter, the Moon's True Distance, according to the Figure, is less than the Apparent Central Distance. This quantity is found by the Rules given on the next page, and which is termed Clearing the Lunar Distance.

* This Correction is simply the Difference between the Semidiameters taken at 16′, and the Dip of the Horizon, taken at 4′, to be added when the Lower Limbs are taken.

TO FIND THE APPARENT ALTITUDES AND DISTANCE.

Turn the Longitude by Dead Reckoning into time by Table XXVI, and *add* it to the Time at the Ship in West Longitude or *subtract* it in East, will give the Approximate Time at Greenwich. Prefix the day of the month one day less than the Sea date, and call it the Greenwich Date.

* Take out the Moon's Semidiameter and Horizontal Parallax from the Nautical Almanac and correct them to the Greenwich Date by Table XXIV, and to the Moon's Semid. *add* her Augmentation, taken from Table VII.

To the observed Altitude of the Sun and Moon's Lower Limbs *add* 12′. But if the Moon's Upper Limb be observed, *subtract* 20′, and if a Star be observed, *subtract* 4′.

Take out the Sun's Semid. from the Nautical Almanac and *add* both it and the Moon's Augmentation Semidiameter to the observed Distance, will give the Apparent central Distance.

If a Star be observed, *add* the Moon's Augmentation Semidiameter to the observed Distance if the nearest Limbs be observed, but *subtract* it if the farthest Limbs be taken, will give the apparent Distance.

If one of the bodies be at a sufficient distance from the Meridian, correct its Apparent Altitude for refraction by Table IV, but if the body be the Moon, by Table XXV, will give its true Altitude, with which find the Mean Time at the Ship as usual; but if both bodies are too near the Meridian an Altitude taken afterwards will give the Error of the Watch on Mean Time at the Ship, which must be farther corrected for the Difference of Longitude in Time the Ship has made in the interval; but it is much more convenient and correct to time the observation, so that one of the Altitudes of the bodies, (the Sun or a Star is preferred) observed with the distance, may also be used to find the Time at the Ship.

To Clear the Lunar Distance.

RULE

1. To the Pro. Log. of the Moon's Horizontal Parallax, Table XXXIV, *add* the Log. Co-Secant of the Apparent Altitude of the Sun or Star, taken from the bottom of Table XXVII, and the Log. Sine of the Apparent Distance found in Table XXXI, their *Sum* will be the Log. of the *first* correction.
2. To the Pro. Log. of the Moon's Horizontal Parallax already found, *add* the Log. Co-Secant of the Moon's Apparent Altitude, taken from the bottom of Table XXVII., and the Log. Tangent of the Apparent Distance found in Table XXXI, their *Sum* will be the Log. of the *second* correction.
3. Take the *first* and *second* corrections from Table XXXII, and place them under the Apparent Distance
4. Take the *third* correction from Table XXXIII, and after applying to it the correction taken from Table P, on the same page, (which is only used when the Sun is observed) and place it under the Second correction, *add* all these corrections to the Apparent Distance, and their *Sum*, rejecting 10 degrees, will be the true Distance.

EXAMPLE 1.

June 3d, 1854. In Latitude 30° 0 N., Longitude by Dead Reckoning 69° 54′ W., the Time by Watch was 2h 58m, Sun's observed Altitude 49° 17′, Moon's observed Altitude L. L, 41° 32′, and the observed Distance 87° 42′ 20″. (See page 164.) Required the true Distance, the Green. Mean Time, the Mean Time at Ship, and the Longitude in

Time at Ship..........	2h 58m	☉'s Obs. Alt.	49° 17′	☽'s Obs. Alt.......	41° 32′	Obs. Dis......	87° 42′ 20″
Long. 69° 54′ W. in time	4 40	Add	12	Add	12	☉'s Semid....	15 48
Green. Date, June 3....	7h 38m	☉'s App. Alt.	49° 29′	☽'s App. Alt......	41° 44′	☽'s Aug. Semid.	15 21
						App. Dist.....	88° 13′ 29″

Moon's Hor. Par.	0° 55′ 37″	Pro. Log....	0.5101	....	Pro. Log...	0.5101	☽'s Sem. Noon...	15′ 8″
Sun's App. Alt..	49 29 0	Log. Co-Sec.	0.1191	☽'s App. Alt. 41° 44′	Log. Co-Sec.	0.1767	Corr. 7½ hours..	3
App. Dist......	88° 13′ 29″	Log Sine..	0.9998	....	Log Tang..	2.5087		15′ 11″
First Correc. +	4 17′ 43″	Log.......	1.6290				Aug..........	10
Second Corr. +	5 1 9	....		....	Log.......	3.1955	Aug. Semid....	15′ 21″
Third Corr.. +	1 51							
Less.....10°=	87° 34′ 12″	True Distance.					Hor. Par. Noon..	55′ 24″
							Cor. 7½ hours...	13
							Correct H. Par..	55′ 37″

Note.—The manner of using the Tables for clearing the Lunar Distance are the same as usually done with others, and requires no explanation, and in Table XXXII directions are given on the face of the Table for taking out and applying the corrections, and in Table P also the precept Add or Subtract to or from the correction in Table XXXIII, are given on the face of the Table.

*** The Moon's Semidiameter and the Horizontal Parallax are taken out for the nearest Noon or Midnight, and their Difference in 12 hours found, with which we enter Table XXIV at the Top, and the Greenwich Time from Noon or Midnight at the side, and at the angle of meeting is the correction to be Added or Subtracted, according as they are increasing or decreasing**

HAVING THE TRUE LUNAR DISTANCE, TO FIND THE CORRESPONDING GREENWICH TIME.

Find in the Nautical Almanac the two distances between wnich the True Distance falls. Take out the first of these and set it down under the True Distance, and note down the hour taken from the head of the same column, and also its Prop. Log., found opposite in the Nautical Almanac.

Take the Difference between the two Distances thus set down, with which enter Table XXXIV, and take out the Pro. Log. of the Difference ; from this, Subtract the Pro. Log. taken from the Nautical Almanac, the remainder is the Pro. Log. of a portion of Time to be Added to the Hour taken from the head of the column, and the result is the Greenwich Mean Time.

True Distance previously found....................	87° 34′ 12″	which falls between VI and IX hours.
Distance at VI Hours............................	86 48 23	Pro. Log. .3208
Difference......................................	0° 45′ 49″	Pro. Log. .5942
Portion of Time to be Added......................	1h 35m 55	Pro. Log. .2734
To the Hour of the preceding Dist. N. A............	6 0 0	
Greenwich Mean Time, June 3d....................	7h 35m 55s	at the time of the Observation.

To Find the Mean Time at the Ship, and thence the Longitude.

The Sun being at a proper Distance from the Meridian, in this case, at the time the Distance was observed the Mean Time at the Ship is found from his Apparent Altitude, after correcting it for Refraction by Table IV, as follows :

Sun's App. Altitude.........	49° 29′	Gr Date. June 3d, 7h 36m 0s.
Ref. Table IV..........Sub.	1	
True Altitude................	49° 28	
Polar Distance..............	67 39	Log. 0.03392
Latitude.....................	30 0	Log. 0.06247
	147° 7′	
Half Sum.................	73° 34′	Log. 4.45163
Difference.................	24° 6′	Log. 4.61101
App. Time at Ship......	2h 58m 33s	=Log. 9.15903
Equa. of Time......Sub.	2 10	
Mean Time at Ship......	2h 56m 23s	
Green. Time by Lunar...	7 35m 55	
Longitude in Time......	4h 39m 32s	=Longitude in 69° 53′ 0″ West at about 3 P. M.

Sun's Declination Noon.........	22° 19′ N.	Dif. 1h 18′
Cor...........Add	2	7
Correct Declination............	22° 21′ N.	60)126
	90 0	2′
Polar Dist....................	67° 39′	
Equation Noon................	2m 13s ·33	Dif. 1h 410
Cor. ....Sub.	3 ·07	7½
Correct Equa..................	2m 10s ·26	2870
		205
		3·07·5

The Difference between the Mean Time at the Ship and the Greenwich Time by observation is the Longitude in Time, which turned into Space by Table XXVI, or it may be computed by the rule given at the bottom of page 140, and the result is the Longitude of the Ship at the time of the observation.

REMARKS.

If the times of the observation are taken by a Chronometer, or which is the same thing, the time of the Distance by Chronometer obtained from a comparison with the same Watch used in taking the times of the observation, and the Error of the Chronometer on Greenwich Mean Time applied to it, we have the Greenwich Time by Chron. at the time of the observation ; then if it agrees nearly with the Greenwich time found by the Lunar Distance, the correctness of the Chronometer is confirmed within certain limits ; but should they differ considerably after several observations, it may be concluded that the Chronometer has altered its rate.

The learner should practice measuring the Lunar Distance when in Sight of Land, or when his Longitude is well known, and by that means establish a confidence in himself. But he must not feel discouraged should it happen that his first attempts fall very wide of the truth, (as is generally the case,) but by a steady perseverance, and profiting by his former errors, he will, after carefully perusing the instructions given at pages from 72 to 76, soon acquire the habit of measuring the Distance tolerably correct. And it is easy to know whether the Distance measured has been too great or too small by simply inspecting the columns of the Nautical Almanac and finding whether the Distance between the bodies is increasing or decreasing: if increasing and the Greenwich Time by Lunar too great, when compared with the Greenwich Date, found as above, then the Distance observed has been too great by the amount of the Difference of Time, say as 3 hours is to the Difference in 3 hours, so is this Difference of Time to a proportion of Space, will give the amount of the Error. When the Distance is decreasing and the Greenwich Time by Lunar too great, then the Distance observed has been too small, and the amount is found in like manner and vice versa. (See the Rules on pages 168 and 169.)

FINDING THE LONGITUDE BY LUNAR OBSERVATION.

Distance between the Moon and a Star.

In the preceding Example the Sun's Distance was observed W. of the Moon, and in the following Observation the Star's Distance is observed East of the Moon, for the purpose of showing the manner of connecting the two Longitudes so deduced, in order to obtain the Mean of the two at the time of the last Observation.

EXAMPLE 2.

June 3d, 1854. On the evening of the same day as in the preceding Example, the following Distances were observed of Antares, East of the Moon, and East of the Meridian. Ship had sailed from Latitude 30° North, and Longitude 69° 52′ 45″ West, by last Lunar. Course S. E. (true) 40 miles. Required the Longitude in, and also the Mean of the two Longitudes, at the time of the last Observation.

June 3d. Times by Watch.. ...	7h 51m 30s	Alt. of Antares........	12° 57′ 0″
" "	7 53 40	L. Limb of the Moon...	60 27 0
Mean of the Times 7h 57m 45s..	7 55 45	Dist. remote Limb.....	85 35 40
	7 57 40	do.	0 34 40 — Mean Dist.... 85° 34′ 37″
	7 59 50	do.	0 33 30
	8 1 58	Alt. of the Moon......	59 31 0
	8 3 59	Altitude of Antares....	15 27 0

The Altitudes are now reduced to the Time of the Mean Distance by Pro. Logs. as follows:

To Find the Star's Altitude.

T. of 1st Alt. 7h 51m 30s 1st Alt. 12° 57′ T. 1st Alt. 7h 51m 30s
" 2d Alt. 8 3 59 2d Alt. 15 27 Mn. of T's 7 57 45
Then say as 12 29 is to 2° 30′ so is 6 15
12m 29s Pro. Log. 1.1589
Arith. Compli...... 8.8411
2° 30′ Pro. Log... 0.0792
6m 15s Pro. Log. 1.4594 1st Alt. Obs. increas. 12° 57′
0.3797 Pro. Log. of the Corr. 1 15′
Alt. of Antares at the Time of the Mean Dist....14° 12′

To Find the Moon's Altitude.

T. of 1st Alt. 7h 53m 40s 1st Alt. 60° 27′ T. 1st Alt. 7h 53m 40s
" 2d Alt. 8 1 58 2d Alt. 59 31 M. of T's 7 57 45
Then say as 8 18 is to 56′ so is 4 5
8m 18s Pro. Log. 1.3362
Arith. Compli. 8.6638
0° 56′ Pro. Log... 0.5071
4m 5s Pro. Log. 1.6443 1st Alt. Obs. decreas. 60° 27′
0.8152 Pro. Log of the Corr. 0 28′
Alt. of the Moon at the Time of the Mean Dist...59° 59

To Find the Greenwich Date and the Necessary Preparations for Clearing the Distance.

Time at the Ship.. 7h 57m 45s Co.S.E. 40=D.L. 0° 28′ Dep. 28′=D. L. 0° 32′ 45″ E. ☽'s Sem. Mid. 15′ 13″ H.Par.55′45′
L. in 69° 20′W. in T. 4 37 20 Lat. Left......30 0 Lon. by Lunar 69 52 45 W. Aug. 13 Corr. 1′
Gr. Date, June 3d, 12 35 5 Lat. In...... .29° 32N. " brought on 69° 20′ 0″W. Aug.Semid. 15′ 26″ H.Par.55′46′

Alt. of Antares........ 14° 12′ Alt. of Moon's L. L.....59° 59′ Obs. Dist. Moon's remote Limb... 85° 34′ 37″
Dip for 21 feet....Sub. 5 Add.. 12 Aug. Semid............... Sub. 15 26
✱'s App. Alt .... 14° 7′ Moon's App. Alt ...... 60° 11′ App. Central Distance.......... 85° 19′ 11″

To Clear the Lunar Distance and Find the Greenwich Time.

☽'s Hor. Parallax........ 0° 55′ 46″ Pro. Log. 0.5089 ....Pro. Log........ 0.5089
✱'s App. Alt. ....14 7 0 Co-Sec... 0.6128 ☽'s App. Alt..... 60° 11′ Co-Secant 0.0617
App. Distance...........85° 19′ 11″ Sine.... 0.9985 ....Tangent........ 2.0866
First Correction .... 4 46 21..Log. 2.1202
Second Corr............ ... 5 3 58 .... 2.6572
Third Corr.............. 3 30
True Dist......Less 10°=85° 13′ 0″
Dist. at Midnight, or XII, 85 29 55 Pro. Log. 0.2843
Difference.............. 16′ 55″ Pro. Log. 1.0270
0.7427= 0h 32m 33s portion of Time to be added
to the Hour of the preceding Distance, N. A..12 0 0
Greenwich Mean Time 12h 32m 33s at the Time of the Distance.

To Find the Mean Time at the Ship, and thence the Longitude.

App. Alt. of Antares .... 14° 7′ Gr. Date, June 3d, 12h 35m Sun's R. Ascen..4h 44m 13s Dif. 1h. 10s×12h 35m
Corr. for Ref.........Sub. 4 Correction 2 5
✱'s True Alt............ 14° 3′ Sun's Corr. R. A. 4h 46m 18s
Polar Distance ....116 6 Log. 0.04671 Equa.... 2m 13s
Latitude............... 29 32 Log. 0.06045 Corr.... . 5 ✱'s Right Ascen., 1854.... 16h 20m 24s
159° 41′ Corr. Eq. 2m 8s
Half Sum .... 79° 50′ Log. 4.24677 ✱'s Declination, 1854..... 26° 6′ S
Difference .... 65 47 Log. 4.96000 90 0
H. Ang. of ✱ East of the Meridian 3h 35m 58s Log. 9.31393 ✱'s Polar Dist.... ....116° 6′
✱'s R. Ascen....... 16 20 24 Mean Time at Greenwich by Lunar.................. 12h 32m 33s
R. A. of the Merid.. 12h 44m 26s Mean Time at Ship 7 56 0
Sun's R. Ascen. .... 4 46 18 Long. by Lunar......................... 69° 8′ 15′ =4h 36m 33s
App. Time .... 7h 58m 8s Long. by last Lunar brought on by D. R... 69 20 0
Equation of Time .Sub. 2 8 ½)138° 28′ 15″
Mean Time at Ship. 7h 56m 0s Mean Long. by Lunar .... 69° 14′ 7″ W. at time of [last Obs

FINDING THE LONGITUDE BY LUNAR OBSERVATIONS.

Distance Observed between the Moon and a Planet.

EXAMPLE 3.

July 3d, 1854. In Latitude 39° 25′ South, Longitude by Dead Reckoning about 80° East, at 8h 30m P. M Apparent Time at Ship, the observed Altitude of the Planet Jupiter was 31° 35′ East of the Meridian, the observed Altitude of the Moon's Lower Limb 38° 51′, and the observed Distance between the centre of Jupiter, East of the Moon, and the Moon's remote Limb was 102° 31′ 43″. Index Error 1′ 30″, subtractive, and the Greenwich Mean Time by Chronometer, being correct, was 3h 14m 28s. Required the Longitude in by the Lunar Distance, and the Error (if any) of the measured Distance.

Preparation for Clearing the Distance.

Green. Time or Date, by Chro., July 3d,	3h 14m 28s	Moon's Semid. Noon 15′ 31″ and H. Par.	56′ 49′
		Corr. Gr. Date 2″ } Add 11 Augm. 9 }	Corr. Gr. Date.. Add 6
Obs. Dist. ☽'s remote Limb	102° 31′ 43″	Aug. Semid. 15′ 42″	Hor. Par. 56′ 55″
Index Error .... Sub.	1 30		
Obs. Distance	102° 30′ 13″		
Moon's Aug. Semid. .... Sub.	15 42	Obs. Alt. Jup. 31° 35′	Obs. Alt. ☽'s L. L. 38° 51′
Apparent Distance	102° 14′ 31″	Dip .... Sub. 4	Corr. .... Add 12
		App. Alt. Jup. 31° 31′	App. Alt. of the ☽ ... 39° 3′

To Clear the Distance.

☽'s Hor. Parallax	56′ 55″	Pro. Log. 0.5000			Pro. Log. 0.5000
Jupiter's App. Alt.	31 31 0	Co-Secant 0.2817	☽'s App. Alt.	39° 3′	Co-Sec... 0.2007
App. Central Distance	102° 14′ 31″	Sine.... 0.9900			Tangent. 1.6637
First Correction	4 29 33	1.7717			
Second Correction	4 52 13				2.3644
Third Correction	2 23				
True Distance, less 10°	101° 38′ 40″				
Distance, N. A., at IIIh	101 46 12	Pro. Log. 0.2618			
Difference	0° 7′ 32″	Pro. Log. 1.3783			

Pro. Log. 1.1165—0h 13m 46s portion of Time to be added
to the time of the preceding Distance, N. A. ... 3 0 0
Greenwich Mean Time by Lunar 3h 13m 46s

To Find the Time at Ship, and thence the Longitude.

App. Alt. of Jupiter... 31° 31′	Green. Date. 3h 14m 28s	Sun's R. A. Noon... 6h 48m 34s	Dif. 1h. 10s×3¼h—32s
Refraction ...... Sub. 2		Corr. .... Add 32	
True Alt. of Jupiter... 31° 29′	East of the Meridian.	Corr. R. Ascen... 6h 49m 6s	
Polar Distance 68 21	Log. 0.03177		
Latitude 39 25	Log. 0.11207	Jup. Dec... 21° 39′ S.	Jup. R. Ascen.... 19h 44m 26s
139° 15′		90 0	Cor. Gr. Date. . Sub. 3
Half Sum .... 69° 38′	Log. 4.54161	Polar Dist.. 68° 21′	Correct R. A... . 19h 44m 23s
Difference .... 38° 9′	Log. 4.79079	Equa. of Time.... 3m 49s ·25	Dif. 1h—·455×3¼—1s ·47
H. Angle of Jup. E. 4h 25m 23s	Log. 9.47624	Corr. .... Add 1 ·47	
R. A. of Jupiter... 19 44 23		Correct Equa.... 3m 50s ·72	
R. A. of the Merid... 15h 19m 0			
Sun's R. Ascen..... 6 49 6			
App. Time at Ship. 8h 29m 54s		Greenwich Mean Time by Lunar.	3h 13m 46s
Equa. of Time. Add 3 51		Mean Time at Ship	8 33 45
Mn. Time at Ship.. 8h 33m 45s		Longitude in .... 79° 59′ 45″ E.	5h 19m 59s

To Find the Amount of Error in the Measurement of the Lunar Distance.

Here the Correct Greenwich Time by Chronometer given being 3h 14m 28s
And the Greenwich Time by Lunar being 3 13 46
Hence their Difference in Time is .... 42 sec.

The Greenwich Time by Lunar being too small, and the Distance between the bodies decreasing, the Distance observed has been too great, the amount of which is found as follows:

Take from the N. A. the Pro. Log. of the Difference of Distance in 3 hours, (already found,)... 0.2618
Place under it the Pro. Log. of the Difference in Time, which is 42s=2.4102
Their Sum.... 2.6710
is the Pro. Log. of a portion of Space, 0° 0′ 23″, and which is the error of the measured Distance having been too great.

The error of the measured Distance may also be found, as before observed, when in sight of land, the position of which is well laid down, by first finding the Ship's true position by bearings of the land, and turning her Longitude into Time and adding it to the Mean Time at the Ship in West Longitude, or subtracting it in East, will give the true Greenwich Time. Then the comparison between this and the Greenwich Time by the Lunar Observation, as in this case, affords the learner the means of judging of the correctness of his observed Lunar Distance.

In observing with the Planets, the usual practice at Sea is to bisect the middle of the Planet on the round limb of the Moon. This saves the trouble of allowing for the semidiameter of the Planet.

FINDING THE LONGITUDE BY LUNAR OBSERVATIONS.

EXAMPLE 4.

July 4th. 1854. In Latitude 40° 20′ S., Longitude at about 81° 30′ E., at 2h 52m 0s P. M. Apparent Time at the Ship. the Sun's observed Altitude was 15° 0′, the Moon's observed Altitude Lower Limb 29° 11′, and the Sun's Distance West of the Moon 100° 12′ 24″, Index Error 2′ 30″ Additive, the Greenwich Time by Chronometer, July 3d, 21h 30m 3s, and which was known to be correct. Required the Longitude in by the Lunar Distance, and also the Error (if any) of the measured Distance.

Preparation for Clearing the Distance.

Green. Time or Date, July 3d.......... (By Chronometer.)	21h 30m 3s	Moon's Semid. Mid....... 15′ 38″ and	Hor. Par. 57′ 14″
		Corr. G. Date 6″ Aug. 8″, Add 14″	Corr. G. Date, Add 21
Obs. Dist. nearest Limbs..............	100° 12′ 24″	Corr. Aug. Semid. ..... 15′ 52″	Correct H. Par.. 57′ 35″
Index Error......................Add	2 30		
Observed Dist. Corrected.............	100° 14′ 54″	Sun's Obs. Alt..... 15° 0′	Moon's Obs. Alt. L. L.. 29° 11′
Sun's Semid........................	15 46	Corr..........Add 12	Cor...............Add 12
Moon's Aug. Semid..................	15 52	Sun's App. Alt.... 15° 12′	Moon's App. Alt...... 29° 23′
Apparent Dist.......................	100° 46′ 32″		

Clearing the Distance.

Moon's Hor. Parallax................	57′ 35″	Pro. Log. 0.4950	............Pro. Log...0.4950
Sun's App. Altitude.................	15° 12	Co-Sec. 0.5814	☽'s App. Alt....29° 23′ Co-Sec.....0.3092
Apparent Distance...................	100° 46′ 32″	Sine.... 0.9923	..........Tang......1.7205
First Correction....................	4 44 38	2.0687	
Second Correction...................	4 54 37		..........2.5247
Third Correction....................	2 35		
True Distance.............Less 10°=	100° 28′ 22		
Dist. Nautical Almanac at XXI hours.	100 13 12	Pro. Log. 0.2876	
Difference..........................	15′ 10″	Pro. Log. 1.0744	

Pro. Log. 0.7868= 0h 29m 25s Portion of Time to be Added

To the Hour of the preceding Dist. Naut. Almanac............ 21h 0 0

Green Mean Time by Lunar.................................. 21h 29m 25s

To Find the Time at the Ship and thence the Longitude.

Green. Date, July 3d... 21h 30m 3s
24 0 0
Time from Noon, July 4, 2h 29m 57s

Dec. Noon, July 4th...... 22° 54′ N
Corr. for 2½h.........Add 1
22° 55′ N
90 0
Polar Dist............ 112° 55′

Equa. of T...4m 0s .1 Dif. 1h .441
Corr. 2½h, Sub. 1 ·10 2½
Corr. Equa...3m 59s 882
220
1·102

Sun's App. Alt............	15° 12′	
Refraction............Sub.	3	
Sun's True Alt............	15° 9″	
Polar Dist................	112 55	Log. 0.03571
Latitude..................	40 20	Log. 0.11788
	168° 24′	
Half Sum..................	84° 12	Log. 4.00456
Difference................	69° 3′	Log. 4.97030
App. Time at Ship......2h 52m 4s		Log. 9.12845
Equa. of Time......Add	3 59	
M. T. at Ship, July 4th. 2h 56m 3s		
Add 24 0 0		
or July 3d............26h 56m 3s		

Green. Mean Time by Lunar, July 3d.......... 21h 29m 25s
Mean Time at Ship, July 3d.............. 26 56 3
Longitude in by Lunar........81° 39′ 30′ E.= 5h 26m 38s

To Find the Amount of Error in the Measurement of the Lunar Distance.

Here the Correct Greenwich Time by Chronometer given is 21h 30m 3s
and the Greenwich Time by Lunar being........................ 21 29 25
Their Difference in Time is..... 38s

The Greenwich Time by Lunar being too Small and the Distance between the bodies increasing the Distance observed has been too Small, and the amount is found as follows:

Set down the Pro. Log. of the Difference of the Distance in 3 hours (already found) 0.2876
And place under it the Pro. Log. of the Difference 38s in Time......... 2.4536
Their Sum......... 2.7412

= the Pro. Log. of a portion of Space 0° 0′ 20″, and which is the Error of the Measured Distance, having been too small.

Hence the following Rule.

Lunar Distance Increasing. { Greenwich Time by Lunar too Great=Distance Observed is too Great
Greenwich Time by Lunar too Small=Distance Observed is too Small

Lunar Distance Decreasing. { Greenwich Time by Lunar too Great=Distance Observed is too Small
Greenwich Time by Lunar too Small=Distance Observed is too Great

by the amount of the Error found as above.

FINDING THE LONGITUDE BY LUNAR OBSERVATION.

EXAMPLE 5.

The Bodies being too near the Meridian the Mean time at Ship is found Afterwards by an Altitude of the Sun, and showing the Manner of Applying it.

August 15th, 1854, or August 14th, 17h 28m 0s Apparent Astronomical Time by Watch, in Latitude 10° 23′ N. Longitude 20° 15′ W. the observed Altitude of the Star Aldebaran was 69° 24′, the Moon's Altitude L. Limb on the Meridian 83° 24′, and the observed Distance Moon's nearest Limb 19° 15′ 6″, Index Error 1′ 45″ Additive. The Course and Distance made good was W. by S. 9 miles, until 18h 14m 28s Astron. Time by the same Watch, when the Sun's observed Altitude was 5° 23′. Required the Latitude in by the Moon's Altitude, the Mean Time by the Sun's Altitude, and the Longitude in at the Time of the Lunar Distance.

Preparation for Clearing the Distance.

App. Astron. T. at Ship, Aug. 14th.	17h 28m	Moon's Semid Mid.........	15′ 15″	and Hor. Par. Mid ...	55′ 52″
Long. 20° 15′ W. in Time....Add.	1 21	Corr. for 7 hours.......Sub.	3	Corr. for 7h.....Sub.	13
Greenwich Date, August 14th.....	18h 49m		15′ 12″	Correct Hor Par....	55′ 39″
✱ East of the Moon.		Moon's Aug...........Add	15		
		Aug. Semid..............	15′ 27″		
Observed Distance nearest Limb..	19° 15′ 6″				
Index Error...............Add	1 45	✱'s Obs. Altitude.........	69° 24′	☽'s Obs. Alt. L. L.	83° 24′ N
Observed Distance Corrected....	19° 16′ 51″	Dip..................Sub.	4	Corr..........Add	12
Moon's Aug. Semid............	15 27	✱'s App. Altitude.........	69° 20′	☽'s App. Alt....	83° 36′
Apparent Distance.............	19° 32′ 18″				

To Clear the Distance

Moon's Hor. Parl........	55′ 39″	Pro. Log. 0.5098		Pro. Log.	0.5098
✱'s App. Altitude.....	69° 20 0	Co-Sec.. 0.0289	☽'s Apparent Altitude.... 83° 36′	Co-Sec.	0.0027
App. Distance........	19° 32′ 18″	Sine.... 0.5244		Tang....	0.5502
First Correction......	2 24 20	Log..... 1.0681			
Second Correction.....	7 35 48			Log.....	1.0627
Third Correction......	0 0 21				
True Dis. less 10°.....	19° 32′ 47″				
Dis. N. A. at XVIIIh	19 57 36	Pro. Log. 0.3115			
	24′ 49″	Pro. Log. 0.8605			
		.5490 = 0h 50m 51s Portion of Time to be Added.			

To the Hour of the preceding Dis. N. A.... 18 0 0

Greenwich Mean Time by Lunar............... 18h 50m 51s

To Find the Latitude by Observation and the Mean Time at the Ship when the Distance was Observed.

		Time by Watch.....	18h 14m 28s	Sun's Dec. Noon, August 15th...	14° 6′ N
Sun's Obs. Alt...........	5° 23′	Long. 20° 15 W. in T.	1 21 0	Corr. for 4½h...............Add	3
Corr.,...............Add	3	Green. Date.......	19h 35m 28s	Correct Dec..................	14° 9
Sun's True Altitude........	5° 26′			Sun's Polar Dist..............	75° 51
Polar Distance............	75 51	Log. 0.01338			
Latitude..................	10 23	Log. 0.00717			
	91° 40′				
Half Sum................	45° 50′	Log. 4.84308			
Difference..............	40° 24′	Log. 4.81166			
App. Time.........18h 12m 10s		Log. 9.67529			
Equa..........Add	4 19				
Mean Time.........18h 16m 29s at Ship.					

☽'s App. Mer. Alt..	83° 36′ N.		
Corr. for Alt....Add	6	Equa. Noon......	4m 17s
True Alt.....	83° 42′	Cor 4½h......Add	2
Zen. Distance.......	6° 18′ S.	Correct Equa....	4m 19s
Declination........	16 41 N.		
Latitude in.......	10° 23′ N.		

To Find the Mean Time at Ship at the Time the Distance was Observed.

Take the Difference between the Times shown by the Watch or Chronometer at the Time the Distance was observed and the Time the Altitude of the Sun was observed, which call the Interval. Turn the Difference of Longitude (made in the Interval) into Time, and *Subtract* it from the Interval if Sailing West or *add* it to Interval when Sailing East, will give the Correct Interval. Subtract the Correct Interval from the Mean Time obtained from the Sun's Altitude, and the result is the Mean Time at Ship at the Time the Lunar Distance was observed; then the Difference between the Greenwich Mean Time found by Lunar and this Mean Time at Ship reduced back, is the Longitude of the Ship in Time.

EXAMPLE IN THE ABOVE CASE.

Mean Time at Ship...	18h 16m 29s	Time of Distance by Watch.............	17h 28m 0
Corrected Interval...................Sub.	45 52	Time of Sun's Altitude by Watch.......	18 14 28
Mean Time at Ship when Dist. was Obs...	17h 30m 37s	Measured Interval by Watch............	46 28
Green. Mean Time by Lunar, August 14th.	18 50 51	Course W. by S. 9 = D. Lon. 9′ W. in Time..Sub.	36
Longitude in............20° 3′ 30″ W. =	1h 20m 14s	Corrected Interval.....................	45m 52s

If the Interval is great it will be more correct to measure the Interval by Chronometer but if the Watch keep uniform Time, the Chronometer is not necessary.

FINDING THE LONGITUDE BY LUNAR OBSERVATIONS.

The Sun being too near the Meridian, the Time is found by the Moon's Altitude.

EXAMPLE 6.

August 15th, 1854, or August 14th, at 22h 30m Apparent Astronomical Time at Ship, the Moon's observed Altitude, Upper Limb, West of the Meridian, was 18° 38′, Sun's Altitude 67° 28′, and his observed Distance East of the Moon 91° 7′ 44″. Index error 1′ 45″, additive. The face of a Chronometer at the same time showed 0h 10m 23s. The Ship sailed S. W. (true) 15 miles until Noon, when the Latitude observed was 9° 56′ N., the Longitude by account at the same time being 21° 30′ West. Required the Longitude by Lunar Observation, and supposing it to be correct, the error of the Chronometer on Greenwich Mean Time, and also the Longitude by Lunar brought up to Noon by the Dead Reckoning.

Preparation for Clearing the Distance.

App. Time at Ship, August 14th,....	22h 30m	Moon's Semid. Noon ....15′ 9″ and Hor. Par. Noon.... 55′ 30″	
Long. 21° 30″ W. in Time.......Add	1 26	Augment......... Add	5
Greenwich Date, Aug. 14th	23h 56m		15′ 14″

Obs. Dist. nearest Limb	91° 7′ 44″					
Index Error.......... Add	1 45					
Obs. Dist. corrected........	91° 9′ 29″					
Sun's Semid.......... Add	15 50	Moon's Obs. Alt. Up. Limb......	18° 38′	Sun's Obs. Alt.	67° 28′
Moon's Aug. Semid... Add	15 14	Sub.	20	Add	12
App. Central Dist	91° 40′ 33″	☽'s App. Central Alt..........	18° 18′	Sun's App. Alt.....	67° 40′

To Clear the Distance

Moon's Hor. Parallax............	0° 55′ 30″	Pro. Log.	0.5110			Pro. Log.	0.5110
Sun's App. Altitude	67 40 0	Co-Sec.	0.0339	☽'s App. Alt....	18° 18′	Co-Secant	0.5031
Apparent Distance..............	91° 40′ 33″	Sine	0.9998			Tangent	2.5340
First Correction.	4 8 39	....	1.5447				
Second Correction	4 59 30.		.	. . . .			3.5481
Third Correction.................	3 8						
True Distance, less 10°...........	90° 51′ 50″						
Dist. N. A. at Noon..............	90 51 50						
	0° 0′ 0″	Green. Time, Aug. 14th... 24h 0m 0s, or Noon of Aug. 15th.					

To Find the Mean Time at the Ship, and thence the Longitude.

App. Alt. of the Moon....	18° 18′	Time by Face of the Chro. 0h 10m 23s.	☽'s R. A. Noon, Aug. 15th,	3h 16m 29s
Cor. for Alt., Table XXV, Add	49			
☽'s True Alt...........	19° 7′		☽'s Dec. Noon, Aug. 15th,	17° 38′ N.
☽'s Polar Dist..........	72 22	Log. 0.02090	Polar Dist.............	72 22
Latitude	10 7	Log. 0.00681		
	101° 36′		Suns R. A. Noon, Aug. 15th,...	9h 38m 34s
Half Sum	50° 48′	Log. 4.80074		
Difference	31° 41′	Log. 4.72084	Equa. of Time, Noon....	4m 16s.
☽'s H. A. West of Mer. 4h 52m 0s		—Log. 9.54879		
☽'s R. Ascen....Add	3 16 29	Course to Noon S. W. 15 miles D. Lat. 11′ Dep. 11′—D.Lon.—0°11′		
R. A. of the Merid..	8h 8m 29s	Latitude Obs. at Noon........... 9° 56′ N.		
Add	24 0 0	Lat. in at Time of Dist..........10° 7′ N.		
	32h 8m 29s			
Sun's R. Ascen..Sub.	9 38 33			
App. Time at Ship..	22h 29m 56s	Greenwich Mean Time by Lunar, Aug. 14th		24h 0m 0s
Equa. of Time. Add	4 16	Mean Time at Ship, Aug. 14th....................		22 34 12
Mean Time at Ship.	22h 34m 12s	Long. in by Lunar................ 21° 27′ 0″ W.=		1h 25m 48s.
		Diff. of Long. made to Noon....... 11 0 W.		
		Long. in by Lunar, Noon .... 21° 38′ 0″ W		

To Find the Error of the Chronometer.

Time by Chronometer when the Distance was Observed....	0h 10m 23s	Past Noon, Aug. 15th.
Greenwich Mean Time by Lunar	0 0 0	or Noon of Aug. 15th.
Hence the Chronometer is Fast of Green. Mean Time.....	0h 10m 23s	

In this case, if the Time at Ship had been found from the Sun's Altitude, the error in the Time would be 8 seconds too great, the Sun being too near the Meridian.

The Moon being the lower body in this case, by raising her the True Distance is 48′ 43″ less than the Apparent Distance. (See Figure 30.) And as before observed, the Difference between the Apparent and the True Distance *can never exceed the Sum of the correction for Altitude.* (That is, the Moon's parallax in Altitude, found in Table XXV, and Sun or Star's correction for Refraction, found in Table IV.) When the difference between the observed and the true Distance exceeds that quantity, it may be concluded that some gross error has been committed in the Clearing of the Lunar Distance.

TO COMPUTE THE ALTITUDES OF THE OBJECTS AT THE TIME THE DISTANCE WAS OBSERVED,

Having the Correct Apparent Time, the Latitude of the Place, and the Approximate Longitude.

It sometimes happens at Sea, in taking a Lunar Observation, that the Altitude of one or both of the objects are lost in consequence of cloudy weather coming on. In that case, if the Apparent Time at the Ship, and the correct Latitude of the place are known, the Apparent Altitudes of the objects may be computed as follows:

RULES

To Compute an Altitude.

1st. If the Time at Ship is not known, and a Chronometer at hand, (and its error on Greenwich known,) take the Greenwich Time by Chronometer at the time of the Distance, from which subtract the Longitude in Time in West, or add it in East Longitude, will give the Mean Time at the Ship. From the Nautical Almanac take out the Equation of Time, and apply it to this Mean Time the contrary way to what is directed in the column for Apparent Time, and the result is the Apparent Time at the Ship at the time the Distance was observed.

If an Altitude of one of the objects has been observed at a proper Distance from the Meridian, the Apparent Time can at once be found from its Altitude.

Or, the Watch may be corrected to Apparent Time by an Altitude taken either before or after the Lunar Distance has been observed, allowing for the difference of Longitude in Time, made in the interval.

If the Apparent Time at Ship is A. M., *add* 12 hours to it; but if P. M., both will then be the Apparent Astronomical Time from the preceding Noon, which must be dated *one* day less than the Sea account; if the Civil day is used, and the Apparent Time is A. M., date it also one day less, but when P. M. date it the same as Civil Time.

2d. Find the Hour Angle of the object, which, if it be the Sun, is the Apparent Time from the nearest Noon. If the object be the Moon or a Planet, find the Greenwich Date as usual, and from the Nautical Almanac take out their Right Ascensions and Declinations, and correct them to the Greenwich Date; but if the object be a Star, take out its Right Ascension and Declination from Table XVIII, and correct the Sun's Right Ascension taken from the Nautical Almanac to the Greenwich Date.

Add the Sun's Right Ascension to the Apparent Time, their Sum (less 24 hours, if it exceed that quantity) will be the Right Ascension of the Meridian, the difference between which and the Right Ascension of the object in Time will be its Hour Angle; write under it the Latitude and the Declination of the object.

3d. Then, if the Latitude of the place and the Declination are both of the same name, that is, both North or both South, their difference will be the Meridian Zenith Distance; but if one be North and the other South, their Sum will be the Meridian Zenith Distance.

4th. Add together the Logs. of the Hour Angle, found in Table XXIX, the Log. Co-Sines of the Latitude and Declination, from the top of Table XXVIII, and the Log. Secant of the Meridian Zenith Distance, from the top of Table XXVII. The Sum of these 4 Logs., (rejecting 10 from the Index,) found in Table XXIX, will give an Arch in Time.

5th. Turn this Arch in Time into Degrees, &c., by Table XXIX, and from the top of Table XXVII take out its Log. Secant, which add to the Log. Secant of the Meridian Zenith Distance, (already found,) the Sum will be the Log. Co-Secant of the True Altitude of the object, found at the bottom of Table XXVII.

6th. As the Apparent Altitudes are used in correcting a Lunar Distance, it is necessary to reduce the True Altitudes thus found as above to the Apparent Altitudes. When the object is the Sun, Planet, or a Star, this is simply the correction for Refraction, taken from Table IV, which must be *added* to the True Altitude. Their *Sum* will be the Apparent Altitude.

But when the object is the Moon, enter Table XXV with the Moon's True Altitude at the side, and her Horizontal Parallax at the top, and take out her correction for Altitude. This *subtracted* from the True Altitude will give her Apparent Altitude.

In the night time, at Sea, a Lunar Distance may often be correctly observed, while the Altitudes of the objects may be in great uncertainty from the obscurity of the horizon; and in the case of the Moon, in cloudy weather, long, dark shadows are sometimes projected on the Sea under her, which renders it impossible to obtain her Altitude correctly. In that case, the Altitudes may be computed by the above Rules. But it rarely happens that a time cannot be chosen to observe the Altitudes correct enough for Clearing the Lunar Distance, as precision in the Altitudes is not necessary, and thus saving the heavy additional calculations of Altitudes in working a Lunar Observation.

TO COMPUTE THE ALTITUDES OF THE OBJECTS AT THE TIME THE DISTANCE WAS OBSERVED.

To Find the Sun's Altitude.

Suppose it was required to find the Sun's Apparent Altitude at the Time of the Distance Observed in Example 1st, page 166, the Mean Time at Greenwich by Chronometer being, June 3d, 7h 36m 0s, Latitude in 30° 0′ N. and Longitude 69° 54′ 15″ W., we proceed as follows:

Green. Time by Chronometer, June 3d	7h 36m 0s	Sun's Dec. Noon.	22° 19′ N.	Equa. of Time Noon	2m 18s
Long. 69° 54′ 15″ W. in Time, Sub.	4 39 37	Corr. for 7½h. Add	2	Corr. for 7½ ... Sub.	8
Mean Time at Ship	2h 56m 23s	Correct Dec.	22° 21′ N.	Correct Equ.	2m 10s
Equa. of Time, Add	2 10				
Apparent Time at Ship	2h 58m 33s	Log. Table XXIX	9.15902		
Sun's Declination	22° 21′ N.	Co-Sine Table XXVIII	4.96608		
Latitude	30 0 N.	Co-Sine Table XXVIII	4.93753		
Meridian Zenith Distance	7° 39′	Sec. Table XXVII	0.00388...0.00388		
Arch. in Time	2h 39m 42s	Log.....Table XXIX	9.06651		
Turned into Degrees by Table XXVI	39° 56′	Sec.....Table XXVII	at Top...0.11532		
Sun's True Altitude	49 28	Co-Sec..Table XXVII	at Bottom 0.11920		
Refraction, Table IV, Add	1				
Sun's Apparent Altitude	49° 29′				

To Find the Moon's Altitude.

Required to compute the Moon's Altitude at the time of the Distance observed, in Example 2d, page 167, the Apparent Time at Ship being, June 3d, 7h 57m 45s, the Latitude in 29° 32′ N., and Longitude by Acct. 69° 20′ W. to find the Moon's Apparent Altitude.

App. Time at Ship, June 3d	7h 57m 45s	App. Time at Ship	7h 58m		Sun's R. A. at Noon.	4h 44m 13s
Sun's R. Ascen	4 46 18	Lon. 69° 20′ W. in Time Add	4 37		Corr. for 12h 35m Add	2 5
R. A. of the Meridian	12h 44m 03s	Greenwich Date, June 3d	12h 35m		Sun's Correct R. A.	4h 46m 18s
Moon's R. Ascen	11 5 13				☽'s R. A. Mid.	11h 4m 13
Moon's Hour Angle	1h 38m 50s	Log.... Table XXIX	8.66664		Corr. for 35m..Add	1 0
Moon's Declination	11° 27′ N.	Co-Sine Table XXVIII	4.99127		☽'s Correct R. A.	11h 5m 13s
Latitude	29° 32′ N.	Co-Sine Table XXVIII	4.93955			
Meridian Zenith Distance	18° 5′	Sec.... Table XXVII	0.02200	0.02200		
Arch. in Time	1h 34m 11s	Log.... Table XXIX	8.61946			
Turned into degrees by Tab. XXVI	23° 33′	Sec.... Table XXVII	at Top	0.03777	☽'s Dec. Mid..	11° 35′ N
Moon's True Altitude	60° 38′	Co-Sec. Table XXVII	at bottom	0.05977	Corr. 35m..Sub	8
Corr. for Alt. Table XXV, Sub.	27				☽'s Corr. Dec..	11° 27 N
Moon's Apparent Alt.	60° 11′	at Time of the Dist. See Ex. 2d, page 167.				

To Find a Star's Altitude.

Required to compute the Altitude of the Star Aldebaran at the Time of the Distance. in Example 5th, page 170, the Apparent Time at Ship being, August 14th, 17h 28m 0s, the Latitude in 10° 23′ N., and Longitude by Acct. 20° 15′ W., to find the Star's Apparent Altitude.

App. T. at Ship, Aug 14th	17h 28m 0s	App. Time at Ship	17h 28m	Sun's R.A. Noon, Aug. 14,	9h 34m 48s
Sun's R. Ascen	9 37 58	Long. 20° 15′ W. in T..	1 21	Cor. for G. Date 18h 49m Add	3 10
	27h 5m 58s	Green. Date, Aug. 14...	18h 49m	Sun's Correct R. A.	9h 37m 58s
Sub.	24 0 0				
R. A. of the Meridian	3h 5m 58s			✱'s R. A. Tab. XIX...	4h 27m 32s
✱'s R. Ascen	4 27 32				
✱'s Hour Angle	1h 21m 34s	Log. Table XXIX	8.49601	✱'s Dec. Tab. XIX...	16° 13′ N
✱'s Declination	16° 13′ N.	Co-Sine Table XXVIII	4.98237		
Latitude	10 23′ N.	Co-Sine Table XXVIII	4.99283		
Meridian Zenith Dist	5° 50′	Sec... Table XXVII	0.00225=0.00225		
Arch in Time	1h 19m 27s	Log... Table XXIX	8.47346		
Tur. into degrees by T. XXVI	19° 52′	Sec.... Table XXVII	at Top....0.02665		
✱'s True Altitude	69 20	Co-Sec. Table XXVII	at bottom 0.02890		
Corr. for Ref., Add	0				
✱'s App. Altitude	69° 20′	at the Time of the Dist. See Ex. 5, page 170.			

It may be remarked here that considerable care is required in correcting the R. A. and Declinations to the Green. Date, and also in having the Apparent Time correct, especially when the object is near the Prime Vertical, but an Error in the Latitude at that time will not much affect the result, and when the object is near the Meridian any probable Error in the Time will not much affect the computation, but an Error in the Latitude will cause nearly an equal Error in the computed Altitude.

NOTE.—An Error of 2′ or 3′ in the Altitude of a Star has more effect in producing an Error in the True Lunar Distance in some cases than an Error of 10′ in the Moon's Altitude would have. This is important to bear in mind in working a Lunar Observation.

FINDING THE LONGITUDE BY LUNAR OBSERVATIONS ON SHORE.

A Lunar Observation may be taken on Shore by the aid of an Artificial Horizon for observing the Sun's Altitude (see pages 77 and 78) only; the Altitude of the Moon can be computed by the preceding rules, and the observations should be taken when the Sun is at a proper Distance from the Meridian with the view of obtaining the Time at the place, from the same Altitude observed with the Distance.

The Observation

Compute the Approximate Distance as directed at page 74, ready for use, and proceed first to observe an Altitude of the Sun in the Artificial Horizon, note down the Time and the Altitude, set the Index of the Sextant to the Approximate Distance, and when brought into the field of view bring the Limbs in contact, note down the time and the observed Distance, proceed to take any odd number of Distances and their corresponding Times, as recommended at page 76, and finish with an Altitude of the Sun, noting down the Time as before.

Find the Mean of the Times of the Distance and the Mean of the Distances, and the Difference between the Times of the Altitudes and the Difference of the Altitudes; then say, as the Difference of the Times is to the Difference of the Altitudes, so is the portion of Time between the Time of the first Altitude and the Mean of the Times of the Distance to a portion of Altitude, which Added or Subtracted to or from the first Altitude, according as it is Increasing or Decreasing, will give the Sun's Altitude at the Time of the Mean Distance.

Having the Sun's observed Altitude, the Latitude of the place (which may be obtained in like manner by the Sun's Meridian Altitude, see page 92,) and the Approximate Longitude, proceed to find the Apparent Time as in the Examples at page 131.

Having the Apparent Time at which the Distance was observed, compute the Moon's Apparent Altitude (by the Rule at page 172), and proceed to work the Lunar as before:

EXAMPLE OF WRITING DOWN THE OBSERVATION

September 26th, 1854. At 3h 57m 15s P. M. Mean Time at New York, in Latitude 40° 42′ 42″ N., and Longitude 74° 0′ 15″ W., the following observation was made to find the Longitude.

Time per Watch.............	3h 53m 0s	Alt. Sun's L. L. Art. Hor. 41° 32′ 0″	
Mean of the Times 3h 57m 15s.	3 55 10	Dis. of Sun and Moon... 55 13 10	Mean Dis..... 55° 14′ 10″
	3 57 25	do. do. 0 14 10	Index Error..Add 50
	3 59 10	do. do. 0 15 10	Obs. Dis...... 55° 15′ 0″
	4 1 28	Alt. Sun's L. L......... 38 33 0	

To Find the Sun's Altitude at the Time of the Mean Distance and thence the Time at the Place.

Time of the 1st Alt.... 3h 53m 0s	1st Alt. 41° 32′	Time of 1st Alt. 3h 53m 0s	8m 28s Pro. Log..... 1.3276
do. 2d Alt.... 4 1 28	2d Alt. 38 33	Mean of the T... 3 57 15	Arith. Co.... .... 8.6724
Say as 8m 28s is to	2° 59′	So is 4m 15s	2° 59′ Pro. Log.... 0.0024
			4m 15s 1.6269
Sun's Obs. Alt. Artif. Hor. 40° 2′ 8″	Time by Watch.... 3h 57m 15s	1° 29′ 52″=Pro. Log... 0.3017	
Index Error........Add 50	Long. 74° W. in Time 4 56 0	1st Alt. 31 32 0	Decreasing.
Observed Angle....... 2)40° 2′ 58″	Greenwich Date.... 8h 53m 0s	Obs.Alt. 40° 2′ 8″ at Time of Dist.	

Alt. of Sun's L. Limb..	20° 1′ 29″		Sun's Declination Noon....	1° 12′ 52″ S.	Dif. 1h 58
Sun's Sem. 16′ Ref. 2′ 29″=	13 31		Corr................Add.	8 42	G. Date 9h
Sun's True Altitude......	20° 15′ 0″		Correct Declination.......	1° 21′ 34″ S.	60)522
Polar Distance..........	91 21 34	Log. 0.00012		90 0 0	8′ 42″
Latitude...............	40 42 42	Log. 0.12033	Polar Distance..........	91° 21′ 34″	
	152° 19′ 16″				
Half Sum......	76° 9′ 38″	Log. 4.37876	Equation of Time, Noon.	8m 37s ·87	Dif. 1h ·840
Difference..............	55° 54′ 38″	Log. 4.91812	Correction..........Add	7 ·56	G. Date 9h
App. Time at Place.....	4h 6m 0s =	Log 9.41733	Correct Equation	8m 45s ·43	7·560
Equation of Time...Sub.	8 45				
Mean Time at Place.....	3h 57m 15s				

TO FIND THE LONGITUDE BY LUNAR OBSERVATIONS ON SHORE.

Having the Apparent Time, to Compute the Moon's Altitude at the Time of the Distance.

App. Time at place .. 4h 6m 0s
Sun's Right Ascen.....12 12 33
R. A. of the Merid. .. 16h 18m 33s
☽'s R. Ascen......... 15 47 12
☽'s Hour Angle..... 0h 31m 21s Log. 7.66891
☽'s Declination...... 20° 30' S. Co-Sine 4.97159
Latitude .... 40 43 N. Co-Sine 4.87964
☽'s Mer Zen. Dist.... 61° 13' ...Secant 0 31740=0.31740
Arch in Time.... 0h 38m 4s = Log. 7.83754
In degrees........ 9° 31' = Secant 0.00602
Moon's True Alt. ..... 28° 21' = Co-Sec........ 0.32342
Corr., Tab. XXV,..Sub. 0 49
Moon's App. Alt..... 27° 32' at the Time of the Distance.

Green. Date, Sept. 26th, 8h 53m 0s.

Sun's R.A. 12h 11m 12s Dif. 1h 9s
Corr.....Add 1 21 9
R. A...12h 12m 33s 60)81s
1m 21s

☽'s R. A. at Noon 15h 26m 42s
At Midnight 15 54 24
Diff. in 12 hours... 0h 27m 42s
Diff. 12h. Pro. Log.. 1.1761
Arith. Comp....... 8.8239
27m 42s Pro. Log.. 0.8128
G. D. 8h 53m Pro. Log. 1.3067
Corr.........20m 30s=0.9434
R. A.....15h 26m 42s
☽'s R. A. 15h 47m 12s
☽'s Declination, Noon...... 18° 53' S.
Corr. G. Date 9h ......Add 1 37
☽'s Correct Dec.......... 20° 30' S

Hence we have the following Observation to Clear the Distance and find the Longitude :

Mn. Time at the place 3h 57m 15s Sun's Obs. Alt. 20° 1' ☽'s App. Alt. 27° 32' Obs. Dist. 55° 15' 0'

Mean Time 3h 57m 15s Sun's Obs. Alt. 20° 1'
Lon. 74° W. in Time 4 56 0 Semid. Add 16
Gr. Date, Sept. 26th 8h 53m 15s Sun's App. Alt. 20° 17'

☽'s Semid., Noon 15' 53" Hor. Par. 58' 12"
Corr. 2" and Augm. 8" 10 Corr. G. D. 8
☽'s Aug. Semid. .... 16' 3" ☽'s H.Par. 58' 20"
Sun's Semid......... 16 0
Obs. Distance.......55° 15 0
App. Distance......55° 47' 3"

Moon's Hor. Parallax........	58' 20"	Pro. Log.	0.4894		Pro. Log.	0.4894
Sun's App. Alt.............	20 17 0	Co-Secant	0.4601	☽'s App. Alt...27° 32'	Co-Secant	0.3351
App. Distance	55° 47' 3"	Sine.....	0.9175	....	Tangent	1.1675
First Correction	4 35 33		1.8670			
Second Correction	5 18 20					1.9920
Third Correction............	0 1 21					
True Distance..............	55° 42' 16"					
Dist., N. A., at VIh..........	54 10 41	Pro. Log.	0.2769			
Difference.................	1° 31' 35"	Pro. Log.	0.2935			

Pro. Log. 0.0166=2h 53m 16s portion of Time to be added
to the Time of the preceding Distance, N. A., 6 0 0
Greenwich Mean Time..... .... 8h 53m 16s
Mean Time at the Place............ 3 57 15
Longitude of New York in Time..... 8h 56m 1s=74° 0' 15" W

Another Example of this method is not necessary, as all the various cases are already given of finding the Longitude by Lunar Observations, and it will be perceived that this is exactly the same, except in the use of the Artificial Horizon, where no correction for the Dip of the Horizon is required in finding the Apparent Altitudes.

A person thus having a good Sextant, an Artificial Horizon, a Nautical Almanac, and an Epitome of Navigation, which together will form an excellent portable Observatory, he may, by the aid of a Compass, travel far inland, remote from human habitations, and be able at any time, when the Sun, Moon, and Stars are visible, to find his position ; and although the Longitude is required to be known with some degree of precision, in order to find the Greenwich Date, for the purpose of correcting the quantities taken from the Nautical Almanac, it may be remedied by working the Lunar over again, using the Longitude so found in the room of the Approximate Longitude first used, to find the Greenwich Date, and to correct the quantities taken from the Almanac anew.

Then, suppose he wishes to know in what direction any given place on the Sea-coast lies, the True Bearing and Distance can be found by Mercator's Sailing.

The Variation of the Compass can be found at Noon, when the Sun is on the Meridian, by simply fixing a wooden pin in a perpendicular position on the side of the compass-box, so that the shadow will be thrown over the centre of the card, this will be the True Meridian line, the difference between which and the North or South points of the Compass is the Variation. (See the Note at page 118, and the Diagram at page 119.) Or, if the Sun is too near the Zenith, it may be found in the morning or evening by an amplitude, that is, if the surface of the ground is level and not very high above the Sea. (See page 116.) The variation so found and applied to the True Bearing, will give the Compass Bearing of any given place required.

FINDING THE LONGITUDE BY OBSERVING THE MOON'S DECLINATION.

When the Moon and a Star are on or near the same Meridian together, the Longitude may be found by measuring their Distance ; because the Star's correct Declination being given in the large Nautical Almanac the Moon's Declination can be deduced therefrom.

The Greenwich Time corresponding to this Declination, taken from the large Nautical Almanac, and compared with the Mean Time at Ship at which the Observation is made, gives the Longitude of the Ship.

And as the Moon changes her Declination at the rate of about 14′ in 1 hour of Time, when near the Equator, an error of 1″ in the Observed Declination will produce an error of 1′ of Longitude, and an error of 1′ in the Observed Declination will produce an error of 1° in the Longitude, even in the most favorable case.

This method is, therefore, not capable of much precision. Besides, it can only be used to advantage when the Moon's Declination changes rapidly, that is, when she is near the Equator ; but when the Moon has great North or South Declination this method is not practicable. It may, however, be found useful in some cases, as the Observation (the objects being on the same vertical line) is much easier to take than a regular Lunar Distance.

THE OBSERVATION.

Finding the Approximate Distance.

1st. Inspect the large Nautical Almanac and find whether the Moon's Declination changes sufficiently rapid for the purpose, if so, then find at what time she passes the Meridian at Greenwich, and reduce it to the time of her passing the Meridian of the Ship,* which will be the Mean Time at the Ship. Turn the Longitude by account into Time, add it to the above Time, in West Longitude, or subtract it in East, will give the Greenwich Date. Apply the Equation of Time to the Mean Time at Ship, will give the Apparent Time at Ship. Now inspect Table XVIII. and find a Star which passes the Meridian at or as near this Apparent Time as possible. Take out the Moon and Star's Declinations from the Nautical Almanac. Then, if they are of the same name, take their difference for the Approximate Distance ; but when of contrary names, take their Sum.

Finding the Proper Star.

2d. Set the Index of the Sextant to this distance, find the Star, and bring it in contact with the round limb of the Moon. Now, having the Watch previously regulated to Apparent Time at the Ship, at the instant of Apparent Time by Watch at which the Moon is on the Meridian, observe her Distance from the Star, and note down the Time and the Distance observed.

Correcting the Observed Altitudes.

3d. Observe also the Altitudes of the Moon and Star *roughly.* If the Lower Limb of the Moon be observed *add* 12′ to it ; if the Upper Limb be observed, *subtract* 20′, and *subtract* 4′ from the Star's Altitude.

Correcting the Semidiameter and Horizontal Parallax.

4th. Take out the Moon's Semidiameter and Horizontal Parallax, correct them to the Greenwich Date, and to the Semidiameter *add* the Augmentation. If the near Limb of the Moon has been observed, *add* the augmented Semidiameter to the observed Distance, but if the far Limb has been observed, *subtract* it.

Finding the Moon's Parallax in Altitude.

5th. To the Secant of the Apparent Altitude of the Moon *add* the Pro. Log. of the Horizontal Parallax, their *Sum* will be the Moon's correction for Altitude, and from Table IV take out the Refraction for her Apparent Altitude.

Applying the Correction for Parallax in Altitude.

6th. If the Moon's Altitude is *less* than the Star's, *subtract* her correction for Altitude from the Apparent Distance, and *add* the Refraction to it ; but if the Moon's Altitude is *greater* than the Star's, *add* her correction to the Distance and *subtract* the Refraction from it.

Applying the Correction for Refraction.

7th. If the Star's Altitude is *less* than the Moon's, *add* its Correction for Refraction to the Distance ; but if the Star's Altitude is the *greatest*, *subtract* it, and the result will be the True Distance, *if the Star is on the Meridian at the same time nearly as the Moon.*

Finding the Correction of the Star's Altitude when not on the Meridian.

8th. But if the Star is not on the Meridian at the Time of the Distance, find the number of minutes, &c., it is distant from the Meridian, by computing its Meridian passage, and find the portion of Altitude wanting of its Meridian Altitude, by the Rules given at page 111.

To Apply the Correction for the Star's Altitude.

9th. Then if the Star's Altitude be *less* than the Moon's, *subtract* this portion of Altitude from the Apparent Distance : but if the Star's Altitude is *greater*, *add* this portion of Altitude to it, and the result is the True Distance between the Moon and the Star.

* To find this correction, say as 360° is to the daily variation of the Moon's passing the Meridian, so is the given Longitude in, to a portion of Time to be added to the Time of her Meridian Passage, in the N. A., in West Longitude, or subtracted from it in East, will give the Mean Time of her Meridian Passage at the Ship.

Having the True Distance between the Moon and Star to find the Moon's Declination.

10. Take from the Large Nautical Almanac the Star's Correct Dec. and mark it North or South; then if the True Dis be less than the Star's Dec. the Diff. is the Moon's Dec. of the same name as the Star's. But if the True Dis. be greater than the Star's Decl. the Diff. will be the Moon's Decl. of a contrary name to the Star's. When the True Distance and the Star's Decl. are equal the Moon is on the Equator.

Having the Moon's Observed Declination to find the Greenwich Time and the Longitude.

11. Find in the large Nautical Almanac the two Declinations between which the observed Declination falls, and take their Difference; take the Difference also between the preceding Declination and the observed Declination. Then say as the Difference of the Declination in one hour is to one hour of Time, so is the Difference between the preceding and the observed Declinations to a portion of Time, which Added to the Hour marked opposite the preceding Declination in the Nautical Almanac, will give the Mean Time at Greenwich at the time the Distance was observed.

Having the Greenwich Time to Find the Longitude.

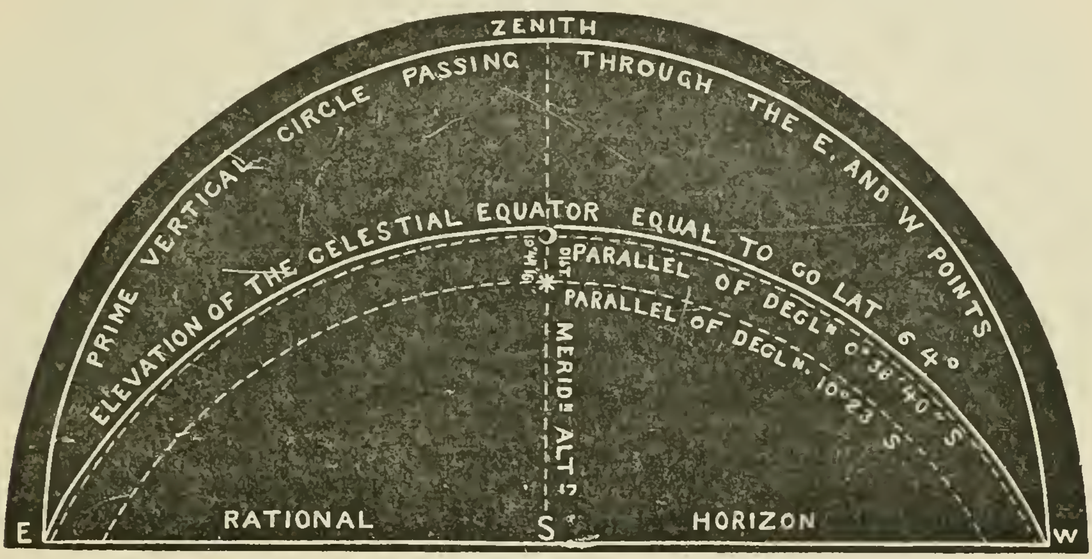
12. The Mean Time at the Ship being found in the usual manner, and it is required to have the Watch previously regulated to Apparent Time, before commencing the observation, then by applying the Equation of Time we have the Mean Time of the Distance, the Difference between which and the Greenwich Mean Time is the Longitude in Time, to be turned into Degrees and Minutes as usual.

The following Diagram will explain the nature of the observation.

PROJECTION OF THE MERIDIAN ALTITUDES OF THE MOON AND STAR SPICA.

Given the Latitude 26° *N., Star's Decl.* 10° 23′ *S., and Dist.* 9° 44′ 21″, *to Find the Moon's Decl*

FIG. 31



EXAMPLE 1.

April 14th, 1851. In Latitude 26° 2′ N., Longitude by Chronometer carried on 38° 0′ W., at 11h 23m 29s M. T at the Ship, the observed Distance of the Star Spica from the near Limb of the Moon was 9° 25′ 32″ Vertically, Moon's observed Altitude, L. L., 62° 41′, and the Star's Altitude 53° 13′. Required the Longitude in.

☽'s Mer. Pass. N. A., April 14th, 11h 18m 0s	Mean T. at Ship.......... 11h 24m	⊙'s R. A. 1h 28m 37s Dif. 9s
Say as 360° is to 52m so is Lon. 38° to 5 29	Long. 38° W. in Time..... 2 32	2 6 14h
Mean Time of Pass. at Ship.....11h 23m 29s	Green. Date, April 14th... 13h 56m	⊙'s R. A. 1h 30m 43s)126
Equation of Time........Sub. 0 15	☽'s Obs. Alt.....62° 41′	✳'s R. A. 13 17 22s 2m 6s
Apparent Time at Ship........11h 23m 14s	Corr........Add 12	Mer. Pass. of ✳ Spica 11h 46m 39s
☽'s App. Alt. 62° 53′ Sec.......... 0.3412	☽'s App. Alt... 62° 53′	App. T. of Obs....... 11 23 45
Hor. Parallax 60′ 15″ Pro. Log..... 0.4753	✳'s Obs. Alt.....53° 13′	✳'s Dist. fr. the Mer. 22m 54s = 7·397
Cor. ☽'s Par. in Alt. 27′ 28″ = Pro. Log. 0.8165	Corr........Sub. 4	Lat. 26° N. and Dec. 10½° S. Log. 0.475
Obs. Dist. ✳ and ☽ near L. 9° 25′ 32″	✳'s App. Alt....53° 9′	Por. of Alt. wanting + 25′ 35″ = 7·872
☽'s Augm. Semid.......Add 16 42	☽'s Semid. Mid. 16′ 26″ Hor. Par...... 60′ 17″	
Central Distance.......... 9 42 14	Augm......... 16 Cor. G. Date. 2	
☽'s Corr. for Par. in Alt.. Add 27 28	Augm. Semid...15′ 42″ Hor. Par,.... 60′ 15″	
10° 9′ 42	☽'s Declination N. A., April 14th, at 13h............ 0° 26′ 21″ S	
Ref. ☽'s Ap. Alt. 62° 52′. Sub. 0 29	do. do. do. at 14h............ 0 39 41 S	
10° 9′ 13″	Difference in 1 hour..... 13′ 20″	
Ref. ✳'s Ap. Alt. 53° 9′..Add 0 43	Then say as 13′ 20″ is to 1 hour so is 12′ 19″ to a portion of Time	
10° 9′ 56″	Difference in 1 hour.... 13′ 20″ Pro. Log. 1.1303	
Por. of Alt. wanting of Mer. + 25′ 35	Arith. Comp. 8.8697	
True Dis. between ✳ and ☽ 9° 44′ 21″	Is to 1 hour.... ....Pro. Log. 0.4771	
✳ Spica Dec. N. A., Ap. 14, 10° 23′ 1″ S.	So is the Diff. betw. the Preced. and Obs. Decl. 12′ 19″ Pro. Log. 1.1648	
Diff. is the ☽'s Obs. Dec. 0° 38 40 S.	Portion of Time to be Added............. 0h 55m 25s = 0.5116	
☽'s Dec. at 13h........ 0 26 21	Time of the preceding Declination..........13h 0 0	
Diff. between the Obs. and the Preceding Decl. 12′ 19″	Grenwich Mean Time...................... 13h 55m 25s	
	Mean Time at Ship 11 23 29	
	Longitude in............. 37° 59′ 0″ W. = 2h 31m 56s	

The result is a Diff. of only 1′ less than that by Chron. brought on by D. R. from Sights taken in the Afternoon.

FINDING THE LONGITUDE FROM THE MERIDIAN ALTITUDES OF THE MOON AND A STAR

The principle of this method is the same as that in the preceding example, that is, of finding the Moon's Declination by observation; but in the room of measuring the Distance between the Moon and a Star, we take the Difference between their True Meridian Altitudes. Then the Difference between this and the Star's Declination is the Moon's observed Declination, which furnishes the Greenwich Time as before.

In this case it is not necessary that the Altitudes of the Moon and Star should be observed at the same time, though they necessarily must pass the Meridian within a short time of each other, in order to obviate the necessity of making a correction for the Ship's change of place, especially when making much Northing or Southing.

The Altitudes should be accurately observed with a Sextant to the nearest second, and at *Twilight*, when the Horizon is distinctly visible. This method is therefore seldom practical in the Night Time, as it depends entirely on the accuracy of the measured Altitude.

By the method given in the 1st Example the Altitudes are not required with precision, as its accuracy depends upon the measured Distance between the Moon and the Star; an ill defined Horizon in the Night Time is therefore no detriment to the former observation.

THE OBSERVATION.

The Proper Time for Observing the Moon's Altitude.

1. The Limits are the same as in the preceding example, that is, the Time must be chosen when the Moon's change of Declination is at the greatest, and also the day on which the Moon will be on the Meridian at Twilight, which can be easily ascertained by inspecting the Nautical Almanac, and by inspecting Table XVIII, find a Star which passes the Meridian about the same time and on the same side of the Zenith.

Find the Mean Time of the Moon's Meridian passage at the Ship, to which apply the Equation of Time, will give the Apparent Time, and the Watch must be previously regulated to the exact Apparent Time at the Ship, (which can be easily done by an Altitude of the Sun before he sets,) because the Moon's Altitude must be observed at the instant of Apparent Time by Watch, (according to computation) at which she is on the Meridian of the Ship, and the Time and Altitude observed noted down.

Observing the Star's Altitude.

2. Find the Star by the rules given at page 106, No. 3, and the Apparent Time of its passing the Meridian by Table XVIII. Observe its Meridian Altitude at this time, which will be indicated by the Watch, either before or after the Meridian passage of the Moon, or according to which of the objects passes the Meridian first.

Correcting the Semidiameter and Horizontal Parallax.

3. Find the Greenwich Date as usual, and take out the Moon's Semidiameter and Horizontal Parallax, correct them to the Greenwich Date, and to the Semid. *add* the Moon's Augmentation.

To Find the Moon's Apparent Altitude.

4. If the Moon's Lower Limb be observed *add* the Aug. Semidiameter, if the Upper Limb *subtract* it, will give the Central Altitude. Take out the Dip of the Horizon accurately from Table V, and Subtract it from the Central Altitude, will give the Apparent Altitude.

To Find the Moon's True Altitude.

5. Add the Log. Sec. of the Apparent Altitude to the Pro. Log. of the Horizontal Parallax, and their Sum will be the Pro. Log. of the Moon's Corr. for Parallax in Altitude, which *add* to the Apparent Alt.

Enter Table IV with the Moon's Apparent Altitude, and take out the Refraction corresponding to it, and which must be *subtracted* from it, and the result is the Moon's True Altitude.

To Find the Star's True Altitude.

6. Enter the same Table with the Star's Observed Altitude, and take out the Refraction, Subtract both Dip and Refraction from the Observed Altitude, will give the Star's True Altitude.

Having the True Altitudes to Find the Moon's Declination.

7. From the Large Nautical Almanac take out the Star's correct Declination and mark it N. or S. Take the Difference between the Star's and the Moon's True Altitudes, then the Difference between this portion of Altitude and the Star's Declination is the Moon's Observed Declination.

If the Difference of the Altitudes be greater than the Star's Declination the Moon's Declination will be of a contrary name to the Star's. But if the Difference of Altitude be less than the Star's Declination the Moon's Declination will be of the same name as the Star's.

Having the Moon's Observed Declination to Find the Greenwich Mean Time.

8. Find in the Large Nautical Almanac the two Declinations between which the observed Declination falls, and take their Difference; take the Difference also between the preceding and the observed Distance; then say as the hourly Difference is to 1 hour so is the Difference between the preceding and the observed Declinations to a portion of Time, which Added to the hour opposite the preceding Declination will give the Greenwich Mean Time at the time of the observation

FINDING THE LONGITUDE FROM THE MERIDIAN ALTITUDES OF THE MOON AND A STAR.

To Choose a Case.

Suppose it was required to find the Longitude by this method, on the evening of the 6th of July, 1854. On inspecting the Nautical Almanac, I find that the Moon's Declination changes at the rate of 123″ in 10 minutes of time; the Moon is also on the Meridian at twilight. And on inspecting Table XVIII, I find that the Star Arcturus will be on the Meridian about the same time. The case is, therefore, practical, and we proceed at once to find the Apparent Time at Ship, and correct the Watch.

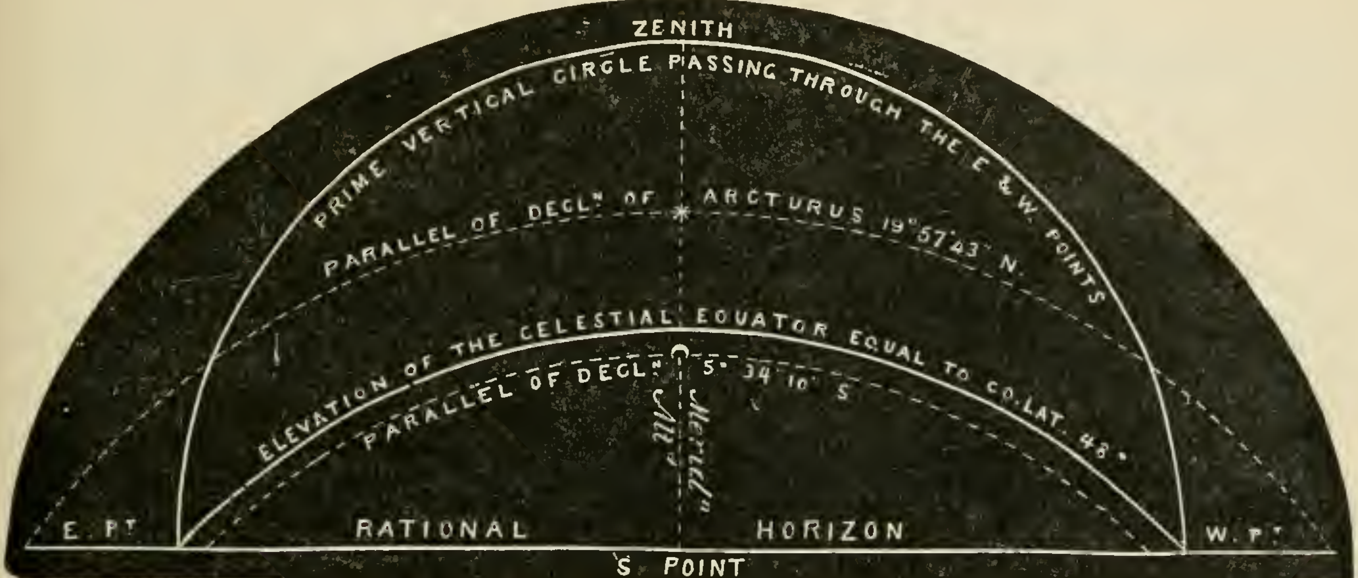
EXAMPLE 2.

July 6th, 1854. In Latitude 42° 10′ North, Longitude 64° 56′ West, at 6h 47m 7s Apparent Time at Ship by Watch, the observed Meridian Altitude of the Moon's Lower Limb was 41° 21′ 10″, and about 23m afterwards the Meridian Altitude of the Star Arcturus was observed to be 67° 52′ 15″, the elevation of the eye being 18 feet. Required the Longitude in at the Time of the Moon's Altitude.

PROJECTION

Of the Meridian Altitudes of the Moon and the Star Arcturus.

FIG. 32.



It will be perceived by the above Diagram, that the Star's Declination (being North of the Celestial Equator) subtracted from the Difference between the Moon and the Star's Altitudes, furnishes at once the Moon's Declination, South of the Equator.

To Find the Longitude from the Moon's Observed Declination.

☽'s Mer. Pass. N. A. July 6th........ 6h 42m 30s M. T. of Pass. at Ship 6h 51m 30s ☽'s Sem. 15′ 59″ H.P. 58′ 39″
Say as 360° is to 50m so is L. 64° 56′ W. to 9 0 Lon. 64° 56′ W. in T. 4 19 44 Cor. G.D. 2 Cor. 14
Mean Time of Pass. Mer. at Ship ..... 6h 51m 30s Gr. Date, July 6th, 11h 11m 14s 15′ 57″ 58′ 25″
Equa. of Time.................. Sub. 4 23 Augment... 11
App. Time at Ship .... 6h 47m 7s Cor. Eq. of Time.. 4m 23s Augm. Semi. 16′ 8″

Obs. Alt. ☽'s Lower Limb..	41° 21′ 10″	✳'s Obs. Alt..	67° 52′ 15″	☽'s True Alt............	42° 15′ 50″
☽'s Augm. Semid......Add	16 8	Dip 4′ 8″ R. 24″=	4 32	✳'s True Alt	67 47 43
Central Altitude	41° 37′ 18″	✳'s True Alt.	67° 47′ 43″	Diff. of Altitudes	25° 31′ 53″
Dip of the Hor. 18 feet......	4 8			✳'s Dec. N. A., July 6th..	19 57 43 N
☽'s App. Alt.............	41° 33′ 10″	App. Alt. Log. Sec.	0.1259	☽'s Obs. Declination......	5° 34′ 10″ S
Corr. for Par. in Alt....Add	43 43	H.P. 58′ 25″ Pro. Log.	0.4887	☽'s Dec. N. A., July 6th, 11h.	5 31 56
	42° 16′ 53″	☽'s C. 43′ 43″ Pro. Log.	0.6146	Diff. of Obs. and preced. Dec.	0° 2′ 14″
Refraction in Alt.... ..Sub.	1 3				
Moon's True Altitude.....	42° 15′ 50″			☽'s Dec. N. Al., July 6th, 11h	5° 31′ 56
				do at 12h	5 44 13
Say as 12′ 17″ is to 1h so is 2′ 14″ to a portion of Time.				Diff. of Dec. in 1 hour......	0° 12′ 17″

Diff. Declination.. 12′ 17″....Pro. Log.....	1.1660	Time of the preceding Declination....	11h 0m 0s
Arith. Compli	8.8340	Portion of Time to be added.........	10 54
I hour................ . ...Pro. Log.....	0.4771	Greenwich Mean Time..............	11h 10m 54s
Diff. of Dec. 2′ 14″.... ....Pro. Log.....	1.9063	Mean Time at Ship	6 51 30
Portion of Time 10m 54s ......Pro. Log.....	1.2174	Longitude in .... 64° 51′ 0″ W.=	4h 19m 24s

Degree of Dependence.

Although the Altitudes are required to be taken with much precision, to insure a tolerable degree of accuracy by this method, still as the errors in the Observation are not multiplied in the computation, it may be used with advantage in fine serene weather, when the Sea is smooth, and the Dip of the Horizon is correctly ascertained, by those persons who may not have had practice in the Lunar method. In this case an error of 10″ in computing the Moon's Declination, will produce an error of 13′ in the Longitude deduced therefrom; and an error of 1′ in the Declination will produce an error of 1° 13′ in the Longitude. This method is therefore *most* suitable for High Latitudes, where the degrees of Longitude are small, and where the actual error in space (that is, Departure) would be small in proportion. It is, however, much inferior to the Lunar method as regards accuracy; but the Observation may be useful to those who can take Altitudes accurately enough, but who make sad work at measuring a Lunar Distance

METHOD OF KEEPING A SHIP'S RECKONING AT SEA;

AND THE MANNER OF WRITING DOWN THE SAME IN A LOG BOOK OR JOURNAL

Description of the Log Slate or Board.

This is ruled in the following form, so as to contain an exact account of the Ship's progress during the 24 hours of a Sea Day, and which commences at Noon, that is, when the Sun is on the Meridian of the Ship. The hours are counted to 12 at Midnight, and called the hours P. M. They are then reckoned over again in the same manner, until the following Noon, and called the hours A. M.

Mode of Reckoning Time.

The Sea Day begins 12 hours before the Civil Day, and 24 hours before the Astronomical Day. So that the end of the Sea Day, the beginning of the Astronomical Day, and the Middle or Noon of the Civil Day, takes place at the same period of time.

This mode of reckoning arises from the custom of seamen dating their Day's Work for the preceding 24 hours the same as the Civil Day, so that occurrences which happen, for instance, on Tuesday the 10th in the afternoon, are entered in the Log marked Wednesday the 11th, P. M., and occurrences which happen on the following morning of the Sea Day, are entered in the Log marked A. M., and which also corresponds to the same hours of the Civil Day

What the Log Board should Contain.

The Log Board should contain a register of the Courses, Distances, Leeway, and the direction of the Wind tacking or wearing Ship, making or shortening Sail, and other matters of importance connected with the Ship's way; and it is the duty of the officer of the Watch to mark the same regularly on the Log Slate (which is generally hung up in the Steerage for that purpose) at the expiration of each Watch, so that the Ship's progress may be ascertained at any given hour of the day.

When land is in sight, the bearing and estimated distance of the most prominent objects, and the time at which the bearing was taken, must be inserted, as also the particulars of speaking vessels at Sea, and any other memoranda intended to be inserted in the Log Book, as a guard against a slip of the memory.

Ruling of the Log Board.

The Log Board is ruled to contain seven columns; the first contains the hours from Noon to Noon, being marked for every hour, similar to a Civil Day; (or sometimes it is marked for every two hours,) in the second and third columns are inserted the rate of sailing by Log per hour, set against the hour when the Log was hove; the fourth column contains the Courses steered by Compass; the fifth, the direction of the Wind; the sixth, the Leeway; and the seventh contains the transactions, remarks on the weather, and ther memoranda.

Setting the Watch at Sea.

When a Ship leaves a Port outward bound, the crew are divided into two Watches, termed the Starboard and Larboard Watches, and who do duty 4 hours alternately, except between 4 and 8 o'clock in the evening, when each Watch does duty 2 hours only. These are called the Dog Watches, and are for the purpose of changing the Night Watches, so that the same party will not be on duty at the same interval of time on two following nights; and it is the custom or rule for the Second Officer, who keeps the Captain's, or Starboard Watch, to take the first Watch, (which is from 8 o'clock in the evening until midnight,) on leaving Port outward bound; and the First Officer, who keeps the Larboard Watch to take the first Watch on leaving Port, homeward bound.

THE LOG BOARD.

H.	K.	F.	COURSES.	WINDS.	L. W.	REMARKS. TUESDAY, APRIL 1ST, 1854.
1	8	3	S. E.	W. S. W.		P. M. Smart breezes and cloudy weather.
2	8	2	"	"		Set studding-sails, low and aloft.
3	8	5	"	"		Stowed the anchors. Unbent and stowed the chain cables in the
4	8	7	"	"		lockers.
5	9	4	"	"		Passed several vessels bound to the Westward.
6	10		"	"		At 6h, very squally. In top-gallant-studding-sails, royals and fly
7	9	5	"	"		ing-jib.
8	9		"	"		At 8h, wind hauled to the Southward, with heavy rain. Took in
9	7		"	S. S. W.		all the studding-sails and braced up sharp.
10	7		"	"		
11	7	4	"	"		Weather gloomy and threatening.
12	6	7	"	"		At Midnight, in top-gallant-sails, and the first reefs of the topsails.
1	7		E. by S.	S. by E.		
2	7		"	"		At 2 A. M. double-reefed the topsails. Strong gale and cloudy
3	6	5	East.	S. S. E.	½	weather.
4	6		"	"		At 4h, sent down the royal yards, and made all snug aloft.
5	6		E. N. E.	S. E.	1	
6	5	8	"	"		At 6h, strong gale and a high sea running. Vessel shipping much
7	5		N. E.	E. S. E.	1½	water on deck.
8	5		"	"		At 8h, tacked ship to the Southward; more moderate weather·
9	6	5	South.	E. S. E.	2	out double-reefs and set top-gallant-sails.
10	6	8	"	"		Spoke the ship Asia, from Manilla to New York, out 85 days;
11	6	9	"	"		all well.
12	6	5	"	"		Noon. Fresh gale and cloudy. Sun obscured.
			Barom. 2920.	Ther. 76°		Magnetic variation 1½ points Westerly.

The above form of ruling for every hour is the most accurate mode, though sometimes another form is used, and marked for every two hours, but which is liable to cause considerable error in the reckoning, in having to double the knots marked opposite the hours, thereby doubling the error in the distance sailed. Besides, it is inconvenient for inserting the Course, when it is changed between the hours so marked.

On proceeding to work a Day's Work, the Courses by Compass are taken from the Log Board, and corrected for the Variation of the Compass and for Leeway, when she makes any. This gives the Course made good between the hours marked on the Board.

Cross off the distance below the hour at which the Course was changed, (as in the form above,) sum up the fathoms, which divide by 10*, the quotient is knots, and the remainder, if above 5, call 1 knot more, but if less than 5, throw it away; carry the quotient to the column of knots, and their sum, contained between the hours corresponding to the Course, will be the distance run on that Course.

To Correct the Courses for Variation.

RULE.

When the Variation is { Westerly, allow it to the Left hand of the Course steered. Easterly, allow it to the Right hand of the Course steered.

To Correct the Courses for Leeway.

RULE.

When the Ship is on the { Starboard Tack, allow it to the Left hand of the Compass Course. Port Tack, allow it to the Right hand of the Compass Course.

EXAMPLE

Of Correcting the Courses and Finding the Distance.

COMPASS COURSE STEERED.	VARIA.	L. WAY.	WIND.	ON WHICH TACK.	COURSE MADE GOOD.	DISTANCE.
S. E. from Noon to Midnight.	1½ pt. W.		S. W.	Wind free.	S. E. by E. ¼ E.	100
E. by S. from Mid to 2 A. M.	" "		S. by E.	Starboard Tack.	E. ¼ N.	14
East from 2h to 4 "	" "	½ pt.	S. S. E.	do.	E. N E.	13
E. N. E. " 4h to 6 "	" "	1 "	S. E.	do.	N. E. ¼ N.	12
N. E. " 6h to 8 "	" "	1½ "	E. S. E.	do.	N. by E.	10
South " 8h to Noon.	" "	2 "	do.	Port Tack.	S. ¼ W.	27

* Or, consider the Sum to be tenths of a mile, note the unit, and carry the tens to the next column, in the same manner as the Sums taken from Tables I and II.

Finding the Variation of the Compass

The Variation of the Compass may be found by an Amplitude, (see page 116,) or by an Azimuth, (see page 118.) It may also be found by inspecting the Chart, or by the Variation Table. The Magnetic Variation is there laid down from actual Observation. (See Remarks, page 120.)

Allowing for Leeway.

Leeway is the effect of the lateral pressure of the Wind and Waves in forcing a vessel out of the Course she is endeavoring to make when close-hauled, and it (is the angle contained between her wake and the point of the Compass right astern) It may be ascertained after heaving the Log, and before the line is drawn in, by bringing it over a Half-Compass, constructed for that purpose, on the Taffrail, the diameter of which being at right angles to the Ship's keel, then the angle between the centre point, and the point or half point over which the line lies, will contain the number of points of Leeway the vessel is then making, providing she has been steered steadily during the time of trial. When a Ship is laying to, the middle point between what she comes up to, and falls off, is taken as the direction of her head by Compass. The Leeway is then estimated from the angle of her wake, as before.

As the correctness of the Reckoning in a great measure depends upon a proper allowance for Leeway, the officer of the Watch should be particular in marking it on the Log Board, or else in reckoning up the day's work, it will be found difficult for a person who has not been on deck the whole time to make a proper allowance.

Correcting the Course for Leeway and Variation.

In correcting the Courses for Variation and Leeway, imagine yourself to be in the centre of the Compass and looking towards that point which represents the Course steered.

EXAMPLES

Of Correcting the Courses Steered for the Effect of Leeway and Variation.

COURSES STEERED.	WINDS.	ON WHICH TACK.	LEEWAY.	VARIATION.	COURSES MADE GOOD.
E. N. E.	N. W.	Wind free.	0	1½ pts. W.	N. E. ½ E.
W. by S.	N.W. by N.	Starboard Tack.	1 pt.	0 "	W. S. W.
N. W. by N.	N. E. by N.	do.	1½	2 " W.	W. by N. ½ N.
South.	E. S. E.	Port Tack.	½	1¼ " E.	S. by W. ¾ W.
N. W.	W. S. W.	do.	2	1 " W.	N. W. by N.
S. S. W.	S. E.	do.	1¼	1¼ " W.	S. S. W.
E. by N.	N. by E.	do.	2½	0¾ " E.	S. E. by E. ¾ E.
West.	N. N. W.	Starboard Tack.	¾	1 " E.	W. ¼ N.

In the above Examples, 6 points of an Angle is allowed between the Ship's head and the point from which the wind blows, this being as near as a square-rigged vessel will lie to the wind when close-hauled in smooth water; but in blowing weather at Sea, it is the practice to round in the weather-braces, so that the Ship's head, though still close-hauled, is about 7 points from the wind, or as it is termed by seamen, on a Western Ocean bowling, the object being to make greater speed and less Leeway.

Fore-and-aft vessels generally lie within from 4 to 5 points of the wind, that is, a point or two higher or nearer the wind than square-rigged vessels do.

In allowing for Leeway and Variation, when they both go the same way, it may be done at once by allowing their Sum; or when in different ways, take their Difference and allow it the same way as that of the greater of the two, whether it be Variation or Leeway.

And the learner should keep the figure of the Compass-card in view while making these allowances, which will be found to greatly assist the memory.

Allowing for the Heave of the Sea.

A Ship is supposed to make Leeway only when she is close-hauled and a rough sea on. But it sometimes happens when the wind is free, a heavy beam-sea may be running, which has the effect of heaving her to leeward of the Course steered. This allowance is called the Heave of the Sea, and will rarely exceed ½ point; because, although the waves appear to have a rolling motion, it is only the crest of the wave which advances, the great body of the water remaining stationary, rising and falling with a motion similar to the shaking of a sail.

And the greater the speed of the vessel the less will be the effect of the waves; on the other hand, the less the speed of the vessel the greater will be the effect of the waves in any given distance sailed; because the fast-sailing vessel will cross any given space in a shorter time than the slow one, and will be subjected to fewer buffetings.

So that the allowance for the Heave of the Sea must rest entirely on the judgment of the Navigator keeping in view the various circumstances of the case.

On allowing for Currents, (see page 29,) and for a description of the Log-Line, Log-Glass, and manner of using the same, (see page 6.)

METHOD OF KEEPING A SHIP'S RECKONING AT SEA.

Allowing For Currents.

Having thus found the Courses made good and the Distance Sailed by the Log, they are entered in the traverse Table, together with the True Set of the Current as a Course, and its Drift as a Distance when the Current is actually known to exist, otherwise much caution is required. (See Remarks at page 29.)

Remarks on the First Day's Work after Leaving the Land.

If a departure has been taken from the Land, the Variation must be allowed on the Bearing b Compass, and the opposite point entered into the Traverse Table as a Course, and the estimated distance off Shore as a Distance, (see page 31) the Difference of Latitude and Departure made good is then found by a case of Traverse Sailing; then the Difference of Latitude made applied to the Latitude left, (or in the case of taking a departure from the Land applied to the Latitude of that place,) will give the Latitude of the Ship. Then with the middle Latitude as a Course, found in Table II, and the Departure made good taken in the Latitude column, the Difference of Longitude corresponding will be found in the Distance column. This applied to the Longitude left, at the preceding Noon, (or in the case of taking a Departure from the Land, applied to the Longitude of that place,) will give the Longitude of the Ship.

Cause of the Errors in the Dead Reckoning.

The Latitude and Longitude thus calculated at Noon is called by Seamen the Dead Reckoning, and it is well named, for it frequently happens that it is *dead enough* as regards the Ship's true position. This is caused by many circumstances, such as bad steerage, local attraction acting on the Steering Compass,(for Remarks see page 120,) unknown currents, false distance given by the Log in squally weather, errors in the Log-Line and Log-Glass, and improper allowances for Leeway and Variation.

Ascertaining the Cause of the Error in the Dead Reckoning.

When the discrepancy is great between the Ship's position by Dead Reckoning and that by Observation, a careful Navigator will investigate the matter, and endeavor to ascertain the cause. If the Log-Line and Glass have been found correct, (see page 6) examine the Steering Compass and see that it is free from Local attraction, and if the Ship has been steered her proper course, and the Log has given her proper Distance run, then the discrepancy may be set down as the effect of a Current, the direction and drift of which may be found by the rules given at page 29, Case 1st, and in that case it may be allowed for in the next day's work, as a Course and Distance Sailed, or, it may be counteracted by altering the Ship's course. (See method of doing so, page 30, Case 3d.)

Allowing for Bad Steerage.

When a Ship is scudding in a Gale of wind some Navigators are in the habit of allowing for the heave of the sea, in forcing the vessel, as they imagine, ahead of the distance run by Log. This allowance is of very doubtful utility. In fact, I have always found it the reverse, especially in a badly steered or bad steering Ship, because on account of her yawing about she must necessarily waste a considerable portion of her Distance run, and the Log will be found to give the Distance run in excess of the actual place o. the Ship by observation, and it is usual in some cases to deduct 1 mile in 10 for bad steerage.

Heaving the Log in Steam Vessels.

In Steam Vessels the Log is found to give too much Distance. This is easily accounted for, and caused by the action of the paddle-wheels driving the water astern. The Log in this case should be hove from the paddle-boxes, outside of the influence of this current of water.

The Use of Keeping the Dead Reckoning.

Nevertheless, the Dead Reckoning even under all these disadvatages should not be neglected, as it sometimes is the only mode we have of detecting any very gross error made in deducing the Ship's position from Astronomical observations and in the detection of Currents, and other matters.

When the Dead Reckoning is Proved to be Erroneous, to take a Fresh Departure.

When the Longitude by Dead Reckoning is proved to have been erroneous from the Sight of Land or by the Chron., the error and rate of which has been recently found, or by Lunar Distances observed on both sides of the Moon, it can answer no useful purpose in carrying it on, and a fresh Departure and Longitude should be adopted and then carried on as before.

Practice of some Navigators Regarding Dead Reckoning.

Some Navigators carry the Longitude by Dead Reckoning on from day to day *only*, as a means of comparing it with the Longitude made by Chronometer. Others again never keep any Dead Reckoning at all trusting entirely upon the Latitude observed and the Longitude by Chronometer.

Practice of Keeping the Reckoning in Fast Sailing Ships.

In fast sailing Ships the Distance run is generally estimated, and the Log seldom or ever hove, and as those Ships generally steer well, their Course steered can be depended upon; and when the Difference of Lat. is obtained from observation, the Distance run and the Departure made good, can also be obtained by a case in Plane Sailing, and more correct than if the Distance had been measured in the usual manner by the Log. (See the following rules for working Day's works.)

METHOD OF KEEPING THE SHIP'S RECKONING AT SEA.

RULES FOR WORKING A DAY'S WORK.

The following rules have been collected with the view of simplifing the matter, and placed so as they can be conveniently referred to by the learner.

Correcting the Courses Sailed.

1. Correct each Course sailed for Variation and Lee-way by the rules (page 182) already given; enter them in the Traverse Table and set against each the Distance run on that Course. If the Ship is in a Current, the Set and Drift of which is known, allow the Variation on its set, and enter it in the Traverse Table as a Course and Distance, but if its Set and Drift is uncertain, it is better to leave it out altogether; also if the ship has taken a Departure from the Land, correct the Bearing by Compass for Variation, and enter the Table with the Opposite Point as a Course, and the estimated Distance off as a Distance.

Finding the Course Made Good.

2. Find the Difference of Latitude and Departure made good, with which enter Table II, and find the Course and Distance made good, by seeking in its columns until they are found to agree, opposite to which will be found the Distance in its column; and if the Departure be greater than the Difference of Latitude, the Course is taken from the bottom of the Table, but if the departure be less than the Difference of Latitude, the Course must be taken from the top of the Table.

Finding the Latitude In.

3. If the Latitude of the place from which the Ship's Departure has been taken, or yesterday's Latitude, and the Difference of Latitude made be both North or both South, their Sum will be the Latitude in of that name; but if the Difference of Latitude be of a contrary name to the Latitude left, their Difference will be the Latitude in, of the same name as the greater of the two.

Finding the Difference of Longitude.

4. Add together the Latitude observed yesterday and the Latitude in to-day, and take their Half Sum for the middle Latitude, then with this middle Latitude (taking the nearest Degree) enter Table II, and seek for the Departure made good in the Latitude column, and the Sum standing opposite in the Distance column will be the Difference of Longitude made, which divided by 60 will give Degrees and Minutes, and mark it of the same name as the Departure.

Finding the Longitude In.

5. If the Longitude of the place from which the Ship's Departure has been taken, or yesterday's Longitude, and the Difference of Longitude made be both East or both West, their Sum will be the Longitude in, of that name; but if the Difference of Longitude be of a contrary name to the Longitude left, their Difference will be the Longitude in of the same name as the greater of the two; but when their Sum exceeds 180° the Ship has crossed the opposite Meridian to Greenwich; in that case Subtract it from 360°, the remainder will be the Longitude in, and of a different name to the first.

Mode of Working the Day's Work when the Distance run is Unknown.

6. When the Distance run is uncertain or even altogether unknown, take the Difference of the observed Latitudes, and the Course made good, with which enter Tables I or II, as usual, and seek for the observed Difference of Latitude in its column, and opposite to which will be found the corresponding Distance run and the Departure. Then proceed as before by rule No. 4, to find the Longitude in by Dead Reckoning

General Remarks on Keeping a Ship's Reckoning, Currents, &c.

If the Latitude yesterday has been observed, the Difference of Latitude made is usually applied to it, the room of the Latitude by Dead Reckoning, and it is called the Latitude in by Dead Reckoning at Noon to-day. Then if it agrees with the Latitude in by observation to-day, the reckoning is said to be just, but it do not so agree the Ship is said to be the amount of the Difference to the Northward or to the Southward o the Dead Reckoning. In like manner, if the Longitude by Chronometer or Lunar observation has been observed and brought up to Noon yesterday, and the Difference of Longitude made by Dead Reckoning being applied to it, then if it agrees with similar observations for Longitude to-day, brought up to Noon, the reckoning is said to be just, but if they do not so agree then the Ship is said to be the amount of the Difference to the Eastward or Westward of the Dead Reckoning on this day's work.

The errors of the Latitude and Longitude so found, furnish the means of Detecting the Set and Drift of the Current (always providing that the Course and Distance Sailed are correctly given,) by taking the Mid Latitude as a Course, and the Error of the Longitude in the Distance column; then in the Latitude column will stand the Departure, with the Departure and the Error in the Latitude find the Course and Distance, and which will be the true Set and Drift of the Current, or in that direction in which the Ship is found to be by observation, when compared with her place as given by the Dead Reckoning.

The Dead Reckoning should not be Altered on Slight Grounds.

The Difference of Longitude made by Dead Reckoning being applied daily to the Long. in by Dead Reckoning is carried on from the commencement of taking a Departure, independent of that by observation, and should not be altered on slight grounds, because the rate of the Chron. may change or the Lunar Distance may be in Error, and the Dead Reckoning may thus be the means of detecting it; but when the Dead Reckoning has been found to be decidedly in Error then a fresh Departure must be taken.

THE DAY'S WORK.

EXAMPLE 1.

At 1 P. M., took our Departure from Neversink Light-Houses, bearing by Compass W. N W., distant 9 miles, and have sailed until Noon this day as per Log; the Variation of the Compass being ½ a point Westerly, and the Sun's Meridian Altitude observed was 66° 30′ South. Required the Latitude in by Observation, the Latitude and Longitude by Dead Reckoning, and the Bearing and Distance of Wreck Hill, in the Island of Bermuda, at Noon.

H.	K.	F.	COURSES.	WINDS.	L. W.	REMARKS ON BOARD, MONDAY, MAY 1ST, 1854.
1				West.		At 1 P.M. Neversink Light-Houses bore W. N. W. 9 miles, in Lati-
2	10	3	S. E. by S.	"		tude 40° 24′ N., Long. 73° 59′ W., from which I take my Dep.
3	10	6	"	"		Set the starboard studding-sails low and aloft.
4	11		"	"		Steady breeze and fine pleasant weather.
5	10	8	"	"		Stowed the anchors and secured the boats.
6	9	4	"	"		
7	10		"	"		
8	10	5	"	"		At 8h, squally-like in the South.
9	10	5	"	"		At 9h, wind hauled more to the Southward. In all the studding-
10	9	8	"	S. W.		sails and braced the yards up.
11	9	4	"	"		
12	8		"	S. W. by S.		Midnight. Squally. Handed the light sails.
1	7		S. E.	S. S. W.		
2	7		"	"		At 2 A. M. in top-gallant-sails and first reefs of the topsails.
3	6		S. E. by E.	S. by W.	½	
4	6		"	"		At 4h, blowing fresh and a head sea.
5	5	4	E. S. E.	South.	1	Sun's Magnetic Bearing at rising was observed to be E. 14° 18′ N.,
6	5	6	"	"		which gives the Magnetic Variation 5°, or about ½ pt Westerly.
7	5		East.	S. S. E.	2	
8	5		"	"		At 8h, tacked ship to the Southward and set top-gallant-sails;
9	6	5	South.	E. S. E.	1½	weather more moderate and clear.
10	6	5	"	"		At 10h, many vessels in company. Spoke the ship Jacob Bell, from
11	6	5	S. E.	E. N. E.	1	Boston to Australia.
12	7	3	"	"		Noon. do. weather. Lat. Obs. 38° 25′ N. Varia. ½ pt. Westerly.

TRAVERSE TABLE.		DIF. OF LAT.		DEPARTURE.	
COURSES.	DIST.	N.	S.	E.	W.
E. by S. ½ S.	9	....	2 ·6	8 ·6	....
S. E. ½ S.	110	....	85 ·0	69 ·8	....
S. E. ½ E.	14	....	8 ·9	10 ·8	....
E. S. E.	12	....	4 ·6	11 ·1	....
E. ½ S.	11	...	1 ·1	10 ·9	....
N. E. by E. ½ E.	10	4 ·7	....	8 ·8	....
S. by W.	13	....	12 ·7	....	2 ·5
S. E. ½ S.	14	....	10 ·8	8 .9	....
		4 ·7	125 ·7	128 ·0	2 ·5
			4 ·7	2 ·5	

Southing . . . . 60)121 ·0 126 ·4 of Eas'g.
Diff. of Latitude made . . . . 2° 1′ S.
Lat. of Neversink L. Houses 40° 24′ N.
Lat. in by D. Reckoning . . . 38° 23′ N.
Sum of the Latitude . . . . . . 78° 47′
Half Sum, or Mid. Lat. . . . . 39° 23′ taken as a Co., and the Dep., 126 ·4, in the Lat. column, and in the Dist. Col. stands the Diff. Lon. 163′ E.= 2° 43′ E.
Long. of Neversink Light-Houses . . . . 73 59 W.
Long. of the Ship by D. Reck. . . . . 71° 16′ W.

Difference of Latitude 121, and Departure 126, made good, found together in the Traverse Table, gives the Course made good S. 46° E., and the Distance made good 175 miles.

To Find the Variation.

Lat. by D. Reck. at Sunrise about 38½° N., and Sun's Declination 15° N., in Table XXXV, gives the true Amplitude . . . . E. 19° 18′ N.
Magnetic Amplitude at Rising . . . . E. 14 18 N.
Magnetic Variation . . . . 5° 0′ W

To Find the Latitude by Observation.

Sun's Mer. Altitude Observed . . . . 66° 30′ S.
Correction, Table IX 12
True Altitude . . . . 66° 42′
Zenith Distance . . . . 23° 18′ N.
Sun's Correct Declination . . . . 15 7 N.
Latitude Observed . . . . 38° 25′ N

Summary.

Course	S. 46° E.
Distance	175
Diff. Latitude	121 S.
Departure	126 E.
Latitude by D. Reck.	38° 23′ N.
Latitude Observed	38 25 N.
Diff. Longitude	2 43 E.
Long. by D. Reck.	71 16 W.

Bearing of Bermuda S. 41° E., or S. E. ½ S., nearly (True.) Distance 484 miles.

To Find the Bearing and Distance of Bermuda.

Lat. of the Ship by Observation . .	38° 25′ N.	Long. 71° 16′ W.	
Lat. of Wreck Hill, Bermuda	32 19	Long. 64 50 W.	
Diff. of Latitude in miles 366 . . .	=6° 6′	6° 26′	
Sum	70 44	60	
Middle Latitude	35° 22′	Dif. Lon. 386	

Middle Lat. 35°, and half the Diff. Long., 193, in the Dist. col., gives half the Dep., 158, in the Lat. col. Then half the Diff. Lat., 183, and Dep., 158, gives the True Course S. 41° E., and half the Dist. 242, which doubled gives the True Distance 484 miles.

THE DAY'S WORK.

EXAMPLE 2.

A Ship from Latitude 35° 42′ N. by Observation, and Longitude 51° 2′ West by Chronometer, yesterday at Noon has sailed until Noon this day as per Log. The Sun's observed Altitude in the morning was 10° 23′, the Greenwich Time by Chronometer 11h 0m 2s, or March 5th, 23h 0m 2s, and the Sun's Meridian Altitude was 45° 32′ S. Required the Latitude and Longitude in, both by Dead Reckoning and Observation, and the Set and Drift of the Current.

In this Example the Fractional parts of the Knots are marked as 1 half knot.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	TRANSACTIONS ON BOARD, MONDAY, MARCH 6TH, 1854.
1	10		N. W. by N.	East.		P. M. Strong gale and squally, with hail and sleet. Vessel shipping
2	10		"	"		much water on deck. Pumps carefully attended.
3	9	1	"	"		At 3h, more moderate and clear weather.
4	10		"	"		At 4h, out double reefs and set top-gallant-sails.
5	10		"	"		Signalized the ship Washington, from New York to Liverpool, out
6	10		"	"		10 days.
7	9	1	"	"		Observed the Sun to set per Compass W. 4° N., which gives the
8	9	1	"	"		Magnetic Variation 11° 30′, or 1 point Westerly.
9	10		"	"		
10	9	1	"	"		At 10h, passing squalls, with showers of hail.
11	9		"	"		
12	8	1	*Summary.*			Midnight. Gale moderating. Out all reefs and set the starboard
1	9	1	Course.......	N. W.		foretopmast-studding-sail.
2	10		Distance	231		
3	10		Diff. Lat......	163 N.		
4	9	1	Departure ..	163 W.		At 4 A. M. set top-gallant and lower studding-sails, royals and flying-jib.
5	9		Lat. D. R..	38° 25′ N.		
6	8	1	Lat. Obs...	38 40 N.		
7	9		Diff. Long....	3 24 W.		At 7h, Longitude in by Chronometer 54° 1′ 30″ W
8	10		Long. D. R.	54 26 W.		
9	10		Lon. Chr. 54° 46′ 30″W.			Unstowed the anchors and bent the cables.
10	10		Barom. 30. Therm. 42°			Carpenter employed fixing the windlass.
11	10		Current N. 47° W. rate			Fresh breezes and clear weather. Variation 1 point Westerly.
12	10		of 1 knt. an hour, nearly.			Noon. Cape Sable, N. S., bore N. W. ½ N. True, Distance 750 miles.

The Ship has been running on a N. W. by N. Course the whole 24 hours. The variation of 1 point allowed to the left, gives the True Course N. W. The knots being summed up gives 227 miles, and the 8 half knots, equal to 4 whole ones, this added to 227 gives the whole Distance 231.

True Course N. 4 pts. W. 231, gives D. L. 123 Dep. 163

Diff. Latitude made..............	2° 43′ N.
Lat. Observed yesterday	35 42 N.
Lat. by D. Reckon. to-day	38° 25′ N.
Sum	)74° 7′
Middle Latitude.................	37° 3′ taken as a

Course, and the Dep., 163, in the Lat. column, the Diff. of Longitude is found in the Distance column

to be 204......................	3° 24′ W.
Long. by Chron. yesterday	51 2 W.
Long. by D. R. since yesterday....	54° 26′ W.

To Find the Set of the Current.

Lat. Obs.	38° 40′ N.	Long. by Chron.	54° 46′ 30″ W.
Lat. D. R.	38 25 N.	Long. by D. R.	54 26 0 W.
Error in Lat.	15′	Error in Long.	0° 20′ 30″

With Latitude 37° as a Course, and Difference of Longitude 20′ 30″, in the Dist. column, opposite to which, in the Lat. column, stands the Dep., 16′. Then with Diff. of Lat. 15, and Dep. 16, the Set of the Current is found to have been N. 47° W. (true) and its Drift 22 miles.

To Find the Magnetic Variation.

Diff. Lat. made to Sunset............	0° 42′ N.
Latitude at Noon....................	35 42 N.
Latitude at Sunset	36° 24′ and the

Sun's Declination corrected, 5° 54′ South, found in Table XXXV, gives the Sun's True Amplitude, W. 7° 30′ S.

Magnetic Bearing at Sunset	W. 4 0 N
Magnetic Variation	11° 30′ W

Sights for Chronometer having been taken in the morning about 7 o'clock, the necessary corrections are made (see Example 1st, page 140,) and the Meridian Altitude having been observed, the Latitude in is found to be 38° 40′. This Latitude is then reduced back to the time the Sights were taken, and the Longitude by Chronometer found, which is then brought up to Noon by the Dead Reckoning, and in this case is 54° 46′ 30″ W. (*This will be found worked out at page* 140.)

Now, as there is a considerable difference between the place of the Ship by Dead Reckoning and that by Observation, and supposing the Course and Distance run to have been correct, we now proceed to find the Set and Drift of the Current.

Again: Suppose that the Course steered could be depended on, and the Distance run uncertain. The Latitude observed yesterday was 35° 42′ N., and to-day 38° 40′, the Difference of Latitude between the Observations being 178 miles. Then, with the Course N. W., and the True Difference of Latitude 178, the True Distance run is found to be 252 miles, and the Departure 178. The Middle Latitude 37°, taken again as a Course, and the Departure 178, in the Latitude column, gives the correct Difference of Longitude made 223, in the Distance column, or 3° 43′ This, added to the Longitude in yesterday, 51° 2′ W., gives the Longitude in by Dead Reckoning to day 54° 45′, and which agrees with that given by Chronometer, nearly.

THE DAY'S WORK.

EXAMPLE 3.

A Ship from Latitude 45° 50′ N. by observation, and Longitude by Chronometer 49° 34′ W. yesterday at Noon, has Sailed until Noon this day as per Log. An Altitude of the Sun in the Morning was observed to be 25° 8′. Time by Chronometer 12h 13m 21s, and which was Fast of Greenwich this day 5m 25s. The Weather being Foggy at Noon the Meridian Altitude of the Sun was lost for the day, but an Altitude was obtained afterwards, and observed to be 42° 30′, the Time by Chronometer being 4h 14m 21s. Required the Ship's position at Noon, both by Dead Reckoning and Observation, and the bearing and Distance of the nearest Land.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, WEDNESDAY, MARCH 15TH, 1854.
1	8		W. S. W.	N. W	½	P. M. Steady breezes and fine pleasant weather, all sail set, close hauled.
2	8		"	"		
3	8		"	"		
4	8		"	"		At 4h, Long. in by Chron. 50° 3′ 30″ W., and Magnetic Vari. as per Azimuth 23° or 2 points Westerly.
5	7	1	"	"		
6	7		"	"		
7	7	1	"	"		At 7h, Barom. falling rapidly to 29° 30′, Lee clouds appeared near, and of a threatening appearance. Took in all the small sails, and double-reefed the top-sails, reefed the coursers and stowed the jib and S. M. Sail.
8	3		South.	W. S. W.	3	
9	3		"	"		
10	3		"	"		
11	2	1	"	"	4	Wind very unsteady and blowing in gusts.
12	2		"	"		At Midnight came on to blow excessive hard, close-reefed the top-sails and handed the foresail, vessel laboring heavy and shipping much water on deck; pumps carefully attended to.
1	2	1	"	"		
2	2	1	"	"	5	
3	2		"	"		
4	2	1	"	"		At 4 A. M. The wind flew round to the N. W. in a heavy rain squall, and the weather clearing up, made sail.
5	4		W. S. W.	N. W.	3	
6	4		"	"		At 6h, shook out the close-reefs and set the jib
7	5	1	"	"	2	At 7h, passed several fishing vessels at anchor.
8	6	1	"	"		At 8h, out double-reefs and set the topgallant-sails
9	7		W. ½ N.	N. by N.	½	At 9h, sounded in 30 fathoms on the Grand Bank of Newfoundland; Long. in by Chron. 49° 58′.
10	8		"	"		
11	8		"	"		Noon, Foggy weather, Sun obscure.
12	8					Cape Race, N. W. ½ W. True, or N. N. W. ½ W. by Compass 138 miles. Variation 2 points Westerly.

COURSE.	DIST.	N.	S.	E.	W.
S. W. ½ W.	54	"	34′ 3	"	41′ 7
S. E. by E.	9	"	5 0	7′ .5	"
E. S. E.	7		2 7	6 5	
E. by S.	7		1 4	6 9	
S. by W.	8		7 8	"	1 6
S. S. W.	12		11 1		4 6
W. S. W.	31		11 9		28 6
		D. LAT.	81 6	20′ 6	69 1
					20 9

Diff. of Lat. made.. 1° 22′ S.
Yesterday's Lat.. 45 50 N. Dep. 48 2 W.
Lat. in........... 44° 28′ N.
Sum...........)90° 18′
Mid. Lat........ 45° 9′ & Dep. 48′
Gives D. Lon. made 68′ = 1° 8 W.
Lon. by Chro. yesterday Noon 49 34 W.
Long. by D. R. to-day........ 50° 42′

To Find the Course.

The Dif. Lat. 81 6 and Dep. 48 2, gives the Course made good S. 31° W., and the Distance 94 miles.

As no Meridian Alt. has been observed to-day the Lat. must be found by the reduction to the Meridian of the Alt. Obs. near Noon, either by the measured Interval of Time between the Observations, which is 4h 1m, as in the 2d Example, given at page 97, (this being the same case worked out) gives Latitude 44° 32′ N., or it may be found by the method given at page 94, that is, of deducing the Time at the Ship from the Greenwich Time by Chron., as follows:

Time by Chron....	4h 14m 21s	Sun's Obs. Alt. P. M.	42° 30′
Chron. Fast.......	5 25	Corr. for Semid. &c.	11
Green. T. by Chron.	4h 8m 56s	True Altitude......	42° 41′
Long. 50° 42′ in T..	3 22 48	Sun's Dec Cor. to the	
M. T. at Ship......	0h 46m 8s	Green. Date......	2° 5′
Equa. Sub.	9 6		
T. Past Noon....	.37m 2s=Log. 7·813	Table XV.	

Summary. Lat. 44½° N.....Dec. 2° S ..Log. 0.293 } Table XV.

Course....	S. 30° W.	8·106 Corr.....	0° 44′
Dist.......	94	True Altitude...............	42 41
Diff. Lat...	82 S.	Meridian Altitude..	43° 25′ S
Departure.	48 W.	Zenith Distance.............	46° 35′ N.
Lat. D. R..	44 28′ N.	Declination.................	2 5 S.
Lat. Obs...	44 32 N.	Lat. in at 37m past Noon......	44° 30′ S.
Diff. Long.	1 8 W.	Co's & Dis. since Nn W.S.W. 5m D.L.	2 N.
Long. D. R.	50 42 W.	Lat in at Noon..............	44° 32′ N.
Lon. by Ch.	50 34 W.		
Barom....	29 90 Ther. 38°		

Having the Correct Latitude at Noon we Proceed now to Find the Longitude in by Chronometer.

The first Altitude observed was taken about 8h 38m in the Morning, or 3h 22m before Noon, and in that interval the Ship had made a W. S. W. Course good, and Distance by Log. 27 miles; this will give the Diff. Latitude 10 and Departure 25; the Diff. Latitude 10 added to the Latitude at Noon, gives the Latitude in at time of the first Altitude 44° 42′ N. The Apparent Time at Ship is thence found to be 8h 38m 54s, and the Mean Time 8h 48 0s, the Difference between which and the Greenwich Time by Chronometer 12h 7m 56s, is 3h 19m 56s, or Longitude 49° 59′ 0″ W. at the time of the Sights. The Departure 25 turned into Longitude is 35′ 0″, which added to it gives the Longitude in at Noon 50° 34′ N.

The Longitude by D. R. is therefore in Error 8′ or 32s of Time. The Time past Noon being Corrected 37m 31s, the Correction for Altitude is 45′, and Lat. at Noon Corrected is 44° 31′ N.

FINDING THE LONGITUDE FROM THE OBSERVED ALTITUDES OF A BODY ON THE PRIME VERTICAL AT EQUAL DISTANCES IN TIME FROM THE MERIDIAN.

On leaving any known Longitude take an Altitude of the Sun on the Prime Vertical, that is, when he bears True East or West, which can only be in the Summer time. But a Star can always be found on the Prime Vertical at any season of the year. Note or find the Apparent Time by Watch when the observation was made, say in the Morning, and find the Time before Noon, (which with the Sun is his Hour Angle.) Then observe another Altitude in the Afternoon, at the same time past Noon by the Watch. Now, if the Ship has not moved to the Eastward or Westward, that is, if she has made no Departure during the Interval, the Sun's Altitude will be the same as in the Morning. But if the Altitudes do not agree, then the Difference is the number of miles of Departure the Ship has made to the Eastward or Westward.

And in Sailing East the P. M. Altitude will be the greatest because the Ship is meeting the Sun, and in Sailing West the P. M. Altitude will be least because she is leaving him. This Departure, so obtained turned into Longitude by a case of Middle Latitude Sailing, furnishes the Difference of Longitude, which applied to the Longitude left will give the Longitude in.

Or one Altitude can be observed on the Morning or Evening of one day, (having the Apparent Time from Noon of the observation), and exactly at the same time on the day following. The Difference between the Altitudes so observed is the Departure made good during the 24 hours, which turned into Longitude and applied to the Longitude left from day to day, will furnish an excellent check on Gross Errors in the Dead Reckoning when there is no Chronometer on board.

The daily Variation of the Equation of Time ought in strictness to be Added to the Time from Noon by Watch, at which the last Altitude should be observed, when the Equation is Decreasing, or Subtracted from it when Increasing; but as this quantity amounts to only a few seconds, it may be neglected.

In the case of observing Stars, 3m 56s should be Subtracted from the Time from Noon by Watch, at which the last Altitude should be observed, when P. M., or Added to it when A. M., because the Stars are that much before the Apparent Time by the Sun every day.

EXAMPLE 1.

June 10th, 1854. A Ship in Latitude 40° 0′ N., and Longitude 45° 0′ W., at 8h 2m A. M. observed the Suns Altitude to be 37° 24′, and then Sailed to the Westward, until 3h 58m P. M. by the same Watch, when the Sun's Alt. was Obs. to be 36° 9′. Required the Dep. made, the Diff. of Long. and the Long. in at the Time of the last Alt.

At 8h 2m A. M. Observed Altitude..........	37° 24′	Departure 75m with Latitude 40°=D. Long......	)98
At 3h 58m P. M. Observed Altitude..........	36 9	Difference of Longitude made................	1° 38′
	1° 15′	Longitude Left..........................	45 0
	60	Longitude in............................	46° 38′
Departure made good....	75		at 3h 58m P. M.

EXAMPLE 2.

March 30th, 1854. A Ship took her Departure from Latitude 40° 43′ N. and Longitude 74° W., at 5h 43m P. M., when the Sun's Altitude was observed to be 6° 6′, and then having Sailed to the Eastward about 255 miles, until the next Evening at 5h 42m by the same Watch, when the Sun's observed Altitude was 10° 16′. Required the Departure made, the Difference of Longitude, and the Longitude in.

March 30th, at 5h 42m P. M. Observed Altitude.	6° 6′	Departure 250, Latitude 41°=D. Long..........	)332
do. 31st, at 5h 42m P. M. Observed Altitude.	10 16	Difference of Longitude made....	5° 32′
	4° 10′	Longitude Left.......................	74 0
	60	Longitude in...	68° 28′
Departure made....	250		

EXAMPLE 3.

By the Stars.

April 11th, 1854. A Ship in Latitude 30° 0′ N. and Longitude 65° 0′ W., at 7h 8m P. M. observed the Altitude of Aldebaran to be 33° 24′ bearing True West. She then Sailed to the Westward about 196 miles until the following Evening at 7h 4m 4s by the same Watch, when the Star's Altitude was observed to be 30° 4′. Required the Departure made. Difference of Longitude, and Longitude in.

As the Star is in advance of App. T. 3m 56s it must be Sub. from the Time by Watch on the following Evening

April 11th, at 7h 8m P. M. Star's Obs. Altitude..	33° 24′	Departure 200, Latitude 30° 0′ N., Diff of Long.	)231
do 12th, at 7h 4m 4s P. M. Star's Obs. Alt....	30 4	Difference of Longitude..................	3° 51′ W.
	3° 20′	Longitude Left...........................	65 0 W.
	60	Longitude in....	68° 51′ W
Departure made....	200		

NAVIGATING THE SHIP.

In the preceding Days' works are given the usual modes of finding the Ship's position at Noon by the Dead Reckoning, and also the Latitude in at or near to Noon by the Sun's Altitude, and the Longitude by Chronometer, and providing the Chronometer kept a steady rate, and that those observations could be obtained every day, nothing more would be required.

But as the Sun is sometimes invisible for several days together it is evident that the Dead Reckoning may become very erroneous during that interval, and it becomes necessary as a measure of precaution when the weather is clear at Twilight to observe Altitudes of the Planets or Stars, for at any time during a clear night, Stars may be observed North and South, on or near the Meridian, (see page 110,) or the Moon either by Day or Night. (See pages 101 and 148.) The Latitude by observation and the Longitude by Chronometer, (or by Lunar observations,) may thence be obtained by any of these bodies in many cases as correctly as by the Sun's Altitude.

The Longitude by Chronometer may also be obtained at Sunrise or Sunset, (see page 146.) or at Noon, from equal Altitudes of the Sun. (See page 147.) In the latter method no Logs. are required, and will be found useful in detecting any gross Error committed in working out the Time in the usual manner, but is best adapted for low Latitudes. (See Remarks, page 130.)

When the Sun is seen through watery clouds, and his Limbs not visible, a tolerable observation for Latitude may be obtained by observing his centre, (see Diagram, page 68, No. 3, and an Example of finding the Latitude by this method at page 89.)

An Altitude of any of the heavenly bodies having been obtained near the Meridian, the Latitude m be found by the Rules given in the body of this work, and although it may probably be a little in error the Time be not exactly known, it is greatly more to be depended upon than the Latitude by Dead Recko ing, however carefully it may have been kept.

An Error of 1 point in a Ship's Course produces an Error in the Dead Reckoning of about 20 miles for every 100 miles run, whether produced by Local Attraction, bad Steerage, or a Current, and it is evident that in Ships of the present day, many of which are constructed to sail twice as fast as the old ones, that an Error in their Course steered will produce twice the Error in their Dead Reckoning in one day's run, than would be the case in a slower sailing vessel; and in that case it would require greater vigilance on the part of the commander of those vessels to ascertain their True Position as often as possible both by day and night, especially in the vicinity of Land or a danger. The following remarks may be found useful.

On Commencing the Voyage, &c.

The first and most important matter is to examine the Binnacle and to see that no foreign articles, suc' as iron, are deposited therein, and whether the steerage Compass is free from local attraction, (by the Rules given at page 120.) At the time of taking a Departure from the Land, if possible, a set of Altitudes of the Sun should be taken for Chronometer to find its Error on Greenwich Mean Time, (see page 155.) and always to use the same Sextant in observing Altitudes for rating the Chronometer.

It is the common practice at Sea to observe a set of Altitudes of the Sun at about 8 or 9 o'clock in the Morning, and to make all the necessary corrections ready for use, as at page 140, and as soon as the Latitude is observed at Noon, the Latitude in at the time of the Sights can be deduced, and thence the Longitude by Chronometer. Or the Sights can be worked out at once, using the Latitude by Dead Reckoning from the preceding Noon; then if it appears there is an Error in the Latitude by Dead Reckoning, the Longitude by Chronometer thus found may be corrected by Table XXX, (see pages 144 and 145,) which saves the labor and time of working it over again. In either case the Longitude in by Chronometer at the time of the Sights is brought up to Noon by the Dead Reckoning, and as before observed, if this could be done dail nothing more would be required for the safe navigation of a Ship on the open Sea, or in the fine seren weather in the Tropics; but when a Ship is approaching Land, or in high Latitudes, where uncertain weather prevails, the heavenly bodies are frequently obscured for several days together, it is necessary to take an Altitude of the first object that becomes visible, and to note the time by Chronometer; if its bearing is near the True North or South the Latitude may at once be found, (by any of the Rules which are appropriated to the Object observed, and will be found in the body of this work,) and if the Altitude of another Object can be obtained at a sufficient Distance East or West of the Meridian, the Longitude by Chronometer may be found. If the object be a Star and not known, see the method of finding the Stars at page 136, or a Planet, at page 134, and as before observed, Twilight is the proper time to observe Altitudes of the Stars. An Altitude of the Sun or Moon also, taken at any time they are visible, and the time noted by the Chronometer, is an observation of great importance to a Ship in the vicinity of the Land, and by which either the Latitude or the Longitude may be obtained, many Examples of which will be found in this work, or the Ship's postion may be determined by Sumner's Method, an Example of which is given at page 152; but as some of the Altitudes may have been observed in stormy weather, when the horizon was ill defined, and used only because no better could be obtained, the Navigator will place that degree of dependence in the result which the circumstances of the case would seem to warrant, and if doubtful they may be confirmed or rejected, as the case may be, by another observation made under more favorable circumstances, or as in the case of finding the Latitude by the Stars N. and S. and taking the Mean of the two Latitudes. The Longitude by Chronometer may also be found by the Altitudes of Stars E. and W., and the Mean of the two Longitudes taken as the true one.

When Altitudes of the Sun have been taken in the Forenoon, as a reserve in case of losing the Meridian Altitude, that one should be used which is the nearest to the Meridian to find the Latitude by, and the one farthest from the Meridian to find the Longitude by Chronometer. And when the Meridian Altitude of the Sun has been observed the Latitude is usually deduced therefrom in preference to all the other observations for Latitude

When a Departure is taken from the Land, the Course is shaped on the Chart by the Rules given at page 48, and which is the True Course. The Variation of the Compass being then allowed for as directed, will give the Compass Course required to steer; the amount of this Variation is generally given on all Charts, but it should be verified by observing the Variation with the Ship's head in different directions. (See page 120.)

Verifying the Chronometer.

When the Ship is passing near any Island or Headland, the position of which is well known, by Sighting it and bringing it to bear true North or South at the time of taking a set of Altitudes, the Sea Error and Rate of the Chronometer may be found. See the method of rating Chronometer at Sea, (page 155,) and Remarks on Chronometer (at page 79.)

But if no land has been seen for many days it may be verified within certain limits by Lunar observations taken East and West of the Moon, and using the Mean of the two Longitudes so found. (See page 1[illegible])

Indications of Stormy Weather.

The height of the Barometer should be frequently noted when on the Southern limits of the S E Trade Wind, or on the Northern limits of the N. E. Trade, or in high Latitudes, where stormy weather may expected. See Remarks on Hurricanes, (page 41,) and the uses of the Barometer and Thermometer pages 82 and 83.)

Falling in with Icebergs.

An Iceberg should always be passed to Windward, if possible, in the night time, because of the loose agments which drift faster than the body of the berg, and stream out to leeward of it, and which may seriously injure a vessel.

Discovery of a Danger.

When a Ship is going free and suddenly discovers she is running into danger, the best means of avoiding it is to haul to the wind on that tack on which she will most rapidly increase her distance from it; by doing so she will gain time in order to prepare for Tacking Ship. If the water should continue to shoal, and if in the night time, the proper way to extricate herself would be to steer out on the opposite course to which she was steering on its discovery; but if that cannot be done on account of the wind, to work to Windward so as to make that Course good.

If the danger is a new discovery, its position should be ascertained by a set of observations taken as soon as possible afterwards, and its place deduced from the place of the Ship by Cross Bearings, or by two Bearings and the Distance sailed between them, by the Rules given (at page 32.) Soundings should also be taken, and the quality of the ground ascertained, which, with the particulars, must be entered in the Ship's Log-Book.

While it is necessary to be on the look out for Coral Reefs and other dangers which may grow up, or be thrown up by Seaquakes, where none formerly existed, it is no less so to guard against false alarms, for it is easy to imagine you see breakers when on the look out for them. For instance, in Moonlight nights, when the clouds are flying, a stray moonbeam falling on the crest of a broken wave, has really all the appearance of a breaker; but if the bearing of it be taken it will be found not to appear again in the same place Clouds and Fog-banks on the horizon often resemble land, though the experienced eye of the Seaman can usually tell the difference. Whales and other large animals are frequently seen asleep on the surface of the ocean and mistaken for rocks; and in some parts of the ocean the surface is covered with a kind of fish-spawn of yellowish-grey color, which at a distance looks like a sand-bank. On the Coast of Africa, also, about the Meridian of Greenwich, a very alarming appearance of breakers is caused by a multitude of Phosphorus Fish, and the Ship seems to be approaching a Sea of fire, and so great is the light from this cause that a book may be read on deck in the darkest night.

RULES TO PREVENT COLLISION ON SHIPS MEETING AT SEA.

Two Ships approaching each other on opposite tacks, close-hauled, and it is doubtful which will weather the other, the Rule is that the one on the Starboard Tack keep her reach, while the one on the Pork Tack must bear up and go under the stern of the other; but if through ignorance or stupidity the one on the Port Tack continues to keep her reach, and a collision is unavoidable, then both vessels should instantly put their helms a-lee, by which means they will be thrown in Stays, and the shock of collision, if it should take place, will be very much lessened.

Two Ships meeting each other right ahead, and steering opposite courses, both having the wind free, the rule is that both vessels Port their helms so as to pass each other on the Port side, or if one of them should be close-hauled, then it is the duty of the other, which is going free, to give way and pass under her stern.

This rule should not be too hastily adopted in the night time, when a vessel or her light is suddenly seen near to on the Starboard bow, because, in this case, were each to Port their helms they would run on board of each other.

This rule is therefore only applicable when vessels meet each other right ahead or a little on the Port bow and steam vessels, which are always supposed to be under the command of their helms, are deemed to be vessels going free.

The commanders of steam vessels say that if sailing vessels would keep their proper course on the approach of a steamer towards them, the officer in charge of those vessels would then see exactly the state of the case and steer so as to clear the sailing vessel, and thereby prevent collision; but it frequently happens that those on board the sailing vessel become alarmed and keep changing their course without any fixed principle, and thereby mutually deceiving each other as to their intentions.

Ships meeting each other at sea in a dark, stormy night, or in foggy weather, the utmost vigilance and presence of mind on the part of the officer of the watch is required to prevent collision, many melancholy instances of which frequently take place.

On a vessel or her light being reported as seen ahead, or on either bow, the officer of the watch should immediately ascertain in which direction the other vessel is steering; if that cannot be done on account of the darkness of the night, take her bearing by the Compass; then her change of bearing in a short time will point out the direction in which she is steering, but if the bearing does not seem to change the vessel must either be coming directly towards you or you are coming up with her. If you are, a running Ship, and the vessel ahead about to cross your bow, if there is a doubt of her doing so in time, it is your duty to bear up and pass astern of her.

In the case of the vessel coming towards you, if she is on the Starboard bow and too near, Starboard your helm; but if seen right ahead or a little on the Port bow, Port your helm; and were each to obey this rule a collision would be impossible. It is only when the one Starboards and the other Ports her helm at the same time that such takes place. The intention of one vessel should be made manifest to the other by a broad sheer in the direction in which she intends to pass; this will save some anxiety of mind on the subject

All vessels in foggy weather should sound an alarm either by bell, gong, or steam-whistle, at intervals of two or three minutes, and that the alarm should be promptly responded to by all vessels withing hearing distance. If the sound of the alarm be heard on the Starboard bow both vessels should instantly Starboard their helms. But if it is heard from right ahead or on the Port bow, both vessels should instantly Port their helms, and by doing so a collision would be impossible. Slacking a vessel's speed will not always prevent collision; the only remedy is the helm, and the promptness with which it is turned in the same direction as above by both vessels. But to make this effectual we must have a universal Law, to be adopted by Ships of all nations.

Error in the Course of a Scudding Ship.

When the Ship is scudding in a Gale and a high Sea running, with the wind on the quarter, she is generally found to have been run off to the leeward of the course intended to have been steered. This is sometimes unavoidable to prevent the sea falling on board, but more frequently caused by bad steerage, that is, by the helmsman hanging on his weather helm when the Ship is on the top of a Sea, in the room of easing it, as he ought to do, the consequence of which is, that the Ship is yawed off nearly before the wind, and runs for some time so before she can be brought up to her course again. In this case the officer of the Watch should mark on the Log-Board the course the vessel is supposed to have made good by Compass; this will seldom amount to more than one point to leeward of the given course, unless the vessel has been wretchedly steered, because we may suppose she has been kept some part of the time at or even to windward of the given course. When the vessel is running in a narrow channel or in the vicinity of a danger, it becomes of the utmost importance that this yawing off should be guarded against, by steering a point, or whatever allowance may be deemed sufficient, to windward of the given course, or by yawing her to wind ward as much as she has been run off, so as to make the course good. This yawing of the vessel about necessarily cuts off a considerable portion of the Distance she would have run on a straight course, hence an allowance of about 1 mile in 10 is deducted from the Distance run by Log., and as before observed, an Error of 1 point in the Course steered will produce an Error in this case of 20 miles for every hundred miles of distance run, which the Ship will be to leeward of her course.

The Proper Tack to Lay To On.

In the Remarks on Hurricanes, at pages 42 and 43, rules are given for Laying To on the Proper Tack in those cases; but as the Storms in Higher Latitudes revolve in a contrary direction to what the regular-built Hurricanes do—for instance, in the North Atlantic Ocean they commence generally at S. E. or South, with rain, and veer gradually round by the West to N. W. and North when the rain ceases, but the most danger is to be apprehended from a sudden shift, which frequently takes place after a heavy fall of rain from S. W. to N. W.; in that case it is evident that the Starboard Tack is the proper one to be on. In a high South Latitude, in the South Atlantic Ocean, Storms commence at N. E. and North, with rain, as in the former case, and veer round by the West to S. W. and South when the rain ceases: sudden changes take place in the same manner from N. W. to S. W. The Port Tack is therefore the proper one to Lay To on in the latter case. (See the Acting of the Barometer in these cases, at page 83.)

Laying To under a Drag.

When a Ship has the misfortune to be dismasted, and totally unmanageable. an endeavor should be made to keep her Head to the Sea. This can be effected (circumstances permitting) by constructing a Drag, as follows:—

Lay across the Gunwale any useless spars and lumber, so that after being lashed together they may be easily launched overboard, to which attach as much of the wreck and heavy articles as possible, so as to sink the spars and lumber square with the surface; to each end of the spars attach the ends of a piece of chain or rope in the form of a span or bridle; now pass the end of a hawser or stream-chain out through the hawse-holes, and bend it on to the middle of the span, and launch the whole concern overboard, and it will be found that the Ship will ride by this Drag nearly head on to the Sea, because by the wind acting on the hull of the vessel, she will drift faster than the Drag will allow her, consequently her head is kept up to the Wind and Sea. In the meantime the crew will be enabled to work more easily in the fixing up and rigging Jury-Masts, in consequence of the vessel having now less rolling motion.

To Construct a Temporary Rudder at Sea.

When a Ship has lost her Rudder at Sea, a temporary one may be made out of a thick spar, shaped into a Rudder-stock, and if it is made several feet shorter than the old one, it can be better secured below water. Make the Rudder with what materials are at hand, and if the upper part of the old stock has been saved, transfer the pintles, &c., to the new one, placing the pintles at the same distance as before, and prepare the Rudder-head for receiving the tiller as soon as it is shipped. Now take a piece of chain, of a sufficient length for guys, middle it exactly, and mark both parts of it at intervals with exactly corresponding marks, take a round turn with the middle of this chain round the foot of the Rudder-stock, and cross the guy on the fore part of the Rudder, and secure it from slipping off.

Then, when the guy-lines, and the purchase for shipping it, are all prepared, launch it overboard, enter the head of the Rudder in the trunk, the guys having been previously passed round, one on each quarter (taking care that the crossing has been retained,) and passed forward, are hauled taught abreast of the main rigging, and the corresponding marks on the chain are then placed at an equal distance from the rails on each side. After the pintles of the rudder are shipped, then clap tackles on the guys and haul them taught, which will bind the lower part of the Rudder to the Ship's stern-post, and at the same time allow it to act freely.

The guys should be cleeted to the Ship's side on the first calm day, to prevent them chafing about in the wash of the Sea.

The reason why the Rudder is not required the whole length is, that the lower part of it, is of no use to the Ship for steering purposes, and it is only the upper part of it that is acted upon by the water, and which has been proved in cases where a Ship, having had the lower part of her Rudder broken off at the lower gudgeon, has been steered as well as if nothing had been amiss with it.

This can be easily accounted for, when we consider the immense pressure of the Ship on the water, and that as she advances, this water, being set free from under her, rushes up her run at an angle of about 45°, and must necessarily strike the upper part of her rudder with a force greater than the actual velocity which she is going through the water.

Making the Land.

This is generally a time of much anxiety, especially in tempestuous weather, when no observations have been recently obtained, because of the uncertainty in the Reckoning, in consequence of the Ship having been probably under the influence of Currents which generally prevail near the land, and great caution is therefore required in approaching it. When *Soundings* can be obtained they should *never* be neglected. (See Remarks on Sounding, at page 52.)

When the Reckoning is doubtful, the usual practice is to get into the parallel of Latitude of the place the Ship intends to make, and then steer true East or West, as the case may be, proceeding cautiously until the land is seen, but care must be taken that the Ship is not too far ahead of her reckoning before falling into its parallel; as in the case of making an island, for instance, laying West of the ship, she must be sure that she is to the Eastward of it before falling into its parallel. It is therefore safest, if there is no Chronometer on board, to keep well to the Eastward before falling into its parallel, and then to steer due West. She will make it ahead.

When a Ship is bound to a Port on a Coast which trends North and South, the Land should be made at some point to windward of it, and which has a high and bold shore; then by running down the Coast the Latitude by Observation will point out her Port of Destination.

When Observations for Latitude and the Chronometer can be depended on, they should be continued up to the latest period at which the land is expected to be seen, because of the currents or tides near the land, and which affect the Ship's Landfall. The Observations should be verified by sounding at least once, even when the weather is clear, and compared with that laid down on the large Chart of the Coast, at or near to the Ship's Position by Observation, the bearing and distance of any part of the Coast can then be ascertained, and a Course shaped accordingly. It is usual to make some prominent headland or lighthouse in the daytime, or some well known light by night. If the Navigator is a stranger to the Coast, he will naturally consult the Sailing Directions, so as to form some idea beforehand of its appearance, or the character of the lights he may expect to see, so that when the Land is seen he may compare it with the description given of it, and also its outline on the Chart. But to remove all doubt the Bearing of three Objects on Shore should be taken, and a cast of the Lead; then if those Bearings laid off on the Chart meet at a point as a common centre, and the Soundings also agree, there can be no farther doubt but that the Landfall is correct. This sometimes is a matter of much importance to a stranger in making the Land, because by mistaking the Land or a Light for some other on the same Coast, fatal errors have been often committed. It is therefore prudent to test it as above mentioned, before shaping a Course to any other part of the Coast.

A Ship on approaching a Coast in thick blowing weather, where shoals lay off some distance, would naturally keep sounding as she stood in, but by mistaking the Soundings so obtained for those outside of the Shoals when they were in fact those near the Beach, and in standing off has run aground on the inside of the Shoals. This is of frequent occurrence, and caused by an error in the Reckoning; and the only remedy to guard against such an accident is to keep the Lead going until the Ship has made an offing equal to the Distance at which the Shoals lay off from the Shore.

When a Ship is caught by thick weather in a narrow channel, between Shoals, and it is not considered prudent to anchor, she is put under easy sail, and tacked or wore round every hour or half hour, as the circumstances of the case require, until the weather clears up, and she can extricate herself.

Signs of Land.

There are some Signs whereby it may be known when a Ship is approaching Land—the most infallible is that of the change in the color of the Sea from a deep blue to a pea green, (a sure indication of being on Soundings,) and from that to a muddy color as she approaches the Coast, where tree-roots and other drift-wood may be met with floating about, and the coasting and fishing vessels of the country. The Bearing of the Land may also be known from the direction in which a flock of Sea-birds are seen flying at Sunset. Ducks, and other kinds of diving-birds, which do not fly far, are a sign of being near the land.

Land is seen at the greatest distance off at Sunrise or Sunset, before the vapors begin to collect around it, in the form of clouds, which frequently hide it from view in the daytime. This is called by seamen the Loom of the Land.

METHOD OF KEEPING THE LOG-BOOK.

The Log-Book is an official Journal or Record of all the transactions which occur during the voyage of a Ship, from the time of her sailing from a port in the country to which she belongs, until her return to a home port again, and her cargo discharged; although it is usual to consider the voyage at an end when she is safely moored in that port, so far as regards the engagements with seamen.

It should, therefore, contain a true and faithful account of all matters connected with the duty of the Ship, of daily occurrence, both at Sea and in port. Accidents, or loss in the Ship's material sustained, and also the misconduct of either the crew or officers, should all be entered distinctly, and in as few words as possible.

While the Ship is in port, the Harbor Log, as it is called, is kept in the common, or Civil Time at the place, the Day beginning at midnight and ending at midnight. It contains an account of the wind and weather, the number of packages received or discharged, as per Cargo Book, the quantity of stores received on board or discharged, the number of hired laborers employed, and the general employment of the crew and when leave is granted to a portion of them to go on shore, to return again at a stated time, if they do not so return, the fact should be entered in the Log-Book, and the length of time they were absent without leave also. Any occurrence which may have a bearing upon the discipline of the Ship should be taken notice of and noted down; because, in the case of trouble with the crew, the Log-Book is received as evidence of the facts of the case in a Court of Justice. These entries should all be made in the evening of the day on which they occur, or on the morning of the following day, while the circumstances are fresh in the memory of the officer whose duty it is to record them. The Log-Book is kept by the 1st officer; but in the event of sickness, or in having been put off duty for misconduct, whoever is appointed in his room by the Captain) must keep the Log. Sometimes the Captain writes it himself. This is legal enough, providing nothing but the truth is recorded.

This is mentioned merely to show that the Chief Mate of a Ship is not justified in retaining the Log-Book after its being demanded from him by the Captain, as some Mates seem to imagine they have a right to do. The Book belongs to the Ship and to her commander.

The Sea Log may be kept in Common or Apparent Civil Time, if required. (See the Example following.) The entries commence at midnight, and are continued until the following midnight, having the Noon of the Sea Day in the middle of it. The Log Board is carried on from Noon to Noon, as usual, the preceding 12 hours work on the Board, that is, from the preceding Noon to midnight, and the following 12 hours, from midnight to Noon, constitute the day's work, as before; the Ship's reckoning up to Noon, in this case, appearing in the middle of the Log. This method is very convenient in case of referring back to dates, and is perfectly easy in practice, because we have only to copy off from the Log Board as above stated.

The old method is still, however, generally used, through the force of habit, and which is an exact copy of the form used on the Log Board. (See page 180.)

The Log-Book commences, as before observed, when the Ship is unmoored, or breaks ground, under charge of the Pilot; and the time at which he leaves the vessel is noted, and the bearing and distance of the land taken as a Departure. Suppose the Ship to have sailed in the morning of the 5th of June, and a Departure taken at 6 A. M., in writing the Log up to Noon, we would say, this day's work ends with 12 hours, (being the end of the Sea Day of June 5th,) to begin the Sea Log. The Course and Distance sailed is then reckoned up, and the Ship's position found at Noon. The Log for the afternoon is then dated the 6th of June.

Suppose the Ship to sail and take her Departure in the afternoon at 6 P. M., we would commence the Sea Day in like manner, noting that the last Harbor Log contains only 12 hours.

On the other hand, when a Ship goes into port in the morning, the Sea Date of the Log and the Civil Date of the place being the same, the entries are continued until midnight, and we say, this day contains 36 hours, to begin the Harbor Log.

And when she goes into port in the afternoon, the entries are continued under the same date until the following midnight, when the same remark is made, that this day ends with 36 hours, to begin the Harbor Log.

METHOD OF KEEPING A SHIP'S LOG-BOOK IN CIVIL TIME.

We shall now proceed to give a few Examples of writing the Harbor Log, and the Log at Sea, by Civil Time, and conclude this work with a short Journal of a voyage, or rather a passage, of a Ship from Santa Cruz to St. John's, N. F.

The Harbor Log.

DAY OF THE MONTH.	WINDS.	REMARKS ON BOARD THE C. S. DAUNTLESS, LYING AT SANTA CRUZ.
Monday, March 13th, 1854. Barom. 30.00	N. E. Therm. 80°	Throughout this day fresh breezes, with passing showers. Crew and 3 laborers employed taking in cargo, (as per Cargo Book,) bending light sails, and other duty. James Collins off duty, sick.
Tuesday, March 14th. Barom. 29.85	N. N. E. Therm. 79°	First part of this day fresh trade, and fine, middle and latter parts. Strong wind and rain squalls. 3 laborers employed. Finished taking on board cargo. Hoisted in the longboat and cleared up the decks. J. Collins returned to his duty.
Wednesday, March 15th, Barom. 30.05	E. N. E. Therm. 81°	Throughout this day moderate and fine weather. Employed filling fresh water, bending sails, and taking in Ship's stores, and in the evening got the Ship ready for Sea, and at 6 P. M. unmoored, and hove up the starboard bower anchor, and hove in to 30 fathoms. Shackle on the small bower. Discharged the laborers.

The Clipper Ship Dauntless, W. Griffen, Commander, from Santa Cruz to St. John's, N. F.

Thursday, March 16th. Barom. 31.00	N. E. Therm. 82°	At 5 A. M. the Pilot came on board. Hove short and made sail. At 5h 30m weighed from the anchorage at Santa Cruz and proceeded to Sea. Light baffling wind and cloudy. At 7 A. M. discharged the Pilot and made all possible sail. The steady Trade set in, with fine pleasant weather. At Noon, the N. E. end of St. Anthony Island, one of the Cape Verde Islands, bore West by Compass, 3 or 4 miles distant. Lat. Obs. 17° 9′ N. Magnetic Varia. 1½ points Westerly.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	*Log Kept in Civil Time.*
1	5		N. W. by N.	N. E. by N.		P. M. Fresh Trade and fine weather.
2	5		"	"		Stowed the anchors, unbent the cables and put them below.
3	6		"	"		At 3h, the N. W. end of St. Anthony bore S. 17° 30′ W., distant
4	8		N. N. W	N. E. by E.		15 miles, from which the Dep. is taken in Lat. 17° 12′ N. Long.
5	9	1	"	"		25° 19′ W. At 5h, set the starboard studding-sails.
6	10		"	"		At 6h, the Mag. Variation at sunset was 17° 30′ Westerly.
7	10	1	"	E. N. E.		Passed several vessels bound West.
8	11		"	"		At 8h, increasing breezes and smooth water.
9	12		"	"		Light squalls from passing clouds.
10	13		"	E. by N.		At 10h, in sky-sails and rounded in the weather braces.
11	13		"	"		
12	13		"	"		Midnight. Fresh Trade and clear weather.

The Departure is taken from the North West end of the Island of St. Anthony, bearing S. 17° 30′ West, and the Variation 17° 30′ West allowed, gives the true bearing South; the Ship is, therefore, on the Meridian of that point, distant 15 miles to the North of it. Sights being taken for Chronometer, its error on Greenwich Mean Time is found to be 0h. 40m 39s too fast, and the Rate since last Observation, taken in a similar manner, 2 sec. 5-10th gaining. We have thence the Sea rror and Rate of it obtained. (See the Rules and Examples given at page 155.)

To shape a Course in this case, we lay the ruler over the place of th Ship and Cape St. John, N. F, and find the true Course to be N. W. ¾ N., the Variation allowed to the right gives the Compass Course required to steer N. by W. ¾ W. The distance off at present is immaterial, but both Bearing and Distance may be found by a case in Middle Latitude or Mercator's Sailing.

In Ships of great speed, when working up the day's work, it will be found more corrrct to turn the Course steered into degrees, and apply the Variation, (also in degrees,) to it, and thence find the Difference of Latitude and Departure.

KEEPING THE LOG-BOOK IN CIVIL TIME.

The Clipper Ship Dauntless, W. Griffen, Commander, from Santa Cruz towards St. Johns.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, FRIDAY, MARCH 17TH, 1854.
1	13	1	N. N. W	E. by N.	"	A. M. Fresh breeze and clear weather.
2	14		"	"	"	At 2h, squared the yards and set the lower studding-sail. Set up
3	15		"	East.	"	and secured the boom braces, and preventer breast and back
4	14	1	"	"	"	stays.
5	15		"	"	"	
6	14	1	"	"	"	At 6h, The Magnetic Variation at Sunrise was 20° Westerly.
7	15		"	"	"	
8	14	1	"	"	"	At 8h, Longitude in by Chronometer was 27° 57′ 30″ W.
9	15		"	"	"	Watch employed about the rigging fixing chafing gear.
10	15		"	"	"	Carpenter repairing the longboat.
11	15		"	"	"	Pumps carefully attended.
12	15		"	"	"	Noon. Strong steady Trade wind

Variation	Course	Dist.	D. Lat.	Dep.				
19° W.	N. 40° W.	287	220 N.	185 W.	Lat. D R. 20° 52′ N. Lat. Obs. 20 50 N.	Lon. D.R. 28° 34′ W. Dif. Lon. 3 15 W.	Lon. Chr. 28° 40′ W. D. R. since yesterday...... 28 34′	Bar. 30 00 Ther. 79°

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS.
1	15		N. N. W.	East.	"	P. M. do. weather. All possible sail set.
2	15		"	"	"	Signalized the Ship Shannon from Havre, bound to New Orleans,
3	15		"	"	"	out 30 days.
4	15		"	"	"	At 4h, Long. in by Chronometer 29° 25′ W.
5	15		"	"	"	At 5h, Carried away the top-gallant studding-sail booms. Made
6	14		"	"	"	up the sails and sent the booms down on deck.
7	15		"	"	"	At Sunset the Magnetic Var. was Obs. to be 20° Westerly.
8	15		"	"	"	At 8h, squally-like clouds in the N. W. and the Barometer falling.
9	15		"	"	"	Ship approaching the Northern limit of the N. E. Trade wind.
10	15		"	"	"	Handed all the small sails.
11	15		"	"	"	At Mid. The wind heading the Ship off, in all studding-sails, and
12	15		"	"	"	braced forward the yards.

H.	K.	H. K.	COURSE.	WINDS.	L. W.	REMARKS, SATURDAY, MARCH 18TH, 1854.
1	10		N. W.	N. E. by N.	"	A. M. Very squally weather, with heavy rain; handed the stay-
2	10		"	"	"	sails and flying-jib.
3	10		"	"	"	
4	10		"	"	"	Heavy ground swell from the N. W.
5	10		"	"	"	
6	10		"	"	"	At Sunrise the Magnetic Varia. was Obs. to be 19° 30′ W.
7	10		"	"	"	
8	10		W. by N.	North.	"	At 8h, In first reef of the top-sails and set top-gallant-sails over
9	10	1	"	"	"	them.
10	10	1	"	"	"	No observations, Sun obscure.
11	10	1	"	"	"	Noon. Strong gale and a high topping sea.
12	10	1	"	"	"	In top-gallant-sails and double-reefed the top-sails.

Variation	Course	Dist.	D. Lat.	Dep.				
19° W.	N. 56° W.	280	156 N	234 W.	Lat. D.R. 23° 26′ N. Lat. Ob.	Lon. D.R. 32° 46′ W. Dif. Lon. 4 12 W.	Long. Chro. 0° 0′ D. R. since yesterday 32° 52′ W.	Bar. 29 .50 Ther. 78°

As sufficient examples of working a Day's work have been already given worked out, it is considered unnecessary to work out those in this Journal, the result only being given, that is, a summary of the whole, including the Latitude by Observation, and Longitude by Chronometer at Noon, the Longitude by Dead Reckoning being carried on from day to day by itself. The Difference of Longitude made is also applied to the Longitude by Chronometer on the preceding day, and placed under the Longitude by Chronometer to-day. This affords a means of comparison. In like manner the Latitude by Dead Reckoning and that by Observation are placed under each other, which will show at any time the effect of a Current or the Errors in the reckoning.

The Variation observed agreeing with that laid down on the Chart, we conclude there is no Local Attractraction on board. The Courses steered by Compass in the above Days' works are turned into Degrees and Minutes, the Variation applied gives the True Course in Degrees; for instance, N. N. W. is N 23° W. nearly, and as the Variation has increased in the first Day's work from 17° 30′ to 20°, we take the Mean, or 19°, as the proper Variation to be allowed on the whole Day's work; this added to N. 23° W. by Compass, gives the True Course N. 42° W., with which and the Distance run, gives the D Latitude and Departure.

METHOD OF KEEPING A SHIP'S LOG-BOOK IN SEA TIME.

Having thus given Examples of Keeping the Harbor and also the Sea Logs. in Civil Time in the commencement of this Journal, the remainder of it will be kept in Sea Time, that is, in the usual manner adopted on board merchant vessels.

The Clipper Ship Dauntless, W. Griffen, Commander.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, SUNDAY, MARCH 19TH, 1854.
1	9		West.	N. by W.	1	P. M. Strong gale and rainy weather.
2	9	1	"	"	"	Sent down the royal-yards and rigged in the flying-jib-boom.
8	9	1	"	"	"	
4	9	1	W. ½ S.	"	1	At 4h, eased the Ship by checking in the weather braces and keeping clean full-and-by, the object being to get well to the Westward before a change of wind takes place, which, by the falling of the Barometer to 29.40 would seem to indicate.
5	10		"	"	"	
6	10		"	"	"	
7	10		"	"	"	
8	10		"	"	"	
9	10		"	"	"	
10	10		"	"	"	At 10h, do. weather.
10	10		"	"	"	
12	10		"	"	"	Midnight. Strong gale and a high sea. Pumps carefully attended Ship keeping perfectly tight.
1	10		"	"	"	
2	10		"	"	"	
3	10		"	"	"	
4	10	1	"	"	"	At 4 A. M. Gale increasing, reefed the coursers and spanker and eased the jib-half-boom in.
5	9	1	"	"	"	
6	9	1	"	"	"	At 6h, the Magnetic Varia. at Sunrise, as near as it could be observed, appeared to be 14° or 1¼ points Westerly.
7	10		"	"	"	
8	10		"	"	"	At 8h, observed an Alt. of the Sun. Long. in by Chron. 36° 0′ W.
9	10		"	"	"	
10	10		"	"	"	
11	10		"	"	"	At 11h 45m, another Alt. of the Sun gave, Lat. in 21° 9′ N.
12	10		"	"	"	Noon. Stormy weather. Sun. obscure.

Variation	Course	Dist.	D. Lat.	Dep.				
17° W.	S. 57° W.	237	129 S.	198 W.	Lat. D.R. 21° 17′N. Lat. Obs. 21 7	Dif. Lon. 3° 34′ Lon. D.R. 36 20 W.	Long. Chr. 36° 36′ D. R. since yesterday..... 36° 26′	Bar. 29.35 Ther. 78°

In the above Day's work it appears that the Magnetic Variation has changed from 19° 30′ to 14°, during the run to the Westward since yesterday evening at Sunset, we therefore use the mean of the two, which is 17° or 1½ points, to correct the Compass Course.

An Altitude of the Sun having been obtained at about 8 o'clock for Chronometer, and another for the Latitude near Noon, the time by Chronometer being noted at the time of each observation, the Latitude is thence found by the method given at page 94, and the Longitude by Chronometer is found by the method given at page 140. This is the simple case; or the Latitude may be found from the two Altitudes having the measured interval of Time between the observations by the method given at page 96. As the Ship has plenty of sea-room it is not necessary to resort to the method given at page 144 in this case; besides the 1st Altitude was observed at a proper distance from the Meridian, and any Error in the Latitude by Dead Reckoning would not affect the Time much, nor the Longitude by Chronometer, because the Ship is in a low Latitude.

One point of Leeway and 1½ points of Variation being allowed to the left of the Course by Compass, gives the True Courses, which, with the Distance run on each, gives the Difference of Latitude and Departure made good, and thence the Latitude and Longitude by Dead Reckoning. Then the Difference of Longitude made by Dead Reckoning applied to the Longitude by Chronometer yesterday, gives the Longitude in by Dead Reckoning since yesterday. This compared with the Longitude by Chronometer to-day shows the Ship to be 10′ of Longitude to the Westward of the Dead Reckoning. In like manner the Difference between the Latitude by Dead Reckoning and that by observation shows the Ship to be 10′ to the Southward of the Dead Reckoning. This may be accounted for in two ways, that is, she must either have gone more distance than the Log has given her, or there may have been a Current setting in the direction of her Course. It is evident it could not have been caused by an Error in the Course, because the Error in the Latitude is to the Southward of the Dead Reckoning, and the Error in the Longitude is to the West of the Dead Reckoning, or in excess; but had the Longitude by Chronometer been to the Eastward of the Dead Reckoning, or less than it, it would then have been concluded that the Error was due to the Course having been more to the Southward than that given by Log

JOURNAL OF A VOYAGE

From Santa Cruz, (Cape Verdes,) towards St. John's, Newfoundland.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, MONDAY, MARCH 20TH, 1854.
1	10		W. S. W.	N.W. by N.	1	At 1 P. M. the wind hauled more to the Westward. Wore ship to the North Eastward.
2	8		N. E. by N.	N. W.	1½	
3	8		"	"		
4	8	1	N. N. E.	N.W. by W.	1½	At 4h, strong gale and rainy weather.
5	8		"	"		
6	8	1	"	"		At 6h 30m, the sky cleared up to the Southward. Observed the Meridian Altitude of the star Sirius, (a good observation,) which gave Lat. in 21° 42′ N. Lat. by D. R. at same time 21° 35′ N.
7	7	1	"	"		
8	7	1	"	"		
9	8		"	"		
10	8		"	"		At 10h, more moderate weather. Out double reefs of the topsails and set top-gallant-sails over them.
11	10		"	"	1	
12	10		"	"		Midnight. Fresh breeze and clear weather.
1	10		"	"		
2	10		"	"		At 2 A. M., weather moderating, and the head sea going down.
3	10		"	"		
4	10		"	"		At 4h, out reefs of the courses and spanker.
5	10		"	"		At 5h 30m, Lat by the Moon 23° 26′ N., D. R. gave 23° 17′ N.
6	10		"	"		At Sunrise, the Magnetic Variation observed was 12° 0′ W.
7	10		"	"		
8	10		"	"		At 8h, Long. in by Chronometer 35° 25′ W.
9	9		"	"		Watch on deck employed repairing chafing gear.
10	9		"	"		Carpenter repairing the Longboat.
11	9		"	"		
12	9		"	"		Noon. Cloudy weather; Sun obscure.

Varia.	Course.	Dist.	D. Lat	Dep.	Lat. D. R. / Lat. Obs.	Dif. Long. / Lon. D.R.	Lon. Chro. / D.R. sin. yest.	Baro. / Therm.
13° W.	N. 23° E.	198	182 N.	76 E.	Lat. D. R. 24° 23′ N. / Lat. Obs. 24 38 N.	Dif. Long. 1° 23′ E. / Lon. D.R. 34 57 W.	Lon. Chro. 35° 8′ W. / D.R. sin. yest. 35 13 W.	Baro. 29.30 / Therm. 77°

To Correct the Courses Steered in Degrees.

Comp. Course	W. S. W. or S. 67° 30′ W.	N. E. by N. or N. 33° 45′ E.	N. N. E. or N. 22° 30′ E.	N. N. E. or N. 22° 30′ E.
	Sub. L. W. 11° 15′ & Va. 13° — 24 15	Add the Diff.... 3 52	Add Diff..... 3 52	Sub. Diff.... 2 0
Course made good......	S. 43° 15′ W.	N. 37° 37′ E.	N. 26° 22′ E.	N. 20° 30′ E.

The Courses being corrected in the above manner, and entered into the Traverse Table, with their respective distances, as usual, the nearest degree being then taken as the Course to find the Difference of Latitude and Departure.

This is a very important matter, and should be attended to in a fast-sailing vessel; because an omission of, say 2°, in the variation allowed on the Course steered, when the distance run is great, will cause a considerable error in the Dead Reckoning. When the Course is near the Meridian, or near a Parallel of Latitude, this error will amount to 4′ in every 100 miles distance; when near 45° the error will be 2′ in every 100 miles.

In looking over this day's work, we find that at 6h 30m the Latitude found by the Meridian Altitude of the Star Sirius, made the Ship 7′ to the Northward of the Dead Reckoning, and at 5h 30′ A. M., by the Meridian Altitude of the Moon, she was 9′ to the Northward of the Dead Reckoning.

And that the Longitude by Chronometer made her 5′ of Longitude to the Eastward of the Dead Reckoning. She has, therefore, made less Leeway than has been allowed her, and gone more Distance than the Log gives her; it is therefore proper to examine the Log-line; and which, on being examined, we find to be 5 feet too long at the 5 knot mark, which would be equivalent to an error of nearly ½ a knot in using the 14 sec. or Short Glass, giving the Distance too small. The proper length between the knots should be 45 feet, whereas the line was found to be 46 feet, or one foot too long on each knot. A measured space of say 22 feet 6 inches, the length of the half-knot, should be marked off on the deck, and a copper nail driven in at each end of it, as a permanent measure, whereby the line may be verified occasionally; because it is liable to shrink up as well as to stretch, when new. In fitting a new line, it should be well stretched and then thoroughly wetted, before it is measured and marked.

JOURNAL OF A VOYAGE.

The Clipper Ship Dauntless, W. Griffen, Commander.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, TUESDAY, MARCH 21ST, 1854.
1	9	1	N. by E. ½ E.	N.W. by W.	½	At 28m past Noon, Lat. Obs. 24° 43′ N.
2	10	1	"	N.W. by W. ½ W.		At 2 P. M., out all reefs. Sent up the royal yards, rigged out the
3	10		"	"		flying-jib-boom, and set the sails.
4	10	1	"	"		At 4h, the Long. in by Chronometer 35° 0′ W.
5	10		"	"		Steady breeze and fine weather.
6	10	1	"	"		Sunset, Magnetic Variation Obs. 12° Westerly.
7	10		"	"		At 7h 20m, Mer. Alt. ✳ Castor. Lat. in 25° 56′ N. D. R. 25° 54′ N.
8	10		"	"		
9	10	1	"	"		At 9h, set the stay-sails, fore and aft.
10	11		"	"		
11	10	1	"	"		
12	11		"	"		Midnight. Steady breeze and fine clear weather.
1	10	1	"	"	½	
2	11		"	"		A. M. Do. weather. All possible sail set.
3	10	1	"	"		
4	11		"	"		At 4h 20m, Mer. Alt. ✳ Antares. Lat. in 27° 25′ N. D. R. 27° 27′ N.
5	10	1	"	"		
6	11		"	"		At 6h 38m, Mer. Alt. ☽ Lat. in 27° 54′ N. D. R. 27° 53′ N.
7	10	1	"	"		
8	11		"	"		At 8h, Long. in by Chronometer 34° 28′ W. An Azimuth taken
9	10	1	"	"		same time gave the Magnetic Variation 14° Westerly.
10	11		"	"		Employed painting the boats, &c.
11	10	1	"	"		Carpenter caulking on deck.
12	11		"	"		Noon. Island of Fayal (Azores) N. 26° E., 650 miles.

Varia.	Course.	Dist.	D. Lat.	Dep.			
13° W.	N. 8° 30′ E.	253	250 N.	37 E.	Lat. D. R. 28° 48′ N. Lat. Obs. 28 50 N.	Dif. Long. 0° 42′ E. Lon. D. R. 34 15 W.	Long. Chro. 34° 22′ W. D.R. sin.yest. 34 26 W.	Bar. 29.80 Ther. 76°

As the Meridian Altitude of the Sun was not obtained yesterday, an Altitude was taken in the afternoon, and the Time noted by Chronometer, by which means the Apparent Time at the Ship was found to be 28m past Noon. The Latitude being then worked out, (by the method given at page 94,) is found as above. The Ship has made 5′ of Difference of Latitude to the Northward since Noon, which subtracted from it, gives the Latitude in at Noon yesterday.

The Magnetic Variation having changed from 12° to 14° during the day's run, the Mean of which, 13°, being applied to the left hand of the Courses by Compass, after being corrected for Leeway, as shown in yesterday's work, will give the True Courses.

The Difference between the Dead Reckoning and Observations to-day is much less than heretofore, being only 2′ of Latitude to the Northward, and 4′ of Longitude to the Eastward.

The Variation was found this morning by an Azimuth, and by the same Altitude which was used for Chronometer. (See the method of doing this at page 150.)

By inspecting Table XVIII, against the Day of the Month, the Times of the Meridian Passages of the Stars Sirius and Antares will be found as above. Then their computed Altitudes furnish the means of finding them. (See page 106, No. 3.) The Latitudes so found, and that by the Dead Reckoning since Noon, on being compared are found to agree, nearly.

By reference to the Nautical Almanac, in the case of the Moon, the Mean Time of her passing the Meridian at Greenwich is found and reduced to the Meridian of the Ship. Then the Equation of Time subtracted, gives the Apparent Time as above. (See page 101.) The Latitude Observed and Dead Reckoning agree, nearly.

The Ship's position being laid down on the Chart each day at Noon, as directed at page 48, and joined together with a pencil line, produces her track. When out on the open Sea, it is not necessary to note the bearing of the Land daily, but in the case of having to pass near to certain land, it is prudent to note its Bearing and Distance at Noon, as we approach it. As in this case the Ship is heading towards the Azores Islands, we therefore find the Bearing and Distance of the nearest. Fayal bears N. N. E. ½ E. True, or N. E. ½ N. by Compass, distant 650 miles; and Flores, which lies West of it, bears N by E ½ E. or N. N. E. ½ E. by Compass, distant 660 miles. The same may found by the Rule in Case 2d in Middle Latitude or Mercator's Sailings

JOURNAL OF A VOYAGE

From Santa Cruz (Cape Verdes.) towards St. Johns, Newfoundland.

H.	K	H. K.	COURSES.	WINDS.	L. W.	REMARKS, WEDNESDAY, MARCH 22D, 1854.
1	10	1	N. by E. ¾ E.	N.W.b.W. ½ W.	¼	P. M. A fresh, steady breeze ; all possible sail set. Signalized
2	11		"	"	"	the Ship South Carolina, from Liverpool, bound to Austra-
3	11		"	"	"	lia, out 15 days.
4	11		"	"	"	At 4h, Long. in by Chron. 34° 22′ W., and an Azimuth Obs. at
5	11	1	"	"	"	the same time gave the Magnetic Varia. 20° W
6	10		"	"	"	
7	11		"	"	"	
8	11		"	"	"	At 8h, Squally ; handed the stay-sails.
9	11		"	"	"	
10	11		"	"	"	At 10h 6m, Alt. Pl't Mars S. gave Lat. 30° 36′ N. } Mean 30°41′N
11	11		"	"	"	do. Alt. Polar ✳ N. gave Lat. 30° 46′ N. }
12	11	1	N. E.	N. W. by W.	0	The Lat. by D. R. since Noon same time........... 30° 39′ N.
1	11		"	"	"	Clear starlight night and smooth water ; set all the stay-sails,
2	11		"	"	"	fore and aft.
3	11		"	"	"	
4	10	1	"	"	"	At 4 A. M. Fresh breeze and showery weather.
5	11		"	"		At Sunrise the Mag. Varia. observed was 25° Westerly.
6	11		"	"	"	At 7h 40m, Mer. Alt. of the ☽ Lat. in 32° 16′ N., D. R. 32° 17′ N.
7	11		"	"	"	Long. in by Chron. same time 33° 42′ W.
8	11		"	"	"	Employed reeving new running rigging and setting up the jib-
10	11		"	"	"	guys and top-gallant backstays.
11	11		"	"	"	Steady breeze and pleasant weather.
12	11		"	"	"	Noon. Island of Flores. (Azores) N. 15° E., Dist. 404 miles.

Variation	Course	Dist.	D. Lat.	Dep.	Lat. D. R. 33° 2′ N.	Dif. Lon. 1° 4′ E.	Lon. Chr. 33° 20′ W.	Bar. 29.80
22° 30′ W.	N. 12° E.	260	252 N.	55 E.	Lat. Obs. 33 1 N.	Lon. D.R. 33 11 W.	D. R. sin. yest. 33° 18′ W.	Ther. 75°

The Magnetic Variation has changed considerably since yesterday morning, at which time it was observed to be 14°. At 4 P. M. it had increased to 20°, and this morning it was found to be 25°. We therefore take the Mean of the two Variations last found, which is 22° 30′, or 2 points Westerly, as the proper Variation to be allowed on the Courses steered.

As the Ship's position by Dead Reckoning agrees very nearly with that by observations to-day, we therefore conclude that the Log is correct.

At about 10 P. M. the Altitude of the Planet Mars, observed to the Southward, gave the Latitude as above, but the night being dark and the horizon doubtful, an Altitude of the Polar Star was observed to the Northward, the Latitude by which differed 10′ from that by the Altitude of Mars, but the Mean of the two agrees nearly with that by Dead Reckoning. (See Remarks, page 110.)

The Moon being on the Meridian at 7h 40m, Apparent Time in the morning, her Meridian Altitude was observed, and at the same time Altitudes of the Sun were taken for the Chronometer, which gave the Latitude and Longitude of the Ship at that time, as above.

The Longitude by Chronometer at Noon was found to-day by equal Altitudes of the Sun, and agrees with that brought up to Noon by the Dead Reckoning since the morning Sights were taken. The first equal Altitude was taken at 7 bells, and the time noted by Chronometer. The Index of the instrument was then screwed back 10′, equal to the Difference of Latitude made to the Northward in 1 hour, and when the Sun's Lower Limb fell to that Altitude, the Time by Chronometer was noted again. This method is fully explained in the Note at page 147.

The Bearing and Distance of the adjacent Land, or that which the Ship is approaching, is again noted at Noon to-day. The Island of Fayal bears N. E. by N. True, or N. E. by E. ; by Compass (Variation 2 points W.) Distant 400 miles ; and the Island of Flores bears N. by E. ¼ E. True, or N. E. ¾ N. ; by Compass Distant 404 miles. That is, ¾ of a point on the Weather or Port bow of the Ship. These bearings are from the Chart. But if a Chart is not at hand, the Bearing and Distance of any of the Islands may be worked out by the Rules given in Case 2d, of Middle Latitude or Mercator Sailing. The Latitudes and Longitudes of the several Islands are given in the Table of Positions at the end of the work

JOURNAL OF A VOYAGE.

The Clipper Ship Dauntless, W. Griffen, Commander

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, THURSDAY, MARCH 23D, 1854.
1	11		N. E.	N. W. by W.	0	P. M. Fresh breeze and clear weather.
2	11		"	"	"	People employed repairing sails, &c.
3	11		N. E. by N.	N. W.	0	Carpenter making a top-gallant studding-sail-boom
4	11		"	"	"	Several vessels in sight, bound West.
5	11		"	"	"	
6	11		"	"	"	At Sunset the Long. by Chron. was 32° 52′ W.
7	10	1	"	"	"	The Dead Reck. at the same time 32 59 W.
8	10	1	"	"	"	Ampli. gave the Mag. Varia. 23° Westerly.
9	10	1	"	"	"	And an Altitude of ✱ Sirius near the Mer. gave Lat in 34° 4′ N.
10	10		"	"	"	The Dead Reckoning since Noon was................ 34 5 N.
11	9	1	"	"	"	
12	9		N. N. E. ¼ E.	N. W. ½ W.	½	Midnight. Cloudy weather.
1	8	1	"	"	"	
2	8	1	"	"	"	At 2 A. M. Less wind and hazy weather.
3	8		"	"	"	
4	8		"	"	"	At 4h. Mer. Alt. of ✱ Antares gave Lat. 35° 25′ N. } The Mean
5	8		"	"	"	and an Alt. of the Polar ✱ gave Lat. 35° 37′ } 35° 31′ N.
6	8		"	"	"	At Sunrise, Mag. Varia. Obs. 23° W. D. R. gave Lat. 35° 34′ N.
7	8		"	"	"	Steady breeze and fine clear weather.
8	8		"	"	"	At 8h 40m. ☽'s Mer. Alt. gave Lat. in 36° 5′ N., D. R. 36° 9′ N.
9	8		"	"	"	Sun's Alt. gave Long. Chron. 32° 3′ W. The D. R. was 32° 29′ W.
10	8		"	"	"	Azimuth Obs. same time gave Mag. Varia. 23° W.
11	8		"	"	"	Watch on deck repairing sails, &c.
12	8		"	"	"	Noon. The Island of Flores (Azores) N. 10° E. (True) 182 miles.
						Current to-day E. by S. (True) 1 mile an hour.

Vari'n	Course	Dist.	D. Lat.	Dep.	Lat. D. R. 36° 38′ N.	Dif. Lon. 0° 58′ E.	Long. Chron. 31° 52′ W.	Bar. 29.80
2 pt. W.	N. 12° 30′ E.	223	217 N.	48′ E.	Lat. Obs. 36 33 N.	Lon. D.R. 32 13 W.	D.R. sin. yest. 32 22 W.	Ther. 70°

The Magnetic Variation having continued the same throughout this day, that is 23° or 2 points Westerly, we allow that quantity on the Courses by Compass.

The Ship's position by observation being to the East of that by the Dead Reckoning, it is evident there must have been a Current setting her in that direction.

At Sunset the Longitude by Chronometer was observed as above, (see the Method of doing this at page 128,) and which was 7′ of Longitude to the Eastward of that by Dead Reckoning since Noon; and at 8h 40m A. M. the Longitude by Chronometer was 26′ to the Eastward of the Dead Reckoning since Noon.

The Latitude observed by the Star Sirius at Sunset was 1′ to the Southward of the Dead Reckoning; and at 8h 40m A. M. the Meridian Altitude of the Moon gave the Latitude 4′ to the Southward of the Dead Reckoning. Now, by the Method given at page 29, of finding the Current, we ascertain that in 15 hours, that is, from Sunset until, say 9 o'clock next morning, the Current has set S. 79° E., E. by S. True, or S. E. by E. by the Compass, and the Drift 15 miles, or at the rate of 1 mile per hour.

Equal Altitudes taken near Noon in the same manner as was done yesterday, corroborates the Long. in by Chronometer at Noon as above. The whole Error in the Longitude, from Noon to Noon, caused by the Current, amounts to 30′ E., and the whole Error in the Latitude in like manner, amounts to 5′ S. From this data we find, as before, that the Current has set E. by S. True, or S. E. by E. by Compass, 24 miles in 24 hours, or at the rate of 1 mile per hour.

This Current is supposed to be a continuation of the Gulf Stream, which, after pursuing its course along the Coast of America, branches off in the direction of the Azores Islands, and after striking the Coast of Africa turns South, passing to the East of the Cape Verde Islands, it joins the great Guinea Current on the S. W. Coast of Africa. (See the Remarks on Currents at page 39.)

The Bearing and Distance of the Isle of Flores, at Noon to-day, is N. by E. nearly, or N. E. by N. by Compass, Distant 182 miles. And suppose it was required to shape a Course so as to keep the Island on the same bearing, and allow for the effect of the Current, we would proceed as follows: The Curren being found to run nearly at right angles to the bearing of the Island, we take the Sum of the bearing N. 10° E., and the Set of the Current S. 79° E. = 89° as a Course, and its rate 1 knot as a Distance gives the Departure 1′, the Ship's rate of Sailing 8 knots, and Departure 1, gives the Course 7°, which subtracted from N. 10° E. gives the True Course N. 3° E., and the Variation being allowed gives the Compass Course N. N. E. ¼ E. (See Method of doing this at page 30, Case 3d.)

JOURNAL OF A VOYAGE

From Santa Cruz, (Cape Verdes,) towards St. John's, Newfoundland.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, FRIDAY, MARCH 24TH, 1854.
1	8		N. by E. ¾ E.	N. W. by W.	½	P. M. Steady breeze and fine clear weather.
2	8		"	"		Employed as yesterday.
3	8		"	"		
4	8		"	"		At 4h, Longitude in by Chronometer 31° 45′ W. Dead Reck.
5	8		"	"		31° 50′ W. An Azimuth Obs. same time gave the Var. 23° W.,
6	8		"	"		and at Sunset an Amplitude gave the Var. 23° 30′ W.
7	8		"	"		At 7h, Obs. Mer. Alt. ✱ Castor. Lat. in 37° 28′ N., D. R. 37° 29′ N.
8	8		"	"		Obs. Alt. of the Polar ✱. Lat. in 37° 28′ N.
9	8		"	"		
10	8		"	"		At 10h, sky overcast, with rain. Handed the staysails, royals, and
11	8		"	"		flying-jib.
12	8	1	"	"		Midnight. Squally, with showers of rain.
1	7	1	"	"		
2	8		"	"		At 2 A. M., weather cleared up. Set the light sails again.
3	7	1	"	"		
4	8	1	"	"	1	At 4h 9m, Obs. M. Alt. ✱ Antares. Lat. 38° 35′ N. Mean 38° 38′ N.
5	8		"	"		Obs. Alt. of the Polar ✱. Lat. 38° 41′ N. D. R. 38° 41′ N.
6	8		N. N. E. ¾ E.	N. W. ½ W.	½	At Sunrise, Mag. Varia. Obs. 23° W., and the Long. in by Chron
7	8		"	"		same time was 31° 20′ W. D. Reckon. 31° 42′ W.
8	8		"	"		At 8h, Long. in by Chron. 31° 12′ W., and at the same time
9	6		N. by E. ¾ E.	N. W. by W.	½	the Isle of Flores was seen bearing N. 23° E. distant 24 miles.
10	6		"	"		Took Sights to verify the rate of the Chronometer.
11	6		"	"		Noon. Light winds and fine. The North end of the Isle of Flores
12	6		"	"		bore W. N. W. by Compass, distant 7 miles.
						Current E. by S. (true,) 1 mile an hour

Varia.	Course.	Dist.	D. Lat.	Dep.	Lat. D. R. / Lat. Obs.	Dif. Long. / Lon. D. R.	Long. Chro. / D.R. sin. yest.	Bar. / Ther.
23° W.	N. 4° 30′ E.	184	183 N.	14 E.	Lat. D. R. 39° 36′ N. Lat. Obs. 39 31 N.	Dif. Long. 0° 18′ E. Lon. D. R. 31 55 W.	Long. Chro. 31° 4′ W. D.R. sin. yest. 31 34 W.	Bar. 29.50 Ther. 69°

The Course was shaped, or rather the Ship lay up, N. by E. ¾ E., and allowing ½ a point of Leeway, she made good the Course N. N. E. ¼ E., as computed at the end of the last day's work, in order to counteract the effect of the current and to keep the Island on the same bearing; and had she been continued on that Course until Noon, she would have closed with the Island on the above bearing. But between the hours of 5 and 8 A. M. she was kept off 1 point, so as to be on its Meridian at 8 o'clock, with the view of verifying the Chronometer when the Island was seen. At 8 A. M. the Island was seen accordingly bearing N. 23° E., distant 24 miles, and which placed the Ship exactly on its Meridian; sights for Chronometer being then taken, in the manner as recommended at page 155 for rating the Chronometer. In this case, the error of the Chronometer on Greenwich Mean Time was found to be 0h 10m 59s. Its error on leaving the Cape Verdes, 8 days ago, was 0h 10m 39s.; consequently it has gained 20 sec. in 8 days, and its daily rate, 2 sec. 5-10th gaining, (its previous rate,) confirmed.

From the above method of allowing for Currents, it will be perceived that if the Set and Drift of a Current be known, it is easy to compute beforehand the precise effect it will have on the Ship's Course, according to her rate of sailing, so that the land may be made on any given bearing. But it must be remembered, that if her rate of sailing changes, the Course must again be computed to this change.

As before observed, the Ship had been kept off 1 point for three hours, with the view of placing her on the Meridian of the Island, in consequence of which she did not fetch it in, but was on its parallel of Latitude at Noon, and she passed 7 miles to the Eastward of its Meridian.

In working up the above day's work, 23° of Variation is allowed on all the Courses, after being corrected for Leeway, and which being entered in the Traverse Table, together with the true Set and Drift of the Current, that is, E. by S. 1 knot an hour, the Dead Reckoning and the Observations taken at various times during the day, will be found to agree, as also the Dead Reckoning and the Observations at Noon.

The Longitude by Dead Reckoning, carried on from day to day since leaving the Cape Verdes, is found to be in error 51′ too far Westerly. Consequently a fresh Departure is taken to-day at Noon, from the North end of the Island of Flores, bearing W. N. W., distant 7 miles, the position of which is Latitude 39° 32′ N., Longitude 31° 12′ W.

JOURNAL OF A VOYAGE.

The Clipper Ship Dauntless, W. Griffen, Commander.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, SATURDAY, MARCH 25TH, 1854.
1	5		N. by E.	N. W. by W.	½	Took a fresh Departure at Noon yesterday, from the N. end of the
2	5		"	"		Isle of Flores bearing W. N. W. by Compass, distant 7 miles.
3	3		"	"		At 3 P. M., light winds, inclining to calm.
4	2		"	"		The Isles of Flores and Corva in sight to the S. W., 12 miles.
5			"	"		At 5h, calm. Heavy threatening clouds rising in the South, indi-
6			"	"		cating a storm. Barom. fallen to 29.20.
7	Calm.		"	"		Handed all the light sails, sent down the royal yards, and made all
8			"	"		snug for a gale. Mag. Varia. Obs. 25° W.
9			"	"	0	At 9h, a breeze sprung up from the Southward, with rain, which
10	5		N. W. ½ N.	South.		rapidly increased to a gale of wind.
11	16		"	"		At 11h, in top-gallant-sails and double-reefed the topsails.
12	15		"	"		At Midnight, handed the S. M. sail and spanker.
1	15		"	"		
2	16		"	"		At 2 A. M., gale increasing and a heavy sea running.
3	16		"	"		
4	16		"	"		At 4h, close-reefed the topsails and foresail and furled the mizzen
5	15		"	"		topsail.
6	15		"	"		Passed several vessels lying to.
7	15		"	"		
8	15		"	"		At 8 A. M., blowing excessively hard, and thick with heavy rain.
9	15		"	"		Vessel shipping much water on deck.
10	15		"	"		Pumps carefully attended.
11	15		"	"		Rigged in the flying-jib-boom.
12	15		"	"		Noon. Do. weather. Sun obscure.
						Bearing and Distance of St. John's, N. 63° W., (true,) 830 miles.

Varia.	Course.	Dist.	D. Lat.	Dep.	Lat. D. R. 41° 19′ N.	Dif. Long. 4° 0′ W.	Lon. Chro. " "	Baro. 29.10
2¼ pt. W	N. 60° W	213	108 N	184 W	Lat. Obs. " "	Lon. D. R. 35 12 W.	D. R. sin. yest. 35° 12′ W.	Therm. 65°

No Observations have been obtained to-day, except at Sunset, when an Amplitude gave the Magnetic Variation 25°, or 2¼ points Westerly.

In working up this day's work, we allow for the Set of the Current E. by S. (true) 1 knot an hour, from Noon until 9 P. M., at which time the wind came out from the Southward, and increased into a gale, consequently, the Ship would soon run to the North Westward, where she would be out of its influence.

There is reason to apprehend that the Ship has been run off to the Northward of her Course to-day, as the Sea broke heavily on the weather quarter; and also from the fault of the helmsman hanging on his weather helm when the Ship was on the top of a Sea, thereby causing her to yaw off. But as there is plenty of Sea-room, it is not deemed necessary to make any allowance for that in this day's work. (See the Remarks on this subject at page 190.)

When the wind came fair last night the Course was shaped as above, from the position of the Ship at that time, in Latitude 39° 44′ N., and Longitude 30° 56′ W. Then a ruler placed over the Ship's place on the Chart and over that of St. John's, gives the True Course N. W. by W. ¾ W., and allowing 2¼ points Variation to the right, gives the Compass Course required to steer N. W. ½ N., and the Distance 1050 miles; or the same may be found by Case 2d, in Middle Latitude or Mercator's Sailings. In this case, the Latitude in at 9 P. M. being 39° 44′ N., and Longitude 30° 56′ W.

In the Table of Positions is found St. John's, Latitude 47° 34′ N., Longitude 52° 45′ W. This gives the True Bearing N. 64 W., or N. W. by W. ¾ W., nearly, and the Distance 1050, same as the Chart.

In like manner, the Bearing and Distance is found to-day at Noon to be N. 63° W., or N. W. by W. ¾ W., nearly, by Compass, Distance 830 miles.

JOURNAL OF A VOYAGE

From Santa Cruz,* (*Cape Verdes,*) *towards St. John's, Newfoundland.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, SUNDAY, MARCH 26TH, 1854.
1	15	1	N. W. ½ N.	S. by W.		P. M. Heavy Southerly gale and a high topping sea running.
2	15	1	"	"		
3	15	1	"	"		
4	15	1	"	S. W. by S.		At 4h, more moderate; wind inclining to Westerly
5	16	1	"	"		Set the reefed S. M. sail and mizen topsail.
6	16	1	"	"		
7	16		"	"		
8	16		"	"		At 8h, the rain ceased, and the weather made an attempt to clear up.
9	16		"	"		
10	16		"	"		At 9h 40m Mer. Alt. ✱ Regulus. Lat. in 42° 59′ N. } Mean 43° 5′N.
11	16		"	"		Same time the Alt. of Pole ✱. Lat. in 43° 11′ N. } D. R. 42° 25′N.
12	16		"	"		Midnight. Blowing hard; vessel shipping much water on deck;
1	16		"	"		pumps carefully attended every 4 hours.
2	16		"	"		
3	16		"	"		
4	16		"	"		At 4 A. M., Mer. Alt. ✱ Antares. Lat. in 43° 46′ N. } Mean 43° 53′N.
5	16		"	"		Same time the Alt. of Polar ✱. Lat. in 44° 0′ N. } D. R. 43° 8′N.
6	16		"	"		At 6h, gale moderating and the sea falling. Out close reefs of the
7	16		"	"		topsails and set the jib.
8	15		"	"		At 8h, obs. an Alt. of the Sun. Long. in by Chron. 41° 12′ W.
9	15		"	"		Weather set in thick again, with mizzling rain.
10	15		"	"		The temperature of the Sea-water at Noon was found to be the
11	15		"	"		same as that of the air, 55°.
12	15		"	"		Noon. Do. weather. Sun obscure.
						True bearing of St. John's, N. 69° W. Distance 468 miles.

Variation	Course	Dist.	D. Lat.	Dep.	Lat. D. R. 44° 1′N.	Dif. Lon. 7° 46′W.	Lon. Chr. 42° 27′W.	Bar. 29.05
2½ pts. W.	N. 65° W	378	162 N.	342 W.	Lat. Obs. 44 46 N.	Lon. D. R. 42 58 W.	D. R. sin. yest. 42° 58′W.	Ther. 55°

The Variation allowed on this day's work is 2½ points Westerly.

At 9h 40m P. M., the Meridian Altitude of the Star Regulus was observed to the Southward, and at the same time an Altitude of the Polar Star was observed to the Northward. The Mean of the two Latitudes so found, compared with that by the Dead Reckoning, places the Ship 40′ to the Northward of the Dead Reckoning

And at 4 A. M., the Meridian Altitude of Antares was observed to the Southward, at the same time the Altitude of the Pole Star was observed to the Northward. The Mean of the two Latitudes places the Ship 45′ to the Northward of the Dead Reckoning. These Observations may not be very accurate, on account of the obscurity of the horizon and the heavy sea running, together with the difficulty of making the Observations, but are sufficiently near to act as a warning that the Dead Reckoning is in error, and by taking Stars North and South of the Meridian the errors in the Observation are very much diminished. For instance, the Difference in the two Latitudes given by Altitudes of Antares and the Pole Star is 14′, but the Mean of the two Latitudes is taken.

The Sun's Altitude was also obtained about 8 o'clock in the morning, and by using the corrected Latitude in finding the Time, we get the Longitude by Chronometer as above, and which places the Ship 33′ of Longitude to the Eastward of the Dead Reckoning. These errors in the Latitude and Longitude so found, shows that the Ship's Course made good is about 1 point further to the Northward than the Course by Compass makes her; she has, therefore, been run off.

The Barometer having fallen to 29.5, and the weather at Noon assumed a very threatening appearance, we may look for a continuance of the gale.

The Ship is now approaching the Eastern edge of the Polar Current, in which we may expect to find large masses of Ice, brought down by it from the Polar regions. On a Ship entering this current the temperature of the Sea water will be found to fall about 20°, and may be easily ascertained by drawing a bucket of water from alongside and plunging the Thermometer into it. (See the Remarks on Currents and the Use of the Thermometer, at page 82.)

The position of the Ship by Observation being laid off on the Chart, the bearing of St. John's is found to be W. by N. ¾ N.; 2½ points Variation allowed on that gives the bearing by Compass N. W., Distance 468 miles.

JOURNAL OF A VOYAGE.

The Clipper Ship Dauntless, W. Griffen, Commander.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, MONDAY, MARCH 27TH, 1854.
1	16	1	N.N.W ½W.	South.		At 1 P. M., temperature of the Sea-water 50°, Air 52°.
2	16	1	"	"		Wind backed into the Southward, and the gale increased.
3	17		"	"		At 1h 30m, temperature of the Sea-water 40°, Air 42°.
4	17		"	"		At 4h, it fell to 35°. Ship was then in the strength of the
5	17		"	"		Polar Current.
6	17		"	"		At 6h, blowing excessively hard. Close-reefed the topsails and
7	10	1	"	"		handed the courses and jib.
8	10	1	"	"		At 8h, the temperature fell to 33° in the water, and at the same
9	10		"	"		time an Iceberg was seen ahead of the Ship. Hauled up and
10	10		"	"		passed to windward of it.
11	9		"	"		At 11h, furled the mizen-topsail.
12	8	1	"	"		Midnight. Ship running under easy sail, and a bright lookout
1	8	1	"	"		kept for ice.
2	8	1	"	"		At 2 A. M., passed another large berg.
3	8	1	"	"		
4	8	1	"	"		At 4h, weather more clear. Set the reefed foresail.
5	12	1	"	"		
6	16		"	"		At 6h, out close reefs and set the reefed mainsail, jib and mizen-
7	16		"	"		topsail.
8	16		"	"		Ship passing a great many Icebergs.
9	16		"	"		
10	17		"	"		Noon. Thick fog and heavy rain. Close-reefed the topsails and
11	17		"	"		furled the courses. Passed several fields and detached pieces
12	17		"	S. S. W.		of ice.
Current South by Compass 1½ knots.						St. John's S. 89° W., (true,) or W. N. W. by Comp., dist. 194 miles.

Variation	Course	Dist.	D. Lat.	Dep.	Lat. D.R. 47° 37′N.	Dif. Lon. 5° 36′W.	Long. Chro. " "	Bar. 29.10
2 pts. W.	N. 54° W.	290	171 N.	234 W.	Lat. Ob.	Lon. D.R. 48 34 W.	D. R. since yesterday 48° 3′W.	Ther. 34°

The Magnetic Variation not having been observed to-day, it is taken from the Chart, which gives 2 points Westerly.

By the decrease in the temperature of the Sea-water, as noted above, the Ship evidently entered the Polar Current soon after mid-day, the Set of which is about South by the Compass, or S. S. E. (true,) and its Drift 1½ knots an hour. It being desirable to get to the Northward of the Parallel of Latitude of St. John's before the wind shifts to the Northward, a Course must be shaped for that purpose. By reference to the Ship's place on the Chart, a N. W. ¾ W. True Course, and Distance 300 miles, would place her to-morrow at Noon near the Eastern edge of the Great Bank, in the Parallel of Latitude required. But to make this Course good, we must allow for the Set and Drift of the Current as follows: The Set of the Current being nearly in a contrary direction to the required Course, we take their Difference, 2¾ points, as a Course, and the Drift, 1½ knots, as a Distance, which gives the Departure, 7-tenths. Then the average rate of sailing, say 13 knots an hour, (which the vessel is expected to make next 24 hours,) as a Distance, and with 7-tenths as a Departure, find the Course, 3°, or ¼ of a point, which subtracted from the given Course, N. W. ¾ W., gives the required Course N.W. ½ W.; the Variation, 2 points W., allowed, gives the Compass Course required to steer N. N. W. ½ W. (See the Rule in Current Sailing, page 30, Case 3d.)

The Ship has passed many Icebergs to-day, and on her approach to them the Thermometer was found to fall to 32°, nearly, but rose 3° after having passed them. The Mean temperature of the Sea-water in the Polar Current appeared to be 35°.

The wind having backed into the Southward again, an omen of bad weather, the sail on the Ship was reduced to the close-reefed topsails before night-fall, and a vigilant lookout kept during the night for Icebergs, as they can be seen at a considerable distance in dark weather, if a good lookout is kept for the glare or reflection, which is a peculiar kind of phosphorus light which surrounds them.

At Noon, a dense fog with heavy rain came on, and as the Barometer is rising, it indicates a shift of wind to the Northward. It was, therefore, deemed prudent to put the Ship under low canvas, in case of a sudden shift; besides, according to the Dead Reckoning, she is to the Northward of the Parallel of Latitude of the intended port.

The Bearing of St. John's at Noon to-day is S. 89° W., or W. N. W. by Compass, nearly, distant 194 miles

JOURNAL OF A VOYAGE

From Santa Cruz, (Cape Verdes,) towards St. John's, Newfoundland.

H.	K.	H. K.	COURSES.	WINDS.	L. W.	REMARKS, TUESDAY, MARCH 28TH, 1854.
1	11		N. W. by N.	W. S. W.		P. M. Dense fog, with mizzling rain. Wind inclining to Wes-
2	11		"	"		erly. No ice visible.
3	10	1	"	"		Bent the cables and got the anchors on the gunwale.
4	10	1	"	"		At 4h, sounded in 60 fathoms. Temperature of the Sea-water 34°
5	10	1	"	"		Air 36°.
6	10	1	"	"		At 6h, blowing excessive hard and heavy sea on.
7	2		Lying to.	"		Wore ship with her head to the Southward. Furled the fore and
8	2		Up S. b W.	W. S. W.	6	mizen topsails, and hove to under the main-topsail.
9	2		Off S. by E.	"		At 9h, less wind and a heavy fall of rain.
10	2		W. N. W.	North.	6	At 10h, the wind changed suddenly to the Northward, in a tre-
11	2					mendous rain squall.
12	2		"	"	4	At Midnight, blowing hard, but the weather clearing up.
1	2		"	"	2	At 1 A. M., set the fore and mizen topsails.
2	5		"	"	¼	At 2h, set the reefed courses and spanker.
3	7		N.W.by W.½W.	N. by E.		At 3h, out double reefs and set top-gallant-sails and jib.
4	14		"	"		At 4h, Mer. Alt. of ✱ Antares. Lat. in 47° 29′ } Mean 47° 34′ N.
5	15		"	"		Same time Alt. of Polar ✱. Lat. in 47° 39′ } D. R. 47° 35′ N.
6	15		"	"		At Sunrise, Mag. Varia. Obs. was 23° Westerly.
7	15		"	"		Out all reefs and checked in the weather braces.
8	15		"	"		At 8 A. M., Long. in by Chron. 51° 18′ W. D. R. 50° 58′ W.
9	15		"	"		St. John's harbor bears W. N. W. by Compass, distant 60 miles.
10	15		"	"		At 10h, the land was seen in that direction.
11	15		"	"		At 11h, made out Signal Hill, bearing W. N. W., distant 5 leagues.
12	15		"	"		Noon. Ship close in with Fort Amherst. Received on board a
	Current South by Compass 1½ knots.					Pilot, and proceeded into port.

Vari'n	Course	Dist.	D. Lat.	Dep.	Lat. D. R. 47° 34′ N.	Dif. Lon. 4° 25′	Long. Chron. 52° 48′ W.	Bar. 28.90
2 pt. W.	S. 89° W.	177	3′ S.	177 W.	Lat. Obs. 47 34 N.	Lon. D. R. 52 59 W.	D. R. sin. yest. 52 28 W.	Ther. 45°

At 1 P. M. came to with the small bower anchor in 8 fathoms water, abreast of the town of St. John's. Furled sails and moored ship, with 45 fathoms cable on each bower anchor, and sent down top-gallant yards. Midnight. Heavy rain squalls from the N. W. This day's work ends with and contains 36 hours, in order to commence the Harbor Log.

On referring to the above Log, it will be noticed that the Ship ran to the N. W. by N. until 4 P. M., when soundings were obtained in 60 fathoms water, on the North Eastern edge of the Great Bank of Newfoundland, and at 6 P. M. she was wore round with her head to the Southward, and hove to under the close-reefed main-topsail for the night, on account of the dense fog which prevailed, in case of meeting with ice; and also with the view of being on the proper tack should a sudden shift of wind from the Northward take place during the night time.

At 9 P. M. the gale began to moderate, and heavy showers of rain fell; the usual precursor of a violent and sudden shift of wind. The Barometer now began to rise rapidly, and at 10, a squall from the Northward struck the Ship, and blew with great fury for about two hours, and she luffed up to the wind on the same tack, and sail was made as the wind moderated.

The sky having now cleared up, the opportunity was taken of finding the Latitude by Observation at 4 A. M., from the Meridian Altitude of Antares to the Southward, and the Altitude of the Polar Star to the Northward. The Mean of the two Latitudes so found agrees with that by Dead Reckoning, and places the Ship in the parallel of Latitude of the intended port, 47° 34′ N.; consequently, it bears W. N. W. by Compass, but we must steer ½ a point more to the Northward, in order to make the necessary allowance for Leeway and Currents.

At Sunrise, the Magnetic Variation was observed to be 23° W., and at 8 A. M. the Longitude by Chronometer, as above, is found to be 20′ to the Westward of that by Dead Reckoning since last Observation, and by a case of Parallel Sailing, or by the Chart, St. John's is found to bear true West, or W. N. W. by Compass, distant 60 miles.

At 10 A. M., High Land was discovered ahead, and at 11 the buildings on Signal Hill, and Fort Amherst, at the entrance of St. John's Harbor, were distinctly made out, and at Noon she closed with the entrance of the Harbor, and took a Pilot on board. Thus making the Passage from Port to Port in 12 days 6 hours, and sailed a distance of 2977 miles.

In working up this day's work, the allowance for the Set and Drift of the Current, as above, (S. S. E. true, 36 miles in 24 hours,) must be inserted in the Traverse Table, along with the other Courses and Distances, and the result of the day's work will be found as above.

Of the Ship's Position at Noon of each day, an Abstract or Memorandum only, is sometimes kept, in the room of keeping a regular Journal. **And frequently an** Abstract or copy of the Ship's Position at Noon is taken from the Journal and kept on a separate sheet of paper, with the view of being **more conveniently referred** to, and is generally ruled in the following form ·

ABSTRACT OF THE FOREGOING JOURNAL.

DATES. 1854.		COURSES.	DIST.	LAT. D. R.	LONG. D. R.	LAT. OBS.	LONG. BY CHRONOM.	DO. CARRIED ON	CURRENTS.	MAG. VAR. OBS.	BAROM. NOON.	THER. AIR.	THER. WA	BEARING AND DISTANCE OF LAND AT NOON.
Friday, March	17th	N. 40° W.	287	20° 52′ N.	28° 34′ W.	20° 50′ N.	28° 40′ W.	28° 34′ W.		19° W.	30.00	79°		
Saturday, "	18th	N. 56° W.	280	23 26	32 46			32 52		20°	29.50	78°		
Sunday, "	19th	S. 57° W.	237	21 17	36 20	21 7	36 36	36 26		17°	29.35	78°		
Monday, "	20th	N. 23° E.	198	24 23	34 57	24 38	35 8	35 13		13°	29.30	77°		
Tuesday, "	21st	N. 8° 30′ E.	253	28 48	34 15	28 50	34 22	34 26		14°	29.80	75°		Isle Fayal N. 26° E. 650 miles.
Wednesd. "	22d	N. 12° E.	260	33 2	33 11	33 1	33 20	33 18		22° 30′	29.50	70°		Isle Flores N. 15° E. 404 "
Thursday, "	23d	N. 12° 30′ E.	223	36 38	32 13	36 33	31 52	32 22	E. by S. 1 mile.	22° 30′	29.80	70°		do. N. 10° E. 182 "
Friday, "	24th	N. 4° 30′ E.	184	39 36	31 55	39 31	31 4	31 34	E. by S. 1 mile.	23°	29.50	69°		do. West 7 "
Saturday, "	25th	N. 60° W.	213	41 19	35 12			35 12		25°	29.10	65°		St. John's N. 63° W. 830 "
Sunday, "	26th	N. 65° W.	378	44 1	42 58	44 46	42 27	42 58		25°	29. 5	55°	55°	do. N. 69° W. 468 "
Monday, "	27th	N. 54° W.	286	47 37	48 34			48 3	S. S. E. 1½ m.'s.	22° 30′	29.10	34°	33°	do. S. 89° W. 194 "
Tuesday, "	28th	S. 89° W.	177	47 34	52 59	47 34	52 48	52 28	S. S. E. 1½ "	22° 30′	29.90	45°	35°	Arrived at St. John's.

Distance sailed by Log 2977 miles. The True Bearing and Distance between **Santa Cruz (Cape Verdes)** in Latitude 17° 2′ N., and Longitude 25° 15′ W., and St. John's, (Newfoundland,) in Latitude 47° 34′ N., and Longitude 52° 45′ W., is found by Mercator's Sailing to be N. 37° W., 2295 miles.

TABLES.

North ¼ East.			North ¼ West.						South ¼ East.			South ¼ West.		
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	60.9	03.0	121	120.9	05.9	181	180.8	08.9	241	240.7	11.8
2	02.0	00.1	62	61.9	03.0	122	121.9	06.0	182	181.8	08.9	242	241.7	11.9
3	03.0	00.1	63	62.9	03.1	123	122.9	06.0	183	182.8	09.0	243	242.7	11.9
4	04.0	00.2	64	63.9	03.1	124	123.9	06.1	184	183.8	09.0	244	243.7	12.0
5	05.0	00.2	65	64.9	03.2	125	124.8	06.1	185	184.8	09.1	245	244.7	12.0
6	06.0	00.3	66	65.9	03.2	126	125.8	06.2	186	185.8	09.1	246	245.7	12.1
7	07.0	00.3	67	66.9	03.3	127	126.8	06.2	187	186.8	09.2	247	246.7	12.1
8	08.0	00.4	68	67.9	03.3	128	127.8	06.3	188	187.8	09.2	248	247.7	12.2
9	09.0	00.4	69	68.9	03.4	129	128.8	06.3	189	188.8	09.3	249	248.7	12.2
10	10.0	00.5	70	69.9	03.4	130	129.8	06.4	190	189.8	09.3	250	249.7	12.3
11	11.0	00.5	71	70.9	03.5	131	130.8	06.4	191	190.8	09.4	251	250.7	12.3
12	12.0	00.6	72	71.9	03.5	132	131.8	06.5	192	191.8	09.4	252	251.7	12.4
13	13.0	00.6	73	72.9	03.6	133	132.8	06.5	193	192.8	09.5	253	252.7	12.4
14	14.0	00.7	74	73.9	03.6	134	133.8	06.6	194	193.8	09.5	254	253.7	12 5
15	15.0	00.7	75	74.9	03.7	135	134.8	06.6	195	194.8	09.6	255	254.7	12.5
16	16.0	00.8	76	75.9	03.7	136	135.8	06.7	196	195.8	09.6	256	255.7	12.6
17	17.0	00.8	77	76.9	03.8	137	136.8	06.7	197	196.8	09.7	257	256.7	12.6
18	18.0	00.9	78	77.9	03.8	138	137.8	06.8	198	197.8	09.7	258	257.7	12.7
19	19.0	00.9	79	78.9	03.9	139	138.8	06.8	199	198.8	09.8	259	258.7	12.7
20	20.0	01.0	80	79.9	03.9	140	139.8	06.9	200	199.8	09.8	260	259.7	12.8
21	21.0	01.0	81	80.9	04.0	141	140.8	06.9	201	200.8	09.9	261	260.7	12.8
22	22.0	01.0	82	81.9	04.0	142	141.8	07.0	202	201.8	09.9	262	261.7	12.9
23	23.0	01.1	83	82.9	04.1	143	142.8	07.0	203	202.8	10.0	263	262.7	12.9
24	24.0	01.2	84	83.9	04.1	144	143.8	07.1	204	203.8	10.0	264	263.7	13.0
25	25.0	01.2	85	84.9	04.2	145	144.8	07.1	205	204.8	10.1	265	264.7	13.0
26	26.0	01.3	86	85.9	04.2	146	145.8	07.2	206	205.8	10.1	266	265.7	13.1
27	27.0	01.3	87	86.9	04.3	147	146.8	07.2	207	206.8	10.2	267	266.7	13.1
28	28.0	01.4	88	87.9	04.3	148	147.8	07.3	208	207.7	10.2	268	267.7	13.2
29	29.0	01.4	89	88.9	04.4	149	148.8	07.3	209	208.7	10.3	269	268.7	13.2
30	30.0	01.5	90	89.9	04.4	150	149.8	07.4	210	209.7	10.3	270	269.7	13.2
31	31.0	01.5	91	90.9	04.5	151	150.8	07.4	211	210.7	10.4	271	270.7	13.3
32	32.0	01.6	92	91.9	04.5	152	151.8	07.5	212	211.7	10.4	272	271.7	13.3
33	33.0	01.6	93	92.9	04.6	153	152.8	07.5	213	212.7	10.5	273	272.7	13.4
34	34.0	01.7	94	93.9	04.6	154	153.8	07.6	214	213.7	10.5	274	273.7	13.4
35	35.0	01.7	95	94.9	04.7	155	154.8	07.6	215	214.7	10.5	275	274.7	13.5
36	36.0	01.8	96	95.9	04.7	156	155.8	07.7	216	215.7	10.6	276	275.7	13.5
37	37.0	01.8	97	96.9	04.8	157	156.8	07.7	217	216.7	10.6	277	276.7	13.6
38	38.0	01.9	98	97.9	04.8	158	157.8	07.8	218	217.7	10.7	278	277.7	13.6
39	39.0	01.9	99	98.9	04.9	159	158.8	07.8	219	218.7	10.7	279	278.7	13.7
40	40.0	02.0	100	99.9	04.9	160	159.8	07.9	220	219.7	10.8	280	279.7	13.7
41	41.0	02.0	101	100.9	05.0	161	160.8	07.9	221	220.7	10.8	281	280.7	13.8
42	41.9	02.1	102	101.9	05.0	162	161.8	07.9	222	221.7	10.9	282	281.7	13.8
43	42.9	02.1	103	102.9	05.1	163	162.8	08.0	223	222.7	10.9	283	282.7	13.9
44	43.9	02.2	104	103.9	05.1	164	163.8	08.0	224	223.7	11.0	284	283.7	13.9
45	44.9	02.2	105	104.9	05.2	165	164.8	08.1	225	224.7	11.0	285	284.7	14.0
46	45.9	02.3	106	105.9	05.2	166	165.8	08.1	226	225.7	11.1	286	285.7	14.0
47	46.9	02.3	107	106.9	05.3	167	166.8	08.2	227	226.7	11.1	287	286.7	14.1
48	47.9	02.4	108	107.9	05.3	168	167.8	08.2	228	227.7	11.2	288	287.7	14.1
49	48.9	02.4	109	108.9	05.3	169	168.8	08.3	229	228.7	11.2	289	288.7	14.2
50	49.9	02.5	110	109.9	05.4	170	169.8	08.3	230	229.7	11.3	290	289.7	14.2
51	50.9	02.5	111	110.9	05.4	171	170.8	08.4	231	230.7	11.3	291	290.6	14.3
52	51.9	02.6	112	111.9	05.5	172	171.8	08.4	232	231.7	11.4	292	291.6	14.3
53	52.9	02.6	113	112.9	05.5	173	172.8	08.5	233	232.7	11.4	293	292.6	14.4
54	53.9	02.6	114	113.9	05.6	174	173.8	08.5	234	233.7	11.5	294	293.6	14.4
55	54.9	02.7	115	114.9	05.6	175	174.8	08.6	235	234.7	11.5	295	294.6	14.5
56	55.9	02.7	116	115.9	05.7	176	175.8	08.6	236	235.7	11.6	296	295.6	14.5
57	56.9	02.8	117	116.9	05.7	177	176.8	08.7	237	236.7	11.6	297	296.6	14.6
58	57.9	02.8	118	117.9	05.8	178	177.8	08.7	238	237.7	11.7	298	297.6	14.6
59	58.9	02.9	119	118.9	05.8	179	178.8	08.8	239	238.7	11.7	299	298.6	14.7
60	59.9	02.9	120	119.9	05.9	180	179.8	08.8	240	239.7	11.8	300	299.6	14.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
East ¾ North.			East ¾ South.			[For 7¾ Pts.]			West ¾ North.			West ¾ South.		

 TABLE I.—DIFFERENCE OF LATITUDE AND DEPARTURE FOR ¼ POINT

North ¼ East. North ¼ West. South ¼ East. South ¼ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.0	121	120.4	11.9	181	180.1	17.7	241	239.8	23.6
2	02.0	00.2	62	61.7	06.1	122	121.4	12.0	182	181.1	17.8	242	240.8	23.7
3	03.0	00.3	63	62.7	06.2	123	122.4	12.1	183	182.1	17.9	243	241.8	23.8
4	04 0	00.4	64	63.7	06.3	124	123.4	12.2	184	183.1	18.0	244	242.8	23.9
5	05.0	00.5	65	64.7	06.4	125	124.4	12.3	185	184.1	18.1	245	243.8	24.0
6	06.0	00.6	66	65.7	06.5	126	125.4	12.4	186	185.1	18.2	246	244.8	24.1
7	07.0	00.7	67	66.7	06.6	127	126.4	12.4	187	186.1	18.3	247	245.8	24.2
8	08.0	00.8	68	67.7	06.7	128	127.4	12.5	188	187.1	18.4	248	246.8	24.3
9	09.0	00.9	69	68.7	06.8	129	128.4	12.6	189	188.1	18.5	249	247.8	24.4
10	10.0	01.0	70	69.7	06.9	130	129.4	12.7	190	189.1	18.6	250	248.8	24.5
11	10.9	01.1	71	70.7	07 0	131	130.4	12.8	191	190.1	18.7	251	249.8	24.6
12	11.9	01.2	72	71.7	07.1	132	131.4	12.9	192	191.1	18.8	252	250.8	24.7
13	12.9	01.3	73	72.6	07.2	133	132.4	13.0	193	192.1	18.9	253	251.8	24.8
14	13.9	01.4	74	73.6	07.3	134	133.4	13.1	194	193.1	19.0	254	252.8	24.9
15	14.9	01.5	75	74.6	07.4	135	134.3	13.2	195	194.1	19.1	255	253.8	25.0
16	15.9	01.6	76	75.6	07.4	136	135.3	13.3	196	195.1	19.2	256	254.8	25.1
17	16.9	01.7	77	76.6	07.5	137	136.3	13.4	197	196.1	19.3	257	255.8	25.2
18	17.9	01.8	78	77.6	07.6	138	137.3	13.5	198	197.0	19.4	258	256.8	25.3
19	18.9	01.9	79	78.6	07.7	139	138.3	13.6	199	198.0	19.5	259	257.8	25.4
20	19.9	02.0	80	79.6	07.8	140	139.3	13.7	200	199.0	19.6	260	258.7	25.5
21	20.9	02.1	81	80.6	07.9	141	140.3	13.8	201	200.0	19.7	261	259.7	25.6
22	21.9	02.2	82	81.6	08.0	142	141.3	13.9	202	201.0	19.8	262	260.7	25.7
23	22.9	02.3	83	82.6	08.1	143	142.3	14.0	203	202.0	19.9	263	261.7	25.8
24	23.9	02.4	84	83.6	08.2	144	143.3	14.1	204	203.0	20.0	264	262.7	25.9
25	24.9	02.5	85	84.6	08.3	145	144.3	14.2	205	204.0	20.1	265	263.7	26.0
26	25.9	02.5	86	85.6	08.4	146	145.3	14.3	206	205.0	20.2	266	264.7	26.1
27	26.9	02.6	87	86.6	08.5	147	146.3	14.4	207	206.0	20.3	267	265.7	26.2
28	27.9	02.7	88	87.6	08.6	148	147.3	14.5	208	207.0	20.4	268	266.7	26.3
29	28.9	02.8	89	88.6	08.7	149	148.3	14.6	209	208.0	20.5	269	267.7	26.4
30	29.9	02.9	90	89.6	08.8	150	149.3	14.7	210	209.0	20.6	270	268.7	26.5
31	30.9	03.0	91	90.6	08.9	151	150.3	14.8	211	210.0	20.7	271	269.7	26.6
32	31.8	03.1	92	91.6	09.0	152	151.3	14.9	212	211.0	20.8	272	270.7	26.7
33	32.8	03.2	93	92.6	09.1	153	152.3	15.0	213	212.0	20.9	273	271.7	26.8
34	33.8	03.3	94	93.5	09.2	154	153.3	15.1	214	213.0	21.0	274	272.7	26.9
35	34.8	03.4	95	94.5	09.3	155	154.3	15.2	215	214.0	21.1	275	273.7	27.0
36	35.8	03.5	96	95.5	09.4	156	155.2	15.3	216	215.0	21.2	276	274.7	27.1
37	36.8	03.6	97	96.5	09.5	157	156.2	15.4	217	216.0	21.3	277	275.7	27.2
38	37.8	03.7	98	97.5	09.6	158	157.2	15.5	218	217.0	21.4	278	276.7	27.2
39	38.8	03.8	99	98.5	09.7	159	158.2	15.6	219	217.9	21.5	279	277.7	27.3
40	39.8	03.9	100	99.5	09.8	160	159.2	15.7	220	218.9	21.6	280	278.7	27.4
41	40.8	04.0	101	100.5	09.9	161	160.2	15.8	221	219.9	21.7	281	279.6	27.5
42	41.8	04.1	102	101.5	10.0	162	161.2	15.9	222	220.9	21.8	282	280.6	27.6
43	42.8	04.2	103	102.5	10.1	163	162.2	16.0	223	221.9	21.9	283	281.6	27.7
44	43.8	04.3	104	103.5	10.2	164	163.2	16.1	224	222.9	22.0	284	282.6	27.8
45	44.8	04.4	105	104.5	10.3	165	164.2	16.2	225	223.9	22.1	285	283.6	27.9
46	45.8	04.5	106	105.5	10.4	166	165.2	16.3	226	224.9	22.2	286	284.6	28.0
47	46.8	04.6	107	106.5	10.5	167	166.2	16.4	227	225.9	22.2	287	285.6	28.1
48	47.8	04.7	108	107.5	10.6	168	167.2	16.5	228	226.9	22.3	288	286.6	28.2
49	48.8	04.8	109	108.6	10.7	169	168.2	16.6	229	227.9	22.4	289	287.6	28.3
50	49.8	04.9	110	109.5	10.8	170	169.2	16.7	230	228.9	22.5	290	288.6	28.4
51	50.8	05.0	111	110.5	10.9	171	170.2	16.8	231	229.9	22.6	291	289.6	28.5
52	51.7	05.1	112	111.5	11.0	172	171.2	16.9	232	230.9	22.7	292	290.6	28.6
53	52.7	05.2	113	112.5	11.1	173	172.2	17.0	233	231.9	22.8	293	291.6	28.7
54	53.7	05.3	114	113.5	11.2	174	173.2	17.1	234	232.9	22.9	294	292.6	28.8
55	54.7	05.4	115	114.4	11.3	175	174.2	17.2	235	233.9	23.0	295	293.6	28.9
56	55.7	05.5	116	115.4	11.4	176	175.2	17.3	236	234.9	23.1	296	294.6	29.0
57	56.7	05.6	117	116.4	11.5	177	176.1	17.3	237	235.9	23.2	297	295.6	29.1
58	57.7	05.7	118	117.4	11.6	178	177.1	17.4	238	236.9	23.3	298	296.6	29.2
59	58.7	05.8	119	118.4	11.7	179	178.1	17.5	239	237.8	23.4	299	297.6	29.3
60	59.7	05.9	120	119.4	11.8	180	179.1	17.6	240	238.8	23.5	300	298.6	29.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

East ¾ North. East ¾ South. [For 7¾ Pts.] West ¾ North West ¾ South

North ¾ East.			North ¾ West.			South ¾ East.			South ¾ West.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.3	09.0	121	119.7	17.8	181	179.0	26.6	241	238.4	35.4
2	02.0	00.3	62	61.3	09.1	122	120.7	17.9	182	180.0	26.7	242	239.4	35.5
3	03.0	00.4	63	62.3	09.2	123	121.7	18.0	183	181.0	26.9	243	240.4	35.7
4	04.0	00.6	64	63.3	09.4	124	122.7	18.2	184	182.0	27.0	244	241.4	35.8
5	04.9	00.7	65	64.3	09.5	125	123.6	18.3	185	183.0	27.1	245	242.3	35.9
6	05.9	00.9	66	65.3	09.7	126	124.6	18.5	186	184.0	27.3	246	243.3	36.1
7	06.9	01.0	67	66.3	09.8	127	125.6	18.6	187	185.0	27.4	247	244.3	36.2
8	07.9	01.2	68	67.3	10.0	128	126.6	18.8	188	186.0	27.6	248	245.3	36.4
9	08.9	01.3	69	68.3	10.1	129	127.6	18.9	189	187.0	27.7	249	246.3	36.5
10	09.9	01.5	70	69.2	10.3	130	128.6	19.1	190	187.9	27.9	250	247.3	36.7
11	10.9	01.6	71	70.2	10.4	131	129.6	19.2	191	188.9	28.0	251	248.3	36.8
12	11.9	01.8	72	71.2	10.6	132	130.6	19.4	192	189.9	28.2	252	249.3	37.0
13	12.9	01.9	73	72.2	10.7	133	131.6	19.5	193	190.9	28.3	253	250.3	37.1
14	13.8	02.1	74	73.2	10.9	134	132.5	19.7	194	191.9	28.5	254	251.3	37.3
15	14.8	02.2	75	74.2	11.0	135	133.5	19.8	195	192.9	28.6	255	252.2	37.4
16	15.8	02.3	76	75.2	11.2	136	134.5	20.0	196	193.9	28.8	256	253.2	37.6
17	16.8	02.5	77	76.2	11.3	137	135.5	20.1	197	194.9	28.9	257	254.2	37.7
18	17.8	02.6	78	77.2	11.4	138	136.5	20.2	198	195.9	29.1	258	255.2	37.9
19	18.8	02.8	79	78.1	11.6	139	137.5	20.4	199	196.8	29.2	259	256.2	38.0
20	19.8	02.9	80	79.1	11.7	140	138.5	20.5	200	197.8	29.3	260	257.2	38.1
21	20.8	03.1	81	80.1	11.9	141	139.5	20.7	201	198.8	29.5	261	258.2	38.3
22	21.8	03.2	82	81.1	12.0	142	140.5	20.8	202	199.8	29.6	262	259.2	38.4
23	22.8	03.4	83	82.1	12.2	143	141.5	21.0	203	200.8	29.8	263	260.2	38.6
24	23.7	03.5	84	83.1	12.3	144	142.4	21.1	204	201.8	29.9	264	261.1	38.7
25	24.7	03.7	85	84.1	12.5	145	143.4	21.3	205	202.8	30.1	265	262.1	38.9
26	25.7	03.8	86	85.1	12.6	146	144.4	21.4	206	203.8	30.2	266	263.1	39.0
27	26.7	04.0	87	86.1	12.8	147	145.4	21.6	207	204.8	30.4	267	264.1	39.2
28	27.7	04.1	88	87.0	12.9	148	146.4	21.7	208	205.7	30.5	268	265.1	39.3
29	28.7	04.3	89	88.0	13.1	149	147.4	21.9	209	206.7	30.7	269	266.1	39.5
30	29.7	04.4	90	89.0	13.2	150	148.4	22.0	210	207.7	30.8	270	267.1	39.6
31	30.7	04.5	91	90.0	13.4	151	149.4	22.2	211	208.7	31.0	271	268.1	39.8
32	31.7	04.7	92	91.0	13.5	152	150.4	22.3	212	209.7	31.1	272	269.1	39.9
33	32.6	04.8	93	92.0	13.6	153	151.3	22.4	213	210.7	31.3	273	270.0	40.1
34	33.6	05.0	94	93.0	13.8	154	152.3	22.6	214	211.7	31.4	274	271.0	40.2
35	34.6	05.1	95	94.0	13.9	155	153.3	22.7	215	212.7	31.5	275	272.0	40.4
36	35.6	05.3	96	95.0	14.1	156	154.3	22.9	216	213.7	31.7	276	273.0	40.5
37	36.6	05.4	97	96.0	14.2	157	155.3	23.0	217	214.7	31.8	277	274.0	40.6
38	37.6	05.6	98	96.9	14.4	158	156.3	23.2	218	215.6	32.0	278	275.0	40.8
39	38.6	05.7	99	97.9	14.5	159	157.3	23.3	219	216.6	32.1	279	276.0	40.9
40	39.6	05.9	100	98.9	14.7	160	158.3	23.5	220	217.6	32.3	280	277.0	41.1
41	40.6	06.0	101	99.9	14.8	161	159.3	23.6	221	218.6	32.4	281	278.0	41.2
42	41.5	06.2	102	100.9	15.0	162	160.2	23.8	222	219.6	32.6	282	278.9	41.4
43	42.5	06.3	103	101.9	15.1	163	161.2	23.9	223	220.6	32.7	283	279.9	41.5
44	43.5	06.5	104	102.9	15.3	164	162.2	24.1	224	221.6	32.9	284	280.9	41.7
45	44.5	06.6	105	103.9	15.4	165	163.2	24.2	225	222.6	33.0	285	281.9	41.8
46	45.5	06.7	106	104.9	15.6	166	164.2	24.4	226	223.6	33.2	286	282.9	42.0
47	46.5	06.9	107	105.8	15.7	167	165.2	24.5	227	224.5	33.3	287	283.9	42.1
48	47.5	07.0	108	106.8	15.8	168	166.2	24.7	228	225.5	33.5	288	284.9	42.3
49	48.5	07.2	109	107.8	16.0	169	167.2	24.8	229	226.5	33.6	289	285.9	42.4
50	49.5	07.3	110	108.8	16.1	170	168.2	24.9	230	227.5	33.7	290	286.9	42.6
51	50.4	07.5	111	109.8	16.3	171	169.1	25.1	231	228.5	33.9	291	287.9	42.7
52	51.4	07.6	112	110.8	16.4	172	170.1	25.2	232	229.5	34.0	292	288.8	42.8
53	52.4	07.8	113	111.8	16.6	173	171.1	25.4	233	230.5	34.2	293	289.8	43.0
54	53.4	07.9	114	112.8	16.7	174	172.1	25.5	234	231.5	34.3	294	290.8	43.3
55	54.4	08.1	115	113.8	16.9	175	173.1	25.7	235	232.5	34.5	295	291.8	43.3
56	55.4	08.2	116	114.7	17.0	176	174.1	25.8	236	233.4	34.6	296	292.8	43.4
57	56.4	08.4	117	115.7	17.2	177	175.1	26.0	237	234.4	34.8	297	293.8	43.6
58	57.4	08.5	118	116.7	17.3	178	176.1	26.1	238	235.4	34.9	298	294.8	43.7
59	58.4	08.7	119	117.7	17.5	179	177.1	26.3	239	236.4	35.1	299	295.8	43.9
60	59.4	08.8	120	118.7	17.6	180	178.1	26.4	240	237.4	35.2	300	296.8	44.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
East ¾ North.			East ¾ South.			[For 7¼ Pts.]			West ¾ North.			West ¾ South		

 TABLE I.—DIFFERENCE OF LATITUDE AND DEPARTURE FOR 1 POINT.

	North *b.* East.			North *b.* West.			South *b.* East.			South *b.* West.			
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.8	11.9	121	118.7	23.6	181	177.5	35.3	241	236.4	47.0
2	02.0	00.4	62	60.8	12.1	122	119.7	23.8	182	178.5	35.5	242	237.4	47.2
3	02.9	00.6	63	61.8	12.3	123	120.6	24.0	183	179.5	35.7	243	238.3	47.4
4	03.9	00.8	64	62.8	12.5	124	121.6	24.2	184	180.5	35.9	244	239.3	47.6
5	04.9	01.0	65	63.8	12.7	125	122.6	24.4	185	181.4	36.1	245	240.3	47.8
6	05.9	01.2	66	64.7	12.9	126	123.6	24.6	186	182.4	36.3	246	241.3	48.0
7	06.9	01.4	67	65.7	13.1	127	124.6	24.8	187	183.4	36.5	247	242.3	48.2
8	07.8	01.6	68	66.7	13.3	128	125.5	25.0	188	184.4	36.7	248	243.2	48.4
9	08.8	01.8	69	67.7	13.5	129	126.5	25.2	189	185.4	36.9	249	244.2	48.6
10	09.8	02.0	70	68.7	13.7	130	127.5	25.4	190	186.3	37.1	250	245.2	48.8
11	10.8	02.1	71	69.6	13.9	131	128.5	25.6	191	187.3	37.3	251	246.2	49.0
12	11.8	02.3	72	70.6	14.0	132	129.5	25.8	192	188.3	37.5	252	247.2	49.2
13	12.8	02.5	73	71.6	14.2	133	130.4	25.9	193	189.3	37.7	253	248.1	49.4
14	13.7	02.7	74	72.6	14.4	134	131.4	26.1	194	190.3	37.8	254	249.1	49.6
15	14.7	02.9	75	73.6	14.6	135	132.4	26.3	195	191.3	38.0	255	250.1	49.7
16	15.7	03.1	76	74.5	14.8	136	133.4	26.5	196	192.2	38.2	256	251.1	49.9
17	16.7	03.3	77	75.5	15.0	137	134.4	26.7	197	193.2	38.4	257	252.1	50.1
18	17.7	03.5	78	76.5	15.2	138	135.3	26.9	198	194.2	38.6	258	253.0	50.3
19	18.6	03.7	79	77.5	15.4	139	136.3	27.1	199	195.2	38.8	259	254.0	50.5
20	19.6	03.9	80	78.5	15.6	140	137.3	27.3	200	196.2	39.0	260	255.0	50.7
21	20.6	04.1	81	79.4	15.8	141	138.3	27.5	201	197.1	39.2	261	256.0	50.9
22	21.6	04.3	82	80.4	16.0	142	139.3	27.7	202	198.1	39.4	262	257.0	51.1
23	22.6	04.5	83	81.4	16.2	143	140.3	27.9	203	199.1	39.6	263	257.9	51.3
24	23.5	04.7	84	82.4	16.4	144	141.2	28.1	204	200.1	39.8	264	258.9	51.5
25	24.5	04.9	85	83.4	16.6	145	142.2	28.3	205	201.1	40.0	265	259.9	51.7
26	25.5	05.1	86	84.3	16.8	146	143.2	28.5	206	202.0	40.2	266	260.9	51.9
27	26.5	05.3	87	85.3	17.0	147	144.2	28.7	207	203.0	40.4	267	261.9	52.1
28	27.5	05.5	88	86.3	17.2	148	145.2	28.9	208	204.0	40.6	268	262.9	52.3
29	28.4	05.7	89	87.3	17.4	149	146.1	29.1	209	205.0	40.8	269	263.8	52.5
30	29.4	05.9	90	88.3	17.6	150	147.1	29.3	210	206.0	41.0	270	264.8	52.7
31	30.4	06.0	91	89.3	17.8	151	148.1	29.5	211	206.9	41.2	271	265.8	52.9
32	31.4	06.2	92	90.2	17.9	152	149.1	29.7	212	207.9	41.4	272	266.8	53.1
33	32.4	06.4	93	91.2	18.1	153	150.1	29.8	213	208.9	41.6	273	267.8	53.3
34	33.3	06.6	94	92.2	18.3	154	151.0	30.0	214	209.9	41.7	274	268.7	53.5
35	34.3	06.8	95	93.2	18.5	155	152.0	30.2	215	210.9	41.9	275	269.7	53.6
36	35.3	07.0	96	94.2	18.7	156	153.0	30.4	216	211.8	42.1	276	270.7	53.8
37	36.3	07.2	97	95.1	18.9	157	154.0	30.6	217	212.8	42.3	277	271.7	54.0
38	37.3	07.4	98	96.1	19.1	158	155.0	30.8	218	213.8	42.5	278	272.7	54.2
39	38.3	07.6	99	97.1	19.3	159	155.9	31.0	219	214.8	42.7	279	273.6	54.4
40	39.2	07.8	100	98.1	19.5	160	156.9	31.2	220	215.8	42.9	280	274.6	54.6
41	40.2	08.0	101	99.1	19.7	161	157.9	31.4	221	216.8	43.1	281	275.6	54.8
42	41.2	08.2	102	100.0	19.9	162	158.9	31.6	222	217.7	43.3	282	276.6	55.0
43	42.2	08.4	103	101.0	20.1	163	159.9	31.8	223	218.7	43.5	283	277.6	55.2
44	43.2	08.6	104	102.0	20.3	164	160.8	32.0	224	219.7	43.7	284	278.5	55.4
45	44.1	08.8	105	103.0	20.5	165	161.8	32.2	225	220.7	43.9	285	279.5	55.6
46	45.1	09.0	106	104.0	20.7	166	162.8	32.4	226	221.7	44.1	286	280.5	55.8
47	46.1	09.2	107	104.9	20.9	167	163.8	32.6	227	222.6	44.3	287	281.5	56.0
48	47.1	09.4	108	105.9	21.1	168	164.8	32.8	228	223.6	44.5	288	282.5	56.2
49	48.1	09.6	109	106.9	21.3	169	165.8	33.0	229	224.6	44.7	289	283.4	56.4
50	49.0	09.8	110	107.9	21.5	170	166.7	33.2	230	225.6	44.9	290	284.4	56.6
51	50.0	09.9	111	108.9	21.7	171	167.7	33.4	231	226.6	45.1	291	285.4	56.8
52	51.0	10.1	112	109.8	21.9	172	168.7	33.6	232	227.5	45.3	292	286.4	57.0
53	52.0	10.3	113	110.8	22.0	173	169.7	33.8	233	228.5	45.5	293	287.4	57.2
54	53.0	10.5	114	111.8	22.2	174	170.7	33.9	234	229.5	45.7	294	288.4	57.4
55	53.9	10.7	115	112.8	22.4	175	171.6	34.1	235	230.5	45.8	295	289.3	57.6
56	54.9	10.9	116	113.8	22.6	176	172.6	34.3	236	231.5	46.0	296	290.3	57.7
57	55.9	11.1	117	114.8	22.8	177	173.6	34.5	237	232.4	46.2	297	291.3	57.9
58	56.9	11.3	118	115.7	23.0	178	174.6	34.7	238	233.4	46.4	298	292.3	58.1
59	57.9	11.5	119	116.7	23.2	179	175.6	34.9	239	234.4	46.6	299	293.3	58.3
60	58.8	11.7	120	117.7	23.4	180	176.5	35.1	240	235.4	46.8	300	294.2	58.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
	East *b.* North.			East *b.* South.			[For 7 Pts.]			West *b.* North.			West *b.* South.	

TABLE I.—DIFFERENCE OF LATITUDE AND DEPARTURE FOR 1¼ POINTS.

North b. East ¼ East.				North b. West ¼ West.			South b. East ¼ East.				South b. West ¼ West.			
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.4	181	175.6	44.0	241	233.8	58.6
2	01.9	00.5	62	60.1	15.1	122	118.3	29.6	182	176.5	44.2	242	234.7	58.8
3	02.9	00.7	63	61.1	15.3	123	119.3	29.9	183	177.5	44.5	243	235.7	59.0
4	03.9	01.0	64	62.1	15.6	124	120.3	30.1	184	178.5	44.7	244	236.7	59.3
5	04.9	01.2	65	63.1	15.8	125	121.3	30.4	185	179.5	45.0	245	237.7	59.5
6	05.8	01.5	66	64.0	16.0	126	122.2	30.6	186	180.4	45.2	246	238.6	59.8
7	06.8	01.7	67	65.0	16.3	127	123.2	30.9	187	181.4	45.4	247	239.6	60.0
8	07.8	01.9	68	66.0	16.5	128	124.2	31.1	188	182.4	45.7	248	240.6	60.3
9	08.7	02.2	69	66.9	16.8	129	125.1	31.3	189	183.3	45.9	249	241.5	60.5
10	09.7	02.4	70	67.9	17.0	130	126.1	31.6	190	184.3	46.2	250	242.5	60.7
11	10.7	02.7	71	68.9	17.3	131	127.1	31.8	191	185.3	46.4	251	243.5	61.0
12	11.6	02.9	72	69.8	17.5	132	128.0	32.1	192	186.2	46.7	252	244.4	61.2
13	12.6	03.2	73	70.8	17.7	133	129.0	32.3	193	187.2	46.9	253	245.4	61.5
14	13.6	03.4	74	71.8	18.0	134	130.0	32.6	194	188.2	47.1	254	246.4	61.7
15	14.6	03.6	75	72.8	18.2	135	131.0	32.8	195	189.2	47.4	255	247.4	62.0
16	15.5	03.9	76	73.7	18.5	136	131.9	33.0	196	190.1	47.6	256	248.3	62.2
17	16.5	04.1	77	74.7	18.7	137	132.9	33.3	197	191.1	47.9	257	249.3	62.4
18	17.5	04.4	78	75.7	19.0	138	133.9	33.5	198	192.1	48.1	258	250.3	62.7
19	18.4	04.6	79	76.6	19.2	139	134.8	33.8	199	193.0	48.4	259	251.2	62.9
20	19.4	04.9	80	77.6	19.4	140	135.8	34.0	200	194.0	48.6	260	252.2	63.2
21	20.4	05.1	81	78.6	19.7	141	136 8	34.3	201	195.0	48.8	261	253.2	63.4
22	21.3	05.3	82	79.5	19.9	142	137.7	34.5	202	195.9	49.1	262	254.1	63.7
23	22.3	05.6	83	80.5	20.2	143	138.7	34.7	203	196.9	49.3	263	255.1	63.9
24	23.3	05.8	84	81.5	20.4	144	139.7	35.0	204	197.9	49.6	264	256.1	64.1
25	24.3	06.1	85	82.5	20.7	145	140.7	35.2	205	198.9	49.8	265	257.1	64.4
26	25.2	06.3	86	83.4	20.9	146	141.6	35.5	206	199.8	50.1	266	258.0	64.6
27	26.2	06.6	87	84.4	21.1	147	142.6	35.7	207	200.8	50.3	267	259.0	64.9
28	27.2	06.8	88	85.4	21.4	148	143.6	36.0	208	201.8	50.5	268	260.0	65.1
29	28.1	07.0	89	86.3	21.6	149	144.5	36.2	209	202.7	50.8	269	260.9	65.4
30	29.1	07.3	90	87.3	21.9	150	145.5	36.4	210	203.7	51.0	270	261.9	65.6
31	30.1	07.5	91	88.3	22.1	151	146.5	36.7	211	204.7	51.3	271	262.9	65.8
32	31.0	07.8	92	89.2	22.4	152	147.4	36.9	212	205.6	51.5	272	263.8	66.1
33	32.0	08.0	93	90.2	22.6	153	148.4	37.2	213	206.6	51.8	273	264.8	66.3
34	33.0	08.3	94	91.2	22.8	154	149.4	37.4	214	207.6	52.0	274	265.8	66.6
35	34.0	08.5	95	92.2	23.1	155	150.4	37.7	215	208.6	52 2	275	266.8	66.8
36	34.9	08.7	96	93.1	23.3	156	151.3	37.9	216	209.5	52.5	276	267.7	67.1
37	35.9	09.0	97	94.1	23.6	157	152.3	38.1	217	210.5	52.7	277	268.7	67.3
38	36.9	09.2	98	95.1	23.8	158	153.3	38.4	218	211.5	53.0	278	269.7	67.5
39	37.8	09.5	99	96.0	24.1	159	154.2	38.6	219	212.4	53.2	279	270.6	67.8
40	38.8	09.7	100	97.0	24.3	160	155.2	38.9	220	213.4	53.5	280	271.6	68.0
41	39.8	10.0	101	98.0	24.5	161	156.2	39.1	221	214.4	53.7	281	272.6	68.3
42	40.7	10.2	102	98.9	24.8	162	157.1	39.4	222	215.3	53.9	282	273.5	68.5
43	41.7	10.4	103	99.9	25.0	163	158.1	39.6	223	216.3	54.2	283	274.5	68.8
44	42.7	10.7	104	100.9	25.3	164	159.1	39.8	224	217.3	54.4	284	275.5	69.0
45	43.7	10.9	105	101.9	25.5	165	160.1	40.1	225	218.3	54.7	285	276.5	69.2
46	44.6	11.2	106	102.8	25.8	166	161.0	40.3	226	219.2	54.9	286	277.4	69.5
47	45.6	11.4	107	103.8	26.0	167	162.0	40.6	227	220.2	55.2	287	278.4	69.7
48	46.6	11.7	108	104.8	26.2	168	163.0	40.8	228	221.2	55.4	288	279.4	70.0
49	47.5	11.9	109	105.7	26.5	169	163.9	41.1	229	222.1	55.6	289	280.3	70.2
50	48.5	12.1	110	106.7	26.7	170	164.9	41.3	230	223.1	55.9	290	281.3	70.5
51	49.5	12.4	111	107.7	27.0	171	165.9	41.5	231	224.1	56.1	291	282.3	70.7
52	50.4	12.6	112	108.6	27.2	172	166.8	41.8	232	225.0	56.4	292	283.2	71.0
53	51.4	12.9	113	109.6	27.5	173	167.8	42.0	233	226.0	56.6	293	284.2	71.2
54	52.4	13.1	114	110.6	27.7	174	168.8	42.3	234	227.0	56.9	294	285.2	71.4
55	53.4	13.4	115	111.6	27.9	175	169.8	42.5	235	228.0	57.1	295	286.2	71.7
56	54.3	13.6	116	112.5	28.2	176	170.7	42.8	236	228.9	57.3	296	287.1	71.9
57	55.3	13.8	117	113.5	28.4	177	171.7	43.0	237	229.9	57.6	297	288.1	72.2
58	56.3	14.1	118	114.5	28.7	178	172.7	43.3	238	230.9	57.8	298	289.1	72.4
59	57.2	14.3	119	115.4	28.9	179	173.6	43.5	239	231.8	58.1	299	290.0	72.7
60	58.2	14.6	120	116.4	29.2	180	174.6	43.7	240	232.8	58.3	300	291.0	72.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
East North East ¾ East.				East South East ¾ East.			[For 6¾ Pts.]		West North West ¾ West.				West South West ¾ West.	

North *b.* East ½ East. North *b.* West ½ West. South *b.* East ½ East. South *b.* West ½ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.4	17.7	121	115.8	35.1	181	173.2	52.5	241	230.6	70.0
2	01.9	00.6	62	59.3	18.0	122	116.7	35.4	182	174.2	52.8	242	231.6	70.2
3	02.9	00.9	63	60.3	18.3	123	117.7	35.7	183	175.1	53.1	243	232.5	70.5
4	03.8	01.2	64	61.2	18.6	124	118.7	36.0	184	176.1	53.4	244	233.5	70.8
5	04.8	01.5	65	62.2	18.9	125	119.6	36.3	185	177.0	53.7	245	234.5	71.1
6	05.7	01.7	66	63.2	19.2	126	120.6	36.6	186	178.0	54.0	246	235.4	71.4
7	06.7	02.0	67	64.1	19.4	127	121.5	36.9	187	178.9	54.3	247	236.4	71.7
8	07.7	02.3	68	65.1	19.7	128	122.5	37.2	188	179.9	54.6	248	237.3	72.0
9	08.6	02.6	69	66.0	20.0	129	123.4	37.4	189	180.9	54.9	249	238.3	72.3
10	09.6	02.9	70	67.0	20.3	130	124.4	37.7	190	181.8	55.2	250	239.2	72.6
11	10.5	03.2	71	67.9	20.6	131	125.4	38.0	191	182.8	55.4	251	240.2	72.9
12	11.5	03.5	72	68.9	20.9	132	126.3	38.3	192	183.7	55.7	252	241.1	73.2
13	12.4	03.8	73	69.9	21.2	133	127.3	38.6	193	184.7	56.0	253	242.1	73.4
14	13.4	04.1	74	70.8	21.5	134	128.2	38.9	194	185.6	56.3	254	243.1	73.7
15	14.4	04.4	75	71.8	21.8	135	129.2	39.2	195	186.6	56.6	255	244.0	74.0
16	15.3	04.6	76	72.7	22.1	136	130.1	39.5	196	187.6	56.9	256	245.0	74.3
17	16.3	04.9	77	73.7	22.4	137	131.1	39.8	197	188.5	57.2	257	245.9	74.6
18	17.2	05.2	78	74.6	22.6	138	132.1	40.1	198	189.5	57.5	258	246.9	74.9
19	18.2	05.5	79	75.6	22.9	139	133.0	40.3	199	190.4	57.8	259	247.8	75.2
20	19.1	05.8	80	76.6	23.2	140	134.0	40.6	200	191.4	58.1	260	248.8	75.5
21	20.1	06.1	81	77.5	23.5	141	134.9	40.9	201	192.3	58.3	261	249.8	75.8
22	21.1	06.4	82	78.5	23.8	142	135.9	41.2	202	193.3	58.6	262	250.7	76.1
23	22.0	06.7	83	79.4	24.1	143	136.8	41.5	203	194.3	58.9	263	251.7	76.3
24	23.0	07.0	84	80.4	24.4	144	137.8	41.8	204	195.2	59.2	264	252.6	76.6
25	23.9	07.3	85	81.3	24.7	145	138.8	42.1	205	196.2	59.5	265	253.6	76.9
26	24.9	07.5	86	82.3	25.0	146	139.7	42.4	206	197.1	59.8	266	254.5	77.2
27	25.8	07.8	87	83.3	25.3	147	140.7	42.7	207	198.1	60.1	267	255.5	77.5
28	26.8	08.1	88	84.2	25.5	148	141.6	43.0	208	199.0	60.4	268	256.5	77.8
29	27.8	08.4	89	85.2	25.8	149	142.6	43.3	209	200.0	60.7	269	257.4	78.1
30	28.7	08.7	90	86.1	26.1	150	143.5	43.5	210	201.0	61.0	270	258.4	78.4
31	29.7	09.0	91	87.1	26.4	151	144.5	43.8	211	201.9	61.3	271	259.3	78.7
32	30.6	09.3	92	88.0	26.7	152	145.5	44.1	212	202.9	61.5	272	260.3	79.0
33	31.6	09.6	93	89.0	27.0	153	146.4	44.4	213	203.8	61.8	273	261.2	79.2
34	32.5	09.9	94	90.0	27.3	154	147.4	44.7	214	204.8	62.1	274	262.2	79.5
35	33.5	10.2	95	90.9	27.6	155	148.3	45.0	215	205.7	62.4	275	263.2	79.8
36	34.4	10.5	96	91.9	27.9	156	149.3	45.3	216	206.7	62.7	276	264.1	80.1
37	35.4	10.7	97	92.8	28.2	157	150.2	45.6	217	207.7	63.0	277	265.1	80.4
38	36.4	11.0	98	93.8	28.4	158	151.2	45.9	218	208.6	63.3	278	266.0	80.7
39	37.3	11.3	99	94.7	28.7	159	152.2	46.2	219	209.6	63.6	279	267.0	81.0
40	38.3	11.6	100	95.7	29.0	160	153.1	46.4	220	210.5	63.9	280	267.9	81.3
41	39.2	11.9	101	96.7	29.3	161	154.1	46.7	221	211.5	64.2	281	268.9	81.6
42	40.2	12.2	102	97.6	29.6	162	155.0	47.0	222	212.4	64.4	282	269.9	81.9
43	41.1	12.5	103	98.6	29.9	163	156.0	47.3	223	213.4	64.7	283	270.8	82.2
44	42.1	12.8	104	99.5	30.2	164	156.9	47.6	224	214.4	65.0	284	271.8	82.4
45	43.1	13.1	105	100.5	30.5	165	157.9	47.9	225	215.3	65.3	285	272.7	82.7
46	44.0	13.4	106	101.4	30.8	166	158.9	48.2	226	216.3	65.6	286	273.7	83.0
47	45.0	13.6	107	102.4	31.1	167	159.8	48.5	227	217.2	65.9	287	274.6	83.3
48	45.9	13.9	108	103.3	31.4	168	160.8	48.8	228	218.2	66.2	288	275.6	83.6
49	46.9	14.2	109	104.3	31.6	169	161.7	49.1	229	219.1	66.5	289	276.6	83.9
50	47.8	14.5	110	105.3	31.9	170	162.7	49.3	230	220.1	66.8	290	277.5	84.2
51	48.8	14.8	111	106.2	32.2	171	163.6	49.6	231	221.1	67.1	291	278.5	84.5
52	49.8	15.1	112	107.2	32.5	172	164.6	49.9	232	222.0	67.3	292	279.4	84.8
53	50.7	15.4	113	108.1	32.8	173	165.6	50.2	233	223.0	67.6	293	280.4	85.1
54	51.7	15.7	14	109.1	33.1	174	166.5	50.5	234	223.9	67.9	294	281.3	85.3
55	52.6	16.0	115	110.0	33.4	175	167.5	50.8	235	224.9	68.2	295	282.3	85.6
56	53.6	16.3	116	111.0	33.7	176	168.4	51.1	236	225.8	68.5	296	283.3	85.9
57	54.5	16.5	117	112.0	34.0	177	169.4	51.4	237	226.8	68.8	297	284.2	86.2
58	55.5	16.8	118	112.9	34.3	178	170.3	51.7	238	227.8	69.1	298	285.2	86.5
59	56.5	17.1	119	113.9	34.5	179	171.3	52.0	239	228.7	69.4	299	286.1	86.8
60	57.4	17.4	120	114.8	34.8	180	172.2	52.3	240	229.7	69.7	300	287.1	87.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

East North East ½ East. East South East ½ East. [For 6½ Pts.] **West North West ½ West. West South West ½ West.**

North *b.* East ¾ East. North *b.* West ¾ West. South *b.* East ¾ East. South *b.* West ¾ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.4	20.6	121	113.9	40.8	181	170.4	61.0	241	226.9	81.2
2	01.9	00.7	62	58.4	20.9	122	114.9	41.1	182	171.4	61.3	242	227.9	81.5
3	02.8	01.0	63	59.3	21.2	123	115.8	41.4	183	172.3	61.7	243	228.8	81.9
4	03.8	01.3	64	60.3	21.6	124	116.8	41.8	184	173.2	62.0	244	229.7	82.2
5	04.7	01.7	65	61.2	21.9	125	117.7	42.1	185	174.2	62.3	245	230.7	82.5
6	05.6	02.0	66	62.1	22.2	126	118.6	42.4	186	175.1	62.7	246	231.6	82.9
7	06.6	02.4	67	63.1	22.6	127	119.6	42.8	187	176.1	63.0	247	232.6	83.2
8	07.5	02.7	68	64.0	22.9	128	120.5	43.1	188	177.0	63.3	248	233.5	83.5
9	08.5	03.0	69	65.0	23.2	129	121.5	43.5	189	178.0	63.7	249	234.4	83.9
10	09.4	03.4	70	65.9	23.6	130	122.4	43.8	190	178.9	64.0	250	235.4	84.2
11	10.4	03.7	71	66.8	23.9	131	123.3	44.1	191	179.8	64.3	251	236.3	84.6
12	11.3	04.0	72	67.8	24.3	132	124.3	44.5	192	180.8	64.7	252	237.3	84.9
13	12.2	04.4	73	68.7	24.6	133	125.2	44.8	193	181.7	65.0	253	238.2	85.2
14	13.2	04.7	74	69.7	24.9	134	126.2	45.1	194	182.7	65.4	254	239.2	85.6
15	14.1	05.1	75	70.6	25.3	135	127.1	45.5	195	183.6	65.7	255	240.1	85.9
16	15.1	05.4	76	71.6	25.6	136	128.0	45.8	196	184.5	66.0	256	241.0	86.2
17	16.0	05.7	77	72.5	25.9	137	129.0	46.2	197	185.5	66.4	257	242.0	86.6
18	16.9	06.1	78	73.4	26.3	138	129.9	46.5	198	186.4	66.7	258	242.9	86.9
19	17.9	06.4	79	74.4	26.6	139	130.9	46.8	199	187.4	67.0	259	243.9	87.3
20	18.8	06.7	80	75.3	27.0	140	131.8	47.2	200	188.3	67.4	260	244.8	87.6
21	19.8	07.1	81	76.3	27.3	141	132.8	47.5	201	189.3	67.7	261	245.7	87.9
22	20.7	07.4	82	77.2	27.6	142	133.7	47.8	202	190.2	68.1	262	246.7	88.3
23	21.7	07.7	83	78.1	28.0	143	134.6	48.2	203	191.1	68.4	263	247.6	88.6
24	22.6	08.1	84	79.1	28.3	144	135.6	48.5	204	192.1	68.7	264	248.6	88.9
25	23.5	08.4	85	80.0	28.6	145	136.5	48.8	205	193.0	69.1	265	249.5	89.3
26	24.5	08.8	86	81.0	29.0	146	137.5	49.2	206	194.0	69.4	266	250.5	89.6
27	25.4	09.1	87	81.9	29.3	147	138.4	49.5	207	194.9	69.7	267	251.4	89.9
28	26.4	09.4	88	82.9	29.6	148	139.3	49.9	208	195.8	70.1	268	252.3	90.3
29	27.3	09.8	89	83.8	30.0	149	140.3	50.2	209	196.8	70.4	269	253.3	90.6
30	28.2	10.1	90	84.7	30.3	150	141.2	50.5	210	197.7	70.7	270	254.2	91.0
31	29.2	10.4	91	85.7	30.7	151	142.2	50.9	211	198.7	71.1	271	255.2	91.3
32	30.1	10.8	92	86.6	31.0	152	143.1	51.2	212	199.6	71.4	272	256.1	91.6
33	31.1	11.1	93	87.6	31.3	153	144.1	51.5	213	200.5	71.8	273	257.0	92.0
34	32.0	11.5	94	88.5	31.7	154	145.0	51.9	214	201.5	72.1	274	258.0	92.3
35	33.0	11.8	95	89.4	32.0	155	145.9	52.2	215	202.4	72.4	275	258.9	92.6
36	33.9	12.1	96	90.4	32.3	156	146.9	52.6	216	203.4	72.8	276	259.9	93.0
37	34.8	12.5	97	91.3	32.7	157	147.8	52.9	217	204.3	73.1	277	260.8	93.3
38	35.8	12.8	98	92.3	33.0	158	148.8	53.2	218	205.3	73.4	278	261.7	93.7
39	36.7	13.1	99	93.2	33.4	159	149.7	53.6	219	206.2	73.8	279	262.7	94.0
40	37.7	13.5	100	94.2	33.7	160	150.6	53.9	220	207.1	74.1	280	263.6	94.3
41	38.6	13.8	101	95.1	34.0	161	151.6	54.2	221	208.1	74.5	281	264.6	94.7
42	39.5	14.1	102	96.0	34.4	162	152.5	54.6	222	209.0	74.8	282	265.5	95.0
43	40.5	14.5	103	97.0	34.7	163	153.5	54.9	223	210.0	75.1	283	266.5	95.3
44	41.4	14.8	104	97.9	35.0	164	154.4	55.2	224	210.9	75.5	284	267.4	95.7
45	42.4	15.2	105	98.9	35.4	165	155.4	55.6	225	211.8	75.8	285	268.3	96.0
46	43.3	15.5	106	99.8	35.7	166	156.3	55.9	226	212.8	76.1	286	269.3	96.4
47	44.3	15.8	107	100.7	36.0	167	157.2	56.3	227	213.7	76.5	287	270.2	96.7
48	45.2	16.2	108	101.7	36.4	168	158.2	56.6	228	214.7	76.8	288	271.2	97.0
49	46.1	16.5	109	102.6	36.7	169	159.1	56.9	229	215.6	77.1	289	272.1	97.4
50	47.1	16.8	110	103.6	37.1	170	160.1	57.3	230	216.6	77.5	290	273.0	97.7
51	48.0	17.2	111	104.5	37.4	171	161.0	57.6	231	217.5	77.8	291	274.0	98.0
52	49.0	17.5	112	105.5	37.7	172	161.9	57.9	232	218.4	78.2	292	274.9	98.4
53	49.9	17.9	113	106.4	38.1	173	162.9	58.3	233	219.4	78.5	293	275.9	98.7
54	50.8	18.2	114	107.3	38.4	174	163.8	58.6	234	220.3	78.8	294	276.8	99.0
55	51.8	18.5	115	108.3	38.7	175	164.8	59.0	235	221.3	79.2	295	277.8	99.4
56	52.7	18.9	116	109.2	39.1	176	165.7	59.3	236	222.2	79.5	296	278.7	99.7
57	53.7	19.2	117	110.2	39.4	177	166.7	59.6	237	223.1	79.8	297	279.6	100.1
58	54.6	19.5	118	111.1	39.8	178	167.6	60.0	238	224.1	80.2	298	280.6	100.4
59	55.6	19.9	119	112.0	40.1	179	168.5	60.3	239	225.0	80.5	299	281.5	100.7
60	56.5	20.2	120	113.0	40.4	180	169.5	60.6	240	226.0	80.9	300	282.5	101.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

East North East ¼ East. East South East ¼ East. [For 6¼ Pts.] West North West ¼ West. West South West ¼ West.

North North East.			North North West.			South South East.			South South West.					
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.4	23.3	121	111.8	46.3	181	167.2	69.3	241	222.7	92.2
2	01.8	00.8	62	57.3	23.7	122	112.7	46.7	182	168.1	69.6	242	223.6	92.6
3	02.8	01.1	63	58.2	24.1	123	113.6	47.1	183	169.1	70.0	243	224.5	93.0
4	03.7	01.5	64	59.1	24.5	124	114.6	47.5	184	170.0	70.4	244	225.4	93.4
5	04.6	01.9	65	60.1	24.9	125	115.5	47.8	185	170.9	70.8	245	226.4	93.8
6	05.5	02.3	66	61.0	25.3	126	116.4	48.2	186	171.8	71.2	246	227.3	94.1
7	06.5	02.7	67	61.9	25.6	127	117.3	48.6	187	172.8	71.6	247	228.2	94.5
8	07.4	03.1	68	62.8	26.0	128	118.3	49.0	188	173.7	71.9	248	229.1	94.9
9	08.3	03.4	69	63.7	26.4	129	119.2	49.4	189	174.6	72.3	249	230.0	95.3
10	09.2	03.8	70	64.7	26.8	130	120.1	49.7	190	175.5	72.7	250	231.0	95.7
11	10.2	04.2	71	65.6	27.2	131	121.0	50.1	191	176.5	73.1	251	231.9	96.1
12	11.1	04.6	72	66.5	27.6	132	122.0	50.5	192	177.4	73.5	252	232.8	96.4
13	12.0	05.0	73	67.4	27.9	133	122.9	50.9	193	178.3	73.9	253	233.7	96.8
14	12.9	05.4	74	68.4	28.3	134	123.8	51.3	194	179.2	74.2	254	234.7	97.2
15	13.9	05.7	75	69.3	28.7	135	124.7	51.7	195	180.2	74.6	255	235.6	97.6
16	14.8	06.1	76	70.2	29.1	136	125.6	52.0	196	181.1	75.0	256	236.5	98.0
17	15.7	06.5	77	71.1	29.5	137	126.6	52.4	197	182.0	75.4	257	237.4	98.3
18	16.6	06.9	78	72.1	29.8	138	127.5	52.8	198	182.9	75.8	258	238.4	98.7
19	17.6	07.3	79	73.0	30.2	139	128.4	53.2	199	183.9	76.2	259	239.3	99.1
20	18.5	07.7	80	73.9	30.6	140	129.3	53.6	200	184.8	76.5	260	240.2	99.5
21	19.4	08.0	81	74.8	31.0	141	130.3	54.0	201	185.7	76.9	261	241.1	99.9
22	20.3	08.4	82	75.8	31.4	142	131.2	54.3	202	186.6	77.3	262	242.1	100.3
23	21.2	08.8	83	76.7	31.8	143	132.1	54.7	203	187.5	77.7	263	243.0	100.6
24	22.2	09.2	84	77.6	32.1	144	133.0	55.1	204	188.5	78.1	264	243.9	101.0
25	23.1	09.6	85	78.5	32.5	145	134.0	55.5	205	189.4	78.5	265	244.8	101.4
26	24.0	09.9	86	79.5	32.9	146	134.9	55.9	206	190.3	78.8	266	245.8	101.8
27	24.9	10.3	87	80.4	33.3	147	135.8	56.3	207	191.2	79.2	267	246.7	102.2
28	25.9	10.7	88	81.3	33.7	148	136.7	56.6	208	192.2	79.6	268	247.6	102.6
29	26.8	11.1	89	82.2	34.1	149	137.7	57.0	209	193.1	80.0	269	248.5	102.9
30	27.7	11.5	90	83.1	34.4	150	138.6	57.4	210	194.0	80.4	270	249.4	103.3
31	28.6	11.9	91	84.1	34.8	151	139.5	57.8	211	194.9	80.7	271	250.4	103.7
32	29.6	12.2	92	85.0	35.2	152	140.4	58.2	212	195.9	81.1	272	251.3	104.1
33	30.5	12.6	93	85.9	35.6	153	141.4	58.6	213	196.8	81.5	273	252.2	104.5
34	31.4	13.0	94	86.8	36.0	154	142.3	58.9	214	197.7	81.9	274	253.1	104.9
35	32.3	13.4	95	87.8	36.4	155	143.2	59.3	215	198.6	82.3	275	254.1	105.2
36	33.3	13.8	96	88.7	36.7	156	144.1	59.7	216	199.6	82.7	276	255.0	105.6
37	34.2	14.2	97	89.6	37.1	157	145.0	60.1	217	200.5	83.0	277	255.9	106.0
38	35.1	14.5	98	90.5	37.5	158	146.0	60.5	218	201.4	83.4	278	256.8	106.4
39	36.0	14.9	99	91.5	37.9	159	146.9	60.8	219	202.3	83.8	279	257.8	106.8
40	37.0	15.3	100	92.4	38.3	160	147.8	61.2	220	203.3	84.2	280	258.7	107.2
41	37.9	15.7	101	93.3	38.7	161	148.7	61.6	221	204.2	84.6	281	259.6	107.5
42	38.8	16 1	102	94.2	39.0	162	149.7	62.0	222	205.1	85.0	282	260.5	107.9
43	39.7	16.5	103	95.2	39.4	163	150.6	62.4	223	206.0	85.3	283	261.5	108.3
44	40.7	16.8	104	96.1	39.8	164	151.5	62.8	224	206.9	85.7	284	262.4	108.7
45	41.6	17.2	105	97.0	40.2	165	152.4	63.1	225	207.9	86.1	285	263.3	109.1
46	42.5	17.6	106	97.9	40.6	166	153.4	63.5	226	208.8	86.5	286	264.2	109.4
47	43.4	18.0	107	98.9	40.9	167	154.3	63.9	227	209.7	86.9	287	265.2	109.8
48	44.3	18.4	108	99.8	41.3	168	155.2	64.3	228	210.6	87.3	288	266.1	110.2
49	45.3	18.8	109	100.7	41.7	169	156.1	64.7	229	211.6	87.6	289	267.0	110.6
50	46.2	19.1	110	101.6	42.1	170	157.1	65.1	230	212.5	88.0	290	267.9	111.0
51	47.1	19.5	111	102.6	42.5	171	158.0	65.4	231	213.4	88.4	291	268.8	111.4
52	48.0	19.9	112	103.5	42.9	172	158.9	65.8	232	214.3	88.8	292	269.8	111.7
53	49.0	20.3	113	104.4	43.2	173	159.8	66.2	233	215.3	89.2	293	270.7	112.1
54	49.9	20.7	114	105.3	43.6	174	160.8	66.6	234	216.2	89.5	294	271.6	112.5
55	50.8	21.0	115	106.2	44.0	175	161.7	67.0	235	217.1	89.9	295	272.5	112.9
56	51.7	21.4	116	107.2	44.4	176	162.6	67.4	236	218.0	90.3	296	273.5	113.3
57	52.7	21.8	117	108.1	44.8	177	163.5	67.7	237	219.0	90.7	297	274.4	113.7
58	53.6	22.2	118	109.0	45.2	178	164.5	68.1	238	219.9	91.1	298	275.3	114.0
59	54 5	22.6	119	109.9	45.5	179	165.4	68.5	239	220.8	91.5	299	276.2	114.4
60	55.4	23.0	120	110.9	45.9	180	166.3	68.9	240	221.7	91.8	300	277.2	114.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.
East North East.			East South East.			[For 6 Pts.]			West North West.			West South West		

TABLE I.—DIFFERENCE OF LATITUDE AND DEPARTURE FOR 2¼ POINTS.

North North East ¼ East. North North West ¼ West. South South East ¼ East. South South West ¼ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.1	26.1	121	109.4	51.7	181	163.6	77.4	241	217.9	103.0
2	01.8	00.9	62	56.0	26.5	122	110.3	52.2	182	164.5	77.8	242	218.8	103.5
3	02.7	01.3	63	57.0	26.9	123	111.2	52.6	183	165.4	78.2	243	219.7	103.9
4	03.6	01.7	64	57.9	27.4	124	112.1	53.0	184	166.3	78.7	244	220.6	104.3
5	04.5	02.1	65	58.8	27.8	125	113.0	53.4	185	167.2	79.1	245	221.5	104.8
6	05.4	02.6	66	59.7	28.2	126	113.9	53.9	186	168.1	79.5	246	222.4	105.2
7	06.3	03.0	67	60.6	28.6	127	114.8	54.3	187	169.0	80.0	247	223.3	105.6
8	07.2	03.4	68	61.5	29.1	128	115.7	54.7	188	169.9	80.4	248	224.2	106.0
9	08.1	03.8	69	62.4	29.5	129	116.6	55.2	189	170.9	80.8	249	225.1	106.5
10	09.0	04.3	70	63.3	29.9	130	117.5	55.6	190	171.8	81.2	250	226.0	106.9
11	09.9	04.7	71	64.2	30.4	131	118.4	56.0	191	172.7	81.7	251	226.9	107.3
12	10.8	05.1	72	65.1	30.8	132	119.3	56.4	192	173.6	82.1	252	227.8	107.7
13	11.8	05.6	73	66.0	31.2	133	120.2	56.9	193	174.5	82.5	253	228.7	108.2
14	12.7	06.0	74	66.9	31.6	134	121.1	57.3	194	175.4	82.9	254	229.6	108.6
15	13.6	06.4	75	67.8	32.1	135	122.0	57.7	195	176.3	83.4	255	230.5	109.0
16	14.5	06.8	76	68.7	32.5	136	122.9	58.1	196	177.2	83.8	256	231.4	109.5
17	15.4	07.3	77	69.6	32.9	137	123.8	58.6	197	178.1	84.2	257	232.3	109.9
18	16.3	07.7	78	70.5	33.3	138	124.8	59.0	198	179.0	84.7	258	233.2	110.3
19	17.2	08.1	79	71.4	33.8	139	125.7	59.4	199	179.9	85.1	259	234.1	110.7
20	18.1	08.6	80	72.3	34.2	140	126.6	59.9	200	180.8	85.5	260	235.0	111.2
21	19.0	09.0	81	73.2	34.6	141	127.5	60.3	201	181.7	85.9	261	235.9	111.6
22	19.9	09.4	82	74.1	35.1	142	128.4	60.7	202	182.6	86.4	262	236.8	112.0
23	20.8	09.8	83	75.0	35.5	143	129.3	61.1	203	183.5	86.8	263	237.7	112.4
24	21.7	10.3	84	75.9	35.9	144	130.2	61.6	204	184.4	87.2	264	238.7	112.9
25	22.6	10.7	85	76.8	36.3	145	131.1	62.0	205	185.3	87.6	265	239.6	113.3
26	23.5	11.1	86	77.7	36.8	146	132.0	62.4	206	186.2	88.1	266	240.5	113.7
27	24.4	11.5	87	78.6	37.2	147	132.9	62.9	207	187.1	88.5	267	241.4	114.2
28	25.3	12.0	88	79.6	37.6	148	133.8	63.3	208	188.0	88.9	268	242.3	114.6
29	26.2	12.4	89	80.5	38.1	149	134.7	63.7	209	188.9	89.4	269	243.2	115.0
30	27.1	12.8	90	81.4	38.5	150	135.6	64.1	210	189.8	89.8	270	244.1	115.4
31	28.0	13.3	91	82.3	38.9	151	136.5	64.6	211	190.7	90.2	271	245.0	115.9
32	28.9	13.7	92	83.2	39.3	152	137.4	65.0	212	191.6	90.6	272	245.9	116.3
33	29.8	14.1	93	84.1	39.8	153	138.3	65.4	213	192.5	91.1	273	246.8	116.7
34	30.7	14.5	94	85.0	40.2	154	139.2	65.8	214	193.5	91.5	274	247.7	117.2
35	31.6	15.0	95	85.9	40.6	155	140.1	66.3	215	194.4	91.9	275	248.6	117.6
36	32.5	15.4	96	86.8	41.0	156	141.0	66.7	216	195.3	92.4	276	249.5	118.0
37	33.4	15.8	97	87.7	41.5	157	141.9	67.1	217	196.2	92.8	277	250.4	118.4
38	34.4	16.2	98	88.6	41.9	158	142.8	67.6	218	197.1	93.2	278	251.3	118.9
39	35.3	16.7	99	89.5	42.3	159	143.7	68.0	219	198.0	93.6	279	252.2	119.3
40	36.2	17.1	100	90.4	42.8	160	144.6	68.4	220	198.9	94.1	280	253.1	119.7
41	37.1	17.5	101	91.3	43.2	161	145.5	68.8	221	199.8	94.5	281	254.0	120.1
42	38.0	18.0	102	92.2	43.6	162	146.4	69.3	222	200.7	94.9	282	254.9	120.6
43	38.9	18.4	103	93.1	44.0	163	147.4	69.7	223	201.6	95.3	283	255.8	121.0
44	39.8	18.8	104	94.0	44.5	164	148.3	70.1	224	202.5	95.8	284	256.7	121.4
45	40.7	19.2	105	94.9	44.9	165	149.2	70.5	225	203.4	96.2	285	257.6	121.9
46	41.6	19.7	106	95.8	45.3	166	150.1	71.0	226	204.3	96.6	286	258.5	122.3
47	42.5	20.1	107	96.7	45.7	167	151.0	71.4	227	205.2	97.1	287	259.4	122.7
48	43.4	20.5	108	97.6	46.2	168	151.9	71.8	228	206.1	97.5	288	260.3	123.1
49	44.3	21.0	109	98.5	46.6	169	152.8	72.3	229	207.0	97.9	289	261.3	123.6
50	45.2	21.4	110	99.4	47.0	170	153.7	72.7	230	207 9	98.3	290	262.2	124.0
51	46.1	21.8	111	100.3	47.5	171	154.6	73.1	231	208.8	98.8	291	263.1	124.4
52	47.0	22.2	112	101.2	47.9	172	155.5	73.5	232	209.7	99.2	292	264.0	124.8
53	47.9	22.7	113	102.2	48.3	173	156.4	74.0	233	210.6	99.6	293	264.9	125.3
54	48.8	23.1	114	103.1	48.7	174	157.3	74.4	234	211.5	100.0	294	265.8	125.7
55	49.7	23.5	115	104.0	49.2	175	158.2	74.8	235	212.4	100.5	295	266.7	126.1
56	50.6	23.9	116	104.9	49.6	176	159.1	75.2	236	213.3	100.9	296	267.6	126.6
57	51.5	24.4	117	105.8	50.0	177	160.0	75.7	237	214.2	101.3	297	268.5	127.0
58	52.4	24.8	118	106.7	50.5	178	160.9	76.1	238	215.1	101.8	298	269.4	127.4
59	53.3	25.2	119	107.6	50.9	179	161.8	76.5	239	216.1	102.2	299	270.3	127.8
60	54.2	25.7	120	108.5	51.3	180	162.7	77.0	240	217.0	102.6	300	271.2	128.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East b. East ¾ East. South East b. East ¾ East. [For 5¾ Pts.] North West b. West ¾ West. South West b. West ¾ West.

 TABLE I.—DIFFERENCE OF LATITUDE AND DEPARTURE FOR 2½ POINTS.

North North East ½ East. North North West ½ West. South South East ½ East. South South West ½ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.8	28.8	121	106.7	57.0	181	159.6	85.3	241	212.5	113.6
2	01.8	00.9	62	54.7	29.2	122	107.6	57.5	182	160.5	85.8	242	213.4	114.1
3	02.6	01.4	63	55.6	29.7	123	108.5	58.0	183	161.4	86.3	243	214.3	114.5
4	03.5	01.9	64	56.4	30.2	124	109.4	58.5	184	162.3	86.7	244	215.2	115.0
5	04.4	02.4	65	57.3	30.6	125	110.2	58.9	185	163.2	87.2	245	216.1	115.5
6	05.3	02.8	66	58.2	31.1	126	111.1	59.4	186	164.0	87.7	246	217.0	116.0
7	06.2	03.3	67	59.1	31.6	127	112.0	59.9	187	164.9	88.2	247	217.8	116.4
8	07.1	03.8	68	60.0	32.1	128	112.9	60.3	188	165.8	88.6	248	218.7	116.9
9	07.9	04.2	69	60.9	32.5	129	113.8	60.8	189	166.7	89.1	249	219.6	117.4
10	08.8	04.7	70	61.7	33.0	130	114.6	61.3	190	167.6	89.6	250	220.5	117.8
11	09.7	05.2	71	62.6	33.5	131	115.5	61.8	191	168.4	90.0	251	221.4	118.3
12	10.6	05.7	72	63.5	33.9	132	116.4	62.2	192	169.3	90.5	252	222.2	118.8
13	11.5	06.1	73	64.4	34.4	133	117.3	62.7	193	170.2	91.0	253	223.1	119.3
14	12.3	06.6	74	65.3	34.9	134	118.2	63.2	194	171.1	91.5	254	224.0	119.7
15	13.2	07.1	75	66.1	35.4	135	119.1	63.6	195	172.0	91.9	255	224.9	120.2
16	14.1	07.5	76	67.0	35.8	136	119.9	64.1	196	172.9	92.4	256	225.8	120.7
17	15.0	08.0	77	67.9	36.3	137	120.8	64.6	197	173.7	92.9	257	226.7	121.1
18	15.9	08.5	78	68.8	36.8	138	121.7	65.1	198	174.6	93.3	258	227.5	121.6
19	16.8	09.0	79	69.7	37.2	139	122.6	65.5	199	175.5	93.8	259	228.4	122.1
20	17.6	09.4	80	70.6	37.7	140	123.5	66.0	200	176.4	94.3	260	229.3	122.6
21	18.5	09.9	81	71.4	38.2	141	124.4	66.5	201	177.3	94.8	261	230.2	123.0
22	19.4	10.4	82	72.3	38.7	142	125.2	66.9	202	178.1	95.2	262	231.1	123.5
23	20.3	10.8	83	73.2	39.1	143	126.1	67.4	203	179.0	95.7	263	231.9	124.0
24	21.2	11.3	84	74.1	39.6	144	127.0	67.9	204	179.9	96.2	264	232.8	124.4
25	22.0	11.8	85	75.0	40.1	145	127.9	68.4	205	180.8	96.6	265	233.7	124.9
26	22.9	12.3	86	75.8	40.5	146	128.8	68.8	206	181.7	97.1	266	234.6	125.4
27	23.8	12.7	87	76.7	41.0	147	129.6	69.3	207	182.6	97.6	267	235.5	125.9
28	24.7	13.2	88	77.6	41.5	148	130.5	69.8	208	183.4	98.1	268	236.4	126.3
29	25.6	13.7	89	78.5	42.0	149	131.4	70.2	209	184.3	98.5	269	237.2	126.8
30	26.5	14.1	90	79.4	42.4	150	132.3	70.7	210	185.2	99.0	270	238.1	127.3
31	27.3	14.6	91	80.3	42.9	151	133.2	71.2	211	186.1	99.5	271	239.0	127.7
32	28.2	15.1	92	81.1	43.4	152	134.1	71.7	212	187.0	99.9	272	239.9	128.2
33	29.1	15.6	93	82.0	43.8	153	134.9	72.1	213	187.8	100.4	273	240.8	128.7
34	30.0	16.0	94	82.9	44.3	154	135.8	72.6	214	188.7	100.9	274	241.6	129.2
35	30.9	16.5	95	83.8	44.8	155	136.7	73.1	215	189.6	101.4	275	242.5	129.6
36	31.7	17.0	96	84.7	45.3	156	137.6	73.5	216	190.5	101.8	276	243.4	130.1
37	32.6	17.4	97	85.5	45.7	157	138.5	74.0	217	191.4	102.3	277	244.3	130.6
38	33.5	17.9	98	86.4	46.2	158	139.3	74.5	218	192.3	102.8	278	245.2	131.0
39	34.4	18.4	99	87.3	46.7	159	140.2	75.0	219	193.1	103.2	279	246.1	131.5
40	35.3	18.9	100	88.2	47.1	160	141.1	75.4	220	194.0	103.7	280	246.9	132.0
41	36.2	19.3	101	89.1	47.6	161	142.0	75.9	221	194.9	104.2	281	247.8	132.5
42	37.0	19.8	102	90.0	48.1	162	142.9	76.4	222	195.8	104.7	282	248.7	132.9
43	37.9	20.3	103	90.8	48.6	163	143.8	76.8	223	196.7	105.1	283	249.6	133.4
44	38.8	20.7	104	91.7	49.0	164	144.6	77.3	224	197.6	105.6	284	250.5	133.9
45	39.7	21.2	105	92.6	49.5	165	145.5	77.8	225	198.4	106.1	285	251.3	134.3
46	40.6	21.7	106	93.5	50.0	166	146.4	78.3	226	199.3	106.5	286	252.2	134.8
47	41.5	22.2	107	94.4	50.4	167	147.3	78.7	227	200.2	107.0	287	253.1	135.3
48	42.3	22.6	108	95.2	50.9	168	148.2	79.2	228	201.1	107.5	288	254.0	135.8
49	43.2	23.1	109	96.1	51.4	169	149.0	79.7	229	202.0	107.9	289	254.9	136.2
50	44.1	23.6	110	97.0	51.9	170	149.9	80.1	230	202.8	108.4	290	255.8	136.7
51	45.0	24.0	111	97.9	52.3	171	150.8	80.6	231	203.7	108.9	291	256.6	137.2
52	45.9	24.5	112	98.8	52.8	172	151.7	81.1	232	204.6	109.4	292	257.5	137.6
53	46.7	25.0	113	99.7	53.3	173	152.6	81.6	233	205.5	109.8	293	258.4	138.1
54	47.6	25.5	114	100.5	53.7	174	153.5	82.0	234	206.4	110.3	294	259.3	138.6
55	48.5	25.9	115	101.4	54.2	175	154.3	82.5	235	207.3	110.8	295	260.2	139.1
56	49.4	26.4	116	102.3	54.7	176	155.2	83.0	236	208.1	111.2	296	261.0	139.5
57	50.3	26.9	117	103.2	55.2	177	156.1	83.4	237	209.0	111.7	297	261.9	140.0
58	51.2	27.3	118	104.1	55.6	178	157.0	83.9	238	209.9	112.2	298	262.8	140.5
59	52.0	27.8	119	104.9	56.1	179	157.9	84.4	239	210.8	112.7	299	263.7	140.9
60	52.9	28.3	120	105.8	56.6	180	158.7	84.9	240	211.7	113.1	300	264.6	141.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East b. East ½ East. South East b. East ½ East. [For 5½ Pts.] North West b. West ½ West. South West b. West ½ West.

North North East ¾ East. North North West ¾ West. South South East ¾ East. South South West ¾ West.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.8	62.2	181	155.2	93.1	241	206.7	123.9
2	01.7	01.0	62	53.2	31.9	122	104.6	62.7	182	156.1	93.6	242	207.6	124.4
3	02.6	01.5	63	54.0	32.4	123	105.5	63.2	183	157.0	94.1	243	208.4	124.9
4	03.4	02.1	64	54.9	32.9	124	106.4	63.7	184	157.8	94.6	244	209.3	125.4
5	04.3	02.6	65	55.8	33.4	125	107.2	64.3	185	158.7	95.1	245	210.1	126.0
6	05.1	03.1	66	56.6	33.9	126	108.1	64.8	186	159.5	95.6	246	211.0	126.5
7	06.0	03.6	67	57.5	34.4	127	108.9	65.3	187	160.4	96.1	247	211.9	127.0
8	06.9	04.1	68	58.3	35.0	128	109.8	65.8	188	161.3	96.7	248	212.7	127.5
9	07.7	04.6	69	59.2	35.5	129	110.6	66.3	189	162.1	97.2	249	213.6	128.0
10	08.6	05.1	70	60.0	36.0	130	111.5	66.8	190	163.0	97.7	250	214.4	128.5
11	09.4	05.7	71	60.9	36.5	131	112.4	67.3	191	163.8	98.2	251	215.3	129.0
12	10.3	06.2	72	61.8	37.0	132	113.2	67.9	192	164.7	98.7	252	216.1	129.6
13	11.2	06.7	73	62.6	37.5	133	114.1	68.4	193	165.5	99.2	253	217.0	130.1
14	12.0	07.2	74	63.5	38.0	134	114.9	68.9	194	166.4	99.7	254	217.9	130.6
15	12.9	07.7	75	64.3	38.6	135	115.8	69.4	195	167.3	100.3	255	218.7	131.1
16	13.7	08.2	76	65.2	39.1	136	116.7	69.9	196	168.1	100.8	256	219.6	131.6
17	14.6	08.7	77	66.0	39.6	137	117.5	70.4	197	169.0	101.3	257	220.4	132.1
18	15.4	09.3	78	66.9	40.1	138	118.4	70.9	198	169.8	101.8	258	221.3	132.6
19	16.3	09.8	79	67.8	40.6	139	119.2	71.5	199	170.7	102.3	259	222.2	133.2
20	17.2	10.3	80	68.6	41.1	140	120.1	72.0	200	171.5	102.8	260	223.0	133.7
21	18.0	10.8	81	69.5	41.6	141	120.9	72.5	201	172.4	103.3	261	223.9	134.2
22	18.9	11.3	82	70.3	42.2	142	121.8	73.0	202	173.3	103.8	262	224.7	134.7
23	19.7	11.8	83	71.2	42.7	143	122.7	73.5	203	174.1	104.4	263	225.6	135.2
24	20.6	12.3	84	72.0	43.2	144	123.5	74.0	204	175.0	104.9	264	226.4	135.7
25	21.4	12.9	85	72.9	43.7	145	124.4	74.5	205	175.8	105.4	265	227.3	136.2
26	22.3	13.4	86	73.8	44.2	146	125.2	75.1	206	176.7	105.9	266	228.2	136.8
27	23.2	13.9	87	74.6	44.7	147	126.1	75.6	207	177.5	106.4	267	229.0	137.3
28	24.0	14.4	88	75.5	45.2	148	126.9	76.1	208	178.4	106.9	268	229.9	137.8
29	24.9	14.9	89	76.3	45.8	149	127.8	76.6	209	179.3	107.4	269	230.7	138.3
30	25.7	15.4	90	77.2	46.3	150	128.7	77.1	210	180.1	108.0	270	231.6	138.8
31	26.6	15.9	91	78.1	46.8	151	129.5	77.6	211	181.0	108.5	271	232.4	139.3
32	27.4	16.5	92	78.9	47.3	152	130.4	78.1	212	181.8	109.0	272	233.3	139.8
33	28.3	17.0	93	79.8	47.8	153	131.2	78.7	213	182.7	109.5	273	234.2	140.4
34	29.2	17.5	94	80.6	48.3	154	132.1	79.2	214	183.6	110.0	274	235.0	140.9
35	30.0	18.0	95	81.5	48.8	155	132.9	79.7	215	184.4	110.5	275	235.9	141.4
36	30.9	18.5	96	82.3	49.4	156	133.8	80.2	216	185.3	111.0	276	236.7	141.9
37	31.7	19.0	97	83.2	49.9	157	134.7	80.7	217	186.1	111.6	277	237.6	142.4
38	32.6	19.5	98	84.1	50.4	158	135.5	81.2	218	187.0	112.1	278	238.4	142.9
39	33.5	20.1	99	84.9	50.9	159	136.4	81.7	219	187.8	112.6	279	239.3	143.4
40	34.3	20.6	100	85.8	51.4	160	137.2	82.3	220	188.7	113.1	280	240.2	143.9
41	35.2	21.1	101	86.6	51.9	161	138.1	82.8	221	189.6	113.6	281	241.0	144.5
42	36.0	21.6	102	87.5	52.4	162	139.0	83.3	222	190.4	114.1	282	241.9	145.0
43	36.9	22.1	103	88.3	53.0	163	139.8	83.8	223	191.3	114.6	283	242.7	145.5
44	37.7	22.6	104	89.2	53.5	164	140.7	84.3	224	192.1	115.2	284	243.6	146.0
45	38.6	23.1	105	90.1	54.0	165	141.5	84.8	225	193.0	115.7	285	244.5	146.5
46	39.5	23.6	106	90.9	54.5	166	142.4	85.3	226	193.8	116.2	286	245.3	147.0
47	40.3	24.2	107	91.8	55.0	167	143.2	85.9	227	194.7	116.7	287	246.2	147.5
48	41.2	24.7	108	92.6	55.5	168	144.1	86.4	228	195.6	117.2	288	247.0	148.1
49	42.0	25.2	109	93.5	56.0	169	145.0	86.9	229	196.4	117.7	289	247.9	148.6
50	42.9	25.7	110	94.4	56.6	170	145.8	87.4	230	197.3	118.2	290	248.7	149.1
51	43.7	26.2	111	95.2	57.1	171	146.7	87.9	231	198.1	118.8	291	249.6	149.6
52	44.6	26.7	112	96.1	57.6	172	147.5	88.4	232	199.0	119.3	292	250.5	150.1
53	45.5	27.2	113	96.9	58.1	173	148.4	88.9	233	199.9	119.8	293	251.3	150.6
54	46.3	27.8	114	97.8	58.6	174	149.2	89.5	234	200.7	120.3	294	252.2	151.1
55	47.2	28.3	115	98.6	59.1	175	150.1	90.0	235	201.6	120.8	295	253.0	151.7
56	48.0	28.8	116	99.5	59.6	176	151.0	90.5	236	202.4	121.3	296	253.9	152.2
57	48.9	29.3	117	100.4	60.2	177	151.8	91.0	237	203.3	121.8	297	254.7	152.7
58	49.7	29.8	118	101.2	60.7	178	152.7	91.5	238	204.1	122.4	298	255.6	153.2
59	50.6	30.3	119	102.1	61.2	179	153.5	92.0	239	205.0	122.9	299	256.5	153.7
60	51.5	30.8	120	102.9	61.7	180	154.4	92.5	240	205.9	123.4	300	257.3	154.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East *b*. East ¼ East. South East *b*. East ¼ East. [For 5¼ Pts.] North West *b*. West ¼ West. South West *b*. West ¼ West

North East *b.* North. North West *b.* North. South East *b.* South. South West *b.* South.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.7	33.9	121	100.6	67.2	181	150.5	100.6	241	200.4	133.9
2	01.7	01.1	62	51.6	34.4	122	101.4	67.8	182	151.3	101.1	242	201.2	134.4
3	02.5	01.7	63	52.4	35.0	123	102.3	68.3	183	152.2	101.7	243	202.0	135.0
4	03.3	02.2	64	53.2	35.6	124	103.1	68.9	184	153.0	102.2	244	202.9	135.6
5	04.2	02.8	65	54.0	36.1	125	103.9	69.4	185	153.8	102.8	245	203.7	136.1
6	05.0	03.3	66	54.9	36.7	126	104.8	70.0	186	154.7	103.3	246	204.5	136.7
7	05.8	03.9	67	55.7	37.2	127	105.6	70.6	187	155.5	103.9	247	205.4	137.2
8	06.7	04.4	68	56.5	37.8	128	106.4	71.1	188	156.3	104.4	248	206.2	137.8
9	07.5	05.0	69	57.4	38.3	129	107.3	71.7	189	157.1	105.0	249	207.0	138.3
10	08.3	05.6	70	58.2	38.9	130	108.1	72.2	190	158.0	105.6	250	207.9	138.9
11	09.1	06.1	71	59.0	39.4	131	108.9	72.8	191	158.8	106.1	251	208.7	139.4
12	10.0	06.7	72	59.9	40.0	132	109.8	73.3	192	159.6	106.7	252	209.5	140.0
13	10.8	07.2	73	60.7	40.6	133	110.6	73.9	193	160.5	107.2	253	210.4	140.6
14	11.6	07.8	74	61.5	41.1	134	111.4	74.4	194	161.3	107.8	254	211.2	141.1
15	12.5	08.3	75	62.4	41.7	135	112.2	75.0	195	162.1	108.3	255	212.0	141.7
16	13.3	08.9	76	63.2	42.2	136	113.1	75.6	196	163.0	108.9	256	212.9	142.2
17	14.1	09.4	77	64.0	42.8	137	113.9	76.1	197	163.8	109.4	257	213.7	142.8
18	15.0	10.0	78	64.9	43.3	138	114.7	76.7	198	164.6	110.0	258	214.5	143.3
19	15.8	10.6	79	65.7	43.9	139	115.6	77.2	199	165.5	110.6	259	215.4	143.9
20	16.6	11.1	80	66.5	44.4	140	116.4	77.8	200	166.3	111.1	260	216.2	144.4
21	17.5	11.7	81	67.3	45.0	141	117.2	78.3	201	167.1	111.7	261	217.0	145.0
22	18.3	12.2	82	68.2	45.6	142	118.1	78.9	202	168.0	112.2	262	217.8	145.6
23	19.1	12.8	83	69.0	46.1	143	118.9	79.4	203	168.8	112.8	263	218.7	146.1
24	20.0	13.3	84	69.8	46.7	144	119.7	80.0	204	169.6	113.3	264	219.5	146.7
25	20.8	13.9	85	70.7	47.2	145	120.6	80.6	205	170.5	113.9	265	220.3	147.2
26	21.6	14.4	86	71.5	47.8	146	121.4	81.1	206	171.3	114.4	266	221.2	147.8
27	22.4	15.0	87	72.3	48.3	147	122.2	81.7	207	172.1	115.0	267	222.0	148.3
28	23.3	15.6	88	73.2	48.9	148	123.1	82.2	208	172.9	115.6	268	222.8	148.9
29	24.1	16.1	89	74.0	49.4	149	123.9	82.8	209	173.8	116.1	269	223.7	149.4
30	24.9	16.7	90	74.8	50.0	150	124.7	83.3	210	174.6	116.7	270	224.5	150.0
31	25.8	17.2	91	75.7	50.6	151	125.6	83.9	211	175.4	117.2	271	225.3	150.6
32	26.6	17.8	92	76.5	51.1	152	126.4	84.4	212	176.3	117.8	272	226.2	151.1
33	27.4	18.3	93	77.3	51.7	153	127.2	85.0	213	177.1	118.3	273	227.0	151.7
34	28.3	18.9	94	78.2	52.2	154	128.0	85.0	214	177.9	118.9	274	227.8	152.2
35	29.1	19.4	95	79.0	52.8	155	128.9	86.1	215	178.8	119.4	275	228.7	152.8
36	29.9	20.0	96	79.8	53.3	156	129.7	86.7	216	179.6	120.0	276	229.5	153.3
37	30.8	20.6	97	80.7	53.9	157	130.5	87.2	217	180.4	120.6	277	230.3	153.9
38	31.6	21.1	98	81.5	54.4	158	131.4	87.8	218	181.3	121.1	278	231.1	154.4
39	32.4	21.7	99	82.3	55.0	159	132.2	88.3	219	182.1	121.7	279	232.0	155.0
40	33.3	22.2	100	83.1	55.6	160	133.0	88.9	220	182.9	122.2	280	232.8	155.6
41	34.1	22.8	101	84.0	56.1	161	133.9	89.4	221	183.8	122.8	281	233.6	156.1
42	34.9	23.3	102	84.8	56.7	162	134.7	90.0	222	184.6	123.3	282	234.5	156.7
43	35.8	23.9	103	85.6	57.2	163	135.5	90.6	223	185.4	123.9	283	235.3	157.2
44	36.6	24.4	104	86.5	57.8	164	136.4	91.1	224	186.2	124.4	284	236.1	157.8
45	37.4	25.0	105	87.3	58.3	165	137.2	91.7	225	187.1	125.0	285	237.0	158.3
46	38.2	25.6	106	88.1	58.9	166	138.0	92.2	226	187.9	125.6	286	237.8	158.9
47	39.1	26.1	107	89.0	59.4	167	138.9	92.8	227	188.7	126.1	287	238.6	159.4
48	39.9	26.7	108	89.8	60.0	168	139.7	93.3	228	189.6	126.7	288	239.5	160.0
49	40.7	27.2	109	90.6	60.6	169	140.5	93.9	229	190.4	127.2	289	240.3	160.6
50	41.6	27.8	110	91.5	61.1	170	141.3	94.4	230	191.2	127.8	290	241.1	161.1
51	42.4	28.3	111	92.3	61.7	171	142.2	95.0	231	192.1	128.3	291	242.0	161.7
52	43.2	28.9	112	93.1	62.2	172	143.0	95.6	232	192.9	128.9	292	242.8	162.2
53	44.1	29.4	113	94.0	62.8	173	143.8	96.1	233	193.7	129.4	293	243.6	162.8
54	44.9	30.0	114	94.8	63.3	174	144.7	96.7	234	194.6	130.0	294	244.5	163.3
55	45.7	30.6	115	95.6	63.9	175	145.5	97.2	235	195.4	130.6	295	245.3	163.9
56	46.6	31.1	116	96.5	64.4	176	146.3	97.8	236	196.2	131.1	296	246.1	164.4
57	47.4	31.7	117	97.3	65.0	177	147.2	98.3	237	197.1	131.7	297	246.9	165.0
58	48.2	32.2	118	98.1	65.6	178	148.0	98.9	238	197.9	132.2	298	247.8	165.6
59	49.1	32.8	119	98.9	66.1	179	148.8	99.4	239	198.7	132.8	299	248.6	166.1
60	49.9	33.3	120	99.8	66.7	180	149.7	100.0	240	199.6	133.3	300	249.4	166.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East ¾ North. North West ¾ North. South East ¾ South. South West ¾ South.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	49.0	36.3	121	97.2	72.1	181	145.4	107.8	241	193.6	143.6
2	01.6	01.2	62	49.8	36.9	122	98.0	72.7	182	146.2	108.4	242	194.4	144.2
3	02.4	01.8	63	50.6	37.5	123	98.8	73.3	183	147.0	109.0	243	195.2	144.8
4	03.2	02.4	64	51.4	38.1	124	99.6	73.9	184	147.8	109.6	244	196.0	145.4
5	04.0	03.0	65	52.2	38.7	125	100.4	74.5	185	148.6	110.2	245	196.8	145.9
6	04.8	03.6	66	53.0	39.3	126	101.2	75.1	186	149.4	110.8	246	197.6	146.5
7	05.6	04.2	67	53.8	39.9	127	102.0	75.7	187	150.2	111.4	247	198.4	147.1
8	06.4	04.8	68	54.6	40.5	128	102.8	76.2	188	151.0	112.0	248	199.2	147.7
9	07.2	05.4	69	55.4	41.1	129	103.6	76.8	189	151.8	112.6	249	200.0	148.3
10	08.0	06.0	70	56.2	41.7	130	104.4	77.4	190	152.6	113.2	250	200.8	148.9
11	08.8	06.6	71	57.0	42.3	131	105.2	78.0	191	153.4	113.8	251	201.6	149.5
12	09.6	07.1	72	57.8	42.9	132	106.0	78.6	192	154.2	114.4	252	202.4	150.1
13	10.4	07.7	73	58.6	43.5	133	106.8	79.2	193	155.0	115.0	253	203.2	150.7
14	11.2	08.3	74	59.4	44.1	134	107.6	79.8	194	155.8	115.6	254	204.0	151.3
15	12.0	08.9	75	60.2	44.7	135	108.4	80.4	195	156.6	116.2	255	204.8	151.9
16	12.9	09.5	76	61.0	45.3	136	109.2	81.0	196	157.4	116.8	256	205.6	152.5
17	13.7	10.1	77	61.8	45.9	137	110.0	81.6	197	158.2	117.4	257	206.4	153.1
18	14.5	10.7	78	62.7	46.5	138	110.8	82.2	198	159.0	117.9	258	207.2	153.7
19	15.3	11.3	79	63.5	47.1	139	111.6	82.8	199	159.8	118.5	259	208.0	154.3
20	16.1	11.9	80	64.3	47.7	140	112.4	83.4	200	160.6	119.1	260	208.8	154.9
21	16.9	12.5	81	65.1	48.3	141	113.3	84.0	201	161.4	119.7	261	209.6	155.5
22	17.7	13.1	82	65.9	48.8	142	114.1	84.6	202	162.2	120.3	262	210.4	156.1
23	18.5	13.7	83	66.7	49.4	143	114.9	85.2	203	163.1	120.9	263	211.2	156.7
24	19.3	14.3	84	67.5	50.0	144	115.7	85.8	204	163.9	121.5	264	212.0	157.3
25	20.1	14.9	85	68.3	50.6	145	116.5	86.4	205	164.7	122.1	265	212.8	157.9
26	20.9	15.5	86	69.1	51.2	146	117.3	87.0	206	165.5	122.7	266	213.7	158.5
27	21.7	16.1	87	69.9	51.8	147	118.1	87.6	207	166.3	123.3	267	214.5	159.1
28	22.5	16.7	88	70.7	52.4	148	118.9	88.2	208	167.1	123.9	268	215.3	159.6
29	23.3	17.3	89	71.5	53.0	149	119.7	88.8	209	167.9	124.5	269	216.1	160.2
30	24.1	17.9	90	72.3	53.6	150	120.5	89.4	210	168.7	125.1	270	216.9	160.8
31	24.9	18.5	91	73.1	54.2	151	121.3	90.0	211	169.5	125.7	271	217.7	161.4
32	25.7	19.1	92	73.9	54.8	152	122.1	90.5	212	170.3	126.3	272	218.5	162.0
33	26.5	19.7	93	74.7	55.4	153	122.9	91.1	213	171.1	126.9	273	219.3	162.6
34	27.3	20.3	94	75.5	56.0	154	123.7	91.7	214	171.9	127.5	274	220.1	163.2
35	28.1	20.8	95	76.3	56.6	155	124.5	92.3	215	172.7	128.1	275	220.9	163.8
36	28.9	21.4	96	77.1	57.2	156	125.3	92.9	216	173.5	128.7	276	221.7	164.4
37	29.7	22.0	97	77.9	57.8	157	126.1	93.5	217	174.3	129.3	277	222.5	165.0
38	30.5	22.6	98	78.7	58.4	158	126.9	94.1	218	175.1	129.9	278	223.3	165.6
39	31.3	23.2	99	79.5	59.0	159	127.7	94.7	219	175.9	130.5	279	224.1	166.2
40	32.1	23.8	100	80.3	59.6	160	128.5	95.3	220	176.7	131.1	280	224.9	166.8
41	32.9	24.4	101	81.1	60.2	161	129.3	95.9	221	177.5	131.6	281	225.7	167.4
42	33.7	25.0	102	81.9	60.8	162	130.1	96.5	222	178.3	132.2	282	226.5	168.0
43	34.5	25.6	103	82.7	61.4	163	130.9	97.1	223	179.1	132.8	283	227.3	168.6
44	35.3	26.2	104	83.5	62.0	164	131.7	97.7	224	179.9	133.4	284	228.1	169.2
45	36.1	26.8	105	84.3	62.5	165	132.5	98.3	225	180.7	134.0	285	228.9	169.8
46	36.9	27.4	106	85.1	63.1	166	133.3	98.9	226	181.5	134.6	286	229.7	170.4
47	37.8	28.0	107	85.9	63.7	167	134.1	99.5	227	182.3	135.2	287	230.5	171.0
48	38.6	28.6	108	86.7	64.3	168	134.9	100.1	228	183.1	135.8	288	231.3	171.6
49	39.4	29.2	109	87.5	64.9	169	135.7	100.7	229	183.9	136.4	289	232.1	172.2
50	40.2	29.8	110	88.4	65.5	170	136.5	101.3	230	184.7	137.0	290	232.9	172.8
51	41.0	30.4	111	89.2	66.1	171	137.3	101.9	231	185.5	137.6	291	233.7	173.3
52	41.8	31.0	112	90.0	66.7	172	138.2	102.5	232	186.3	138.2	292	234.5	173.9
53	42.6	31.6	113	90.8	67.3	173	139.0	103.1	233	187.1	138.8	293	235.3	174.5
54	43.4	32.2	114	91.6	67.9	174	139.8	103.7	234	188.0	139.4	294	236.1	175.1
55	44.2	32.8	115	92.4	68.5	175	140.6	104.2	235	188.8	140.0	295	236.9	175.7
56	45.0	33.4	116	93.2	69.1	176	141.4	104.8	236	189.6	140.6	296	237.7	176.3
57	45.8	34.0	117	94.0	69.7	177	142.2	105.4	237	190.4	141.2	297	238.6	176.9
58	46.6	34.6	118	94.8	70.3	178	143.0	106.0	238	191.2	141.8	298	239.4	177.5
59	47.4	35.1	119	95.6	70.9	179	143.8	106.6	239	192.0	142.4	299	240.2	178.1
60	48.2	35.7	120	96.4	71.5	180	144.6	107.2	240	192.8	143.0	300	241.0	178.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East ¾ East. South East ¾ East [For 4¾ Pts.] North West ¾ West. South West ¾ West.

North East ½ North. North West ½ North. South East ½ South. South West ½ South.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.2	38.7	121	93.5	76.8	181	139.9	114.8	241	186.3	152.9
2	01.5	01.3	62	47.9	39.3	122	94.3	77.4	182	140.7	115.5	242	187.1	153.5
3	02.3	01.9	63	48.7	40.0	123	95.1	78.0	183	141.5	116.1	243	187.8	154.2
4	03.1	02.5	64	49.5	40.6	124	95.9	78.7	184	142.2	116.7	244	188.6	154.8
5	03.9	03.2	65	50.2	41.2	125	96.6	79.3	185	143.0	117.4	245	189.4	155.4
6	04.6	03.8	66	51.0	41.9	126	97.4	79.9	186	143.8	118.0	246	190.2	156.1
7	05.4	04.4	67	51.8	42.5	127	98.2	80.6	187	144.6	118.6	247	190.9	156.7
8	06.2	05.1	68	52.6	43.1	128	98.9	81.2	188	145.3	119.3	248	191.7	157.3
9	07.0	05.7	69	53.3	43.8	129	99.7	81.8	189	146.1	119.9	249	192.5	158.0
10	07.7	06.3	70	54.1	44.4	130	100.5	82.5	190	146.9	120.5	250	193.3	158.6
11	08.5	07.0	71	54.9	45.0	131	101.3	83.1	191	147.6	121.2	251	194.0	159.2
12	09.3	07.6	72	55.7	45.7	132	102.0	83.7	192	148.4	121.8	252	194.8	159.9
13	10.0	08.2	73	56.4	46.3	133	102.8	84.4	193	149.2	122.4	253	195.6	160.5
14	10.8	08.9	74	57.2	46.9	134	103.6	85.0	194	150.0	123.1	254	196.3	161.1
15	11.6	09.5	75	58.0	47.6	135	104.4	85.6	195	150.7	123.7	255	197.1	161.8
16	12.4	10.2	76	58.7	48.2	136	105.1	86.3	196	151.5	124.3	256	197.9	162.4
17	13.1	10.8	77	59.5	48.8	137	105.9	86.9	197	152.3	125.0	257	198.7	163.0
18	13.9	11.4	78	60.3	49.5	138	106.7	87.5	198	153.1	125.6	258	199.4	163.7
19	14.7	12.1	79	61.1	50.1	139	107.4	88.2	199	153.8	126.2	259	200.2	164.3
20	15.5	12.7	80	61.8	50.8	140	108.2	88.8	200	154.6	126.9	260	201.0	164.9
21	16.2	13.3	81	62.6	51.4	141	109.0	89.4	201	155.4	127.5	261	201.8	165.6
22	17.0	14.0	82	63.4	52.0	142	109.8	90.1	202	156.1	128.1	262	202.5	166.2
23	17.8	14.6	83	64.2	52.7	143	110.5	90.7	203	156.9	128.8	263	203.3	166.8
24	18.6	15.2	84	64.9	53.3	144	111.3	91.4	204	157.7	129.4	264	204.1	167.5
25	19.3	15.9	85	65.7	53.9	145	112.1	92.0	205	158.5	130.1	265	204.8	168.1
26	20.1	16.5	86	66.5	54.6	146	112.9	92.6	206	159.2	130.7	266	205.6	168.7
27	20.9	17.1	87	67.3	55.2	147	113.6	93.3	207	160.0	131.3	267	206.4	169.4
28	21.6	17.8	88	68.0	55.8	148	114.4	93.9	208	160.8	132.0	268	207.2	170.0
29	22.4	18.4	89	68.8	56.5	149	115.2	94.5	209	161.6	132.6	269	207.9	170.7
30	23.2	19.0	90	69.6	57.1	150	116.0	95.2	210	162.3	133.2	270	208.7	171.3
31	24.0	19.7	91	70.3	57.7	151	116.7	95.8	211	163.1	133.9	271	209.5	171.9
32	24.7	20.3	92	71.1	58.4	152	117.5	96.4	212	163.9	134.5	272	210.3	172.6
33	25.5	20.9	93	71.9	59.0	153	118.3	97.1	213	164.7	135.1	273	211.0	173.2
34	26.3	21.6	94	72.7	59.6	154	119.0	97.7	214	165.4	135.8	274	211.8	173.8
35	27.1	22.2	95	73.4	60.3	155	119.8	98.3	215	166.2	136.4	275	212.6	174.5
36	27.8	22.8	96	74.2	60.9	156	120.6	99.0	216	167.0	137.0	276	213.4	175.1
37	28.6	23.5	97	75.0	61.5	157	121.4	99.6	217	167.7	137.7	277	214.1	175.7
38	29.4	24.1	98	75.8	62.2	158	122.1	100.2	218	168.5	138.3	278	214.9	176.4
39	30.1	24.7	99	76.5	62.8	159	122.9	100.9	219	169.3	138.9	279	215.7	177.0
40	30.9	25.4	100	77.3	63.4	160	123.7	101.5	220	170.1	139.6	280	216.4	177.6
41	31.7	26.0	101	78.1	64.1	161	124.5	102.1	221	170.8	140.2	281	217.2	178.3
42	32.5	26.6	102	78.8	64.7	162	125.2	102.8	222	171.6	140.8	282	218.0	178.9
43	33.2	27.3	103	79.6	65.3	163	126.0	103.4	223	172.4	141.5	283	218.8	179.5
44	34.0	27.9	104	80.4	66.0	164	126.8	104.0	224	173.2	142.1	284	219.5	180.2
45	34.8	28.5	105	81.2	66.6	165	127.5	104.7	225	173.9	142.7	285	220.3	180.8
46	35.6	29.2	106	81.9	67.2	166	128.3	105.3	226	174.7	143.4	286	221.1	181.4
47	36.3	29.8	107	82.7	67.9	167	129.1	105.9	227	175.5	144.0	287	221.9	182.1
48	37.1	30.5	108	83.5	68.5	168	129.9	106.6	228	176.2	144.6	288	222.6	182.7
49	37.9	31.1	109	84.3	69.1	169	130.6	107.2	229	177.0	145.3	289	223.4	183.3
50	38.7	31.7	110	85.0	69.8	170	131.4	107.8	230	177.8	145.9	290	224.2	184.0
51	39.4	32.4	111	85.8	70.4	171	132.2	108.5	231	178.6	146.5	291	224.9	184.6
52	40.2	33.0	112	86.6	71.1	172	133.0	109.1	232	179.3	147.2	292	225.7	185.2
53	41.0	33.6	113	87.4	71.7	173	133.7	109.8	233	180.1	147.8	293	226.5	185.9
54	41.7	34.3	114	88.1	72.3	174	134.5	110.4	234	180.9	148.4	294	227.3	186.5
55	42.5	34.9	115	88.9	73.0	175	135.3	111.0	235	181.7	149.1	295	228.0	187.1
56	43.3	35.5	116	89.7	73.6	176	136.0	111.7	236	182.4	149.7	296	228.8	187.8
57	44.1	36.2	117	90.4	74.2	177	136.8	112.3	237	183.2	150.4	297	229.6	188.4
58	44.8	36.8	118	91.2	74.9	178	137.6	112.9	238	184.0	151.0	298	230.4	189.0
59	45.6	37.4	119	92.0	75.5	179	138.4	113.6	239	184.7	151.6	299	231.1	189.7
60	46.4	38.1	120	92.8	76.1	180	139.1	114.2	240	185.5	152.3	300	231.9	190.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East ½ East. South East ½ East. [For 4½ Pts.] North West ½ West. South West ½ West.

North East ¼ North. North West ¼ North. South East ¼ South. South West ¼ South.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	45.2	41.0	121	89.7	81.3	181	134.1	121.6	241	178.6	161.8
2	01.5	01.3	62	45.9	41.6	122	90.4	81.9	182	134.9	122.2	242	179.3	162.5
3	02.2	02.0	63	46.7	42.3	123	91.1	82.6	183	135.6	122.9	243	180.1	163.2
4	03.0	02.7	64	47.4	43.0	124	91.9	83.3	184	136.3	123.6	244	180.8	163.9
5	03.7	03.4	65	48.2	43.7	125	92.6	83.9	185	137.1	124.2	245	181.5	164.5
6	04.4	04.0	66	48.9	44.3	126	93.4	84.6	186	137.8	124.9	246	182.3	165.2
7	05.2	04.7	67	49.6	45.0	127	94.1	85.3	187	138.6	125.6	247	183.0	165.9
8	05.9	05.4	68	50.4	45.7	128	94.8	86.0	188	139.3	126.3	248	183.8	166.5
9	06.7	06.0	69	51.1	46.3	129	95.6	86.6	189	140.0	126.9	249	184.5	167.2
10	07.4	06.7	70	51.9	47.0	130	96.3	87.3	190	140.8	127.6	250	185.2	167.9
11	08.2	07.4	71	52.6	47.7	131	97.1	88.0	191	141.5	128.3	251	186.0	168.6
12	08.9	08.1	72	53.3	48.4	132	97.8	88.6	192	142.3	128.9	252	186.7	169.2
13	09.6	08.7	73	54.1	49.0	133	98.5	89.3	193	143.0	129.6	253	187.5	169.9
14	10.4	09.4	74	54.8	49.7	134	99.3	90.0	194	143.7	130.3	254	188.2	170.6
15	11.1	10.1	75	55.6	50.4	135	100.0	90.7	195	144.5	131.0	255	188.9	171.2
16	11.9	10.7	76	56.3	51.0	136	100.8	91.3	196	145.2	131.6	256	189.7	171.9
17	12.6	11.4	77	57.1	51.7	137	101.5	92.0	197	146.0	132.3	257	190.4	172.6
18	13.3	12.1	78	57.8	52.4	138	102.3	92.7	198	146.7	133.0	258	191.2	173.3
19	14.1	12.8	79	58.5	53.1	139	103.0	93.3	199	147.4	133.6	259	191.9	173.9
20	14.8	13.4	80	59.3	53.7	140	103.7	94.0	200	148.2	134.3	260	192.6	174.6
21	15.6	14.1	81	60.0	54.4	141	104.5	94.7	201	148.9	135.0	261	193.4	175.3
22	16.3	14.8	82	60.8	55.1	142	105.2	95.4	202	149.7	135.7	262	194.1	175.9
23	17.0	15.4	83	61.5	55.7	143	106.0	96.0	203	150.4	136.3	263	194.9	176.6
24	17.8	16.1	84	62.2	56.4	144	106.7	96.7	204	151.2	137.0	264	195.6	177.3
25	18.5	16.8	85	63.0	57.1	145	107.4	97.4	205	151.9	137.7	265	196.4	178.0
26	19.3	17.5	86	63.7	57.8	146	108.2	98.0	206	152.6	138.3	266	197.1	178.6
27	20.0	18.1	87	64.5	58.4	147	108.9	98.7	207	153.4	139.0	267	197.8	179.3
28	20.7	18.8	88	65.2	59.1	148	109.7	99.4	208	154.1	139.7	268	198.6	180.0
29	21.5	19.5	89	65.9	59.8	149	110.4	100.1	209	154.9	140.4	269	199.3	180.6
30	22.2	20.1	90	66.7	60.4	150	111.1	100.7	210	155.6	141.0	270	200.1	181.3
31	23.0	20.8	91	67.4	61.1	151	111.9	101.4	211	156.3	141.7	271	200.8	182.0
32	23.7	21.5	92	68.2	61.8	152	112.6	102.1	212	157.1	142.4	272	201.5	182.7
33	24.5	22.2	93	68.9	62.5	153	113.4	102.7	213	157.8	143.0	273	202.3	183.3
34	25.2	22.8	94	69.6	63.1	154	114.1	103.4	214	158.6	143.7	274	203.0	184.0
35	25.9	23.5	95	70.4	63.8	155	114.8	104.1	215	159.3	144.4	275	203.8	184.7
36	26.7	24.2	96	71.1	64.5	156	115.6	104.8	216	160.0	145.1	276	204.5	185.4
37	27.4	24.8	97	71.9	65.1	157	116.3	105.4	217	160.8	145.7	277	205.2	186.0
38	28.2	25.5	98	72.6	65.8	158	117.1	106.1	218	161.5	146.4	278	206.0	186.7
39	28.9	26.2	99	73.4	66.5	159	117.8	106.8	219	162.3	147.1	279	206.7	187.4
40	29.6	26.9	100	74.1	67.2	160	118.6	107.4	220	163.0	147.7	280	207.5	188.0
41	30.4	27.5	101	74.8	67.8	161	119.3	108.1	221	163.8	148.4	281	208.2	188.7
42	31.1	28.2	102	75.6	68.5	162	120.0	108.8	222	164.5	149.1	282	208.9	189.4
43	31.9	28.9	103	76.3	69.2	163	120.8	109.5	223	165.2	149.8	283	209.7	190.1
44	32.6	29.5	104	77.1	69.8	164	121.5	110.1	224	166.0	150.4	284	210.4	190.7
45	33.3	30.2	105	77.8	70.5	165	122.3	110.8	225	166.7	151.1	285	211.2	191.4
46	34.1	30.9	106	78.5	71.2	166	123.0	111.5	226	167.5	151.8	286	211.9	192.1
47	34.8	31.6	107	79.3	71.9	167	123.7	112.2	227	168.2	152.4	287	212.7	192.7
48	35.6	32.2	108	80.0	72.5	168	124.5	112.8	228	168.9	153.1	288	213.4	193.4
49	36.3	32.9	109	80.8	73.2	169	125.2	113.5	229	169.7	153.8	289	214.1	194.1
50	37.0	33.6	110	81.5	73.9	170	126.0	114.2	230	170.4	154.5	290	214.9	194.8
51	37.8	34.2	111	82.2	74.5	171	126.7	114.8	231	171.2	155.1	291	215.6	195.4
52	38.5	34.9	112	83.0	75.2	172	127.4	115.5	232	171.9	155.8	292	216.4	196.1
53	39.3	35.6	113	83.7	75.9	173	128.2	116.2	233	172.6	156.5	293	217.1	196.8
54	40.0	36.3	114	84.5	76.6	174	128.9	116.9	234	173.4	157.1	294	217.8	197.4
55	40.8	36.9	115	85.2	77.2	175	129.7	117.5	235	174.1	157.8	295	218.6	198.1
56	41.5	37.6	116	86.0	77.9	176	130.4	118.2	236	174.9	158.5	296	219.3	198.8
57	42.2	38.3	117	86.7	78.6	177	131.1	118.9	237	175.6	159.2	297	220.1	199.5
58	43.0	39.0	118	87.4	79.2	178	131.9	119.5	238	176.3	159.8	298	220.8	200.1
59	43.7	39.6	119	88.2	79.9	179	132.6	120.2	239	177.1	160.5	299	221.5	200.8
60	44.5	40.3	120	88.9	80.6	180	133.4	120.9	240	177.8	161.2	300	222.3	201.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East ¼ East. South East ¼ East. [For 4¼ Pts.] North West ¼ West. South West ¼ West.

North East.			North West.					South East.			South West.			
Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	122	86.3	86.3	182	128.7	128.7	242	171.1	171.1
3	02.1	02.1	63	44.5	44.5	123	87.0	87.0	183	129.4	129.4	243	171.8	171.8
4	02.8	02.8	64	45.3	45.3	124	87.7	87.7	184	130.1	130.1	244	172.5	172.5
5	03.5	03.5	65	46.0	46.0	125	88.4	88.4	185	130.8	130.8	245	173.2	173.2
6	04.2	04.2	66	46.7	46.7	126	89.1	89.1	186	131.5	131.5	246	173.9	173.9
7	04.9	04.9	67	47.4	47.4	127	89.8	89.8	187	132.2	132.2	247	174.7	174.7
8	05.7	05.7	68	48.1	48.1	128	90.5	90.5	188	132.9	132.9	248	175.4	175.4
9	06.4	06.4	69	48.8	48.8	129	91.2	91.2	189	133.6	133.6	249	176.1	176.1
10	07.1	07.1	70	49.5	49.5	130	91.9	91.9	190	134.4	134.4	250	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	132	93.3	93.3	192	135.8	135.8	252	178.2	178.2
13	09.2	09.2	73	51.6	51.6	133	94.0	94.0	193	136.5	136.5	253	178.9	178.9
14	09.9	09.9	74	52.3	52.3	134	94.8	94.8	194	137.2	137.2	254	179.6	179.6
15	10.6	10.6	75	53.0	53.0	135	95.5	95.5	195	137.9	137.9	255	180.3	180.3
16	11.3	11.3	76	53.7	53.7	136	96.2	96.2	196	138.6	138.6	256	181.0	181.0
17	12.0	12.0	77	54.4	54.4	137	96.9	96.9	197	139.3	139.3	257	181.7	181.7
18	12.7	12.7	78	55.2	55.2	138	97.6	97.6	198	140.0	140.0	258	182.4	182.4
19	13.4	13.4	79	55.9	55.9	139	98.3	98.3	199	140.7	140.7	259	183.1	183.1
20	14.1	14.1	80	56.6	56.6	140	99.0	99.0	200	141.4	141.4	260	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	142	100.4	100.4	202	142.8	142.8	262	185.3	185.3
23	16.3	16.3	83	58.7	58.7	143	101.1	101.1	203	143.5	143.5	263	186.0	186.0
24	17.0	17.0	84	59.4	59.4	144	101.8	101.8	204	144.2	144.2	264	186.7	186.7
25	17.7	17.7	85	60.1	60.1	145	102.5	102.5	205	145.0	145.0	265	187.4	187.4
26	18.4	18.4	86	60.8	60.8	146	103.2	103.2	206	145.7	145.7	266	188.1	188.1
27	19.1	19.1	87	61.5	61.5	147	103.9	103.9	207	146.4	146.4	267	188.8	188.8
28	19.8	19.8	88	62.2	62.2	148	104.7	104.7	208	147.1	147.1	268	189.5	189.5
29	20.5	20.5	89	62.9	62.9	149	105.4	105.4	209	147.8	147.8	269	190.2	190.2
30	21.2	21.2	90	63.6	63.6	150	106.1	106.1	210	148.5	148.5	270	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	152	107.5	107.5	212	149.9	149.9	272	192.3	192.3
33	23.3	23.3	93	65.8	65.8	153	108.2	108.2	213	150.6	150.6	273	193.0	193.0
34	24.0	24.0	94	66.5	66.5	154	108.9	108.9	214	151.3	151.3	274	193.7	193.7
35	24.7	24.7	95	67.2	67.2	155	109.6	109.6	215	152.0	152.0	275	194.5	194.5
36	25.5	25.5	96	67.9	67.9	156	110.3	110.3	216	152.7	152.7	276	195.2	195.2
37	26.2	26.2	97	68.6	68.6	157	111.0	111.0	217	153.4	153.4	277	195.9	195.9
38	26.9	26.9	98	69.3	69.3	158	111.7	111.7	218	154.1	154.1	278	196.6	196.6
39	27.6	27.6	99	70.0	70.0	159	112.4	112.4	219	154.9	154.9	279	197.3	197.3
40	28.3	28.3	100	70.7	70.7	160	113.1	113.1	220	155.6	155.6	280	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	102	72.1	72.1	162	114.6	114.6	222	157.0	157.0	282	199.4	199.4
43	30.4	30.4	103	72.8	72.8	163	115.3	115.3	223	157.7	157.7	283	200.1	200.1
44	31.1	31.1	104	73.5	73.5	164	116.0	116.0	224	158.4	158.4	284	200.8	200.8
45	31.8	31.8	105	74.2	74.2	165	116.7	116.7	225	159.1	159.1	285	201.5	201.5
46	32.5	32.5	106	75.0	75.0	166	117.4	117.4	226	159.8	159.8	286	202.2	202.2
47	33.2	33.2	107	75.7	75.7	167	118.1	118.1	227	160.5	160.5	287	202.9	202.9
48	33.9	33.9	108	76.4	76.4	168	118.8	118.8	228	161.2	161.2	288	203.6	203.6
49	34.6	34.6	109	77.1	77.1	169	119.5	119.5	229	161.9	161.9	289	204.4	204.4
50	35.4	35.4	110	77.8	77.8	170	120.2	120.2	230	162.6	162.6	290	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	112	79.2	79.2	172	121.6	121.6	232	164.0	164.0	292	206.5	206.5
53	37.5	37.5	113	79.9	79.9	173	122.3	122.3	233	164.8	164.8	293	207.2	207.2
54	38.2	38.2	114	80.6	80.6	174	123.0	123.0	234	165.5	165.5	294	207.9	207.9
55	38.9	38.9	115	81.3	81.3	175	123.7	123.7	235	166.2	166.2	295	208.6	208.6
56	39.6	39.6	116	82.0	82.0	176	124.5	124.5	236	166.9	166.9	296	209.3	209.3
57	40.3	40.3	117	82.7	82.7	177	125.2	125.2	237	167.6	167.6	297	210.0	210.0
58	41.0	41.0	118	83.4	83.4	178	125.9	125.9	238	168.3	168.3	298	210.7	210.7
59	41.7	41.7	119	84.1	84.1	179	126.6	126.6	239	169.0	169.0	299	211.4	211.4
60	42.4	42.4	120	84.9	84.9	180	127.3	127.3	240	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

North East. North West [For 4 Pts.] South East. South West.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 1 DEGREE.

$0^h\ 4^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	01.1	121	121.0	02.1	181	181.0	03.2	241	241.0	04.2
2	02.0	00.0	62	62.0	01.1	122	122.0	02.1	182	182.0	03.2	242	242.0	04.2
3	03.0	00.1	63	63.0	01.1	123	123.0	02.1	183	183.0	03.2	243	243.0	04.2
4	04.0	00.1	64	64.0	01.1	124	124.0	02.2	184	184.0	03.2	244	244.0	04.3
5	05.0	00.1	65	65.0	01.1	125	125.0	02.2	185	185.0	03.2	245	245.0	04.3
6	06.0	00.1	66	66.0	01.2	126	126.0	02.2	186	186.0	03.2	246	246 0	04.3
7	07.0	00.1	67	67.0	01.2	127	127.0	02.2	187	187.0	03.3	247	247.0	04.3
8	08.0	00.1	68	68.0	01.2	128	128.0	02.2	188	188.0	03.3	248	248.0	04.3
9	09.0	00.2	69	69.0	01.2	129	129.0	02.3	189	189.0	03.3	249	249.0	04.3
10	10.0	00.2	70	70.0	01.2	130	130.0	02.3	190	190.0	03.3	250	250.0	04.4
11	11.0	00.2	71	71.0	01.2	131	131.0	02.3	191	191.0	03.3	251	251.0	04.4
12	12.0	00.2	72	72.0	01.3	132	132.0	02.3	192	192.0	03.4	252	252.0	04.4
13	13.0	00.2	73	73.0	01.3	133	133.0	02.3	193	193.0	03.4	253	253.0	04.4
14	14.0	00.2	74	74.0	01.3	134	134.0	02.3	194	194.0	03.4	254	254.0	04.4
15	15.0	00.3	75	75.0	01.3	135	135.0	02.4	195	195.0	03.4	255	255.0	04.5
16	16.0	00.3	76	76.0	01.3	136	136.0	02.4	196	196.0	03.4	256	256.0	04.5
17	17.0	00.3	77	77.0	01.3	137	137.0	02.4	197	197.0	03.4	257	257.0	04.5
18	18.0	00.3	78	78.0	01.4	138	138.0	02.4	198	198.0	03.5	258	258.0	04.5
19	19.0	00.3	79	79.0	01.4	139	139.0	02.4	199	199.0	03.5	259	259.0	04.5
20	20.0	00.3	80	80.0	01.4	140	140.0	02.4	200	200.0	03.5	260	260.0	04.5
21	21.0	00.4	81	81.0	01.4	141	141.0	02.5	201	201.0	03.5	261	261.0	04.6
22	22.0	00.4	82	82.0	01.4	142	142.0	02.5	202	202.0	03.5	262	262.0	04.6
23	23.0	00.4	83	83.0	01.4	143	143.0	02.5	203	203.0	03.5	263	263.0	04.6
24	24.0	00.4	84	84.0	01.5	144	144.0	02.5	204	204.0	03.6	264	264.0	04.6
25	25.0	00.4	85	85.0	01.5	145	145.0	02.5	205	205.0	03.6	265	265.0	04.6
26	26.0	00.5	86	86.0	01.5	146	146.0	02.5	206	206.0	03.6	266	266.0	04.6
27	27.0	00.5	87	87.0	01.5	147	147.0	02.6	207	207.0	03.6	267	267.0	04.7
28	28.0	00.5	88	88.0	01.5	148	148.0	02.6	208	208.0	03.6	268	268.0	04.7
29	29.0	00.5	89	89.0	01.6	149	149.0	02.6	209	209.0	03.6	269	269.0	04.7
30	30.0	00.5	90	90.0	01.6	150	150.0	02.6	210	210.0	03.7	270	270.0	04.7
31	31.0	00.5	91	91.0	01.6	151	151.0	02.6	211	211.0	03.7	271	271.0	04.7
32	32.0	00.6	92	92.0	01.6	152	152.0	02.7	212	212.0	03.7	272	272.0	04.7
33	33.0	00.6	93	93.0	01.6	153	153.0	02.7	213	213.0	03.7	273	273.0	04.8
34	34.0	00.6	94	94.0	01.6	154	154.0	02.7	214	214.0	03.7	274	274.0	04.8
35	35.0	00.6	95	95.0	01.7	155	155.0	02.7	215	215.0	03.8	275	275.0	04.8
36	36.0	00.6	96	96.0	01.7	156	156.0	02.7	216	216.0	03.8	276	276.0	04.8
37	37.0	00.6	97	97.0	01.7	157	157.0	02.7	217	217.0	03.8	277	277.0	04.8
38	38.0	00.7	98	98.0	01.7	158	158.0	02.8	218	218.0	03.8	278	278.0	04.9
39	39.0	00.7	99	99.0	01.7	159	159.0	02.8	219	219.0	03.8	279	279.0	04.9
40	40.0	00.7	100	100.0	01.7	160	160.0	02.8	220	220.0	03.8	280	280.0	04.9
41	41.0	00.7	101	101.0	01.8	161	161.0	02.8	221	221.0	03.9	281	281.0	04.9
42	42.0	00.7	102	102.0	01.8	162	162.0	02.8	222	222.0	03.9	282	282.0	04.9
43	43.0	00.8	103	103.0	01.8	163	163.0	02.8	223	223.0	03.9	283	283.0	04.9
44	44.0	00.8	104	104.0	01.8	164	164.0	02.9	224	224.0	03.9	284	284.0	05.0
45	45.0	00.8	105	105.0	01.8	165	165.0	02.9	225	225.0	03.9	285	285.0	05.0
46	46.0	00.8	106	106.0	01.8	166	166.0	02.9	226	226.0	03.9	286	286.0	05.0
47	47.0	00.8	107	107.0	01.9	167	167.0	02.9	227	227.0	04.0	287	287.0	05.0
48	48.0	00.8	108	108.0	01.9	168	168.0	02.9	228	228.0	04.0	288	288.0	05.0
49	49.0	00.9	109	109.0	01.9	169	169.0	02.9	229	229.0	04.0	289	289.0	05.0
50	50.0	00.9	110	110.0	01.9	170	170.0	03.0	230	230.0	04.0	290	290.0	05.1
51	51.0	00.9	111	111.0	01.9	171	171.0	03.0	231	231.0	04.0	291	291.0	05.1
52	52.0	00.9	112	112.0	02.0	172	172.0	03.0	232	232.0	04.0	292	292.0	05.1
53	53.0	00.9	113	113.0	02.0	173	173.0	03.0	233	233.0	04.1	293	293.0	05.1
54	54.0	00.9	114	114.0	02.0	174	174.0	03.0	234	234.0	04.1	294	294.0	05.1
55	55.0	01.0	115	115.0	02.0	175	175.0	03.1	235	235.0	04.1	295	295.0	05.1
56	56.0	01.0	116	116.0	02.0	176	176.0	03.1	236	236.0	04.1	296	296.0	05.2
57	57.0	01.0	117	117.0	02.0	177	177.0	03.1	237	237.0	04.1	297	297.0	05 2
58	58.0	01.0	118	118.0	02.1	178	178.0	03.1	238	238.0	04.2	298	298.0	05.2
59	59.0	01.0	119	119.0	02.1	179	179.0	03.1	239	239.0	04.2	299	299.0	05.2
60	60.0	01.0	120	120.0	02.1	180	180.0	03.1	240	240.0	04.2	300	300.0	05.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 89 Degrees. $5^h\ 56^m$.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 2 DEGREES. 0h 8m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.0	61	61.0	02.1	121	120.9	04.2	181	180.9	06.3	241	240.9	08.4
2	02.0	00.1	62	62.0	02.2	122	121.9	04.3	182	181.9	06.4	242	241.9	08.4
3	03.0	00.1	63	63.0	02.2	123	122.9	04.3	183	182.9	06.4	243	242.9	08.5
4	04.0	00.1	64	64.0	02.2	124	123.9	04.3	184	183.9	06.4	244	243.9	08.5
5	05.0	00.2	65	65.0	02.3	125	124.9	04.4	185	184.9	06.5	245	244.9	08.6
6	06.0	00.2	66	66.0	02.3	126	125.9	04.4	186	185.9	06.5	246	245.9	08.6
7	07.0	00.2	67	67.0	02.3	127	126.9	04.4	187	186.9	06.5	247	246.8	08.6
8	08.0	00.3	68	68.0	02.4	128	127.9	04.5	188	187.9	06.6	248	247.8	08.7
9	09.0	00.3	69	69.0	02.4	129	128.9	04.5	189	188.9	06.6	249	248.8	08.7
10	10.0	00.3	70	70.0	02.4	130	129.9	04.5	190	189.9	06.6	250	249.8	08.7
11	11.0	00.4	71	71.0	02.5	131	130.9	04.6	191	190.9	06.7	251	250.8	08.8
12	12.0	00.4	72	72.0	02.5	132	131.9	04.6	192	191.9	06.7	252	251.8	08.8
13	13.0	00.5	73	73.0	02.5	133	132.9	04.6	193	192.9	06.7	253	252.8	08.8
14	14.0	00.5	74	74.0	02.6	134	133.9	04.7	194	193.9	06.8	254	253.8	08.9
15	15.0	00.5	75	75.0	02.6	135	134.9	04.7	195	194.9	06.8	255	254.8	08.9
16	16.0	00.6	76	76.0	02.7	136	135.9	04.7	196	195.9	06.8	256	255.8	08.9
17	17.0	00.6	77	77.0	02.7	137	136.9	04.8	197	196.9	06.9	257	256.8	09.0
18	18.0	00.6	78	78.0	02.7	138	137.9	04.8	198	197.9	06.9	258	257.8	09.0
19	19.0	00.7	79	79.0	02.8	139	138.9	04.9	199	198.9	06.9	259	258.8	09.0
20	20.0	00.7	80	80.0	02.8	140	139.9	04.9	200	199.9	07.0	260	259.8	09.1
21	21.0	00.7	81	81.0	02.8	141	140.9	04.9	201	200.9	07.0	261	260.8	09.1
22	22.0	00.8	82	82.0	02.9	142	141.9	05.0	202	201.9	07.0	262	261.8	09.1
23	23.0	00.8	83	82.9	02.9	143	142.9	05.0	203	202.9	07.1	263	262.8	09.2
24	24.0	00.8	84	83.9	02.9	144	143.9	05.0	204	203.9	07.1	264	263.8	09.2
25	25.0	00.9	85	84.9	03.0	145	144.9	05.1	205	204.9	07.2	265	264.8	09.2
26	26.0	00.9	86	85.9	03.0	146	145.9	05.1	206	205.9	07.2	266	265.8	09.3
27	27.0	00.9	87	86.9	03.0	147	146.9	05.1	207	206.9	07.2	267	266.8	09.3
28	28.0	01.0	88	87.9	03.1	148	147.9	05.2	208	207.9	07.3	268	267.8	09.4
29	29.0	01.0	89	88.9	03.1	149	148.9	05.2	209	208.9	07.3	269	268.8	09.4
30	30.0	01.0	90	89.9	03.1	150	149.9	05.2	210	209.9	07.3	270	269.8	09.4
31	31.0	01.1	91	90.9	03.2	151	150.9	05.3	211	210.9	07.4	271	270.8	09.5
32	32.0	01.1	92	91.9	03.2	152	151.9	05.3	212	211.9	07.4	272	271.8	09.5
33	33.0	01.2	93	92.9	03.2	153	152.9	05.3	213	212.9	07.4	273	272.8	09.5
34	34.0	01.2	94	93.9	03.3	154	153.9	05.4	214	213.9	07.5	274	273.8	09.6
35	35.0	01.2	95	94.9	03.3	155	154.9	05.4	215	214.9	07.5	275	274.8	09.6
36	36.0	01.3	96	95.9	03.4	156	155.9	05.4	216	215.9	07.5	276	275.8	09.6
37	37.0	01.3	97	96.9	03.4	157	156.9	05.5	217	216.9	07.6	277	276.8	09.7
38	38.0	01.3	98	97.9	03.4	158	157.9	05.5	218	217.9	07.6	278	277.8	09.7
39	39.0	01.4	99	98.9	03.5	159	158.9	05.5	219	218.9	07.6	279	278.8	09.7
40	40.0	01.4	100	99.9	03.5	160	159.9	05.6	220	219.9	07.7	280	279.8	09.8
41	41.0	01.4	101	100.9	03.5	161	160.9	05.6	221	220.9	07.7	281	280.8	09.8
42	42.0	01.5	102	101.9	03.6	162	161.9	05.7	222	221.9	07.7	282	281.8	09.8
43	43.0	01.5	103	102.9	03.6	163	162.9	05.7	223	222.9	07.8	283	282.8	09.9
44	44.0	01.5	104	103.9	03.6	164	163.9	05.7	224	223.9	07.8	284	283.8	09.9
45	45.0	01.6	105	104.9	03.7	165	164.9	05.8	225	224.9	07.9	285	284.8	09.9
46	46.0	01.6	106	105.9	03.7	166	165.9	05.8	226	225.9	07.9	286	285.8	10.0
47	47.0	01.6	107	106.9	03.7	167	166.9	05.8	227	226.9	07.9	287	286.8	10.0
48	48.0	01.7	108	107.9	03.8	168	167.9	05.9	228	227.9	08.0	288	287.8	10.1
49	49.0	01.7	109	108.9	03.8	169	168.9	05.9	229	228.9	08.0	289	288.8	10.1
50	50.0	01.7	110	109.9	03.8	170	169.9	05.9	230	229.9	08.0	290	289.8	10.1
51	51.0	01.8	111	110.9	03.9	171	170.9	06.0	231	230.9	08.1	291	290.8	10.2
52	52.0	01.8	112	111.9	03.9	172	171.9	06.0	232	231.9	08.1	292	291.8	10.2
53	53.0	01.8	113	112.9	03.9	173	172.9	06.0	233	232.9	08.1	293	292.8	10.2
54	54.0	01.9	114	113.9	04.0	174	173.9	06.1	234	233.9	08.2	294	293.8	10.3
55	55.0	01.9	115	114.9	04.0	175	174.9	06.1	235	234.9	08.2	295	294.8	10.3
56	56.0	02.0	116	115.9	04.0	176	175.9	06.1	236	235.9	08.2	296	295.8	10.3
57	57.0	02.0	117	116.9	04.1	177	176.9	06.2	237	236.9	08.3	297	296.8	10.4
58	58.0	02.0	118	117.9	04.1	178	177.9	06.2	238	237.9	08.3	298	297.8	10.4
59	59.0	02.1	119	118.9	04.2	179	178.9	06.2	239	238.9	08.3	299	298.8	10.4
60	60.0	02.1	120	119.9	04.2	180	179.9	06.3	240	239.9	08.4	300	299.8	10.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 88 Degrees. 5h 52m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 3 DEGREES. 0h 12m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	03.2	121	120.8	06.3	181	180.8	09.5	241	240.7	12.6
2	02.0	00.1	62	61.9	03.2	122	121.8	06.4	182	181.8	09.5	242	241.7	12.7
3	03.0	00.2	63	62.9	03.3	123	122.8	06.4	183	182.7	09.6	243	242.7	12.7
4	04.0	00.2	64	63.9	03.3	124	123.8	06.5	184	183.7	09.6	244	243.7	12.8
5	05.0	00.3	65	64.9	03.4	125	124.8	06.5	185	184.7	09.7	245	244.7	12.8
6	06.0	00.3	66	65.9	03.5	126	125.8	06.6	186	185.7	09.7	246	245.7	12.9
7	07.0	00.4	67	66.9	03.5	127	126.8	06.6	187	186.7	09.8	247	246.7	12.9
8	08.0	00.4	68	67.9	03.6	128	127.8	06.7	188	187.7	09.8	248	247.7	13.0
9	09.0	00.5	69	68.9	03.6	129	128.8	06.8	189	188.7	09.9	249	248.7	13.0
10	10.0	00.5	70	69.9	03.7	130	129.8	06.8	190	189.7	09.9	250	249.7	13.1
11	11.0	00.6	71	70.9	03.7	131	130.8	06.9	191	190.7	10.0	251	250.7	13.1
12	12.0	00.6	72	71.9	03.8	132	131.8	06.9	192	191.7	10.0	252	251.7	13.2
13	13.0	00.7	73	72.9	03.8	133	132.8	07.0	193	192.7	10.1	253	252.7	13.2
14	14.0	00.7	74	73.9	03.9	134	133.8	07.0	194	193.7	10.2	254	253.7	13.3
15	15.0	00.8	75	74.9	03.9	135	134.8	07.1	195	194.7	10.2	255	254.7	13.3
16	16.0	00.8	76	75.9	04.0	136	135.8	07.1	196	195.7	10.3	256	255.6	13.4
17	17.0	00.9	77	76.9	04.0	137	136.8	07.2	197	196.7	10.3	257	256.6	13.5
18	18.0	00.9	78	77.9	04.1	138	137.8	07.2	198	197.7	10.4	258	257.6	13.5
19	19.0	01.0	79	78.9	04.1	139	138.8	07.3	199	198.7	10.4	259	258.6	13.6
20	20.0	01.0	80	79.9	04.2	140	139.8	07.3	200	199.7	10.5	260	259.6	13.6
21	21.0	01.1	81	80.9	04.2	141	140.8	07.4	201	200.7	10.5	261	260.6	13.7
22	22.0	01.2	82	81.9	04.3	142	141.8	07.4	202	201.7	10.6	262	261.6	13.7
23	23.0	01.2	83	82.9	04.3	143	142.8	07.5	203	202.7	10.6	263	262.6	13.8
24	24.0	01.3	84	83.9	04.4	144	143.8	07.5	204	203.7	10.7	264	263.6	13.8
25	25.0	01.3	85	84.9	04.4	145	144.8	07.6	205	204.7	10.7	265	264.6	13.9
26	26.0	01.4	86	85.9	04.5	146	145.8	07.6	206	205.7	10.8	266	265.6	13.9
27	27.0	01.4	87	86.9	04.6	147	146.8	07.7	207	206.7	10.8	267	266.6	14.0
28	28.0	01.5	88	87.9	04.6	148	147.8	07.7	208	207.7	10.9	268	267.6	14.0
29	29.0	01.5	89	88.9	04.7	149	148.8	07.8	209	208.7	10.9	269	268.6	14.1
30	30.0	01.6	90	89.9	04.7	150	149.8	07.9	210	209.7	11.0	270	269.6	14.1
31	31.0	01.6	91	90.9	04.8	151	150.8	07.9	211	210.7	11.0	271	270.6	14.2
32	32.0	01.7	92	91.9	04.8	152	151.8	08.0	212	211.7	11.1	272	271.6	14.2
33	33.0	01.7	93	92.9	04.9	153	152.8	08.0	213	212.7	11.1	273	272.6	14.3
34	34.0	01.8	94	93.9	04.9	154	153.8	08.1	214	213.7	11.2	274	273.6	14.3
35	35.0	01.8	95	94.9	05.0	155	154.8	08.1	215	214.7	11.3	275	274.6	14.4
36	36.0	01.9	96	95.9	05.0	156	155.8	08.2	216	215.7	11.3	276	275.6	14.4
37	36.9	01.9	97	96.9	05.1	157	156.8	08.2	217	216.7	11.4	277	276.6	14.5
38	37.9	02.0	98	97.9	05.1	158	157.8	08.3	218	217.7	11.4	278	277.6	14.5
39	38.9	02.0	99	98.9	05.2	159	158.8	08.3	219	218.7	11.5	279	278.6	14.6
40	39.9	02.1	100	99.9	05.2	160	159.8	08.4	220	219.7	11.5	280	279.6	14.7
41	40.9	02.1	101	100.9	05.3	161	160.8	08.4	221	220.7	11.6	281	280.6	14.7
42	41.9	02.2	102	101.9	05.3	162	161.8	08.5	222	221.7	11.6	282	281.6	14.8
43	42.9	02.3	103	102.9	05.4	163	162.8	08.5	223	222.7	11.7	283	282.6	14.8
44	43.9	02.3	104	103.9	05.4	164	163.8	08.6	224	223.7	11.7	284	283.6	14.9
45	44.9	02.4	105	104.9	05.5	165	164.8	08.6	225	224.7	11.8	285	284.6	14.9
46	45.9	02.4	106	105.9	05.5	166	165.8	08.7	226	225.7	11.8	286	285.6	15.0
47	46.9	02.5	107	106.9	05.6	167	166.8	08.7	227	226.7	11.9	287	286.6	15.0
48	47.9	02.5	108	107.9	05.7	168	167.8	08.8	228	227.7	11.9	288	287.6	15.1
49	48.9	02.6	109	108.9	05.7	169	168.8	08.8	229	228.7	12.0	289	288.6	15.1
50	49.9	02.6	110	109.8	05.8	170	169.8	08.9	230	229.7	12.0	290	289.6	15.2
51	50.9	02.7	111	110.8	05.8	171	170.8	08.9	231	230.7	12.1	291	290.6	15.2
52	51.9	02.7	112	111.8	05.9	172	171.8	09.0	232	231.7	12.1	292	291.6	15.3
53	52.9	02.8	113	112.8	05.9	173	172.8	09.1	233	232.7	12.2	293	292.6	15.3
54	53.9	02.8	114	113.8	06.0	174	173.8	09.1	234	233.7	12.2	294	293.6	15.4
55	54.9	02.9	115	114.8	06.0	175	174.8	09.2	235	234.7	12.3	295	294.6	15.4
56	55.9	02.9	116	115.8	06.1	176	175.8	09.2	236	235.7	12.4	296	295.6	15.5
57	56.9	03.0	117	116.8	06.1	177	176.8	09.3	237	236.7	12.4	297	296.6	15.5
58	57.9	03.0	118	117.8	06.2	178	177.8	09.3	238	237.7	12.5	298	297.6	15.6
59	58.9	03.1	119	118.8	06.2	179	178.8	09.4	239	238.7	12.5	299	298.6	15.6
60	59.9	03.1	120	119.8	06.3	180	179.8	09.4	240	239.7	12.6	300	299.6	15.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 4 DEGREES. $0^h\ 16^m$

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.9	04.3	121	120.7	08.4	181	180.6	12.6	241	240.4	16.8
2	02.0	00.1	62	61.8	04.3	122	121.7	08.5	182	181.6	12.7	242	241.4	16.9
3	03.0	00.2	63	62.8	04.4	123	122.7	08.6	183	182.6	12.8	243	242.4	17.0
4	04.0	00.3	64	63.8	04.5	124	123.7	08.6	184	183.6	12.8	244	243.4	17.0
5	05.0	00.3	65	64.8	04.5	125	124.7	08.7	185	184.5	12.9	245	244.4	17.1
6	06.0	00.4	66	65.8	04.6	126	125.7	08.8	186	185.5	13.0	246	245.4	17.2
7	07.0	00.5	67	66.8	04.7	127	126.7	08.9	187	186.5	13.0	247	246.4	17.2
8	08.0	00.6	68	67.8	04.7	128	127.7	08.9	188	187.5	13.1	248	247.4	17.3
9	09.0	00.6	69	68.8	04.8	129	128.7	09.0	189	188.5	13.2	249	248.4	17.4
10	10.0	00.7	70	69.8	04.9	130	129.7	09.1	190	189.5	13.3	250	249.4	17.4
11	11.0	00.8	71	70.8	05.0	131	130.7	09.1	191	190.5	13.3	251	250.4	17.5
12	12.0	00.8	72	71.8	05.0	132	131.7	09.2	192	191.5	13.4	252	251.4	17.6
13	13.0	00.9	73	72.8	05.1	133	132.7	09.3	193	192.5	13.5	253	252.4	17.6
14	14.0	01.0	74	73.8	05.2	134	133.7	09.3	194	193.5	13.5	254	253.4	17.7
15	15.0	01.0	75	74.8	05.2	135	134.7	09.4	195	194.5	13.6	255	254.4	17.8
16	16.0	01.1	76	75.8	05.3	136	135.7	09.5	196	195.5	13.7	256	255.4	17.9
17	17.0	01.2	77	76.8	05.4	137	136.7	09.6	197	196.5	13.7	257	256.4	17.9
18	18.0	01.3	78	77.8	05.4	138	137.7	09.6	198	197.5	13.8	258	257.4	18.0
19	19.0	01.3	79	78.8	05.5	139	138.7	09.7	199	198.5	13.9	259	258.4	18.1
20	20.0	01.4	80	79.8	05.6	140	139.7	09.8	200	199.5	14.0	260	259.4	18.1
21	20.9	01.5	81	80.8	05.7	141	140.7	09.8	201	200.5	14.0	261	260.4	18.2
22	21.9	01.5	82	81.8	05.7	142	141.7	09.9	202	201.5	14.1	262	261.4	18.3
23	22.9	01.6	83	82.8	05.8	143	142.7	10.0	203	202.5	14.2	263	262.4	18.3
24	23.9	01.7	84	83.8	05.9	144	143.6	10.0	204	203.5	14.2	264	263.4	18.4
25	24.9	01.7	85	84.8	05.9	145	144.6	10.1	205	204.5	14.3	265	264.4	18.5
26	25.9	01.8	86	85.8	06.0	146	145.6	10.2	206	205.5	14.4	266	265.4	18.6
27	26.9	01.9	87	86.8	06.1	147	146.6	10.3	207	206.5	14.4	267	266.3	18.6
28	27.9	02.0	88	87.8	06.1	148	147.6	10.3	208	207.5	14.5	268	267.3	18.7
29	28.9	02.0	89	88.8	06.2	149	148.6	10.4	209	208.5	14.6	269	268.3	18.8
30	29.9	02.1	90	89.8	06.3	150	149.6	10.5	210	209.5	14.6	270	269.3	18.8
31	30.9	02.2	91	90.8	06.3	151	150.6	10.5	211	210.5	14.7	271	270.3	18.9
32	31.9	02.2	92	91.8	06.4	152	151.6	10.6	212	211.5	14.8	272	271.3	19.0
33	32.9	02.3	93	92.8	06.5	153	152.6	10.7	213	212.5	14.9	273	272.3	19.0
34	33.9	02.4	94	93.8	06.6	154	153.6	10.7	214	213.5	14.9	274	273.3	19.1
35	34.9	02.4	95	94.8	06.6	155	154.6	10.8	215	214.5	15.0	275	274.3	19.2
36	35.9	02.5	96	95.8	06.7	156	155.6	10.9	216	215.5	15.1	276	275.3	19.3
37	36.9	02.6	97	96.8	06.8	157	156.6	11.0	217	216.5	15.1	277	276.3	19.3
38	37.9	02.7	98	97.8	06.8	158	157.6	11.0	218	217.5	15.2	278	277.3	19.4
39	38.9	02.7	99	98.8	06.9	159	158.6	11.1	219	218.5	15.3	279	278.3	19.5
40	39.9	02.8	100	99.8	07.0	160	159.6	11.2	220	219.5	15.3	280	279.3	19.5
41	40.9	02.9	101	100.8	07.0	161	160.6	11.2	221	220.5	15.4	281	280.3	19.6
42	41.9	02.9	102	101.8	07.1	162	161.6	11.3	222	221.5	15.5	282	281.3	19.7
43	42.9	03.0	103	102.7	07.2	163	162.6	11.4	223	222.5	15.6	283	282.3	19.7
44	43.9	03.1	104	103.7	07.3	164	163.6	11.4	224	223.5	15.6	284	283.3	19.8
45	44.9	03.1	105	104.7	07.3	165	164.6	11.5	225	224.5	15.7	285	284.3	19.9
46	45.9	03.2	106	105.7	07.4	166	165.6	11.6	226	225.4	15.8	286	285.3	20.0
47	46.9	03.3	107	106.7	07.5	167	166.6	11.6	227	226.4	15.8	287	286.3	20.0
48	47.9	03.3	108	107.7	07.5	168	167.6	11.7	228	227.4	15.9	288	287.3	20.1
49	48.9	03.4	109	108.7	07.6	169	168.6	11.8	229	228.4	16.0	289	288.3	20.2
50	49.9	03.5	110	109.7	07.7	170	169.6	11.9	230	229.4	16.0	290	289.3	20.2
51	50.9	03.6	111	110.7	07.7	171	170.6	11.9	231	230.4	16.1	291	290.3	20.3
52	51.9	03.6	112	111.7	07.8	172	171.6	12.0	232	231.4	16.2	292	291.3	20.4
53	52.9	03.7	113	112.7	07.9	173	172.6	12.1	233	232.4	16.3	293	292.3	20.4
54	53.9	03.8	114	113.7	08.0	174	173.6	12.1	234	233.4	16.3	294	293.3	20.5
55	54.9	03.8	115	114.7	08.0	175	174.6	12.2	235	234.4	16.4	295	294.3	20.6
56	55.9	03.9	116	115.7	08.1	176	175.6	12.3	236	235.4	16.5	296	295.3	20.6
57	56.9	04.0	117	116.7	08.2	177	176.6	12.3	237	236.4	16.5	297	296.3	20.7
58	57.9	04.0	118	117.7	08.2	178	177.6	12.4	238	237.4	16.6	298	297.3	20.8
59	58.9	04.1	119	118.7	08.3	179	178.6	12.5	239	238.4	16.7	299	298.3	20.9
60	59.9	04.2	120	119.7	08.4	180	179.6	12.6	240	239.4	16.7	300	299.3	20.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 86 Degrees. $5^h\ 44^m$.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 5 DEGREES. $0^h\ 20^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.8	05.3	121	120.5	10.5	181	180.3	15.8	241	240.1	21.0
2	02.0	00.2	62	61.8	05.4	122	121.5	10.6	182	181.3	15.9	242	241.1	21.1
3	03.0	00.3	63	62.8	05.5	123	122.5	10.7	183	182.3	15.9	243	242.1	21.2
4	04.0	00.3	64	63.8	05.6	124	123.5	10.8	184	183.3	16.0	244	243.1	21.3
5	05.0	00.4	65	64.8	05.7	125	124.5	10.9	185	184.3	16.1	245	244.1	21.4
6	06.0	00.5	66	65.7	05.8	126	125.5	11.0	186	185.3	16.2	246	245.1	21.4
7	07.0	00.6	67	66.7	05.8	127	126.5	11.1	187	186.3	16.3	247	246.1	21.5
8	08.0	00.7	68	67.7	05.9	128	127.5	11.2	188	187.3	16.4	248	247.1	21.6
9	09.0	00.8	69	68.7	06.0	129	128.5	11.2	189	188.3	16.5	249	248.1	21.7
10	10.0	00.9	70	69.7	06.1	130	129.5	11.3	190	189.3	16.6	250	249.0	21.8
11	11.0	01.0	71	70.7	06.2	131	130.5	11.4	191	190.3	16.6	251	250.0	21.9
12	12.0	01.0	72	71.7	06.3	132	131.5	11.5	192	191.3	16.7	252	251.0	22.0
13	13.0	01.1	73	72.7	06.4	133	132.5	11.6	193	192.3	16.8	253	252.0	22.1
14	13.9	01.2	74	73.7	06.4	134	133.5	11.7	194	193.3	16.9	254	253.0	22.1
15	14.9	01.3	75	74.7	06.5	135	134.5	11.8	195	194.3	17.0	255	254.0	22.2
16	15.9	01.4	76	75.7	06.6	136	135.5	11.9	196	195.3	17.1	256	255.0	22.3
17	16.9	01.5	77	76.7	06.7	137	136.5	11.9	197	196.3	17.2	257	256.0	22.4
18	17.9	01.6	78	77.7	06.8	138	137.5	12.0	198	197.2	17.3	258	257.0	22.5
19	18.9	01.7	79	78.7	06.9	139	138.5	12.1	199	198.2	17.3	259	258.0	22.6
20	19.9	01.7	80	79.7	07.0	140	139.5	12.2	200	199.2	17.4	260	259.0	22.7
21	20.9	01.8	81	80.7	07.1	141	140.5	12.3	201	200.2	17.5	261	260.0	22.7
22	21.9	01.9	82	81.7	07.1	142	141.5	12.4	202	201.2	17.6	262	261.0	22.8
23	22.9	02.0	83	82.7	07.2	143	142.5	12.5	203	202.2	17.7	263	262.0	22.9
24	23.9	02.1	84	83.7	07.3	144	143.5	12.6	204	203.2	17.8	264	263.0	23.0
25	24.9	02.2	85	84.7	07.4	145	144.4	12.6	205	204.2	17.9	265	264.0	23.1
26	25.9	02.3	86	85.7	07.5	146	145.4	12.7	206	205.2	18.0	266	265.0	23.2
27	26.9	02.4	87	86.7	07.6	147	146.4	12.8	207	206.2	18.0	267	266.0	23.3
28	27.9	02.4	88	87.7	07.7	148	147.4	12.9	208	207.2	18.1	268	267.0	23.4
29	28.9	02.5	89	88.7	07.8	149	148.4	13.0	209	208.2	18.2	269	268.0	23.4
30	29.9	02.6	90	89.7	07.8	150	149.4	13.1	210	209.2	18.3	270	269.0	23.5
31	30.9	02.7	91	90.7	07.9	151	150.4	13.2	211	210.2	18.4	271	270.0	23.6
32	31.9	02.8	92	91.6	08.0	152	151.4	13.2	212	211.2	18.5	272	271.0	23.7
33	32.9	02.9	93	92.6	08.1	153	152.4	13.3	213	212.2	18.6	273	272.0	23.8
34	33.9	03.0	94	93.6	08.2	154	153.4	13.4	214	213.2	18.7	274	273.0	23.9
35	34.9	03.1	95	94.6	08.3	155	154.4	13.5	215	214.2	18.7	275	274.0	24.0
36	35.9	03.1	96	95.6	08.4	156	155.4	13.6	216	215.2	18.8	276	274.9	24.1
37	36.9	03.2	97	96.6	08.5	157	156.4	13.7	217	216.2	18.9	277	275.9	24.1
38	37.9	03.3	98	97.6	08.5	158	157.4	13.8	218	217.2	19.0	278	276.9	24.2
39	38.9	03.4	99	98.6	08.6	159	158.4	13.9	219	218.2	19.1	279	277.9	24.3
40	39.8	03.5	100	99.6	08.7	160	159.4	13.9	220	219.2	19.2	280	278.9	24.4
41	40.8	03.6	101	100.6	08.8	161	160.4	14.0	221	220.2	19.3	281	279.9	24.5
42	41.8	03.7	102	101.6	08.9	162	161.4	14.1	222	221.2	19.3	282	280.9	24.6
43	42.8	03.7	103	102.6	09.0	163	162.4	14.2	223	222.2	19.4	283	281.9	24.7
44	43.8	03.8	104	103.6	09.1	164	163.4	14.3	224	223.1	19.5	284	282.9	24.8
45	44.8	03.9	105	104.6	09.2	165	164.4	14.4	225	224.1	19.6	285	283.9	24.8
46	45.8	04.0	106	105.6	09.2	166	165.4	14.5	226	225.1	19.7	286	284.9	24.9
47	46.8	04.1	107	106.6	09.3	167	166.4	14.6	227	226.1	19.8	287	285.9	25.0
48	47.8	04.2	108	107.6	09.4	168	167.4	14.6	228	227.1	19.9	288	286.9	25.1
49	48.8	04.3	109	108.6	09.5	169	168.4	14.7	229	228.1	20.0	289	287.9	25.2
50	49.8	04.4	110	109.6	09.6	170	169.4	14.8	230	229.1	20.0	290	288.9	25.3
51	50.8	04.4	111	110.6	09.7	171	170.3	14.9	231	230.1	20.1	291	289.9	25.4
52	51.8	04.5	112	111.6	09.8	172	171.3	15.0	232	231.1	20.2	292	290.9	25.4
53	52.8	04.6	113	112.6	09.8	173	172.3	15.1	233	232.1	20.3	293	291.9	25.5
54	53.8	04.7	114	113.6	09.9	174	173.3	15.2	234	233.1	20.4	294	292.9	25.6
55	54.8	04.8	115	114.6	10.0	175	174.3	15.3	235	234.1	20.5	295	293.9	25.7
56	55.8	04.9	116	115.6	10.1	176	175.3	15.3	236	235.1	20.6	296	294.9	25.8
57	56.8	05.0	117	116.6	10.2	177	176.3	15.4	237	236.1	20.7	297	295.9	25.9
58	57.8	05.1	118	117.6	10.3	178	177.3	15.5	238	237.1	20.7	298	296.9	26.0
59	58.8	05.1	119	118.5	10.4	179	178.3	15.6	239	238.1	20.8	299	297.9	26.1
60	59.8	05.2	120	119.5	10.5	180	179.3	15.7	240	239.1	20.9	300	298.9	26.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 85 Degrees. $5^h\ 40^m$.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 6 DEGREES. 0h 24m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.7	06.4	121	120.3	12.6	181	180.0	18.9	241	239.7	25.2
2	02.0	00.2	62	61.7	06.5	122	121.3	12.8	182	181.0	19.0	242	240.7	25.3
3	03.0	00.3	63	62.7	06.6	123	122.3	12.9	183	182.0	19.1	243	241.7	25.4
4	04.0	00.4	64	63.6	06.7	124	123.3	13.0	184	183.0	19.2	244	242.7	25.5
5	05.0	00.5	65	64.6	06.8	125	124.3	13.1	185	184.0	19.3	245	243.7	25.6
6	06.0	00.6	66	65.6	06.9	126	125.3	13.2	186	185.0	19.4	246	244.7	25.7
7	07.0	00.7	67	66.6	07.0	127	126.3	13.3	187	186.0	19.5	247	245.6	25.8
8	08.0	00.8	68	67.6	07.1	128	127.3	13.4	188	187.0	19.7	248	246.6	25.9
9	09.0	00.9	69	68.6	07.2	129	128.3	13.5	189	188.0	19.8	249	247.6	26.0
10	09.9	01.0	70	69.6	07.3	130	129.3	13.6	190	189.0	19.9	250	248.6	26.1
11	10.9	01.1	71	70.6	07.4	131	130.3	13.7	191	190.0	20.0	251	249.6	26.2
12	11.9	01.3	72	71.6	07.5	132	131.3	13.8	192	190.9	20.1	252	250.6	26.3
13	12.9	01.4	73	72.6	07.6	133	132.3	13.9	193	191.9	20.2	253	251.6	26.4
14	13.9	01.5	74	73.6	07.7	134	133.3	14.0	194	192.9	20.3	254	252.6	26.6
15	14.9	01.6	75	74.6	07.8	135	134.3	14.1	195	193.9	20.4	255	253.6	26.7
16	15.9	01.7	76	75.6	07.9	136	135.3	14.2	196	194.9	20.5	256	254.6	26.8
17	16.9	01.8	77	76.6	08.0	137	136.2	14.3	197	195.9	20.6	257	255.6	26.9
18	17.9	01.9	78	77.6	08.2	138	137.2	14.4	198	196.9	20.7	258	256.6	27.0
19	18.9	02.0	79	78.6	08.3	139	138.2	14.5	199	197.9	20.8	259	257.6	27.1
20	19.9	02.1	80	79.6	08.4	140	139.2	14.6	200	198.9	20.9	260	258.6	27.2
21	20.9	02.2	81	80.6	08.5	141	140.2	14.7	201	199.9	21.0	261	259.6	27.3
22	21.9	02.3	82	81.6	08.6	142	141.2	14.8	202	200.9	21.1	262	260.6	27.4
23	22.9	02.4	83	82.5	08.7	143	142.2	14.9	203	201.9	21.2	263	261.6	27.5
24	23.9	02.5	84	83.5	08.8	144	143.2	15.1	204	202.9	21.3	264	262.6	27.6
25	24.9	02.6	85	84.5	08.9	145	144.2	15.2	205	203.9	21.4	265	263.5	27.7
26	25.9	02.7	86	85.5	09.0	146	145.2	15,3	206	204.9	21.5	266	264.5	27.8
27	26.9	02.8	87	86.5	09.1	147	146.2	15.4	207	205.9	21.6	267	265.5	27.9
28	27.8	02.9	88	87.5	09.2	148	147.2	15.5	208	206.9	21.7	268	266.5	28.0
29	28.8	03.0	89	88.5	09.3	149	148.2	15.6	209	207.9	21.8	269	267.5	28,1
30	29.8	03.1	90	89.5	09.4	150	149.2	15.7	210	208.8	22.0	270	268.5	28.2
31	30.8	03.2	91	90.5	09.5	151	150.2	15.8	211	209.8	22.1	271	269.5	28.3
32	31.8	03.3	92	91.5	09.6	152	151.2	15.9	212	210.8	22.2	272	270.5	28.4
33	32.8	03.4	93	92.5	09.7	153	152.2	16.0	213	211.8	22.3	273	271.5	28.5
34	33.8	03.6	94	93.5	09.8	154	153.2	16.1	214	212.8	22.4	274	272.5	28.6
35	34.8	03.7	95	94.5	09.9	155	154.2	16.2	215	213.8	22.5	275	273.5	28.7
36	35.8	03.8	96	95.5	10.0	156	155.1	16.3	216	214.8	22.6	276	274.5	28.8
37	36.8	03.9	97	96.5	10.1	157	156.1	16.4	217	215.8	22.7	277	275.5	29.0
38	37.8	04.0	98	97.5	10.2	158	157.1	16.5	218	216.8	22.8	278	276.5	29.1
39	38.8	04.1	99	98.5	10.3	159	158.1	16.6	219	217.8	22.9	279	277.5	29.2
40	39.8	04.2	100	99.5	10.5	160	159.1	16.7	220	218.8	23.0	280	278.5	29.3
41	40.8	04.3	101	100.4	10.6	161	160.1	16.8	221	219.8	23.1	281	279.5	29.4
42	41.8	04.4	102	101.4	10.7	162	161.1	16.9	222	220.8	23.2	282	280.5	29.5
43	42.8	04.5	103	102.4	10.8	163	162.1	17.0	223	221.8	23.3	283	281.4	29.6
44	43.8	04.6	104	103.4	10.9	164	163.1	17.1	224	222.8	23.4	284	282.4	29.7
45	44.8	04.7	105	104.4	11.0	165	164.1	17.2	225	223.8	23.5	285	283.4	29.8
46	45.7	04.8	106	105.4	11.1	166	165.1	17.4	226	224.8	23.6	286	284.4	29.9
47	46.7	04.9	107	106.4	11.2	167	166.1	17.5	227	225.8	23.7	287	285.4	30.0
48	47.7	05.0	108	107.4	11.3	168	167.1	17.6	228	226.8	23.8	288	286.4	30.1
49	48.7	05.1	109	108.4	11.4	169	168.1	17.7	229	227.8	23.9	289	287.4	30.2
50	49.7	05.2	110	109.4	11.5	170	169.1	17.8	230	228.7	24.0	290	288.4	30.3
51	50.7	05.3	111	110.4	11.6	171	170.1	17.9	231	229.7	24.1	291	289.4	30.4
52	51.7	05.4	112	111.4	11.7	172	171.1	18.0	232	230.7	24.3	292	290.4	30.5
53	52.7	05.5	113	112.4	11.8	173	172.1	18.1	233	231.7	24.4	293	291.4	30.6
54	53.7	05.6	114	113.4	11.9	174	173.0	18.2	234	232.7	24.5	294	292.4	30.7
55	54.7	05.7	115	114.4	12.0	175	174.0	18.3	235	233.7	24.6	295	293.4	30.8
56	55.7	05.9	116	115.4	12.1	176	175.0	18.4	236	234.7	24.7	296	294.4	30.9
57	56.7	06.0	117	116.4	12.2	177	176.0	18.5	237	235.7	24.8	297	295.4	31.0
58	57.7	06.1	118	117.4	12.3	178	177.0	18.6	238	236.7	24.9	298	296.4	31.1
59	58.7	06.2	119	118.3	12.4	179	178.0	18.7	239	237.7	25.0	299	297.4	31.3
60	59.7	06.3	120	119.3	12.5	180	179.0	18.8	240	238.7	25.1	300	298.4	31.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 7 DEGREES. 0h 28m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.5	07.4	121	120.1	14.7	181	179.7	22.1	241	239.2	29.4
2	02.0	00.2	62	61.5	07.6	122	121.1	14.9	182	180.6	22.2	242	240.2	29.5
3	03.0	00.4	63	62.5	07.7	123	122.1	15.0	183	181.6	22.3	243	241.2	29.6
4	04.0	00.5	64	63.5	07.8	124	123.1	15.1	184	182.6	22.4	244	242.2	29.7
5	05.0	00.6	65	64.5	07.9	125	124.1	15.2	185	183.6	22.5	245	243.2	29.9
6	06.0	00.7	66	65.5	08.0	126	125.1	15.4	186	184.6	22.7	246	244.2	30.0
7	06.9	00.9	67	66.5	08.2	127	126.1	15.5	187	185.6	22.8	247	245.2	30.1
8	07.9	01.0	68	67.5	08.3	128	127.0	15.6	188	186.6	22.9	248	246.2	30.2
9	08.9	01.1	69	68.5	08.4	129	128.0	15.7	189	187.6	23.0	249	247.1	30.3
10	09.9	01.2	70	69.5	08.5	130	129.0	15.8	190	188.6	23.2	250	248.1	30.5
11	10.9	01.3	71	70.5	08.7	131	130.0	16.0	191	189.6	23.3	251	249.1	30.6
12	11.9	01.5	72	71.5	08.8	132	131.0	16.1	192	190.6	23.4	252	250.1	30.7
13	12.9	01.6	73	72.5	08.9	133	132.0	16.2	193	191.6	23.5	253	251.1	30.8
14	13.9	01.7	74	73.4	09.0	134	133.0	16.3	194	192.6	23.6	254	252.1	31.0
15	14.9	01.8	75	74.4	09.1	135	134.0	16.5	195	193.5	23.8	255	253.1	31.1
16	15.9	01.9	76	75.4	09.3	136	135.0	16.6	196	194.5	23.9	256	254.1	31.2
17	16.9	02.1	77	76.4	09.4	137	136.0	16.7	197	195.5	24.0	257	255.1	31.3
18	17.9	02.2	78	77.4	09.5	138	137.0	16.8	198	196.5	24.1	258	256.1	31.4
19	18.9	02.3	79	78.4	09.6	139	138.0	16.9	199	197.5	24.3	259	257.1	31.6
20	19.9	02.4	80	79.4	09.7	140	139.0	17.1	200	198.5	24.4	260	258.1	31.7
21	20.8	02.6	81	80.4	09.9	141	139.9	17.2	201	199.5	24.5	261	259.1	31.8
22	21.8	02.7	82	81.4	10.0	142	140.9	17.3	202	200.5	24.6	262	260.0	31.9
23	22.8	02.8	83	82.4	10.1	143	141.9	17.4	203	201.5	24.7	263	261.0	32.1
24	23.8	02.9	84	83.4	10.2	144	142.9	17.5	204	202.5	24.9	264	262.0	32.2
25	24.8	03.0	85	84.4	10.4	145	143.9	17.7	205	203.5	25.0	265	263.0	32.3
26	25.8	03.2	86	85.4	10.5	146	144.9	17.8	206	204.5	25.1	266	264.0	32.4
27	26.8	03.3	87	86.4	10.6	147	145.9	17.9	207	205.5	25.2	267	265.0	32.5
28	27.8	03.4	88	87.3	10.7	148	146.9	18.0	208	206.4	25.3	268	266.0	32.7
29	28.8	03.5	89	88.3	10.8	149	147.9	18.2	209	207.4	25.5	269	267.0	32.8
30	29.8	03.7	90	89.3	11.0	150	148.9	18.3	210	208.4	25.6	270	268.0	32.9
31	30.8	03.8	91	90.3	11.1	151	149.9	18.4	211	209.4	25.7	271	269.0	33.0
32	31.8	03.9	92	91.3	11.2	152	150.9	18.5	212	210.4	25.8	272	270.0	33.1
33	32.8	04.0	93	92.3	11.3	153	151.9	18.6	213	211.4	26.0	273	271.0	33.3
34	33.7	04.1	94	93.3	11.5	154	152.9	18.8	214	212.4	26.1	274	272.0	33.4
35	34.7	04.3	95	94.3	11.6	155	153.8	18.9	215	213.4	26.2	275	273.0	33.5
36	35.7	04.4	96	95.3	11.7	156	154.8	19.0	216	214.4	26.3	276	273.9	33.6
37	36.7	04.5	97	96.3	11.8	157	155.8	19.1	217	215.4	26.4	277	274.9	33.8
38	37.7	04.6	98	97.3	11.9	158	156.8	19.3	218	216.4	26.6	278	275.9	33.9
39	38.7	04.8	99	98.3	12.1	159	157.8	19.4	219	217.4	26.7	279	276.9	34.0
40	39.7	04.9	100	99.3	12.2	160	158.8	19.5	220	218.4	26.8	280	277.9	34.1
41	40.7	05.0	101	100.2	12.3	161	159.8	19.6	221	219.4	26.9	281	278.9	34.2
42	41.7	05.1	102	101.2	12.4	162	160.8	19.7	222	220.3	27.1	282	279.9	34.4
43	42.7	05.2	103	102.2	12.6	163	161.8	19.9	223	221.3	27.2	283	280.9	34.5
44	43.7	05.4	104	103.2	12.7	164	162.8	20.0	224	222.3	27.3	284	281.9	34.6
45	44.7	05.5	105	104.2	12.8	165	163.8	20.1	225	223.3	27.4	285	282.9	34.7
46	45.7	05.6	106	105.2	12.9	166	164.8	20.2	226	224.3	27.5	286	283.9	34.9
47	46.6	05.7	107	106.2	13.0	167	165.8	20.4	227	225.3	27.7	287	284.9	35.0
48	47.6	05.8	108	107.2	13.2	168	166.7	20.5	228	226.3	27.8	288	285.9	35.1
49	48.6	06.0	109	108.2	13.3	169	167.7	20.6	229	227.3	27.9	289	286.8	35.2
50	49.6	06.1	110	109.2	13.4	170	168.7	20.7	230	228.3	28.0	290	287.8	35.3
51	50.6	06.2	111	110.2	13.5	171	159.7	20.8	231	229.3	28.2	291	288.8	35.5
52	51.6	06.3	112	111.2	13.6	172	170.7	21.0	232	230.3	28.3	292	289.8	35.6
53	52.6	06.5	113	112.2	13.8	173	171.7	21.1	233	231.3	28.4	293	290.8	35.7
54	53.6	06.6	114	113.2	13.9	174	172.7	21.2	234	232.3	28.5	294	291.8	35.8
55	54.6	06.7	115	114.1	14.0	175	173.7	21.3	235	233.2	28.6	295	292.8	36.0
56	55.6	06.8	116	115.1	14.1	176	174.7	21.4	236	234.2	28.8	296	293.8	36.1
57	56.6	06.9	117	116.1	14.3	177	175.7	21.6	237	235.2	28.9	297	294.8	36.2
58	57.6	07.1	118	117.1	14.4	178	176.7	21.7	238	236.2	29.0	298	295.8	36.3
59	58.6	07.2	119	118.1	14.5	179	177.7	21.8	239	237.2	29.1	299	296.8	36.4
60	59.6	07.3	120	119.1	14.6	180	178.7	21.9	240	238.2	29.2	300	297.8	36.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 8 DEGREES. $0^h\ 32^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.1	61	60.4	08.5	121	119.8	16.8	181	179.2	25.2	241	238.7	33.5
2	02.0	00.3	62	61.4	08.6	122	120.8	17.0	182	180.2	25.3	242	239.6	33.7
3	03.0	00.4	63	62.4	08.8	123	121.8	17.1	183	181.2	25.5	243	240.6	33.8
4	04.0	00.6	64	63.4	08.9	124	122.8	17.3	184	182.2	25.6	244	241.6	34.0
5	05.0	00.7	65	64.4	09.0	125	123.8	17.4	185	183.2	25.7	245	242.6	34.1
6	05.9	00.8	66	65.4	09.2	126	124.8	17.5	186	184.2	25.9	246	243.6	34.2
7	06.9	01.0	67	66.3	09.3	127	125.8	17.7	187	185.2	26.0	247	244.6	34.4
8	07.9	01.1	68	67.3	09.5	128	126.8	17.8	188	186.2	26.2	248	245.6	34.5
9	08.9	01.3	69	68.3	09.6	129	127.7	18.0	189	187.2	26.3	249	246.6	34.7
10	09.9	01.4	70	69.3	09.7	130	128.7	18.1	190	188.2	26.4	250	247.6	34.8
11	10.9	01.5	71	70.3	09.9	131	129.7	18.2	191	189.1	26.6	251	248.6	34.9
12	11.9	01.7	72	71.3	10.0	132	130.7	18.4	192	190.1	26.7	252	249.5	35.1
13	12.9	01.8	73	72.3	10.2	133	131.7	18.5	193	191.1	26.9	253	250.5	35.2
14	13.9	01.9	74	73.3	10.3	134	132.7	18.6	194	192.1	27.0	254	251.5	35.3
15	14.9	02.1	75	74.3	10.4	135	133.7	18.8	195	193.1	27.1	255	252.5	35.5
16	15.8	02.2	76	75.3	10.6	136	134.7	18.9	196	194.1	27.3	256	253.5	35.6
17	16.8	02.4	77	76.3	10.7	137	135.7	19.1	197	195.1	27.4	257	254.5	35.8
18	17.8	02.5	78	77.2	10.9	138	136.7	19.2	198	196.1	27.6	258	255.5	35.9
19	18.8	02.6	79	78.2	11.0	139	137.7	19.3	199	197.1	27.7	259	256.5	36.0
20	19.8	02.8	80	79.2	11.1	140	138.6	19.5	200	198.1	27.8	260	257.5	36.2
21	20.8	02.9	81	80.2	11.3	141	139.6	19.6	201	199.0	28.0	261	258.5	36.3
22	21.8	03.1	82	81.2	11.4	142	140.6	19.8	202	200.0	28.1	262	259.5	36.5
23	22.8	03.2	83	82.2	11.6	143	141.6	19.9	203	201.0	28.3	263	260.4	36.6
24	23.8	03.3	84	83.2	11.7	144	142.6	20.0	204	202.0	28.4	264	261.4	36.7
25	24.8	03.5	85	84.2	11.8	145	143.6	20.2	205	203.0	28.5	265	262.4	36.9
26	25.7	03.6	86	85.2	12.0	146	144.6	20.3	206	204.0	28.7	266	263.4	37.0
27	26.7	03.8	87	86.2	12.1	147	145.6	20.5	207	205.0	28.8	267	264.4	37.2
28	27.7	03.9	88	87.1	12.2	148	146.6	20.6	208	206.0	28.9	268	265.4	37.3
29	28.7	04.0	89	88.1	12.4	149	147.5	20.7	209	207.0	29.1	269	266.4	37.4
30	29.7	04.2	90	89.1	12.5	150	148.5	20.9	210	208.0	29.2	270	267.4	37.6
31	30.7	04.3	91	90.1	12.7	151	149.5	21.0	211	208.9	29.4	271	268.4	37.7
32	31.7	04.5	92	91.1	12.8	152	150.5	21.2	212	209.9	29.5	272	269.4	37.9
33	32.7	04.6	93	92.1	12.9	153	151.5	21.3	213	210.9	29.6	273	270.3	38.0
34	33.7	04.7	94	93.1	13.1	154	152.5	21.4	214	211.9	29.8	274	271.3	38.1
35	34.7	04.9	95	94.1	13.2	155	153.5	21.6	215	212.9	29.9	275	272.3	38.3
36	35.6	05.0	96	95.1	13.4	156	154.5	21.7	216	213.9	30.1	276	273.3	38.4
37	36.6	05.1	97	96.1	13.5	157	155.5	21.9	217	214.9	30.2	277	274.3	38.6
38	37.6	05.3	98	97.0	13.6	158	156.5	22.0	218	215.9	30.3	278	275.3	38.7
39	38.6	05.4	99	98.0	13.8	159	157.5	22.1	219	216.9	30.5	279	276.3	38.8
40	39.6	05.6	100	99.0	13.9	160	158.4	22.3	220	217.9	30.6	280	277.3	39.0
41	40.6	05.7	101	100.0	14.1	161	159.4	22.4	221	218.8	30.8	281	278.3	39.1
42	41.6	05.8	102	101.0	14.2	162	160.4	22.5	222	219.8	30.9	282	279.3	39.2
43	42.6	06.0	103	102.0	14.3	163	161.4	22.7	223	220.8	31.0	283	280.2	39.4
44	43.6	06.1	104	103.0	14.5	164	162.4	22.8	224	221.8	31.2	284	281.2	39.5
45	44.6	06.3	105	104.0	14.6	165	163.4	23.0	225	222.8	31.3	285	282.2	39.7
46	45.6	06.4	106	105.0	14.8	166	164.4	23.1	226	223.8	31.5	286	283.2	39.8
47	46.5	06.5	107	106.0	14.9	167	165.4	23.2	227	224.8	31.6	287	284.2	39.9
48	47.5	06.7	108	106.9	15.0	168	166.4	23.4	228	225.8	31.7	288	285.2	40.1
49	48.5	06.8	109	107.9	15.2	169	167.4	23.5	229	226.8	31.9	289	286.2	40.2
50	49.5	07.0	110	108.9	15.3	170	168.3	23.7	230	227.8	32.0	290	287.2	40.4
51	50.5	07.1	111	109.9	15.4	171	169.3	23.8	231	228.8	32.1	291	288.2	40.5
52	51.5	07.2	112	110.9	15.6	172	170.3	23.9	232	229.7	32.3	292	289.2	40.6
53	52.5	07.4	113	111.9	15.7	173	171.3	24.1	233	230.7	32.4	293	290.1	40.8
54	53.5	07.5	114	112.9	15.9	174	172.3	24.2	234	231.7	32.6	294	291.1	40.9
55	54.5	07.7	115	113.9	16.0	175	173.3	24.4	235	232.7	32.7	295	292.1	41.1
56	55.5	07.8	116	114.9	16.1	176	174.3	24.5	236	233.7	32.8	296	293.1	41.2
57	56.4	07.9	117	115.9	16.3	177	175.3	24.6	237	234.7	33.0	297	294.1	41.3
58	57.4	08.1	118	116.9	16.4	178	176.3	24.8	238	235.7	33.1	298	295.1	41.5
59	58.4	08.2	119	117.8	16.6	179	177.3	24.9	239	236.7	33.3	299	296.1	41.6
60	59.4	08.4	120	118.8	16.7	180	178.3	25.1	240	237.7	33.4	300	297.1	41.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 82 Degrees. $5^h\ 28^m$.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 9 DEGREES. 0h 36m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.2	09.5	121	119.5	18.9	181	178.8	28.3	241	238.0	37.7
2	02.0	00.3	62	61.2	09.7	122	120.5	19.1	182	179.8	28.5	242	239.0	37.9
3	03.0	00.5	63	62.2	09.9	123	121.5	19.2	183	180.7	28.6	243	240.0	38.0
4	04.0	00.6	64	63.2	10.0	124	122.5	19.4	184	181.7	28.8	244	241.0	38.2
5	04.9	00.8	65	64.2	10.2	125	123.5	19.6	185	182.7	28.9	245	242.0	38.3
6	05.9	00.9	66	65.2	10.3	126	124.4	19.7	186	183.7	39.1	246	243.0	38.5
7	06.9	01.1	67	66.2	10.5	127	125.4	19.9	187	184.7	29.3	247	244.0	38.6
8	07.9	01.3	68	67.2	10.6	128	126.4	20.0	188	185.7	29.4	248	244.9	38.8
9	08.9	01.4	69	68.2	10.8	129	127.4	20.2	189	186.7	29.6	249	245.9	39.0
10	09.9	01.6	70	69.1	11.0	130	128.4	20.3	190	187.7	29.7	250	246.9	39.1
11	10.9	01.7	71	70.1	11.1	131	129.4	20.5	191	188.6	29.9	251	247.9	39.3
12	11.9	01.9	72	71.1	11.3	132	130.4	20.6	192	189.6	30.0	252	248.9	39.4
13	12.8	02.0	73	72.1	11.4	133	131.4	20.8	193	190.6	30.2	253	249.9	39.6
14	13.8	02.2	74	73.1	11.6	134	132.4	21.0	194	191.6	30.3	254	250.9	39.7
15	14.8	02.3	75	74.1	11.7	135	133.3	21.1	195	192.6	30.5	255	251.9	39.9
16	15.8	02.5	76	75.1	11.9	136	134.3	21.3	196	193.6	30.7	256	252.8	40.0
17	16.8	02.7	77	76.1	12.0	137	135.3	21.4	197	194.6	30.8	257	253.8	40.2
18	17.8	02.8	78	77.0	12.2	138	136.3	21.6	198	195.6	31.0	258	254.8	40.4
19	18.8	03.0	79	78.0	12.4	139	137.3	21.7	199	196.5	31.1	259	255.8	40.5
20	19.8	03.1	80	79.0	12.5	140	138.3	21.9	200	197.5	31.3	260	256.8	40.7
21	20.7	03.3	81	80.0	12.7	141	139.3	22.1	201	198.5	31.4	261	257.8	40.8
22	21.7	03.4	82	81.0	12.8	142	140.3	22.2	202	199.5	31.6	262	258.8	41.0
23	22.7	03.6	83	82.0	13.0	143	141.2	22.4	203	200.5	31.8	263	259.8	41.1
24	23.7	03.8	84	83.0	13.1	144	142.2	22.5	204	201.5	31 9	264	260.7	41.3
25	24.7	03.9	85	84.0	13.3	145	143.2	22.7	205	202.5	32.1	265	261.7	41.5
26	25.7	04.1	86	84.9	13.5	146	144.2	22.8	206	203.5	32.2	266	262.7	41.6
27	26.7	04.2	87	85.9	13.6	147	145.2	23.0	207	204.5	32.4	267	263.7	41.8
28	27.7	04.4	88	86.9	13.8	148	146.2	23.2	208	205.4	32.5	268	264.7	41.9
29	28.6	04.5	89	87.9	13.9	149	147.2	23.3	209	206.4	32.7	269	265.7	42.1
30	29.6	04.7	90	88.9	14.1	150	148.2	23.5	210	207.4	32.9	270	266.7	42.2
31	30.6	04.8	91	89.9	14.2	151	149.1	23.6	211	208.4	33.0	271	267.7	42.4
32	31.6	05.0	92	90.9	14.4	152	150.1	23.8	212	209.4	33.2	272	268.7	42.6
33	32.6	05.2	93	91.9	14.5	153	151.1	23.9	213	210.4	33.3	273	269.6	42.7
34	33.6	05.3	94	92.8	14.7	154	152.1	24.1	214	211.4	33.5	274	270.6	42.9
35	34.6	05.5	95	93.8	14.9	155	153.1	24.2	215	212.4	33.6	275	271.6	43.0
36	35.6	05.6	96	94.8	15.0	156	154.1	24.4	216	213.3	33.8	276	272.6	43.2
37	36.5	05.8	97	95.8	15.2	157	155.1	24.6	217	214.3	33.9	277	273.6	43.3
38	37.5	05.9	98	96.8	15.3	158	156.1	24.7	218	215.3	34.1	278	274.6	43.5
39	38.5	06.1	99	97.8	15.5	159	157.0	24.9	219	216.3	34.3	279	275.6	43.6
40	39.5	06.3	100	98.8	15.6	160	158.0	25.0	220	217.3	34.4	280	276.6	43.8
41	40.5	06.4	101	99.8	15.8	161	159.0	25.2	221	218.3	34.6	281	277.5	44.0
42	41.5	06.6	102	100.7	16.0	162	160.0	25.3	222	219.3	34.7	282	278.5	44.1
43	42.5	06.7	103	101.7	16.1	163	161.0	25.5	223	220.3	34.9	283	279.5	44.3
44	43.5	06.9	104	102.7	16.3	164	162.0	25.7	224	221.2	35.0	284	280.5	44.4
45	44.4	07.0	105	103.7	16.4	165	163.0	25.8	225	222.2	35.2	285	281.5	44.6
46	45.4	07.2	106	104.7	16.6	166	164.0	26.0	226	223.2	35.4	286	282.5	44.7
47	46.4	07.4	107	105.7	16.7	167	164.9	26.1	227	224.2	35.5	287	283.5	44.9
48	47.4	07.5	108	106.7	16.9	168	165.9	26.3	228	225.2	35.7	288	284.5	45.1
49	48.4	07.7	109	107.7	17.1	169	166.9	26.4	229	226.2	35.8	289	285.4	45.2
50	49.4	07.8	110	108.6	17.2	170	167.9	26.6	230	227.2	36.0	290	286.4	45.4
51	50.4	08.0	111	109.6	17.4	171	168.9	26.8	231	228.2	36.1	291	287.4	45.5
52	51.4	08.1	112	110.6	17.5	172	169.9	26.9	232	229.1	36.3	292	288.4	45.7
53	52.3	08.3	113	111.6	17.7	173	170.9	27.1	233	230.1	36.4	293	289.4	45.8
54	53.3	08.4	114	112.6	17.8	174	171.9	27.2	234	231.1	36.6	294	290.4	46.0
55	54.3	08.6	115	113.6	18.0	175	172.8	27.4	235	232.1	36.8	295	291.4	46.1
56	55.3	08.8	116	114.6	18.1	176	173.8	27.5	236	233.1	36.9	296	292.4	46.3
57	56.3	08.9	117	115.6	18.3	177	174.8	27.7	237	234.1	37.1	297	293.3	46.5
58	57.3	09.1	118	116.5	18.5	178	175.8	27.8	238	235.1	37.2	298	294.3	46.6
59	58.3	09.2	119	117.5	18.6	179	176.8	28.0	239	236.1	37.4	299	295.3	46.8
60	59.3	09.4	120	118.5	18.8	180	177.8	28.2	240	237.0	37.5	300	296.3	46.9
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 81 Degrees. 5h 24m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 10 DEGREES. $0^h\ 40^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	60.1	10.6	121	119.2	21.0	181	178.3	31.4	241	237.3	41.8
2	02.0	00.3	62	61.1	10.8	122	120.1	21.2	182	179.2	31.6	242	238.3	42.0
3	03.0	00.5	63	62.0	10.9	123	121.1	21.4	183	180.2	31.8	243	239.3	42.2
4	03.9	00.7	64	63.0	11.1	124	122.1	21.5	184	181.2	32.0	244	240.3	42.4
5	04.9	00.9	65	64.0	11.3	125	123.1	21.7	185	182.2	32.1	245	241.3	42.5
6	05.9	01.0	66	65.0	11.5	126	124.1	21.9	186	183.2	32.3	246	242.3	42.7
7	06.9	01.2	67	66.0	11.6	127	125.1	22.1	187	184.2	32.5	247	243.2	42.9
8	07.9	01.4	68	67.0	11.8	128	126.1	22.2	188	185.1	32.6	248	244.2	43.1
9	08.9	01.6	69	68.0	12.0	129	127.0	22.4	189	186.1	32.8	249	245.2	43.2
10	09.8	01.7	70	68.9	12.2	130	128.0	22.6	190	187.1	33.0	250	246.2	43.4
11	10.8	01.9	71	69.9	12.3	131	129.0	22.7	191	188.1	33.2	251	247.2	43.6
12	11.8	02.1	72	70.9	12.5	132	130.0	22.9	192	189.1	33.3	252	248.2	43.8
13	12.8	02.3	73	71.9	12.7	133	131.0	23.1	193	190.1	33.5	253	249.2	43.9
14	13.8	02.4	74	72.9	12.8	134	132.0	23.3	194	191.1	33.7	254	250.1	44.1
15	14.8	02.6	75	73.9	13.0	135	132.9	23.4	195	192.0	33.9	255	251.1	44.3
16	15.8	02.8	76	74.8	13.2	136	133.9	23.6	196	193.0	34.0	256	252.1	44.5
17	16.7	03.0	77	75.8	13.4	137	134.9	23.8	197	194.0	34.2	257	253.1	44.6
18	17.7	03.1	78	76.8	13.5	138	135.9	24.0	198	195.0	34.4	258	254.1	44.8
19	18.7	03.3	79	77.8	13.7	139	136.9	24.1	199	196.0	34.6	259	255.1	45.0
20	19.7	03.5	80	78.8	13.9	140	137.9	24.3	200	197.0	34.7	260	256.1	45.1
21	20.7	03.6	81	79.8	14.1	141	138.9	24.5	201	197.9	34.9	261	257.0	45.3
22	21.7	03.8	82	80.8	14.2	142	139.8	24.7	202	198.9	35.1	262	258.0	45.5
23	22.7	04.0	83	81.7	14.4	143	140.8	24.8	203	199.9	35.3	263	259.0	45.7
24	23.6	04.2	84	82.7	14.6	144	141.8	25.0	204	200.9	35.4	264	260.0	45.8
25	24.6	04.3	85	83.7	14.8	145	142.8	25.2	205	201.9	35.6	265	261.0	46.0
26	25.6	04.5	86	84.7	14.9	146	143.8	25.4	206	202.9	35.8	266	262.0	46.2
27	26.6	04.7	87	85.7	15.1	147	144.8	25.5	207	203.9	35.9	267	262.9	46.4
28	27.6	04.9	88	86.7	15.3	148	145.8	25.7	208	204.8	36.1	268	263.9	46.5
29	28.6	05.0	89	87.6	15.5	149	146.7	25.9	209	205.8	36.3	269	264.9	46.7
30	29.5	05.2	90	88.6	15.6	150	147.7	26.0	210	206.8	36.5	270	265.9	46.9
31	30.5	05.4	91	89.6	15.8	151	148.7	26.2	211	207.8	36.6	271	266.9	47.1
32	31.5	05.6	92	90.6	16.0	152	149.7	26.4	212	208.8	36.8	272	267.9	47.2
33	32.5	05.7	93	91.6	16.1	153	150.7	26.6	213	209.8	37.0	273	268.9	47.4
34	33.5	05.9	94	92.6	16.3	154	151.7	26.7	214	210.7	37.2	274	269.8	47.6
35	34.5	06.1	95	93.6	16.5	155	152.6	26.9	215	211.7	37.3	275	270.8	47.8
36	35.5	06.3	96	94.5	16.7	156	153.6	27.1	216	212.7	37.5	276	271.8	47.9
37	36.4	06.4	97	95.5	16.8	157	154.6	27.3	217	213.7	37.7	277	272.8	48.1
38	37.4	06.6	98	96.5	17.0	158	155.6	27.4	218	214.7	37.9	278	273.8	48.3
39	38.4	06.8	99	97.5	17.2	159	156.6	27.6	219	215.7	38.0	279	274.8	48.4
40	39.4	06.9	100	98.5	17.4	160	157.6	27.8	220	216.7	38.2	280	275.7	48.6
41	40.4	07.1	101	99.5	17.5	161	158.6	28.0	221	217.6	38.4	281	276.7	48.8
42	41.4	07.3	102	100.5	17.7	162	159.5	28.1	222	218.6	38.5	282	277.7	49.0
43	42.3	07.5	103	101.4	17.9	163	160.5	28.3	223	219.6	38.7	283	278.7	49.1
44	43.3	07.6	104	102.4	18.1	164	161.5	28.5	224	220.6	38.9	284	279.7	49.3
45	44.3	07.8	105	103.4	18.2	165	162.5	28.7	225	221.6	39.1	285	280.7	49.5
46	45.3	08.0	106	104.4	18.4	166	163.5	28.8	226	222.6	39.2	286	281.7	49.7
47	46.3	08.2	107	105.4	18.6	167	164.5	29.0	227	223.6	39.4	287	282.6	49.8
48	47.3	08.3	108	106.4	18.8	168	165.4	29.2	228	224.5	39.6	288	283.6	50.0
49	48.3	08.5	109	107.3	18.9	169	166.4	29.3	229	225.5	39.8	289	284.6	50.2
50	49.2	08.7	110	108.3	19.1	170	167.4	29.5	230	226.5	39.9	290	285.6	50.4
51	50.2	08.9	111	109.3	19.3	171	168.4	29.7	231	227.5	40.1	291	286.6	50.5
52	51.2	09.0	112	110.3	19.4	172	169.4	29.9	232	228.5	40.3	292	287.6	50.7
53	52.2	09.2	113	111.3	19.6	173	170.4	30.0	233	229.5	40.5	293	288.5	50.9
54	53.2	09.4	114	112.3	19.8	174	171.4	30.2	234	230.4	40.6	294	289.5	51.1
55	54.2	09.6	115	113.3	20.0	175	172.3	30.4	235	231.4	40.8	295	290.5	51.2
56	55.1	09.7	116	114.2	20.1	176	173.3	30.6	236	232.4	41.0	296	291.5	51.4
57	56.1	09.9	117	115.2	20.3	177	174.3	30.7	237	233.4	41.2	297	292.5	51.6
58	57.1	10.1	118	116.2	20.5	178	175.3	30.9	238	234.4	41.3	298	293.5	51.7
59	58.1	10.2	119	117.2	20.7	179	176.3	31.1	239	235.4	41.5	299	294.5	51.9
60	59.1	10.4	120	118.2	20.8	180	177.3	31.3	240	236.4	41.7	300	295.4	52.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 11 DEGREES. $0^h\ 44^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.9	11.6	121	118.8	23.1	181	177.7	34.5	241	236.6	46.0
2	02.0	00.4	62	60.9	11.8	122	119.8	23.3	182	178.7	34.7	242	237.6	46.2
3	02.9	00.6	63	61.8	12.0	123	120.7	23.5	183	179.6	34.9	243	238.5	46.4
4	03.9	00.8	64	62.8	12.2	124	121.7	23.7	184	180.6	35.1	244	239.5	46.6
5	04.9	01.0	65	63.8	12.4	125	122.7	23.9	185	181.6	35.3	245	240.5	46.7
6	05.9	01.1	66	64.8	12.6	126	123.7	24.0	186	182.6	35.5	246	241.5	46.9
7	06.9	01.3	67	65.8	12.8	127	124.7	24.2	187	183.6	35.7	247	242.5	47.1
8	07.9	01.5	68	66.8	13.0	128	125.6	24.4	188	184.5	35.9	248	243.4	47.3
9	08.8	01.7	69	67.7	13.2	129	126.6	24.6	189	185.5	36.1	249	244.4	47.5
10	09.8	01.9	70	68.7	13.4	130	127.6	24.8	190	186.5	36.3	250	245.4	47.7
11	10.8	02.1	71	69.7	13.5	131	128.6	25.0	191	187.5	36.4	251	246.4	47.9
12	11.8	02.3	72	70.7	13.7	132	129.6	25.2	192	188.5	36.6	252	247.4	48.1
13	12.8	02.5	73	71.7	13.9	133	130.6	25.4	193	189.5	36.8	253	248.4	48.3
14	13.7	02.7	74	72.6	14.1	134	131.5	25.6	194	190.4	37.0	254	249.3	48.5
15	14.7	02.9	75	73.6	14.3	135	132.5	25.8	195	191.4	37.2	255	250.3	48.7
16	15.7	03.1	76	74.6	14.5	136	133.5	26.0	196	192.4	37.4	256	251.3	48.8
17	16.7	03.2	77	75.6	14.7	137	134.5	26.1	197	193.4	37.6	257	252.3	49.0
18	17.7	03.4	78	76.6	14.9	138	135.5	26.3	198	194.4	37.8	258	253.3	49.2
19	18.7	03.6	79	77.5	15.1	139	136.4	26.5	199	195.3	38.0	259	254.2	49.4
20	19.6	03.8	80	78.5	15.3	140	137.4	26.7	200	196.3	38.2	260	255.2	49.6
21	20.6	04.0	81	79.5	15.5	141	138.4	26.9	201	197.3	38.4	261	256.2	49.8
22	21.6	04.2	82	80.5	15.6	142	139.4	27.1	202	198.3	38.5	262	257.2	50.0
23	22.6	04.4	83	81.5	15.8	143	140.4	27.3	203	199.3	38.7	263	258.2	50.2
24	23.6	04.6	84	82.5	16.0	144	141.4	27.5	204	200.3	38.9	264	259.1	50.4
25	24.5	04.8	85	83.4	16.2	145	142.3	27.7	205	201.2	39.1	265	260.1	50.6
26	25.5	05.0	86	84.4	16.4	146	143.3	27.9	206	202.2	39.3	266	261.1	50.8
27	26.5	05.2	87	85.4	16.6	147	144.3	28.0	207	203.2	39.5	267	262.1	50.9
28	27.5	05.3	88	86.4	16.8	148	145.3	28.2	208	204.2	39.7	268	263.1	51.1
29	28.5	05.5	89	87.4	17.0	149	146.3	28.4	209	205.2	39.9	269	264.1	51.3
30	29.4	05.7	90	88.3	17.2	150	147.2	28.6	210	206.1	40.1	270	265.0	51.5
31	30.4	05.9	91	89.3	17.4	151	148.2	28.8	211	207.1	40.3	271	266.0	51.7
32	31.4	06.1	92	90.3	17.6	152	149.2	29.0	212	208.1	40.4	272	267.0	51.9
33	32.4	06.3	93	91.3	17.7	153	150.2	29.2	213	209.1	40.5	273	268.0	52.1
34	33.4	06.5	94	92.3	17.9	154	151.2	29.4	214	210.1	40.8	274	269.0	52.3
35	34.4	06.7	95	93.3	18.1	155	152.2	29.6	215	211.0	41.0	275	269.9	52.5
36	35.3	06.9	96	94.2	18.3	156	153.1	29.8	216	212.0	41.2	276	270.9	52.7
37	36.3	07.1	97	95.2	18.5	157	154.1	30.0	217	213.0	41.4	277	271.9	52.9
38	37.3	07.3	98	96.2	18.7	158	155.1	30.1	218	214.0	41.6	278	272.9	53.0
39	38.3	07.4	99	97.2	18.9	159	156.1	30.3	219	215.0	41.8	279	273.9	53.2
40	39.3	07.6	100	98.2	19.1	160	157.1	30.5	220	216.0	42.0	280	274.9	53.4
41	40.2	07.8	101	99.1	19.3	161	158.0	30.7	221	216.9	42.2	281	275.8	53.6
42	41.2	08.0	102	100.1	19.5	162	159.0	30.9	222	217.9	42.4	282	276.8	53.8
43	42.2	08.2	103	101.1	19.7	163	160.0	31.1	223	218.9	42.6	283	277.8	54.0
44	43.2	08.4	104	102.1	19.8	164	161.0	31.3	224	219.9	42.7	284	278.8	54.2
45	44.2	08.6	105	103.1	20.0	165	162.0	31.5	225	220.9	42.9	285	279.8	54.4
46	45.2	08.8	106	104.1	20.2	166	163.0	31.7	226	221.8	43.1	286	280.7	54.6
47	46.1	09.0	107	105.0	20.4	167	163.9	31.9	227	222.8	43.3	287	281.7	54.8
48	47.1	09.2	108	106.0	20.6	168	164.9	32.1	228	223.8	43.5	288	282.7	55.0
49	48.1	09.3	109	107.0	20.8	169	165.9	32.2	229	224.8	43.7	289	283.7	55.1
50	49.1	09.5	110	108.0	21.0	170	166.9	32.4	230	225.8	43.9	290	284.7	55.3
51	50.1	09.7	111	109.0	21.2	171	167.9	32.6	231	226.8	44.1	291	285.7	55.5
52	51.0	09.9	112	109.9	21.4	172	168.8	32.8	232	227.7	44.3	292	286.6	55.7
53	52.0	10.1	113	110.9	21.6	173	169.8	33.0	233	228.7	44.5	293	287.6	55.9
54	53.0	10.3	114	111.9	21.8	174	170.8	33.2	234	229.7	44.6	294	288.6	56.1
55	54.0	10.5	115	112.9	21.9	175	171.8	33.4	235	230.7	44.8	295	289.6	56.3
56	55.0	10.7	116	113.9	22.1	176	172.8	33.6	236	231.7	45.0	296	290.6	56.5
57	56.0	10.9	117	114.9	22.3	177	173.7	33.8	237	232.6	45.2	297	291.5	56.7
58	56.9	11.1	118	115.8	22.5	178	174.7	34.0	238	233.6	45.4	298	292.5	56.9
59	57.9	11.3	119	116.8	22.7	179	175.7	34.2	239	234.6	45.6	299	293.5	57.1
60	58.9	11.4	120	117.8	22.9	180	176.7	34.3	240	235.6	45.8	300	294.5	57.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 79 Degrees. $5^h\ 16^m$.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 12 DEGREES. $0^h\ 48^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.7	12.7	121	118.4	25.2	181	177.0	37.6	241	235.7	50.1
2	02.0	00.4	62	60.6	12.9	122	119.3	25.4	182	178.0	37.8	242	236.7	50.3
3	02.9	00.6	63	61.6	13.1	123	120.3	25.6	183	179.0	38.0	243	237.7	50.5
4	03.9	00.8	64	62.6	13.3	124	121.3	25.8	184	180.0	38.3	244	238.7	50.7
5	04.9	01.0	65	63.6	13.5	125	122.3	26.0	185	181.0	38.5	245	239.6	50.9
6	05.9	01.2	66	64.6	13.7	126	123.2	26.2	186	181.9	38.7	246	240.6	51.1
7	06.8	01.5	67	65.5	13.9	127	124.2	26.4	187	182.9	38.9	247	241.6	51.4
8	07.8	01.7	68	66.5	14.1	128	125.2	26.6	188	183.9	39.1	248	242.6	51.6
9	08.8	01.9	69	67.5	14.3	129	126.2	26.8	189	184.9	39.3	249	243.6	51.8
10	09.8	02.1	70	68.5	14.6	130	127.2	27.0	190	185.8	39.5	250	244.5	52.0
11	10.8	02.3	71	69.4	14.8	131	128.1	27.2	191	186.8	39.7	251	245.5	52.2
12	11.7	02.5	72	70.4	15.0	132	129.1	27.4	192	187.8	39.9	252	246.5	52.4
13	12.7	02.7	73	71.4	15.2	133	130.1	27.7	193	188.8	40.1	253	247.5	52.6
14	13.7	02.9	74	72.4	15.4	134	131.1	27.9	194	189.8	40.3	254	248.4	52.8
15	14.7	03.1	75	73.4	15.6	135	132.0	28.1	195	190.7	40.5	255	249.4	53.0
16	15.7	03.3	76	74.3	15.8	136	133.0	28.3	196	191.7	40.8	256	250.4	53.2
17	16.6	03.5	77	75.3	16.0	137	134.0	28.5	197	192.7	41.0	257	251.4	53.4
18	17.6	03.7	78	76.3	16.2	138	135.0	28.7	198	193.7	41.2	258	252.4	53.6
19	18.6	04.0	79	77.3	16.4	139	136.0	28.9	199	194.7	41.4	259	253.3	53.8
20	19.6	04.2	80	78.3	16.6	140	136.9	29.1	200	195.6	41.6	260	254.3	54.1
21	20.5	04.4	81	79.2	16.8	141	137.9	29.3	201	196.6	41.8	261	255.3	54.3
22	21.5	04.6	82	80.2	17.0	142	138.9	29.5	202	197.6	42.0	262	256.3	54.5
23	22.5	04.8	83	81.2	17.3	143	139.9	29.7	203	198.6	42.2	263	257.3	54.7
24	23.5	05.0	84	82.2	17.5	144	140.9	29.9	204	199.5	42.4	264	258.2	54.9
25	24.5	05.2	85	83.1	17.7	145	141.8	30.1	205	200.5	42.6	265	259.2	55.1
26	25.4	05.4	86	84.1	17.9	146	142.8	30.4	206	201.5	42.8	266	260.2	55.3
27	26.4	05.6	87	85.1	18.1	147	143.8	30.6	207	202.5	43.0	267	261.2	55.5
28	27.4	05.8	88	86.1	18.3	148	144.8	30.8	208	203.5	43.2	268	262.1	55.7
29	28.4	06.0	89	87.1	18.5	149	145.7	31.0	209	204.4	43.5	269	263.1	55.9
30	29.3	06.2	90	88.0	18.7	150	146.7	31.2	210	205.4	43.7	270	264.1	56.1
31	30.3	06.4	91	89.0	18.9	151	147.7	31.4	211	206.4	43.9	271	265.1	56.3
32	31.3	06.7	92	90.0	19.1	152	148.7	31.6	212	207.4	44.1	272	266.1	56.6
33	32.3	06.9	93	91.0	19.3	153	149.7	31.8	213	208.3	44.3	273	267.0	56.8
34	33.3	07.1	94	91.9	19.5	154	150.6	32.0	214	209.3	44.5	274	268.0	57.0
35	34.2	07.3	95	92.9	19.8	155	151.6	32.2	215	210.3	44.7	275	269.0	57.2
36	35.2	07.5	96	93.9	20.0	156	152.6	32.4	216	211.3	44.9	276	270.0	57.4
37	36.2	07.7	97	94.9	20.2	157	153.6	32.6	217	212.3	45.1	277	270.9	57.6
38	37.2	07.9	98	95.9	20.4	158	154.5	32.9	218	213.2	45.3	278	271.9	57.8
39	38.1	08.1	99	96.8	20.6	159	155.5	33.1	219	214.2	45.5	279	272.9	58.0
40	39.1	08.3	100	97.8	20.8	160	156.5	33.3	220	215.2	45.7	280	273.9	58.2
41	40.1	08.5	101	98.8	21.0	161	157.5	33.5	221	216.2	45.9	281	274.9	58.4
42	41.1	08.7	102	99.8	21.2	162	158.5	33.7	222	217.1	46.2	282	275.8	58.6
43	42.1	08.9	103	100.7	21.4	163	159.4	33.9	223	218.1	46.4	283	276.8	58.8
44	43.0	09.1	104	101.7	21.6	164	160.4	34.1	224	219.1	46.6	284	277.8	59.0
45	44.0	09.4	105	102.7	21.8	165	161.4	34.3	225	220.1	46.8	285	278.8	59.3
46	45.0	09.6	106	103.7	22.0	166	162.4	34.5	226	221.1	47.0	286	279.8	59.5
47	46.0	09.8	107	104.7	22.2	167	163.4	34.7	227	222.0	47.2	287	280.7	59.7
48	47.0	10.0	108	105.7	22.5	168	164.3	34.9	228	223.0	47.4	288	281.7	59.9
49	47.9	10.2	109	106.6	22.7	169	165.3	35.1	229	224.0	47.6	289	282.7	60.1
50	48.9	10.4	110	107.6	22.9	170	166.3	35.3	230	225.0	47.8	290	283.7	60.3
51	49.9	10.6	111	108.6	23.1	171	167.3	35.6	231	226.0	48.0	291	284.6	60.5
52	50.9	10.8	112	109.6	23.3	172	168.2	35.8	232	226.9	48.2	292	285.6	60.7
53	51.8	11.0	113	110.5	23.5	173	169.2	36.0	233	227.9	48.4	293	286.6	60.9
54	52.8	11.2	114	111.5	23.7	174	170.2	36.2	234	228.9	48.7	294	287.6	61.1
55	53.8	11.4	115	112.5	23.9	175	171.2	36.4	235	229.9	48.9	295	288.6	61.3
56	54.8	11.6	116	113.5	24.1	176	172.2	36.6	236	230.8	49.1	296	289.5	61.5
57	55.8	11.9	117	114.4	24.3	177	173.1	36.8	237	231.8	49.3	297	290.5	61.7
58	56.7	12.1	118	115.4	24.5	178	174.1	37.0	238	232.8	49.5	298	291.5	62.0
59	57.7	12.3	119	116.4	24.7	179	175.1	37.2	239	233.8	49.7	299	292.5	62.2
60	58.7	12.5	120	117.4	24.9	180	176.1	37.4	240	234.8	49.9	300	293.4	62.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 78 Degrees. $5^h\ 12^m$.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 13 DEGREES. 0h 52m

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.4	13.7	121	117.9	27.2	181	176.4	40.7	241	234.8	54.2
2	01.9	00.4	62	60.4	13.9	122	118.9	27.4	182	177.3	40.9	242	235.8	54.4
3	02.9	00.7	63	61.4	14.2	123	119.8	27.7	183	178.3	41.2	243	236.8	54.7
4	03.9	00.9	64	62.4	14.4	124	120.8	27.9	184	179.3	41.4	244	237.7	54.9
5	04.9	01.1	65	63.3	14.6	125	121.8	28.1	185	180.3	41.6	245	238.7	55.1
6	05.8	01.3	66	64.3	14.8	126	122.8	28.3	186	181.2	41.8	246	239.7	55.3
7	06.8	01.6	67	65.3	15.1	127	123.7	28.6	187	182.2	42.1	247	240.7	55.6
8	07.8	01.8	68	66.3	15.3	128	124.7	28.8	188	183.2	42.3	248	241.6	55.8
9	08.8	02.0	69	67.2	15.5	129	125.7	29.0	189	184.2	42.5	249	242.6	56.0
10	09.7	02.2	70	68.2	15.7	130	126.7	29.2	190	185.1	42.7	250	243.6	56.2
11	10.7	02.5	71	69.2	16.0	131	127.6	29.5	191	186.1	43.0	251	244.6	56.5
12	11.7	02.7	72	70.2	16.2	132	128.6	29.7	192	187.1	43.2	252	245.5	56.7
13	12.7	02.9	73	71.1	16.4	133	129.6	29.9	193	188.1	43.4	253	246.5	56.9
14	13.6	03.1	74	72.1	16.6	134	130.6	30.1	194	189.0	43.6	254	247.5	57.1
15	14.6	03.4	75	73.1	16.9	135	131.5	30.4	195	190.0	43.9	255	248.5	57.4
16	15.6	03.6	76	74.1	17.1	136	132.5	30.6	196	191.0	44.1	256	249.4	57.6
17	16.6	03.8	77	75.0	17.3	137	133.5	30.8	197	192.0	44.3	257	250.4	57.8
18	17.5	04.0	78	76.0	17.5	138	134.5	31.0	198	192.9	44.5	258	251.4	58.0
19	18.5	04.3	79	77.0	17.8	139	135.4	31.3	199	193.9	44.8	259	252.4	58.3
20	19.5	04.5	80	77.9	18.0	140	136.4	31.5	200	194.9	45.0	260	253.3	58.5
21	20.5	04.7	81	78.9	18.2	141	137.4	31.7	201	195.8	45.2	261	254.3	58.7
22	21.4	04.9	82	79.9	18.4	142	138.4	31.9	202	196.8	45.4	262	255.3	58.9
23	22.4	05.2	83	80.9	18.7	143	139.3	32.2	203	197.8	45.7	263	256.3	59.2
24	23.4	05.4	84	81.8	18.9	144	140.3	32.4	204	198.8	45.9	264	257.2	59.4
25	24.4	05.6	85	82.8	19.1	145	141.3	32.6	205	199.7	46.1	265	258.2	59.6
26	25.3	05.8	86	83.8	19.3	146	142.3	32.8	206	200.7	46.3	266	259.2	59.8
27	26.3	06.1	87	84.8	19.6	147	143.2	33.1	207	201.7	46.6	267	260.2	60.1
28	27.3	06.3	88	85.7	19.8	148	144.2	33.3	208	202.7	46.8	268	261.1	60.3
29	28.3	06.5	89	86.7	20.0	149	145.2	33.5	209	203.6	47.0	269	262.1	60.5
30	29.2	06.7	90	87.7	20.2	150	146.2	33.7	210	204.6	47.2	270	263.1	60.7
31	30.2	07.0	91	88.7	20.5	151	147.1	34.0	211	205.6	47.5	271	264.1	61.0
32	31.2	07.2	92	89.6	20.7	152	148.1	34.2	212	206.6	47.7	272	265.0	61.2
33	32.2	07.4	93	90.6	20.9	153	149.1	34.4	213	207.5	47.9	273	266.0	61.4
34	33.1	07.6	94	91.6	21.1	154	150.1	34.6	214	208.5	48.1	274	267.0	61.6
35	34.1	07.9	95	92.6	21.4	155	151.0	34.9	215	209.5	48.4	275	268.0	61.9
36	35.1	08.1	96	93.5	21.6	156	152.0	35.1	216	210.5	48.6	276	268.9	62.1
37	36.1	08.3	97	94.5	21.8	157	153.0	35.3	217	211.4	48.8	277	269.9	62.3
38	37.0	08.5	98	95.5	22.0	158	154.0	35.5	218	212.4	49.0	278	270.9	62.5
39	38.0	08.8	99	96.5	22.3	159	154.9	35.8	219	213.4	49.3	279	271.8	62.8
40	39.0	09.0	100	97.4	22.5	160	155.9	36.0	220	214.4	49.5	280	272.8	63.0
41	39.9	09.2	101	98.4	22.7	161	156.9	36.2	221	215.3	49.7	281	273.8	63.2
42	40.9	09.4	102	99.4	22.9	162	157.8	36.4	222	216.3	49.9	282	274.8	63.4
43	41.9	09.7	103	100.4	23.2	163	158.8	36.7	223	217.3	50.2	283	275.7	63.7
44	42.9	09.9	104	101.3	23.4	164	159.8	36.9	224	218.3	50.4	284	276.7	63.9
45	43.8	10.1	105	102.3	23.6	165	160.8	37.1	225	219.2	50.6	285	277.7	64.1
46	44.8	10.3	106	103.3	23.8	166	161.7	37.3	226	220.2	50.8	286	278.7	64.3
47	45.8	10.6	107	104.3	24.1	167	162.7	37.6	227	221.2	51.1	287	279.6	64.6
48	46.8	10.8	108	105.2	24.3	168	163.7	37.8	228	222.2	51.3	288	280.6	64.8
49	47.7	11.0	109	106.2	24.5	169	164.7	38.0	229	223.1	51.5	289	281.6	65.0
50	48.7	11.2	110	107.2	24.7	170	165.6	38.2	230	224.1	51.7	290	282.6	65.2
51	49.7	11.5	111	108.2	25.0	171	166.6	38.5	231	225.1	52.0	291	283.5	65.5
52	50.7	11.7	112	109.1	25.2	172	167.6	38.7	232	226.1	52.2	292	284.5	65.7
53	51.6	11.9	113	110.1	25.4	173	168.6	38.9	233	227.0	52.4	293	285.5	65.9
54	52.6	12.1	114	111.1	25.6	174	169.5	39.1	234	228.0	52.6	294	286.5	66.1
55	53.6	12.4	115	112.1	25.9	175	170.5	39.4	235	229.0	52.9	295	287.4	66.4
56	54.6	12.6	116	113.0	26.1	176	171.5	39.6	236	230.0	53.1	296	288.4	66.6
57	55.5	12.8	117	114.0	26.3	177	172.5	39.8	237	230.9	53.3	297	289.4	66.8
58	56.5	13.0	118	115.0	26.5	178	173.4	40.0	238	231.9	53.5	298	290.4	67.0
59	57.5	13.3	119	116.0	26.8	179	174.4	40.3	239	232.9	53.8	299	291.3	67.3
60	58.5	13.5	120	116.9	27.0	180	175.4	40.5	240	233.8	54.0	300	292.3	67.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 77 Degrees. 5h 8m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 14 DEGREES. 0h 56m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.2	61	59.2	14.8	121	117.4	29.3	181	175.6	43.8	241	233.8	58.3
2	01.9	00.5	62	60.2	15.0	122	118.4	29.5	182	176.6	44.0	242	234.8	58.5
3	02.9	00.7	63	61.1	15.2	123	119.3	29.8	183	177.6	44.3	243	235.8	58.8
4	03.9	01.0	64	62.1	15.5	124	120.3	30.0	184	178.5	44.5	244	236.8	59.0
5	04.9	01.2	65	63.1	15.7	125	121.3	30.2	185	179.5	44.8	245	237.7	59.3
6	05.8	01.5	66	64.0	16.0	126	122.3	30.5	186	180.5	45.0	246	238.7	59.5
7	06.8	01.7	67	65.0	16.2	127	123.2	30.7	187	181.4	45.2	247	239.7	59.8
8	07.8	01.9	68	66.0	16.5	128	124.2	31.0	188	182.4	45.5	248	240.6	60.0
9	08.7	02.2	69	67.0	16.7	129	125.2	31.2	189	183.4	45.7	249	241.6	60.2
10	09.7	02.4	70	67.9	16.9	130	126.1	31.4	190	184.4	46.0	250	242.6	60.5
11	10.7	02.7	71	68.9	17.2	131	127.1	31.7	191	185.3	46.2	251	243.5	60.7
12	11.6	02.9	72	69.9	17.4	132	128.1	31.9	192	186.3	46.4	252	244.5	61.0
13	12.6	03.1	73	70.8	17.7	133	129.0	32.2	193	187.3	46.7	253	245.5	61.2
14	13.6	03.4	74	71.8	17.9	134	130.0	32.4	194	188.2	46.9	254	246.5	61.4
15	14.6	03.6	75	72.8	18.1	135	131.0	32.7	195	189.2	47.2	255	247.4	61.7
16	15.5	03.9	76	73.7	18.4	136	132.0	32.9	196	190.2	47.4	256	248.4	61.9
17	16.5	04.1	77	74.7	18.6	137	132.9	33.1	197	191.1	47.7	257	249.4	62.2
18	17.5	04.4	78	75.7	18.9	138	133.9	33.4	198	192.1	47.9	258	250.3	62.4
19	18.4	04.6	79	76.7	19.1	139	134.9	33.6	199	193.1	48.1	259	251.3	62.7
20	19.4	04.8	80	77.6	19.4	140	135.8	33.9	200	194.1	48.4	260	252.3	62.9
21	20.4	05.1	81	78.6	19.6	141	136.8	34.1	201	195.0	48.6	261	253.2	63.1
22	21.3	05.3	82	79.6	19.8	142	137.8	34.4	202	196.0	48.9	262	254.2	63.4
23	22.3	05.6	83	80.5	20.1	143	138.8	34.6	203	197.0	49.1	263	255.2	63.6
24	23.3	05.8	84	81.5	20.3	144	139.7	34.8	204	197.9	49.4	264	256.2	63.9
25	24.3	06.0	85	82.5	20.6	145	140.7	35.1	205	198.9	49.6	265	257.1	64.1
26	25.2	06.3	86	83.4	20.8	146	141.7	35.3	206	199.9	49.8	266	258.1	64.4
27	26.2	06.5	87	84.4	21.0	147	142.6	35.6	207	200.9	50.1	267	259.1	64.6
28	27.2	06.8	88	85.4	21.3	148	143.6	35.8	208	201.8	50.3	268	260.0	64.8
29	28.1	07.0	89	86.4	21.5	149	144.6	36.0	209	202.8	50.6	269	261.0	65.1
30	29.1	07.3	90	87.3	21.8	150	145.5	36.3	210	203.8	50.8	270	262.0	65.3
31	30.1	07.5	91	88.3	22.0	151	146.5	36.5	211	204.7	51.0	271	263.0	65.6
32	31.0	07.7	92	89.3	22.3	152	147.5	36.8	212	205.7	51.3	272	263.9	65.8
33	32.0	08.0	93	90.2	22.5	153	148.5	37.0	213	206.7	51.5	273	264.9	66.0
34	33.0	08.2	94	91.2	22.7	154	149.4	37.3	214	207.6	51.8	274	265.9	66.3
35	34.0	08.5	95	92.2	23.0	155	150.4	37.5	215	208.6	52.0	275	266.8	66.5
36	34.9	08.7	96	93.1	23.2	156	151.4	37.7	216	209.6	52.3	276	267.8	66.8
37	35.9	09.0	97	94.1	23.5	157	152.3	38.0	217	210.6	52.5	277	268.8	67.0
38	36.9	09.2	98	95.1	23.7	158	153.3	38.2	218	211.5	52.7	278	269.7	67.3
39	37.8	09.4	99	96.1	24.0	159	154.3	38.5	219	212.5	53.0	279	270.7	67.5
40	38.8	09.7	100	97.0	24.2	160	155.2	38.7	220	213.5	53.2	280	271.7	67.7
41	39.8	09.9	101	98.0	24.4	161	156.2	38.9	221	214.4	53.5	281	272.7	68.0
42	40.8	10.2	102	99.0	24.7	162	157.2	39.2	222	215.4	53.7	282	273.6	68.2
43	41.7	10.4	103	99.9	24.9	163	158.2	39.4	223	216.4	53.9	283	274.6	68.5
44	42.7	10.6	104	100.9	25.2	164	159.1	39.7	224	217.3	54.2	284	275.6	68.7
45	43.7	10.9	105	101.9	25.4	165	160.1	39.9	225	218.3	54.4	285	276.5	68.9
46	44.6	11.1	106	102.9	25.6	166	161.1	40.2	226	219.3	54.7	286	277.5	69.2
47	45.6	11.4	107	103.8	25.9	167	162.0	40.4	227	220.3	54.9	287	278.5	69.4
48	46.6	11.6	108	104.8	26.1	168	163.0	40.6	228	221.2	55.2	288	279.4	69.7
49	47.5	11.9	109	105.8	26.4	169	164.0	40.9	229	222.2	55.4	289	280.4	69.9
50	48.5	12.1	110	106.7	26.6	170	165.0	41.1	230	223.2	55.6	290	281.4	70.2
51	49.5	12.3	111	107.7	26.9	171	165.9	41.4	231	224.1	55.9	291	282.4	70.4
52	50.5	12.6	112	108.7	27.1	172	166.9	41.6	232	225.1	56.1	292	283.3	70.6
53	51.4	12.8	113	109.6	27.3	173	167.9	41.9	233	226.1	56.4	293	284.3	70.9
54	52.4	13.1	114	110.6	27.6	174	168.8	42.1	234	227.0	56.6	294	285.3	71.1
55	53.4	13.3	115	111.6	27.8	175	169.8	42.3	235	228.0	56.9	295	286.2	71.4
56	54.3	13.5	116	112.6	28.1	176	170.8	42.6	236	229.0	57.1	296	287.2	71.6
57	55.3	13.8	117	113.5	28.3	177	171.7	42.8	237	230.0	57.3	297	288.2	71.9
58	56.3	14.0	118	114.5	28.5	178	172.7	43.1	238	230.9	57.6	298	289.1	72.1
59	57.2	14.3	119	115.5	28.8	179	173.7	43.3	239	231.9	57.8	299	290.1	72.3
60	58.2	14.5	120	116.4	29.0	180	174.7	43.5	240	232.9	58.1	300	291.1	72.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 15 DEGREES. 1h 0m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.9	15.8	121	116.9	31.3	181	174.8	46.8	241	232.8	62.4
2	01.9	00.5	62	59.9	16.0	122	117.8	31.6	182	175.8	47.1	242	233.8	62.6
3	02.9	00.8	63	60.9	16.3	123	118.8	31.8	183	176.8	47.4	243	234.7	62.9
4	03.9	01.0	64	61.8	16.6	124	119.8	32.1	184	177.7	47.6	244	235.7	63.2
5	04.8	01.3	65	62.8	16.8	125	120.7	32.4	185	178.7	47.9	245	236.7	63.4
6	05.8	01.6	66	63.8	17.1	126	121.7	32.6	186	179.7	48.1	246	237.6	63.7
7	06.8	01.8	67	64.7	17.3	127	122.7	32.9	187	180.6	48.4	247	238.6	63.9
8	07.7	02.1	68	65.7	17.6	128	123.6	33.1	188	181.6	48.7	248	239.5	64.2
9	08.7	02.3	69	66.6	17.9	129	124.6	33.4	189	182.6	48.9	249	240.5	64.4
10	09.7	02.6	70	67.6	18.1	130	125.6	33.6	190	183.5	49.2	250	241.5	64.7
11	10.6	02.8	71	68.6	18.4	131	126.5	33.9	191	184.5	49.4	251	242.4	65.0
12	11.6	03.1	72	69.5	18.6	132	127.5	34.2	192	185.5	49.7	252	243.4	65.2
13	12.6	03.4	73	70.5	18.9	133	128.5	34.4	193	186.4	50.0	253	244.4	65.5
14	13.5	03.6	74	71.5	19.2	134	129.4	34.7	194	187.4	50.2	254	245.3	65.7
15	14.5	03.9	75	72.4	19.4	135	130.4	34.9	195	188.4	50.5	255	246.3	66.0
16	15.5	04.1	76	73.4	19.7	136	131.4	35.2	196	189.3	50.7	256	247.3	66.3
17	16.4	04.4	77	74.4	19.9	137	132.3	35.5	197	190.3	51.0	257	248.2	66.5
18	17.4	04.7	78	75.3	20.2	138	133.3	35.7	198	191.3	51.2	258	249.2	66.8
19	18.4	04.9	79	76.3	20.4	139	134.3	36.0	199	192.2	51.5	259	250.2	67.0
20	19.3	05.2	80	77.3	20.7	140	135.2	36.2	200	193.2	51.8	260	251.1	67.3
21	20.3	05.4	81	78.2	21.0	141	136.2	36.5	201	194.2	52.0	261	252.1	67.6
22	21.3	05.7	82	79.2	21.2	142	137.2	36.8	202	195.1	52.3	262	253.1	67.8
23	22.2	06.0	83	80.2	21.5	143	138.1	37.0	203	196.1	52.5	263	254.0	68.1
24	23.2	06.2	84	81.1	21.7	144	139.1	37.3	204	197.0	52.8	264	255.0	68.3
25	24.1	06.5	85	82.1	22.0	145	140.1	37.5	205	198.0	53.1	265	256.0	68.6
26	25.1	06.7	86	83.1	22.3	146	141.0	37.8	206	199.0	53.3	266	256.9	68.8
27	26.1	07.0	87	84.0	22.5	147	142.0	38.0	207	199.9	53.6	267	257.9	69.1
28	27.0	07.2	88	85.0	22.8	148	143.0	38.3	208	200.9	53.8	268	258.9	69.4
29	28.0	07.5	89	86.0	23.0	149	143.9	38.6	209	201.9	54.1	269	259.8	69.6
30	29.0	07.8	90	86.9	23.3	150	144.9	38.8	210	202.8	54.4	270	260.8	69.9
31	29.9	08.0	91	87.9	23.6	151	145.9	39.1	211	203.8	54.6	271	261.8	70.1
32	30.9	08.3	92	88.9	23.8	152	146.8	39.3	212	204.8	54.9	272	262.7	70.4
33	31.9	08.5	93	89.8	24.1	153	147.8	39.6	213	205.7	55.1	273	263.7	70.7
34	32.8	08.8	94	90.8	24.3	154	148.8	39.9	214	206.7	55.4	274	264.7	70.9
35	33.8	09.1	95	91.8	24.6	155	149.7	40.1	215	207.7	55.6	275	265.6	71.2
36	34.8	09.3	96	92.7	24.8	156	150.7	40.4	216	208.6	55.9	276	266.6	71.4
37	35.7	09.6	97	93.7	25.1	157	151.7	40.6	217	209.6	56.2	277	267.6	71.7
38	36.7	09.8	98	94.7	25.4	158	152.6	40.9	218	210.6	56.4	278	268.5	72.0
39	37.7	10.1	99	95.6	25.6	159	153.6	41.2	219	211.5	56.7	279	269.5	72.2
40	38.6	10.4	100	96.6	25.9	160	154.5	41.4	220	212.5	56.9	280	270.5	72.5
41	39.6	10.6	101	97.6	26.1	161	155.5	41.7	221	213.5	57.2	281	271.4	72.7
42	40.6	10.9	102	98.5	26.4	162	156.5	41.9	222	214.4	57.5	282	272.4	73.0
43	41.5	11.1	103	99.5	26.7	163	157.4	42.2	223	215.4	57.7	283	273.4	73.2
44	42.5	11.4	104	100.5	26.9	164	158.4	42.4	224	216.4	58.0	284	274.3	73.5
45	43.5	11.6	105	101.4	27.2	165	159.4	42.7	225	217.3	58.2	285	275.3	73.8
46	44.4	11.9	106	102.4	27.4	166	160.3	43.0	226	218.3	58.5	286	276.3	74.0
47	45.4	12.2	107	103.4	27.7	167	161.3	43.2	227	219.3	58.8	287	277.2	74.3
48	46.4	12.4	108	104.3	28.0	168	162.3	43.5	228	220.2	59.0	288	278.2	74.5
49	47.3	12.7	109	105.3	28.2	169	163.2	43.7	229	221.2	59.3	289	279.2	74.8
50	48.3	12.9	110	106.3	28.5	170	164.2	44.0	230	222.2	59.5	290	280.1	75.1
51	49.3	13.2	111	107.2	28.7	171	165.2	44.3	231	223.1	59.8	291	281.1	75.3
52	50.2	13.5	112	108.2	29.0	172	166.1	44.5	232	224.1	60.0	292	282.1	75.6
53	51.2	13.7	113	109.1	29.2	173	167.1	44.8	233	225.1	60.3	293	283.0	75.8
54	52.2	14.0	114	110.1	29.5	174	168.1	45.0	234	226.0	60.6	294	284.0	76.1
55	53.1	14.2	115	111.1	29.8	175	169.0	45.3	235	227.0	60.8	295	284.9	76.4
56	54.1	14.5	116	112.0	30.0	176	170.0	45.6	236	228.0	61.1	296	285.9	76.6
57	55.1	14.8	117	113.0	30.3	177	171.0	45.8	237	228.9	61.3	297	286.9	76.9
58	56.0	15.0	118	114.0	30.5	178	171.9	46.1	238	229.9	61.6	298	287.8	77.1
59	57.0	15.3	119	114.9	30.8	179	172.9	46.3	239	230.9	61.9	299	288.8	77.4
60	58.0	15.5	120	115.9	31.1	180	173.9	46.6	240	231.8	62.1	300	289.8	77.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 75 Degrees. 5h 0m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 16 DEGREES. 1h 4m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.6	16.8	121	116.3	33.4	181	174.0	49.9	241	231.7	66.4
2	01.9	00.6	62	59.6	17.1	122	117.3	33.6	182	174.9	50.2	242	232.6	66.7
3	02.9	00.8	63	60.6	17.4	123	118.2	33.9	183	175.9	50.4	243	233.6	67.0
4	03.8	01.1	64	61.5	17.6	124	119.2	34.2	184	176.9	50.7	244	234.5	67.3
5	04.8	01.4	65	62.5	17.9	125	120.2	34.5	185	177.8	51.0	245	235.5	67.5
6	05.8	01.7	66	63.4	18.2	126	121.1	34.7	186	178.8	51.3	246	236.5	67.8
7	06.7	01.9	67	64.4	18.5	127	122.1	35.0	187	179.8	51.5	247	237.4	68.1
8	07.7	02.2	68	65.4	18.7	128	123.0	35.3	188	180.7	51.8	248	238.4	68.4
9	08.7	02.5	69	66.3	19.0	129	124.0	35.6	189	181.7	52.1	249	239.4	68.6
10	09.6	02.8	70	67.3	19.3	130	125.0	35.8	190	182.6	52.4	250	240.3	68.9
11	10.6	03.0	71	68.2	19.6	131	125.9	36.1	191	183.6	52.6	251	241.3	69.2
12	11.5	03.3	72	69.2	19.8	132	126.9	36.4	192	184.6	52.9	252	242.2	69.5
13	12.5	03.6	73	70.2	20.1	133	127.8	36.7	193	185.5	53.2	253	243.2	69.7
14	13.5	03.9	74	71.1	20.4	134	128.8	36.9	194	186.5	53.5	254	244.2	70.0
15	14.4	04.1	75	72.1	20.7	135	129.8	37.2	195	187.4	53.7	255	245.1	70.3
16	15.4	04.4	76	73.1	20.9	136	130.7	37.5	196	188.4	54.0	256	246.1	70.6
17	16.3	04.7	77	74.0	21.2	137	131.7	37.8	197	189.4	54.3	257	247.0	70.8
18	17.3	05.0	78	75.0	21.5	138	132.7	38.0	198	190.3	54.6	258	248.0	71.1
19	18.3	05.2	79	75.9	21.8	139	133.6	38.3	199	191.3	54.9	259	249.0	71.4
20	19.2	05.5	80	76.9	22.1	140	134.6	38.6	200	192.3	55.1	260	249.9	71.7
21	20.2	05.8	81	77.9	22.3	141	135.5	38.9	201	193.2	55.4	261	250.9	71.9
22	21.1	06.1	82	78.8	22.6	142	136.5	39.1	202	194.2	55.7	262	251.9	72.2
23	22.1	06.3	83	79.8	22.9	143	137.5	39.4	203	195.1	56.0	263	252.8	72.5
24	23.1	06.6	84	80.7	23.2	144	138.4	39.7	204	196.1	56.2	264	253.8	72.8
25	24.0	06.9	85	81.7	23.4	145	139.4	40.0	205	197.1	56.5	265	254.7	73.0
26	25.0	07.2	86	82.7	23.7	146	140.3	40.2	206	198.0	56.8	266	255.7	73.3
27	26.0	07.4	87	83.6	24.0	147	141.3	40.5	207	199.0	57.1	267	256.7	73.6
28	26.9	07.7	88	84.6	24.3	148	142.3	40.8	208	199.9	57.3	268	257.6	73.9
29	27.9	08.0	89	85.6	24.5	149	143.2	41.1	209	200.9	57.6	269	258.6	74.1
30	28.8	08.3	90	86.5	24.8	150	144.2	41.3	210	201.9	57.9	270	259.5	74.4
31	29.8	08.5	91	87.5	25.1	151	145.2	41.6	211	202.8	58.2	271	260.5	74.7
32	30.8	08.8	92	88.4	25.4	152	146.1	41.9	212	203.8	58.4	272	261.5	75.0
33	31.7	09.1	93	89.4	25.6	153	147.1	42.2	213	204.7	58.7	273	262.4	75.2
34	32.7	09.4	94	90.4	25.9	154	148.0	42.4	214	205.7	59.0	274	263.4	75.5
35	33.6	09.6	95	91.3	26.2	155	149.0	42.7	215	206.7	59.3	275	264.3	75.8
36	34.6	09.9	96	92.3	26.5	156	150.0	43.0	216	207.6	59.5	276	265.3	76.1
37	35.6	10.2	97	93.2	26.7	157	150.9	43.3	217	208.6	59.8	277	266.3	76.4
38	36.5	10.5	98	94.2	27.0	158	151.9	43.6	218	209.6	60.1	278	267.2	76.6
39	37.5	10.7	99	95.2	27.3	159	152.8	43.8	219	210.5	60.4	279	268.2	76.9
40	38.5	11.0	100	96.1	27.6	160	153.8	44.1	220	211.5	60.6	280	269.2	77.2
41	39.4	11.3	101	97.1	27.8	161	154.8	44.4	221	212.4	60.9	281	270.1	77.5
42	40.4	11.6	102	98.0	28.1	162	155.7	44.7	222	213.4	61.2	282	271.1	77.7
43	41.3	11.9	103	99.0	28.4	163	156.7	44.9	223	214.4	61.5	283	272.0	78.0
44	42.3	12.1	104	100.0	28.7	164	157.6	45.2	224	215.3	61.7	284	273.0	78.3
45	43.3	12.4	105	100.9	28.9	165	158.6	45.5	225	216.3	62.0	285	274.0	78.6
46	44.2	12.7	106	101.9	29.2	166	159.6	45.8	226	217.2	62.3	286	274.9	78.8
47	45.2	13.0	107	102.9	29.5	167	160.5	46.0	227	218.2	62.6	287	275.9	79.1
48	46.1	13.2	108	103.8	29.8	168	161.5	46.3	228	219.2	62.8	288	276.8	79.4
49	47.1	13.5	109	104.8	30.0	169	162.5	46.6	229	220.1	63.1	289	277.8	79.7
50	48.1	13.8	110	105.7	30.3	170	163.4	46.9	230	221.1	63.4	290	278.8	79.9
51	49.0	14.1	111	106.7	30.6	171	164.4	47.1	231	222.1	63.7	291	279.7	80.2
52	50.0	14.3	112	107.7	30.9	172	165.3	47.4	232	223.0	63.9	292	280.7	80.5
53	50.9	14.6	113	108.6	31.1	173	166.3	47.7	233	224.0	64.2	293	281.6	80.8
54	51.9	14.9	114	109.6	31.4	174	167.3	48.0	234	224.9	64.5	294	282.6	81.0
55	52.9	15.2	115	110.5	31.7	175	168.2	48.2	235	225.9	64.8	295	283.6	81.3
56	53.8	15.4	116	111.5	32.0	176	169.2	48.5	236	226.9	65.1	296	284.5	81.6
57	54.8	15.7	117	112.5	32.2	177	170.1	48.8	237	227.8	65.3	297	285.5	81.9
58	55.8	16.0	118	113.4	32.5	178	171.1	49.1	238	228.8	65.6	298	286.5	82.1
59	56.7	16.3	119	114.4	32.8	179	172.1	49.3	239	229.7	65.9	299	287.4	82.4
60	57.7	16.5	120	115.4	33.1	180	173.0	49.6	240	230.7	66.2	300	288.4	82.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 17 DEGREES. 1h 8m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.3	17.8	121	115.7	35.4	181	173.1	52.9	241	230.5	70.5
2	01.9	00.6	62	59.3	18.1	122	116.7	35.7	182	174.0	53.2	242	231.4	70.8
3	02.9	00.9	63	60.2	18.4	123	117.6	36.0	183	175.0	53.5	243	232.4	71.0
4	03.8	01.2	64	61.2	18.7	124	118.6	36.3	184	176.0	53.8	244	233.3	71.3
5	04.8	01.5	65	62.2	19.0	125	119.5	36.5	185	176.9	54.1	245	234.3	71.6
6	05.7	01.8	66	63.1	19.3	126	120.5	36.8	186	177.9	54.4	246	235.3	71.9
7	06.7	02.0	67	64.1	19.6	127	121.5	37.1	187	178.8	54.7	247	236.2	72.2
8	07.7	02.3	68	65.0	19.9	128	122.4	37.4	188	179.8	55.0	248	237.2	72.5
9	08.6	02.6	69	66.0	20.2	129	123.4	37.7	189	180.7	55.3	249	238.1	72.8
10	09.6	02.9	70	66.9	20.5	130	124.3	38.0	190	181.7	55.6	250	239.1	73.1
11	10.5	03.2	71	67.9	20.8	131	125.3	38.3	191	182.7	55.8	251	240.0	73.4
12	11.5	03.5	72	68.9	21.1	132	126.2	38.6	192	183.6	56.1	252	241.0	73.7
13	12.4	03.8	73	69.8	21.3	133	127.2	38.9	193	184.6	56.4	253	241.9	74.0
14	13.4	04.1	74	70.8	21.6	134	128.1	39.2	194	185.5	56.7	254	242.9	74.3
15	14.3	04.4	75	71.7	21.9	135	129.1	39.5	195	186.5	57.0	255	243.9	74.6
16	15.3	04.7	76	72.7	22.2	136	130.1	39.8	196	187.4	57.3	256	244.8	74.8
17	16.3	05.0	77	73.6	22.5	137	131.0	40.1	197	188.4	57.6	257	245.8	75.1
18	17.2	05.3	78	74.6	22.8	138	132.0	40.3	198	189.3	57.9	258	246.7	75.4
19	18.2	05.6	79	75.5	23.1	139	132.9	40.6	199	190.3	58.2	259	247.7	75.7
20	19.1	05.8	80	76.5	23.4	140	133.9	40.9	200	191.3	58.5	260	248.6	76.0
21	20.1	06.1	81	77.5	23.7	141	134.8	41.2	201	192.2	58.8	261	249.6	76.3
22	21.0	06.4	82	78.4	24.0	142	135.8	41.5	202	193.2	59.1	262	250.6	76.6
23	22.0	06.7	83	79.4	24.3	143	136.8	41.8	203	194.1	59.4	263	251.5	76.9
24	23.0	07.0	84	80.3	24.6	144	137.7	42.1	204	195.1	59.6	264	252.5	77.2
25	23.9	07.3	85	81.3	24.9	145	138.7	42.4	205	196.0	59.9	265	253.4	77.5
26	24.9	07.6	86	82.2	25.1	146	139.6	42.7	206	197.0	60.2	266	254.4	77.8
27	25.8	07.9	87	83.2	25.4	147	140.6	43.0	207	198.0	60.5	267	255.3	78.1
28	26.8	08.2	88	84.2	25.7	148	141.5	43.3	208	198.9	60.8	268	256.3	78.4
29	27.7	08.5	89	85.1	26.0	149	142.5	43.6	209	199.9	61.1	269	257.2	78.6
30	28.7	08.8	90	86.1	26.3	150	143.4	43.9	210	200.8	61.4	270	258.2	78.9
31	29.6	09.1	91	87.0	26.6	151	144.4	44.1	211	201.8	61.7	271	259.2	79.2
32	30.6	09.4	92	88.0	26.9	152	145.4	44.4	212	202.7	62.0	272	260.1	79.5
33	31.6	09.6	93	88.9	27.2	153	146.3	44.7	213	203.7	62.3	273	261.1	79.8
34	32.5	09.9	94	89.9	27.5	154	147.3	45.0	214	204.6	62.6	274	262.0	80.1
35	33.5	10.2	95	90.8	27.8	155	148.2	45.3	215	205.6	62.9	275	263.0	80.4
36	34.4	10.5	96	91.8	28.1	156	149.2	45.6	216	206.6	63.2	276	263.9	80.7
37	35.4	10.8	97	92.8	28.4	157	150.1	45.9	217	207.5	63.4	277	264.9	81.0
38	36.3	11.1	98	93.7	28.7	158	151.1	46.2	218	208.5	63.7	278	265.9	81.3
39	37.3	11.4	99	94.7	28.9	159	152.1	46.5	219	209.4	64.0	279	266.8	81.6
40	38.3	11.7	100	95.6	29.2	160	153.0	46.8	220	210.4	64.3	280	267.8	81.9
41	39.2	12.0	101	96.6	29.5	161	154.0	47.1	221	211.3	64.6	281	268.7	82.2
42	40.2	12.3	102	97.5	29.8	162	154.9	47.4	222	212.3	64.9	282	269.7	82.4
43	41.1	12.6	103	98.5	30.1	163	155.9	47.7	223	213.3	65.2	283	270.6	82.7
44	42.1	12.9	104	99.5	30.4	164	156.8	47.9	224	214.2	65.5	284	271.6	83.0
45	43.0	13.2	105	100.4	30.7	165	157.8	48.2	225	215.2	65.8	285	272.5	83.3
46	44.0	13.4	106	101.4	31.0	166	158.7	48.5	226	216.1	66.1	286	273.5	83.6
47	44.9	13.7	107	102.3	31.3	167	159.7	48.8	227	217.1	66.4	287	274.5	83.9
48	45.9	14.0	108	103.3	31.6	168	160.7	49.1	228	218.0	66.7	288	275.4	84.2
49	46.9	14.3	109	104.2	31.9	169	161.6	49.4	229	219.0	67.0	289	276.4	84.5
50	47.8	14.6	110	105.2	32.2	170	162.6	49.7	230	220.0	67.2	290	277.3	84.8
51	48.8	14.9	111	106.1	32.5	171	163.5	50.0	231	220.9	67.5	291	278.3	85.1
52	49.7	15.2	112	107.1	32.7	172	164.5	50.3	232	221.9	67.8	292	279.2	85.4
53	50.7	15.5	113	108.1	33.0	173	165.4	50.6	233	222.8	68.1	293	280.2	85.7
54	51.6	15.8	114	109.0	33.3	174	166.4	50.9	234	223.8	68.4	294	281.2	86.0
55	52.6	16.1	115	110.0	33.6	175	167.4	51.2	235	224.7	68.7	295	282.1	86.2
56	53.6	16.4	116	110.9	33.9	176	168.3	51.5	236	225.7	69.0	296	283.1	86.5
57	54.5	16.7	117	111.9	34.2	177	169.3	51.7	237	226.6	69.3	297	284.0	86.8
58	55.5	17.0	118	112.8	34.5	178	170.2	52.0	238	227.6	69.6	298	285.0	87.1
59	56.4	17.2	119	113.8	34.8	179	171.2	52.3	239	228.6	69.9	299	285.9	87.4
60	57.4	17.5	120	114.8	35.1	180	172.1	52.6	240	229.5	70.2	300	286.9	87.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 73 Degrees. 4h 52m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 18 DEGREES. 1h 12m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	01.0	00.3	61	58.0	18.9	121	115.1	37.4	181	172.1	55.9	241	229.2	74.5
2	01.9	00.6	62	59.0	19.2	122	116.0	37.7	182	173.1	56.2	242	230.2	74.8
3	02.9	00.9	63	59.9	19.5	123	117.0	38.0	183	174.0	56.6	243	231.1	75.1
4	03.8	01.2	64	60.9	19.8	124	117.9	38.3	184	175.0	56.9	244	232.1	75.4
5	04.8	01.5	65	61.8	20.1	125	118.9	38.6	185	175.9	57.2	245	233.0	75.7
6	05.7	01.9	66	62.8	20.4	126	119.8	38.9	186	176.9	57.5	246	234.0	76.0
7	06.7	02.2	67	63.7	20.7	127	120.8	39.2	187	177.8	57.8	247	234.9	76.3
8	07.6	02.5	68	64.7	21.0	128	121.7	39.6	188	178.8	58.1	248	235.9	76.6
9	08.6	02.8	69	65.6	21.3	129	122.7	39.9	189	179.7	58.4	249	236.8	76.9
10	09.5	03.1	70	66.6	21.6	130	123.6	40.2	190	180.7	58.7	250	237.8	77.3
11	10.5	03.4	71	67.5	21.9	131	124.6	40.5	191	181.7	59.0	251	238.7	77.6
12	11.4	03.7	72	68.5	22.2	132	125.5	40.8	192	182.6	59.3	252	239.7	77.9
13	12.4	04.0	73	69.4	22.6	133	126.5	41.1	193	183.6	59.6	253	240.6	78.2
14	13.3	04.3	74	70.4	22.9	134	127.4	41.4	194	184.5	59.9	254	241.6	78.5
15	14.3	04.6	75	71.3	23.2	135	128.4	41.7	195	185.5	60.3	255	242.5	78.8
16	15.2	04.9	76	72.3	23.5	136	129.3	42.0	196	186.4	60.6	256	243.5	79.1
17	16.2	05.3	77	73.2	23.8	137	130.3	42.3	197	187.4	60.9	257	244.4	79.4
18	17.1	05.6	78	74.2	24.1	138	131.2	42.6	198	188.3	61.2	258	245.4	79.7
19	18.1	05.9	79	75.1	24.4	139	132.2	43.0	199	189.3	61.5	259	246.3	80.0
20	19.0	06.2	80	76.1	24.7	140	133.1	43.3	200	190.2	61.8	260	247.3	80.3
21	20.0	06.5	81	77.0	25.0	141	134.1	43.6	201	191.2	62.1	261	248.2	80.7
22	20.9	06.8	82	78.0	25.3	142	135.1	43.9	202	192.1	62.4	262	249.2	81.0
23	21.9	07.1	83	78.9	25.6	143	136.0	44.2	203	193.1	62.7	263	250.1	81.3
24	22.8	07.4	84	79.9	26.0	144	137.0	44.5	204	194.0	63.0	264	251.1	81.6
25	23.8	07.7	85	80.8	26.3	145	137.9	44.8	205	195.0	63.3	265	252.0	81.9
26	24.7	08.0	86	81.8	26.6	146	138.9	45.1	206	195.9	63.7	266	253.0	82.2
27	25.7	08.3	87	82.7	26.9	147	139.8	45.4	207	196.9	64.0	267	253.9	82.5
28	26.6	08.7	88	83.7	27.2	148	140.8	45.7	208	197.8	64.3	268	254.9	82.8
29	27.6	09.0	89	84.6	27.5	149	141.7	46.0	209	198.8	64.6	269	255.8	83.1
30	28.5	09.3	90	85.6	27.8	150	142.7	46.4	210	199.7	64.9	270	256.8	83.4
31	29.5	09.6	91	86.5	28.1	151	143.6	46.7	211	200.7	65.2	271	257.7	83.7
32	30.4	09.9	92	87.5	28.4	152	144.6	47.0	212	201.6	65.5	272	258.7	84.1
33	31.4	10.2	93	88.4	28.7	153	145.5	47.3	213	202.6	65.8	273	259.6	84.4
34	32.3	10.5	94	89.4	29.0	154	146.5	47.6	214	203.5	66.1	274	260.6	84.7
35	33.3	10.8	95	90.4	29.4	155	147.4	47.9	215	204.5	66.4	275	261.5	85.0
36	34.2	11.1	96	91.3	29.7	156	148.4	48.2	216	205.4	66.7	276	262.5	85.3
37	35.2	11.4	97	92.3	30.0	157	149.3	48.5	217	206.4	67.1	277	263.4	85.6
38	36.1	11.7	98	93.2	30.3	158	150.3	48.8	218	207.3	67.4	278	264.4	85.9
39	37.1	12.1	99	94.2	30.6	159	151.2	49.1	219	208.3	67.7	279	265.3	86.2
40	38.0	12.4	100	95.1	30.9	160	152.2	49.4	220	209.2	68.0	280	266.3	86.5
41	39.0	12.7	101	96.1	31.2	161	153.1	49.8	221	210.2	68.3	281	267.2	86.8
42	39.9	13.0	102	97.0	31.5	162	154.1	50.1	222	211.1	68.6	282	268.2	87.1
43	40.9	13.3	103	98.0	31.8	163	155.0	50.4	223	212.1	68.9	283	269.1	87.5
44	41.8	13.6	104	98.9	32.1	164	156.0	50.7	224	213.0	69.2	284	270.1	87.8
45	42.8	13.9	105	99.9	32.4	165	156.9	51.0	225	214.0	69.5	285	271.1	88.1
46	43.7	14.2	106	100.8	32.8	166	157.9	51.3	226	214.9	69.8	286	272.0	88.4
47	44.7	14.5	107	101.8	33.1	167	158.8	51.6	227	215.9	70.1	287	273.0	88.7
48	45.7	14.8	108	102.7	33.4	168	159.8	51.9	228	216.8	70.5	288	273.9	89.0
49	46.6	15.1	109	103.7	33.7	169	160.7	52.2	229	217.8	70.8	289	274.9	89.3
50	47.6	15.5	110	104.6	34.0	170	161.7	52.5	230	218.7	71.1	290	275.8	89.6
51	48.5	15.8	111	105.6	34.3	171	162.6	52.8	231	219.7	71.4	291	276.8	89.9
52	49.5	16.1	112	106.5	34.6	172	163.6	53.2	232	220.6	71.7	292	277.7	90.2
53	50.4	16.4	113	107.5	34.9	173	164.5	53.5	233	221.6	72.0	293	278.7	90.5
54	51.4	16.7	114	108.4	35.2	174	165.5	53.8	234	222.5	72.3	294	279.6	90.9
55	52.3	17.0	115	109.4	35.5	175	166.4	54.1	235	223.5	72.6	295	280.6	91.2
56	53.3	17.3	116	110.3	35.8	176	167.4	54.4	236	224.4	72.9	296	281.5	91.5
57	54.2	17.6	117	111.3	36.2	177	168.3	54.7	237	225.4	73.2	297	282.5	91.8
58	55.2	17.9	118	112.2	36.5	178	169.3	55.0	238	226.4	73.5	298	283.4	92.1
59	56.1	18.2	119	113.2	36.8	179	170.2	55.3	239	227.3	73.9	299	284.4	92.4
60	57.1	18.5	120	114.1	37.1	180	171.2	55.6	240	228.3	74.2	300	285.3	92.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 72 Degrees. 4h 48m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 19 DEGREES. 1h 16m

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.7	19.9	121	114.4	39.4	181	171.1	58.9	241	227.9	78.5
2	01.9	00.7	62	58.6	20.2	122	115.4	39.7	182	172.1	59.3	242	228.8	78.8
3	02.8	01.0	63	59.6	20.5	123	116.3	40.0	183	173.0	59.6	243	229.8	79.1
4	03.8	01.3	64	60.5	20.8	124	117.2	40.4	184	174.0	59.9	244	230.7	79.4
5	04.7	01.6	65	61.5	21.2	125	118.2	40.7	185	174.9	60.2	245	231.7	79.8
6	05.7	02.0	66	62.4	21.5	126	119.1	41.0	186	175.9	60.6	246	232.6	80.1
7	06.6	02.3	67	63.3	21.8	127	120.1	41.3	187	176.8	60.9	247	233.5	80.4
8	07.6	02.6	68	64.3	22.1	128	121.0	41.7	188	177.8	61.2	248	234.5	80.7
9	08.5	02.9	69	65.2	22.5	129	122.0	42.0	189	178.7	61.5	249	235.4	81.1
10	09.5	03.3	70	66.2	22.8	130	122.9	42.3	190	179.6	61.9	250	236.4	81.4
11	10.4	03.6	71	67.1	23.1	131	123.9	42.6	191	180.6	62.2	251	237.3	81.7
12	11.3	03.9	72	68.1	23.4	132	124.8	43.0	192	181.5	62.5	252	238.3	82.0
13	12.3	04.2	73	69.0	23.8	133	125.8	43.3	193	182.5	62.8	253	239.2	82.4
14	13.2	04.6	74	70.0	24.1	134	126.7	43.6	194	183.4	63.2	254	240.2	82.7
15	14.2	04.9	75	70.9	24.4	135	127.6	44.0	195	184.4	63.5	255	241.1	83.0
16	15.1	05.2	76	71.9	24.7	136	128.6	44.3	196	185.3	63.8	256	242.1	83.3
17	16.1	05.5	77	72.8	25.1	137	129.5	44.6	197	186.3	64.1	257	243.0	83.7
18	17.0	05.9	78	73.8	25.4	138	130.5	44.9	198	187.2	64.5	258	243.9	84.0
19	18.0	06.2	79	74.7	25.7	139	131.4	45.3	199	188.2	64.8	259	244.9	84.3
20	18.9	06.5	80	75.6	26.0	140	132.4	45.6	200	189.1	65.1	260	245.8	84.6
21	19.9	06.8	81	76.6	26.4	141	133.3	45.9	201	190.0	65.4	261	246.8	85.0
22	20.8	07.2	82	77.5	26.7	142	134.3	46.2	202	191.0	65.8	262	247.7	85.3
23	21.7	07.5	83	78.5	27.0	143	135.2	46.6	203	191.9	66.1	263	248.7	85.6
24	22.7	07.8	84	79.4	27.3	144	136.2	46.9	204	192.9	66.4	264	249.6	86.0
25	23.6	08.1	85	80.4	27.7	145	137.1	47.2	205	193.8	66.7	265	250.6	86.3
26	24.6	08.5	86	81.3	28.0	146	138.0	47.5	206	194.8	67.1	266	251.5	86.6
27	25.5	08.8	87	82.3	28.3	147	139.0	47.9	207	195.7	67.4	267	252.5	86.9
28	26.5	09.1	88	83.2	28.7	148	139.9	48.2	208	196.7	67.7	268	253.4	87.3
29	27.4	09.4	89	84.2	29.0	149	140.9	48.5	209	197.6	68.0	269	254.3	87.6
30	28.4	09.8	90	85.1	29.3	150	141.8	48.8	210	198.6	68.4	270	255.3	87.9
31	29.3	10.1	91	86.0	29.6	151	142.8	49.2	211	199.5	68.7	271	256.2	88.2
32	30.3	10.4	92	87.0	30.0	152	143.7	49.5	212	200.4	69.0	272	257.2	88.6
33	31.2	10.7	93	87.9	30.3	153	144.7	49.8	213	201.4	69.3	273	258.1	88.9
34	32.1	11.1	94	88.9	30.6	154	145.6	50.1	214	202.3	69.7	274	259.1	89.2
35	33.1	11.4	95	89.8	30.9	155	146.6	50.5	215	203.3	70.0	275	260.0	89.5
36	34.0	11.7	96	90.8	31.3	156	147.5	50.8	216	204.2	70.3	276	261.0	89.9
37	35.0	12.0	97	91.7	31.6	157	148.4	51.1	217	205.2	70.6	277	261.9	90.2
38	35.9	12.4	98	92.7	31.9	158	149.4	51.4	218	206.1	71.0	278	262.9	90.5
39	36.9	12.7	99	93.6	32.2	159	150.3	51.8	219	207.1	71.3	279	263.8	90.8
40	37.8	13.0	100	94.6	32.6	160	151.3	52.1	220	208.0	71.6	280	264.7	91.2
41	38.8	13.3	101	95.5	32.9	161	152.2	52.4	221	209.0	72.0	281	265.7	91.5
42	39.7	13.7	102	96.4	33.2	162	153.2	52.7	222	209.9	72.3	282	266.6	91.8
43	40.7	14.0	103	97.4	33.5	163	154.1	53.1	223	210.9	72.6	283	267.6	92.1
44	41.6	14.3	104	98.3	33.9	164	155.1	53.4	224	211.8	72.9	284	268.5	92.5
45	42.5	14.7	105	99.3	34.2	165	156.0	53.7	225	212.7	73.3	285	269.5	92.8
46	43.5	15.0	106	100.2	34.5	166	157.0	54.0	226	213.7	73.6	286	270.4	93.1
47	44.4	15.3	107	101.2	34.8	167	157.9	54.4	227	214.6	73.9	287	271.4	93.4
48	45.4	15.6	108	102.1	35.2	168	158.8	54.7	228	215.6	74.2	288	272.3	93.8
49	46.3	16.0	109	103.1	35.5	169	159.8	55.0	229	216.5	74.6	289	273.3	94.1
50	47.3	16.3	110	104.0	35.8	170	160.7	55.3	230	217.5	74.9	290	274.2	94.4
51	48.2	16.6	111	105.0	36.1	171	161.7	55.7	231	218.4	75.2	291	275.1	94.7
52	49.2	16.9	112	105.9	36.5	172	162.6	56.0	232	219.4	75.5	292	276.1	95.1
53	50.1	17.3	113	106.8	36.8	173	163.6	56.3	233	220.3	75.9	293	277.0	95.4
54	51.1	17.6	114	107.8	37.1	174	164.5	56.6	234	221.3	76.2	294	278.0	95.7
55	52.0	17.9	115	108.7	37.4	175	165.5	57.0	235	222.2	76.5	295	278.9	96.0
56	52.9	18.2	116	109.7	37.8	176	166.4	57.3	236	223.1	76.8	296	279.9	96.4
57	53.9	18.6	117	110.6	38.1	177	167.4	57.6	237	224.1	77.2	297	280.8	96.7
58	54.8	18.9	118	111.6	38.4	178	168.3	58.0	238	225.0	77.5	298	281.8	97.0
59	55.8	19.2	119	112.5	38.7	179	169.2	58.3	239	226.0	77.8	299	282.7	97.3
60	56.7	19.5	120	113.5	39.1	180	170.2	58.6	240	226.9	78.1	300	283.7	97.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 71 Degrees. 4h 44m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 20 DEGREES. 1h 20m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.3	61	57.3	20.9	121	113.7	41.4	181	170.1	61.9	241	226.5	82.4
2	01.9	00.7	62	58.3	21.2	122	114.6	41.7	182	171.0	62.2	242	227.4	82.8
3	02.8	01.0	63	59.2	21.5	123	115.6	42.1	183	172.0	62.6	243	228.3	83.1
4	03.8	01.4	64	60.1	21.9	124	116.5	42.4	184	172.9	62.9	244	229.3	83.5
5	04.7	01.7	65	61.1	22.2	125	117.5	42.8	185	173.8	63.3	245	230.2	83.8
6	05.6	02.1	66	62.0	22.6	126	118.4	43.1	186	174.8	63.6	246	231.2	84.1
7	06.6	02.4	67	63.0	22.9	127	119.3	43.4	187	175.7	64.0	247	232.1	84.5
8	07.5	02.7	68	63.9	23.3	128	120.3	43.8	188	176.7	64.3	248	233.0	84.8
9	08.5	03.1	69	64.8	23.6	129	121.2	44.1	189	177.6	64.6	249	234.0	85.2
10	09.4	03.4	70	65.8	23.9	130	122.2	44.5	190	178.5	65.0	250	234.9	85.5
11	10.3	03.8	71	66.7	24.3	131	123.1	44.8	191	179.5	65.3	251	235.9	85.8
12	11.3	04.1	72	67.7	24.6	132	124.0	45.1	192	180.4	65.7	252	236.8	86.2
13	12.2	04.4	73	68.6	25.0	133	125.0	45.5	193	181.4	66.0	253	237.7	86.5
14	13.2	04.8	74	69.5	25.3	134	125.9	45.8	194	182.3	66.4	254	238.7	86.9
15	14.1	05.1	75	70.5	25.7	135	126.9	46.2	195	183.2	66.7	255	239.6	87.2
16	15.0	05.5	76	71.4	26.0	136	127.8	46.5	196	184.2	67.0	256	240.6	87.6
17	16.0	05.8	77	72.4	26.3	137	128.7	46.9	197	185.1	67.4	257	241.5	87.9
18	16.9	06.2	78	73.3	26.7	138	129.7	47.2	198	186.1	67.7	258	242.4	88.2
19	17.9	06.5	79	74.2	27.0	139	130.6	47.5	199	187.0	68.1	259	243.4	88.6
20	18.8	06.8	80	75.2	27.4	140	131.6	47.9	200	187.9	68.4	260	244.3	88.9
21	19.7	07.2	81	76.1	27.7	141	132.5	48.2	201	188.9	68.7	261	245.3	89.3
22	20.7	07.5	82	77.1	28.0	142	133.4	48.6	202	189.8	69.1	262	246.2	89.6
23	21.6	07.9	83	78.0	28.4	143	134.4	48.9	203	190.8	69.4	263	247.1	90.0
24	22.6	08.2	84	78.9	28.7	144	135.3	49.3	204	191.7	69.8	264	248.1	90.3
25	23.5	08.6	85	79.9	29.1	145	136.3	49.6	205	192.6	70.1	265	249.0	90.6
26	24.4	08.9	86	80.8	29.4	146	137.2	49.9	206	193.6	70.5	266	250.0	91.0
27	25.4	09.2	87	81.8	29.8	147	138.1	50.3	207	194.5	70.8	267	250.9	91.3
28	26.3	09.6	88	82.7	30.1	148	139.1	50.6	208	195.5	71.1	268	251.8	91.7
29	27.3	09.9	89	83.6	30.4	149	140.0	51.0	209	196.4	71.5	269	252.8	92.0
30	28.2	10.3	90	84.6	30.8	150	141.0	51.3	210	197.3	71.8	270	253.7	92.3
31	29.1	10.6	91	85.5	31.1	151	141.9	51.6	211	198.3	72.2	271	254.7	92.7
32	30.1	10.9	92	86.5	31.5	152	142.8	52.0	212	199.2	72.5	272	255.6	93.0
33	31.0	11.3	93	87.4	31.8	153	143.8	52.3	213	200.2	72.9	273	256.5	93.4
34	31.9	11.6	94	88.3	32.1	154	144.7	52.7	214	201.1	73.2	274	257.5	93.7
35	32.9	12.0	95	89.3	32.5	155	145.7	53.0	215	202.0	73.5	275	258.4	94.1
36	33.8	12.3	96	90.2	32.8	156	146.6	53.4	216	203.0	73.9	276	259.4	94.4
37	34.8	12.7	97	91.2	33.2	157	147.5	53.7	217	203.9	74.2	277	260.3	94.7
38	35.7	13.0	98	92.1	33.5	158	148.5	54.0	218	204.9	74.6	278	261.2	95.1
39	36.6	13.3	99	93.0	33.9	159	149.4	54.4	219	205.8	74.9	279	262.2	95.4
40	37.6	13.7	100	94.0	34.2	160	150.4	54.7	220	206.7	75.2	280	263.1	95.8
41	38.5	14.0	101	94.9	34.5	161	151.3	55.1	221	207.7	75.6	281	264.1	96.1
42	39.5	14.4	102	95.8	34.9	162	152.2	55.4	222	208.6	75.9	282	265.0	96.4
43	40.4	14.7	103	96.8	35.2	163	153.2	55.7	223	209.6	76.3	283	265.9	96.8
44	41.3	15.0	104	97.7	35.6	164	154.1	56.1	224	210.5	76.6	284	266.9	97.1
45	42.3	15.4	105	98.7	35.9	165	155.0	56.4	225	211.4	77.0	285	267.8	97.5
46	43.2	15.7	106	99.6	36.3	166	156.0	56.8	226	212.4	77.3	286	268.8	97.8
47	44.2	16.1	107	100.5	36.6	167	156.9	57.1	227	213.3	77.6	287	269.7	98.2
48	45.1	16.4	108	101.5	36.9	168	157.9	57.5	228	214.2	78.0	288	270.6	98.5
49	46.0	16.8	109	102.4	37.3	169	158.8	57.8	229	215.2	78.3	289	271.6	98.8
50	47.0	17.1	110	103.4	37.6	170	159.7	58.1	230	216.1	78.7	290	272.5	99.2
51	47.9	17.4	111	104.3	38.0	171	160.7	58.5	231	217.1	79.0	291	273.5	99.5
52	48.9	17.8	112	105.2	38.3	172	161.6	58.8	232	218.0	79.3	292	274.4	99.9
53	49.8	18.1	113	106.2	38.6	173	162.6	59.2	233	218.9	79.7	293	275.3	100.2
54	50.7	18.5	114	107.1	39.0	174	163.5	59.5	234	219.9	80.0	294	276.3	100.6
55	51.7	18.8	115	108.1	39.3	175	164.4	59.9	235	220.8	80.4	295	277.2	100.9
56	52.6	19.2	116	109.0	39.7	176	165.4	60.2	236	221.8	80.7	296	278.1	101.2
57	53.6	19.5	117	109.9	40.0	177	166.3	60.5	237	222.7	81.1	297	279.1	101.6
58	54.5	19.8	118	110.9	40.4	178	167.3	60.9	238	223.6	81.4	298	280.0	101.9
59	55.4	20.2	119	111.8	40.7	179	168.2	61.2	239	224.6	81.7	299	281.0	102.3
60	56.4	20.5	120	112.8	41.0	180	169.1	61.6	240	225.5	82.1	300	281.9	102.6
Dist.	Dep.	Lat.	Dist	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 21 DEGREES. 1h 24m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.9	21.9	121	113.0	43.4	181	169.0	64.9	241	225.0	86.4
2	01.9	00.7	62	57.9	22.2	122	113.9	43.7	182	169.9	65.2	242	225.9	86.7
3	02.8	01.1	63	58.8	22.6	123	114.8	44.1	183	170.8	65.6	243	226.9	87.1
4	03.7	01.4	64	59.7	22.9	124	115.8	44.4	184	171.8	65.9	244	227.8	87.4
5	04.7	01.8	65	60.7	23.3	125	116.7	44.8	185	172.7	66.3	245	228.7	87.8
6	05.6	02.2	66	61.6	23.7	126	117.6	45.2	186	173.6	66.7	246	229.7	88.2
7	06.5	02.5	67	62.5	24.0	127	118.6	45.5	187	174.6	67.0	247	230.6	88.5
8	07.5	02.9	68	63.5	24.4	128	119.5	45.9	188	175.5	67.4	248	231.5	88.9
9	08.4	03.2	69	64.4	24.7	129	120.4	46.2	189	176.4	67.7	249	232.5	89.2
10	09.3	03.6	70	65.4	25.1	130	121.4	46.6	190	177.4	68.1	250	233.4	89.6
11	10.3	03.9	71	66.3	25.4	131	122.3	46.9	191	178.3	68.4	251	234.3	90.0
12	11.2	04.3	72	67.2	25.8	132	123.2	47.3	192	179.2	68.8	252	235.3	90.3
13	12.1	04.7	73	68.2	26.2	133	124.2	47.7	193	180.2	69.2	253	236.2	90.7
14	13.1	05.0	74	69.1	26.5	134	125.1	48.0	194	181.1	69.5	254	237.1	91.0
15	14.0	05.4	75	70.0	26.9	135	126.0	48.4	195	182.0	69.9	255	238.1	91.4
16	14.9	05.7	76	71.0	27.2	136	127.0	48.7	196	183.0	70.2	256	239.0	91.7
17	15.9	06.1	77	71.9	27.6	137	127.9	49.1	197	183.9	70.6	257	239.9	92.1
18	16.8	06.5	78	72.8	28.0	138	128.8	49.5	198	184.8	71.0	258	240.9	92.5
19	17.7	06.8	79	73.8	28.3	139	129.8	49.8	199	185.8	71.3	259	241.8	92.8
20	18.7	07.2	80	74.7	28.7	140	130.7	50.2	200	186.7	71.7	260	242.7	93.2
21	19.6	07.5	81	75.6	29.0	141	131.6	50.5	201	187.6	72.0	261	243.7	93.5
22	20.5	07.9	82	76.6	29.4	142	132.6	50.9	202	188.6	72.4	262	244.6	93.9
23	21.5	08.2	83	77.5	29.7	143	133.5	51.2	203	189.5	72.7	263	245.5	94.3
24	22.4	08.6	84	78.4	30.1	144	134.4	51.6	204	190.5	73.1	264	246.5	94.6
25	23.3	09.0	85	79.4	30.5	145	135.4	52.0	205	191.4	73.5	265	247.4	95.0
26	24.3	09.3	86	80.3	30.8	146	136.3	52.3	206	192.3	73.8	266	248.3	95.3
27	25.2	09.7	87	81.2	31.2	147	137.2	52.7	207	193.3	74.2	267	249.3	95.7
28	26.1	10.0	88	82.2	31.5	148	138.2	53.0	208	194.2	74.5	268	250.2	96.0
29	27.1	10.4	89	83.1	31.9	149	139.1	53.4	209	195.1	74.9	269	251.1	96.4
30	28.0	10.8	90	84.0	32.3	150	140.0	53.8	210	196.1	75.3	270	252.1	96.8
31	28.9	11.1	91	85.0	32.6	151	141.0	54.1	211	197.0	75.6	271	253.0	97.1
32	29.9	11.5	92	85.9	33.0	152	141.9	54.5	212	197.9	76.0	272	253.9	97.5
33	30.8	11.8	93	86.8	33.3	153	142.8	54.8	213	198.9	76.3	273	254.9	97.8
34	31.7	12.2	94	87.8	33.7	154	143.8	55.2	214	199.8	76.7	274	255.8	98.2
35	32.7	12.5	95	88.7	34.0	155	144.7	55.5	215	200.7	77.0	275	256.7	98.6
36	33.6	12.9	96	89.6	34.4	156	145.6	55.9	216	201.7	77.4	276	257.7	98.9
37	34.5	13.3	97	90.6	34.8	157	146.6	56.3	217	202.6	77.8	277	258.6	99.3
38	35.5	13.6	98	91.5	35.1	158	147.5	56.6	218	203.5	78.1	278	259.5	99.6
39	36.4	14.0	99	92.4	35.5	159	148.4	57.0	219	204.5	78.5	279	260.5	100.0
40	37.3	14.3	100	93.4	35.8	160	149.4	57.3	220	205.4	78.8	280	261.4	100.3
41	38.3	14.7	101	94.3	36.2	161	150.3	57.7	221	206.3	79.2	281	262.3	100.7
42	39.2	15.1	102	95.2	36.6	162	151.2	58.1	222	207.3	79.6	282	263.3	101.1
43	40.1	15.4	103	96.2	36.9	163	152.2	58.4	223	208.2	79.9	283	264.2	101.4
44	41.1	15.8	104	97.1	37.3	164	153.1	58.8	224	209.1	80.3	284	265.1	101.8
45	42.0	16.1	105	98.0	37.6	165	154.0	59.1	225	210.1	80.6	285	266.1	102.1
46	42.9	16.5	106	99.0	38.0	166	155.0	59.5	226	211.0	81.0	286	267.0	102.5
47	43.9	16.8	107	99.9	38.3	167	155.9	59.8	227	211.9	81.3	287	267.9	102.9
48	44.8	17.2	108	100.8	38.7	168	156.8	60.2	228	212.9	81.7	288	268.9	103.2
49	45.7	17.6	109	101.8	39.1	169	157.8	60.6	229	213.8	82.1	289	269.8	103.6
50	46.7	17.9	110	102.7	39.4	170	158.7	60.9	230	214.7	82.4	290	270.7	103.9
51	47.6	18.3	111	103.6	39.8	171	159.6	61.3	231	215.7	82.8	291	271.7	104.3
52	48.5	18.6	112	104.6	40.1	172	160.6	61.6	232	216.6	83.1	292	272.6	104.6
53	49.5	19.0	113	105.5	40.5	173	161.5	62.0	233	217.5	83.5	293	273.5	105.0
54	50.4	19.4	114	106.4	40.9	174	162.4	62.4	234	218.5	83.9	294	274.5	105.4
55	51.3	19.7	115	107.4	41.2	175	163.4	62.7	235	219.4	84.2	295	275.4	105.7
56	52.3	20.1	116	108.3	41.6	176	164.3	63.1	236	220.3	84.6	296	276.3	106.1
57	53.2	20.4	117	109.2	41.9	177	165.2	63.4	237	221.3	84.9	297	277.3	106.4
58	54.1	20.8	118	110.2	42.3	178	166.2	63.8	238	222.2	85.3	298	278.2	106.8
59	55.1	21.1	119	111.1	42.6	179	167.1	64.1	239	223.1	85.6	299	279.1	107.2
60	56.0	21.5	120	112.0	43.0	180	168.0	64.5	240	224.1	86.0	300	280.1	107.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 69 Degrees. 4h 36m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 22 DEGREES. 1h 28m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.6	22.9	121	112.2	45.3	181	167.8	67.8	241	223.5	90.3
2	01.9	00.7	62	57.5	23.2	122	113.1	45.7	182	168.7	68.2	242	224.4	90.7
3	02.8	01.1	63	58.4	23.6	123	114.0	46.1	183	169.7	68.6	243	225.3	91.0
4	03.7	01.5	64	59.3	24.0	124	115.0	46.5	184	170.6	68.9	244	226.2	91.4
5	04.6	01.9	65	60.3	24.3	125	115.9	46.8	185	171.5	69.3	245	227.2	91.8
6	05.6	02.2	66	61.2	24.7	126	116.8	47.2	186	172.5	69.7	246	228.1	92.2
7	06.5	02.6	67	62.1	25.1	127	117.8	47.6	187	173.4	70.1	247	229.0	92.5
8	07.4	03.0	68	63.0	25.5	128	118.7	47.9	188	174.3	70.4	248	229.9	92.9
9	08.3	03.4	69	64.0	25.8	129	119.6	48.3	189	175.2	70.8	249	230.9	93.3
10	09.3	03.7	70	64.9	26.2	130	120.5	48.7	190	176.2	71.2	250	231.8	93.7
11	10.2	04.1	71	65.8	26.6	131	121.5	49.1	191	177.1	71.5	251	232.7	94.0
12	11.1	04.5	72	66.8	27.0	132	122.4	49.4	192	178.0	71.9	252	233.7	94.4
13	12.1	04.9	73	67.7	27.3	133	123.3	49.8	193	178.9	72.3	253	234.6	94.8
14	13.0	05.2	74	68.6	27.7	134	124.2	50.2	194	179.9	72.7	254	235.5	95.2
15	13.9	05.6	75	69.5	28.1	135	125.2	50.6	195	180.8	73.0	255	236.4	95.5
16	14.8	06.0	76	70.5	28.5	136	126.1	50.9	196	181.7	73.4	256	237.4	95.9
17	15.8	06.4	77	71.4	28.8	137	127.0	51.3	197	182.7	73.8	257	238.3	96.3
18	16.7	06.7	78	72.3	29.2	138	128.0	51.7	198	183.6	74.2	258	239.2	96.6
19	17.6	07.1	79	73.2	29.6	139	128.9	52.1	199	184.5	74.5	259	240.1	97.0
20	18.5	07.5	80	74.2	30.0	140	129.8	52.4	200	185.4	74.9	260	241.1	97.4
21	19.5	07.9	81	75.1	30.3	141	130.7	52.8	201	186.4	75.3	261	242.0	97.8
22	20.4	08.2	82	76.0	30.7	142	131.7	53.2	202	187.3	75.7	262	242.9	98.1
23	21.3	08.6	83	77.0	31.1	143	132.6	53.6	203	188.2	76.0	263	243.8	98.5
24	22.3	09.0	84	77.9	31.5	144	133.5	53.9	204	189.1	76.4	264	244.8	98.9
25	23.2	09.4	85	78.8	31.8	145	134.4	54.3	205	190.1	76.8	265	245.7	99.3
26	24.1	09.7	86	79.7	32.2	146	135.4	54.7	206	191.0	77.2	266	246.6	99.6
27	25.0	10.1	87	80.7	32.6	147	136.3	55.1	207	191.9	77.5	267	247.6	100.0
28	26.0	10.5	88	81.6	33.0	148	137.2	55.4	208	192.9	77.9	268	248.5	100.4
29	26.9	10.9	89	82.5	33.3	149	138.2	55.8	209	193.8	78.3	269	249.4	100.8
30	27.8	11.2	90	83.4	33.7	150	139.1	56.2	210	194.7	78.7	270	250.3	101.1
31	28.7	11.6	91	84.4	34.1	151	140.0	56.6	211	195.6	79.0	271	251.3	101.5
32	29.7	12.0	92	85.3	34.5	152	140.9	56.9	212	196.6	79.4	272	252.2	101.9
33	30.6	12.4	93	86.2	34.8	153	141.9	57.3	213	197.5	79.8	273	253.1	102.3
34	31.5	12.7	94	87.2	35.2	154	142.8	57.7	214	198.4	80.2	274	254.0	102.6
35	32.5	13.1	95	88.1	35.6	155	143.7	58.1	215	199.3	80.5	275	255.0	103.0
36	33.4	13.5	96	89.0	36.0	156	144.6	58.4	216	200.3	80.9	276	255.9	103.4
37	34.3	13.9	97	89.9	36.3	157	145.6	58.8	217	201.2	81.3	277	256.8	103.8
38	35.2	14.2	98	90.9	36.7	158	146.5	59.2	218	202.1	81.7	278	257.8	104.1
39	36.2	14.6	99	91.8	37.1	159	147.4	59.6	219	203.1	82.0	279	258.7	104.5
40	37.1	15.0	100	92.7	37.5	160	148.3	59.9	220	204.0	82.4	280	259.6	104.9
41	38.0	15.4	101	93.6	37.8	161	149.3	60.3	221	204.9	82.8	281	260.5	105.3
42	38.9	15.7	102	94.6	38.2	162	150.2	60.7	222	205.8	83.2	282	261.5	105.6
43	39.9	16.1	103	95.5	38.6	163	151.1	61.1	223	206.8	83.5	283	262.4	106.0
44	40.8	16.5	104	96.4	39.0	164	152.1	61.4	224	207.7	83.9	284	263.3	106.4
45	41.7	16.9	105	97.4	39.3	165	153.0	61.8	225	208.6	84.3	285	264.2	106.8
46	42.7	17.2	106	98.3	39.7	166	153.9	62.2	226	209.5	84.7	286	365.2	107.1
47	43.6	17.6	107	99.2	40.1	167	154.8	62.6	227	210.5	85.0	287	266.1	107.5
48	44.5	18.0	108	100.1	40.5	168	155.8	62.9	228	211.4	85.4	288	267.0	107.9
49	45.4	18.4	109	101.1	40.8	169	156.7	63.3	229	212.3	85.8	289	268.0	108.3
50	46.4	18.7	110	102.0	41.2	170	157.6	63.7	230	213.3	86.2	290	268.9	108.6
51	47.3	19.1	111	102.9	41.6	171	158.5	64.1	231	214.2	86.5	291	269.8	109.0
52	48.2	19.5	112	103.8	42.0	172	159.5	64.4	232	215.1	86.9	292	270.7	109.4
53	49.1	19.9	113	104.8	42.3	173	160.4	64.8	233	216.0	87.3	293	271.7	109.8
54	50.1	20.2	114	105.7	42.7	174	161.3	65.2	234	217.0	87.7	294	272.6	110.1
55	51.0	20.6	115	106.6	43.1	175	162.3	65.6	235	217.9	88.0	295	273.5	110.5
56	51.9	21.0	116	107.6	43.5	176	163.2	65.9	236	218.8	88.4	296	274.4	110.9
57	52.8	21.4	117	108.5	43.8	177	164.1	66.3	237	219.7	88.8	297	275.4	111.3
58	53.8	21.7	118	109.4	44.2	178	165.0	66.7	238	220.7	89.2	298	276.3	111.6
59	54.7	22.1	119	110.3	44.6	179	166.0	67.1	239	221.6	89.5	299	277.2	112.0
60	55.6	22.5	120	111.3	45.0	180	166.9	67.4	240	222.5	89.9	300	278.2	112.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 68 Degrees. 4h 32m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 23 DEGREES. 1h 32m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	56.2	23.8	121	111.4	47.3	181	166.6	70.7	241	221.8	94.2
2	01.8	00.8	62	57.1	24.2	122	112.3	47.7	182	167.5	71.1	242	222.8	94.6
3	02.8	01.2	63	58.0	24.6	123	113.2	48.1	183	168.5	71.5	243	223.7	94.9
4	03.7	01.6	64	58.9	25.0	124	114.1	48.5	184	169.4	71.9	244	224.6	95.3
5	04.6	02.0	65	59.8	25.4	125	115.1	48.8	185	170.3	72.3	245	225.5	95.7
6	05.5	02.3	66	60.8	25.8	126	116.0	49.2	186	171.2	72.7	246	226.4	96.1
7	06.4	02.7	67	61.7	26.2	127	116.9	49.6	187	172.1	73.1	247	227.4	96.5
8	07.4	03.1	68	62.6	26.6	128	117.8	50.0	188	173.1	73.5	248	228.3	96.9
9	08.3	03.5	69	63.5	27.0	129	118.7	50.4	189	174.0	73.8	249	229.2	97.3
10	09.2	03.9	70	64.4	27.4	130	119.7	50.8	190	174.9	74.2	250	230.1	97.7
11	10.1	04.3	71	65.4	27.7	131	120.6	51.2	191	175.8	74.6	251	231.0	98.1
12	11.0	04.7	72	66.3	28.1	132	121.5	51.6	192	176.7	75.0	252	232.0	98.5
13	12.0	05.1	73	67.2	28.5	133	122.4	52.0	193	177.7	75.4	253	232.9	98.9
14	12.9	05.5	74	68.1	28.9	134	123.3	52.4	194	178.6	75.8	254	233.8	99.2
15	13.8	05.9	75	69.0	29.3	135	124.3	52.7	195	179.5	76.2	255	234.7	99.6
16	14.7	06.3	76	70.0	29.7	136	125.2	53.1	196	180.4	76.6	256	235.6	100.0
17	15.6	06.6	77	70.9	30.1	137	126.1	53.5	197	181.3	77.0	257	236.6	100.4
18	16.6	07.0	78	71.8	30.5	138	127.0	53.9	198	182.3	77.4	258	237.5	100.8
19	17.5	07.4	79	72.7	30.9	139	128.0	54.3	199	183.2	77.8	259	238.4	101.2
20	18.4	07.8	80	73.6	31.3	140	128.9	54.7	200	184.1	78.1	260	239.3	101.6
21	19.3	08.2	81	74.6	31.6	141	129.8	55.1	201	185.0	78.5	261	240.3	102.0
22	20.3	08.6	82	75.5	32.0	142	130.7	55.5	202	185.9	78.9	262	241.2	102.4
23	21.2	09.0	83	76.4	32.4	143	131.6	55.9	203	186.9	79.3	263	242.1	102.8
24	22.1	09.4	84	77.3	32.8	144	132.6	56.3	204	187.8	79.7	264	243.0	103.2
25	23.0	09.8	85	78.2	33.2	145	133.5	56.7	205	188.7	80.1	265	243.9	103.5
26	23.9	10.2	86	79.2	33.6	146	134.4	57.0	206	189.6	80.5	266	244.9	103.9
27	24.9	10.5	87	80.1	34.0	147	135.3	57.4	207	190.5	80.9	267	245.8	104.3
28	25.8	10.9	88	81.0	34.4	148	136.2	57.8	208	191.5	81.3	268	246.7	104.7
29	26.7	11.3	89	81.9	34.8	149	137.2	58.2	209	192.4	81.7	269	247.6	105.1
30	27.6	11.7	90	82.8	35.2	150	138.1	58.6	210	193.3	82.1	270	248.5	105.5
31	28.5	12.1	91	83.8	35.6	151	139.0	59.0	211	194.2	82.4	271	249.5	105.9
32	29.5	12.5	92	84.7	35.9	152	139.9	59.4	212	195.1	82.8	272	250.4	106.3
33	30.4	12.9	93	85.6	36.3	153	140.8	59.8	213	196.1	83.2	273	251.3	106.7
34	31.3	13.3	94	86.5	36.7	154	141.8	60.2	214	197.0	83.6	274	252.2	107 1
35	32.2	13.7	95	87.4	37.1	155	142.7	60.6	215	197.9	84.0	275	253.1	107.5
36	33.1	14.1	96	88.4	37.5	156	143.6	61.0	216	198.8	84.4	276	254.1	107.8
37	34.1	14.5	97	89.3	37.9	157	144.5	61.3	217	199.7	84.8	277	255.0	108.2
38	35.0	14.8	98	90.2	38.3	158	145.4	61.7	218	200.7	85.2	278	255.9	108.6
39	35.9	15.2	99	91.1	38.7	159	146.4	62.1	219	201.6	85.6	279	256.8	109.0
40	36.8	15.6	100	92.1	39.1	160	147.3	62.5	220	202.5	86.0	280	257.7	109.4
41	37.7	16.0	101	93.0	39.5	161	148.2	62.9	221	203.4	86.4	281	258.7	109.8
42	38.7	16.4	102	93.9	39.9	162	149.1	63.3	222	204.4	86.7	282	259.6	110.2
43	39.6	16.8	103	94.8	40.2	163	150.0	63.7	223	205.3	87.1	283	260.5	110.6
44	40.5	17.2	104	95.7	40.6	164	151.0	64.1	224	206.2	87.5	284	261.4	111.0
45	41.4	17.6	105	96.7	41.0	165	151.9	64.5	225	207.1	87.9	285	262.3	111.4
46	42.3	18.0	106	97.6	41.4	166	152.8	64.9	226	208.0	88.3	286	263.3	111.7
47	43.3	18.4	107	98.5	41.8	167	153.7	65.3	227	209.0	88.7	287	264.2	112.1
48	44.2	18.8	108	99.4	42.2	168	154.6	65.6	228	209.9	89.1	288	265.1	112.5
49	45.1	19.1	109	100.3	42.6	169	155.6	66.0	229	210.8	89.5	289	266.0	112.9
50	46.0	19.5	110	101.3	43.0	170	156.5	66.4	230	211.7	89.9	290	266.9	113.3
51	46.9	19.9	111	102.2	43.4	171	157.4	66.8	231	212.6	90.3	291	267.9	113.7
52	47.9	20.3	112	103.1	43.8	172	158.3	67.2	232	213.6	90.6	292	268.8	114.1
53	48.8	20.7	113	104.0	44.2	173	159.2	67.6	233	214.5	91.0	293	269.7	114.5
54	49.7	21.1	114	104.9	44.5	174	160.2	68.0	234	215.4	91.4	294	270.6	114.9
55	50.6	21.5	115	105.9	44.9	175	161.1	68.4	235	216.3	91.8	295	271.5	115.3
56	51.5	21.9	116	106.8	45.3	176	162.0	68.8	236	217.2	92.2	296	272.5	115.7
57	52.5	22.3	117	107.7	45.7	177	162.9	69.2	237	218.2	92.6	297	273.4	116.0
58	53.4	22.7	118	108.6	46.1	178	163.8	69.6	238	219.1	93.0	298	274.3	116.4
59	54.3	23.1	119	109.5	46.5	179	164.8	69.9	239	220.0	93.4	299	275.2	116.8
60	55.2	23.4	120	110.5	46.9	180	165.7	70.3	240	220.9	93.8	300	276.2	117.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 24 DEGREES. 1h 36m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.7	24.8	121	110.5	49.2	181	165.4	73.6	241	220.2	98.0
2	01.8	00.8	62	56.6	25.2	122	111.5	49.6	182	166.3	74.0	242	221.1	98.4
3	02.7	01.2	63	57.6	25.6	123	112.4	50.0	183	167.2	74.4	243	222.0	98.8
4	03.7	01.6	64	58.5	26.0	124	113.3	50.4	184	168.1	74.8	244	222.9	99.2
5	04.6	02.0	65	59.4	26.4	125	114.2	50.8	185	169.0	75.2	245	223.8	99.7
6	05.5	02.4	66	60.3	26.8	126	115.1	51.2	186	169.9	75.7	246	224.7	100.1
7	06.4	02.8	67	61.2	27.3	127	116.0	51.7	187	170.8	76.1	247	225.6	100.5
8	07.3	03.3	68	62.1	27.7	128	116.9	52.1	188	171.7	76.5	248	226.6	100.9
9	08.2	03.7	69	63.0	28.1	129	117.8	52.5	189	172.7	76.9	249	227.5	101.3
10	09.1	04.1	70	63.9	28.5	130	118.8	52.9	190	173.6	77.3	250	228.4	101.7
11	10.0	04.5	71	64.9	28.9	131	119.7	53.3	191	174.5	77.7	251	229.3	102.1
12	11.0	04.9	72	65.8	29.3	132	120.6	53.7	192	175.4	78.1	252	230.2	102.5
13	11.9	05.3	73	66.7	29.7	133	121.5	54.1	193	176.3	78.5	253	231.1	102.9
14	12.8	05.7	74	67.6	30.1	134	122.4	54.5	194	177.2	78.9	254	232.0	103.3
15	13.7	06.1	75	68.5	30.5	135	123.3	54.9	195	178.1	79.3	255	233.0	103.7
16	14.6	06.5	76	69.4	30.9	136	124.2	55.3	196	179.1	79.7	256	233.9	104.1
17	15.5	06.9	77	70.3	31.3	137	125.2	55.7	197	180.0	80.1	257	234.8	104.5
18	16.4	07.3	78	71.3	31.7	188	126.1	56.1	198	180.9	80.5	258	235.7	104.9
19	17.4	07.7	79	72.2	32.1	139	127.0	56.5	199	181.8	80.9	259	236.6	105.3
20	18.3	08.1	80	73.1	32.5	140	127.9	56.9	200	182.7	81.3	260	237.5	105.8
21	19.2	08.5	81	74.0	32.9	141	128.8	57.3	201	183.6	81.8	261	238.4	106.2
22	20.1	08.9	82	74.9	33.4	142	129.7	57.8	202	184.5	82.2	262	239.3	106.6
23	21.0	09.4	83	75.8	33.8	143	130.6	58.2	203	185.4	82.6	263	240.3	107.0
24	21.9	09.8	84	76.7	34.2	144	131.6	58.6	204	186.4	83.0	264	241.2	107.4
25	22.8	10.2	85	77.7	34.6	145	132.5	59.0	205	187.3	83.4	265	242.1	107.8
26	23.8	10.6	86	78.6	35.0	146	133.4	59.4	206	188.2	83.8	266	243.0	108.2
27	24.7	11.0	87	79.5	35.4	147	134.3	59.8	207	189.1	84.2	267	243.9	108.6
28	25.6	11.4	88	80.4	35.8	148	135.2	60.2	208	190.0	84.6	268	244.8	109.0
29	26.5	11.8	89	81.3	36.2	149	136.1	60.6	209	190.9	85.0	269	245.7	109.4
30	27.4	12.2	90	82.2	36.6	150	137.0	61.0	210	191.8	85.4	270	246.7	109.8
31	28.3	12.6	91	83.1	37.0	151	137.9	61.4	211	192.8	85.8	271	247.6	110.2
32	29.2	13.0	92	84.0	37.4	152	138.9	61.8	212	193.7	86.2	272	248.5	110.6
33	30.1	13.4	93	85.0	37.8	153	139.8	62.2	213	194.6	86.6	273	249.4	111.0
34	31.1	13.8	94	85.9	38.2	154	140.7	62.6	214	195.5	87.0	274	250.3	111.4
35	32.0	14.2	95	86.8	38.6	155	141.6	63.0	215	196.4	87.4	275	251.2	111.9
36	32.9	14.6	96	87.7	39.0	156	142.5	63.5	216	197.3	87.9	276	252.1	112.3
37	33.8	15.0	97	88.6	39.5	157	143.4	63.9	217	198.2	88.3	277	253.1	112.7
38	34.7	15.5	98	89.5	39.9	158	144.3	64.3	218	199.2	88.7	278	254.0	113.1
39	35.6	15.9	99	90.4	40.3	159	145.3	64.7	219	200.1	89.1	279	254.9	113.5
40	36.5	16.3	100	91.4	40.7	160	146.2	65.1	220	201.0	89.5	280	255.8	113.9
41	37.5	16.7	101	92.3	41.1	161	147.1	65.5	221	201.9	89.9	281	256.7	114.3
42	38.4	17.1	102	93.2	41.5	162	148.0	65.9	222	202.8	90.3	282	257.6	114.7
43	39.3	17.5	103	94.1	41.9	163	148.9	66.3	223	203.7	90.7	283	258.5	115.1
44	40.2	17.9	104	95.0	42.3	164	149.8	66.7	224	204.6	91.1	284	259.4	115.5
45	41.1	18.3	105	95.9	42.7	165	150.7	67.1	225	205.5	91.5	285	260.4	115.9
46	42.0	18.7	106	96.8	43.1	166	151.6	67.5	226	206.5	91.9	286	261.3	116.3
47	42.9	19.1	107	97.7	43.5	167	152.6	67.9	227	207.4	92.3	287	262.2	116.7
48	43.9	19.5	108	98.7	43.9	168	153.5	68.3	228	208.3	92.7	288	263.1	117.1
49	44.8	19.9	109	99.6	44.3	169	154.4	68.7	229	209.2	93.1	289	264.0	117.5
50	45.7	20.3	110	100.5	44.7	170	155.3	69.1	230	210.1	93.5	290	264.9	118.0
51	46.6	20.7	111	101.4	45.1	171	156.2	69.6	231	211.0	94.0	291	265.8	118.4
52	47.5	21.2	112	102.3	45.6	172	157.1	70.0	232	211.9	94.4	292	266.8	118.8
53	48.4	21.6	113	103.2	46.0	173	158.0	70.4	233	212.9	94.8	293	267.7	119.2
54	49.3	22.0	114	104.1	46.4	174	159.0	70.8	234	213.8	95.2	294	268.6	119.6
55	50.2	22.4	115	105.1	46.8	175	159.9	71.2	235	214.7	95.6	295	269.5	120.0
56	51.2	22.8	116	106.0	47.2	176	160.8	71.6	236	215.6	96.0	296	270.4	120.4
57	52.1	23.2	117	106.9	47.6	177	161.7	72.0	237	216.5	96.4	297	271.3	120.8
58	53.0	23.6	118	107.8	48.0	178	162.6	72.4	238	217.4	96.8	298	272.2	121.2
59	53.9	24.0	119	108.7	48.4	179	163.5	72.8	239	218.3	97.2	299	273.2	121.6
60	54.8	24.4	120	109.6	48.8	180	164.4	73.2	240	219.3	97.6	300	274.1	122.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 66 Degrees. 4h 24m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 25 DEGREES. 1h 40m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	55.3	25.8	121	109.7	51.1	181	164.0	76.5	241	218.4	101.9
2	01.8	00.8	62	56.2	26.2	122	110.6	51.6	182	164.9	76.9	242	219.3	102.3
3	02.7	01.3	63	57.1	26.6	123	111.5	52.0	183	165.9	77.3	243	220.2	102 7
4	03.6	01.7	64	58.0	27.0	124	112.4	52.4	184	166.8	77.8	244	221.1	103.1
5	04.5	02.1	65	58.9	27.5	125	113.3	52.8	185	167.7	78.2	245	222.0	103.5
6	05.4	02.5	66	59.8	27.9	126	114.2	53.2	186	168.6	78.6	246	223.0	104.0
7	06.3	03.0	67	60.7	28.3	127	115.1	53.7	187	169.5	79.0	247	223.9	104.4
8	07.3	03.4	68	61.6	28.7	128	116.0	54.1	188	170.4	79.5	248	224.8	104 8
9	08.2	03.8	69	62.5	29.2	129	116.9	54.5	189	171.3	79.9	249	225.7	105.2
10	09.1	04.2	70	63.4	29.6	130	117.8	54.9	190	172.2	80.3	250	226.6	105.7
11	10.0	04.6	71	64.3	30.0	131	118.7	55.4	191	173.1	80.7	251	227.5	106.1
12	10.9	05.1	72	65.3	30.4	132	119.6	55.8	192	174.0	81.1	252	228.4	106.5
13	11.8	05.5	73	66.2	30.9	133	120.5	56.2	193	174.9	81.6	253	229.3	106.9
14	12.7	05.9	74	67.1	31.3	134	121.4	56.6	194	175.8	82.0	254	230.2	107.3
15	13.6	06.3	75	68.0	31.7	135	122.4	57.1	195	176.7	82.4	255	231.1	107.8
16	14.5	06.8	76	68.9	32.1	136	123.3	57.5	196	177.6	82.8	256	232.0	108.2
17	15.4	07.2	77	69.8	32.5	137	124.2	57.9	197	178.5	83.3	257	232.9	108.6
18	16.3	07.6	78	70.7	33.0	138	125.1	58.3	198	179.4	83.7	258	233.8	109.0
19	17.2	08.0	79	71.6	33.4	139	126.0	58.7	199	180.4	84.1	259	234.7	109.5
20	18.1	08.5	80	72.5	33.8	140	126.9	59.2	200	181.3	84.5	260	235.6	109.9
21	19.0	08.9	81	73.4	34.2	141	127.8	59.6	201	182.2	84.9	261	236.5	110.3
22	19.9	09.3	82	74.3	34.7	142	128.7	60.0	202	183.1	85.4	262	237.5	110.7
23	20.8	09.7	83	75.2	35.1	143	129.6	60.4	203	184.0	85.8	263	238.4	111.1
24	21.8	10.1	84	76.1	35.5	144	130.5	60.9	204	184.9	86.2	264	239.3	111.6
25	22.7	10.6	85	77.0	35.9	145	131.4	61.3	205	185.8	86.6	265	240.2	112.0
26	23.6	11.0	86	77.9	36.3	146	132.3	61.7	206	186.7	87.1	266	241.1	112.4
27	24.5	11.4	87	78.8	36.8	147	133.2	62.1	207	187.6	87.5	267	242.0	112.8
28	25.4	11.8	88	79.8	37.2	148	134.1	62.5	208	188.5	87.9	268	242.9	113.3
29	26.3	12.3	89	80.7	37.6	149	135.0	63.0	209	189.4	88.3	269	243.8	113.7
30	27.2	12.7	90	81.6	38.0	150	135.9	63.4	210	190.3	88.7	270	244.7	114.1
31	28.1	13.1	91	82.5	38.5	151	136.9	63.8	211	191.2	89.2	271	245.6	114.5
32	29.0	13.5	92	83.4	38.9	152	137.8	64.2	212	192.1	89.6	272	246.5	115.0
33	29.9	13.9	93	84.3	39.3	153	138.7	64.7	213	193.0	90.0	273	247.4	115.4
34	30.8	14.4	94	85.2	39.7	154	139.6	65.1	214	193.9	90.4	274	248.3	115.8
35	31.7	14.8	95	86.1	40.1	155	140.5	65.5	215	194.9	90.9	275	249.2	116.2
36	32.6	15.2	96	87.0	40.6	156	141.4	65.9	216	195.8	91.3	276	250.1	116.6
37	33.5	15.6	97	87.9	41.0	157	142.3	66.4	217	196.7	91.7	277	251.0	117.1
38	34.4	16.1	98	88.8	41.4	158	143.2	66.8	218	197.6	92.1	278	252.0	117.5
39	35.3	16.5	99	89.7	41.8	159	144.1	67.2	219	198.5	92.6	279	252.9	117.9
40	36.3	16.9	100	90.6	42.3	160	145.0	67.6	220	199.4	93.0	280	253.8	118.3
41	37.2	17.3	101	91.5	42.7	161	145.9	68.0	221	200.3	93.4	281	254.7	118.8
42	38.1	17.7	102	92.4	43.1	162	146.8	68.5	222	201.2	93.8	282	255.6	119.2
43	39.0	18.2	103	93.3	43.5	163	147.7	68.9	223	202.1	94.2	283	256.5	119.6
44	39.9	18.6	104	94.3	44.0	164	148.6	69.3	224	203.0	94.7	284	257.4	120.0
45	40.8	19.0	105	95.2	44.4	165	149.5	69.7	225	203.9	95.1	285	258.3	120.4
46	41.7	19.4	106	96.1	44.8	166	150.4	70.2	226	204.8	95.5	286	259.2	120.9
47	42.6	19.9	107	97.0	45.2	167	151.4	70.6	227	205.7	95.9	287	260.1	121.3
48	43.5	20.3	108	97.9	45.6	168	152.3	71.0	228	206.6	96.4	288	261.0	121.7
49	44.4	20.7	109	98.8	46.1	169	153.2	71.4	229	207.5	96.8	289	261.9	122.1
50	45.3	21.1	110	99.7	46.5	170	154.1	71.8	230	208.5	97.2	290	262.8	122.6
51	46.2	21.6	111	100.6	46.9	171	155.0	72.3	231	209.4	97.6	291	263.7	123.0
52	47.1	22.0	112	101.5	47.3	172	155.9	72.7	232	210.3	98.0	292	264.6	123.4
53	48.0	22.4	113	102.4	47.8	173	156.8	73.1	233	211.2	98.5	293	265.5	123.8
54	48.9	22.8	114	103.3	48.2	174	157.7	73.5	234	212.1	98.9	294	266.5	124.2
55	49.8	23.2	115	104.2	48.6	175	158.6	74.0	235	213.0	99.3	295	267.4	124.7
56	50.8	23.7	116	105.1	49.0	176	159.5	74.4	236	213.9	99.7	296	268.3	125.1
57	51.7	24.1	117	106.0	49.4	177	160.4	74.8	237	214.8	100.2	297	269.2	125.5
58	52.6	24.5	118	106.9	49.9	178	161.3	75.2	238	215.7	100.6	298	270.1	125.9
59	53.5	24.9	119	107.9	50.3	179	162.2	75.6	239	216.6	101.0	299	271.0	126.4
60	54.4	25.4	120	108.8	50.7	180	163.1	76.1	240	217.5	101.4	300	271.9	126.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 65 Degrees. 4h 20m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 26 DEGREES. 1h 44m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.4	61	54.8	26.7	121	108.8	53.0	181	162.7	79.3	241	216.6	105.6
2	01.8	00.9	62	55.7	27.2	122	109.7	53.5	182	163.6	79.8	242	217.5	106.1
3	02.7	01.3	63	56.6	27.6	123	110.6	53.9	183	164.5	80.2	243	218.4	106.5
4	03.6	01.8	64	57.5	28.1	124	111.5	54.4	184	165.4	80.7	244	219.3	107.0
5	04.5	02.2	65	58.4	28.5	125	112.3	54.8	185	166.3	81.1	245	220.2	107.4
6	05.4	02.6	66	59.3	28.9	126	113.2	55.2	186	167.2	81.5	246	221.1	107.8
7	06.3	03.1	67	60.2	29.4	127	114.1	55.7	187	168.1	82.0	247	222.0	108.3
8	07.2	03.5	68	61.1	29.8	128	115.0	56.1	188	169.0	82.4	248	222.9	108.7
9	08.1	03.9	69	62.0	30.2	129	115.9	56.5	189	169.9	82.9	249	223.8	109.2
10	09.0	04.4	70	62.9	30.7	130	116.8	57.0	190	170.8	83.3	250	224.7	109.6
11	09.9	04.8	71	63.8	31.1	131	117.7	57.4	191	171.7	83.7	251	225.6	110.0
12	10.8	05.3	72	64.7	31.6	132	118.6	57.9	192	172.6	84.2	252	226.5	110.5
13	11.7	05.7	73	65.6	32.0	133	119.5	58.3	193	173.5	84.6	253	227.4	110.9
14	12.6	06.1	74	66.5	32.4	134	120.4	58.7	194	174.4	85.0	254	228.3	111.3
15	13.5	06.6	75	67.4	32.9	135	121.3	59.2	195	175.3	85.5	255	229.2	111.8
16	14.4	07.0	76	68.3	33.3	136	122.2	59.6	196	176.2	85.9	256	230.1	112.2
17	15.3	07.5	77	69.2	33.8	137	123.1	60.1	197	177.1	86.4	257	231.0	112.7
18	16.2	07.9	78	70.1	34.2	138	124.0	60.5	198	178.0	86.8	258	231.9	113.1
19	17.1	08.3	79	71.0	34.6	139	124.9	60.9	199	178.9	87.2	259	232.8	113.5
20	18.0	08.8	80	71.9	35.1	140	125.8	61.4	200	179.8	87.7	260	233.7	114.0
21	18.9	09.2	81	72.8	35.5	141	126.7	61.8	201	180.7	88.1	261	234.6	114.4
22	19.8	09.6	82	73.7	35.9	142	127.6	62.2	202	181.6	88.6	262	235.5	114.9
23	20.7	10.1	83	74.6	36.4	143	128.5	62.7	203	182.5	89.0	263	236.4	115.3
24	21.6	10.5	84	75.5	36.8	144	129.4	63.1	204	183.4	89.4	264	237.3	115.7
25	22.5	11.0	85	76.4	37.3	145	130.3	63.6	205	184.3	89.9	265	238.2	116.2
26	23.4	11.4	86	77.3	37.7	146	131.2	64.0	206	185.2	90.3	266	239.1	116.6
27	24.3	11.8	87	78.2	38.1	147	132.1	64.4	207	186.1	90.7	267	240.0	117.0
28	25.2	12.3	88	79.1	38.6	148	133.0	64.9	208	186.9	91.2	268	240.9	117.5
29	26.1	12.7	89	80.0	39.0	149	133.9	65.3	209	187.8	91.6	269	241.8	117.9
30	27.0	13.2	90	80.9	39.5	150	134.8	65.8	210	188.7	92.1	270	242.7	118.4
31	27.9	13.6	91	81.8	39.9	151	135.7	66.2	211	189.6	92.5	271	243.6	118.8
32	28.8	14.0	92	82.7	40.3	152	136.6	66.6	212	190.5	92.9	272	244.5	119.2
33	29.7	14.5	93	83.6	40.8	153	137.5	67.1	213	191.4	93.4	273	245.4	119.7
34	30.6	14.9	94	84.5	41.2	154	138.4	67.5	214	192.3	93.8	274	246.3	120.1
35	31.5	15.3	95	85.4	41.6	155	139.3	67.9	215	193.2	94.2	275	247.2	120.6
36	32.4	15.8	96	86.3	42.1	156	140.2	68.4	216	194.1	94.7	276	248.1	121.0
37	33.3	16.2	97	87.2	42.5	157	141.1	68.8	217	195.0	95.1	277	249.0	121.4
38	34.2	16.7	98	88.1	43.0	158	142.0	69.3	218	195.9	95.6	278	249.9	121.9
39	35.1	17.1	99	89.0	43.4	159	142.9	69.7	219	196.8	96.0	279	250.8	122.3
40	36.0	17.5	100	89.9	43.8	160	143.8	70.1	220	197.7	96.4	280	251.7	122.7
41	36.9	18.0	101	90.8	44.3	161	144.7	70.6	221	198.6	96.9	281	252.6	123.2
42	37.7	18.4	102	91.7	44.7	162	145.6	71.0	222	199.5	97.3	282	253.5	123.6
43	38.6	18.8	103	92.6	45.2	163	146.5	71.5	223	200.4	97.8	283	254.4	124.1
44	39.5	19.3	104	93.5	45.6	164	147.4	71.9	224	201.3	98.2	284	255.3	124.5
45	40.4	19.7	105	94.4	46.0	165	148.3	72.3	225	202.2	98.6	285	256.2	124.9
46	41.3	20.2	106	95.3	46.5	166	149.2	72.8	226	203.1	99.1	286	257.1	125.4
47	42.2	20.6	107	96.2	46.9	167	150.1	73.2	227	204.0	99.5	287	258.0	125.8
48	43.1	21.0	108	97.1	47.3	168	151.0	73.6	228	204.9	99.9	288	258.9	126.3
49	44.0	21.5	109	98.0	47.8	169	151.9	74.1	229	205.8	100.4	289	259.8	126.7
50	44.9	21.9	110	98.9	48.2	170	152.8	74.5	230	206.7	100.8	290	260.7	127.1
51	45.8	22.4	111	99.8	48.7	171	153.7	75.0	231	207.6	101.3	291	261.5	127.6
52	46.7	22.8	112	100.7	49.1	172	154.6	75.4	232	208.5	101.7	292	262.4	128.0
53	47.6	23.2	113	101.6	49.5	173	155.5	75.8	233	209.4	102.1	293	263.3	128.4
54	48.5	23.7	114	102.5	50.0	174	156.4	76.3	234	210.3	102.6	294	264.2	128.9
55	49.4	24.1	115	103.4	50.4	175	157.3	76.7	235	211.2	103.0	295	265.1	129.3
56	50.3	24.5	116	104.3	50.9	176	158.2	77.2	236	212.1	103.5	296	266.0	129.8
57	51.2	25.0	117	105.2	51.3	177	159.1	77.6	237	213.0	103.9	297	266.9	130.2
58	52.1	25.4	118	106.1	51.7	178	160.0	78.0	238	213.9	104.3	298	267.8	130.6
59	53.0	25.9	119	107.0	52.2	179	160.9	78.5	239	214.8	104.8	299	268.7	131.1
60	53.9	26.3	120	107.9	52.6	180	161.8	78.9	240	215.7	105.2	300	269.6	131.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 64 Degrees. 4h 16m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 27 DEGREES. 1h 48m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	54.4	27.7	121	107.8	54.9	181	161.3	82.2	241	214.7	109.4
2	01.8	00.9	62	55.2	28.1	122	108.7	55.4	182	162.2	82.6	242	215.6	109.9
3	02.7	01.4	63	56.1	28.6	123	109.6	55.8	183	163.1	83.1	243	216.5	110.3
4	03.6	01.8	64	57.0	29.1	124	110.5	56.3	184	163.9	83.5	244	217.4	110.8
5	04.5	02.3	65	57.9	29.5	125	111.4	56.7	185	164.8	84.0	245	218.3	111.2
6	05.3	02.7	66	58.8	30.0	126	112.3	57.2	186	165.7	84.4	246	219.2	111.7
7	06.2	03.2	67	59.7	30.4	127	113.2	57.7	187	166.6	84.9	247	220.1	112.1
8	07.1	03.6	68	60.6	30.9	128	114.0	58.1	188	167.5	85.4	248	221.0	112.6
9	08.0	04.1	69	61.5	31.3	129	114.9	58.6	189	168.4	85.8	249	221.9	113.0
10	08.9	04.5	70	62.4	31.8	130	115.8	59.0	190	169.3	86.3	250	222.8	113.5
11	09.8	05.0	71	63.3	32.2	131	116.7	59.5	191	170.2	86.7	251	223.6	114.0
12	10.7	05.4	72	64.2	32.7	132	117.6	59.9	192	171.1	87.2	252	224.5	114.4
13	11.6	05.9	73	65.0	33.1	133	118.5	60.4	193	172.0	87.6	253	225.4	114.9
14	12.5	06.4	74	65.9	33.6	134	119.4	60.8	194	172.9	88.1	254	226.3	115.3
15	13.4	06.8	75	66.8	34.0	135	120.3	61.3	195	173.7	88.5	255	227.2	115.8
16	14.3	07.3	76	67.7	34.5	136	121.2	61.7	196	174.6	89.0	256	228.1	116.2
17	15.1	07.7	77	68.6	35.0	137	122.1	62.2	197	175.5	89.4	257	229.0	116.7
18	16.0	08.2	78	69.5	35.4	138	123.0	62.7	198	176.4	89.9	258	229.9	117.1
19	16.9	08.6	79	70.4	35.9	139	123.8	63.1	199	177.3	90.3	259	230.8	117.6
20	17.8	09.1	80	71.3	36.3	140	124.7	63.6	200	178.2	90.8	260	231.7	118.0
21	18.7	09.5	81	72.2	36.8	141	125.6	64.0	201	179.1	91.3	261	232.6	118.5
22	19.6	10.0	82	73.1	37.2	142	126.5	64.5	202	180.0	91.7	262	233.4	118.9
23	20.5	10.4	83	74.0	37.7	143	127.4	64.9	203	180.9	92.2	263	234.3	119.4
24	21.4	10.9	84	74.8	38.1	144	128.3	65.4	204	181.8	92.6	264	235.2	119.9
25	22.3	11.3	85	75.7	38.6	145	129.2	65.8	205	182.7	93.1	265	236.1	120.3
26	23.2	11.8	86	76.6	39.0	146	130.1	66.3	206	183.5	93.5	266	237.0	120.8
27	24.1	12.3	87	77.5	39.5	147	131.0	66.7	207	184.4	94.0	267	237.9	121.2
28	24.9	12.7	88	78.4	40.0	148	131.9	67.2	208	185.3	94.4	268	238.8	121.7
29	25.8	13.2	89	79.3	40.4	149	132.8	67.6	209	186.2	94.9	269	239.7	122.1
30	26.7	13.6	90	80.2	40.9	150	133.7	68.1	210	187.1	95.3	270	240.6	122.6
31	27.6	14.1	91	81.1	41.3	151	134.5	68.6	211	188.0	95.8	271	241.5	123.0
32	28.5	14.5	92	82.0	41.8	152	135.4	69.0	212	188.9	96.2	272	242.4	123.5
33	29.4	15.0	93	82.9	42.2	153	136.3	69.5	213	189.8	96.7	273	243.2	123.9
34	30.3	15.4	94	83.8	42.7	154	137.2	69.9	214	190.7	97.2	274	244.1	124.4
35	31.2	15.9	95	84.6	43.1	155	138.1	70.4	215	191.6	97.6	275	245.0	124.8
36	32.1	16.3	96	85.5	43.6	156	139.0	70.8	216	192.5	98.1	276	245.9	125.3
37	33.0	16.8	97	86.4	44.0	157	139.9	71.3	217	193.3	98.5	277	246.8	125.8
38	33.9	17.3	98	87.3	44.5	158	140.8	71.7	218	194.2	99.0	278	247.7	126.2
39	34.7	17.7	99	88.2	44.9	159	141.7	72.2	219	195.1	99.4	279	248.6	126.7
40	35.6	18.2	100	89.1	45.4	160	142.6	72.6	220	196.0	99.9	280	249.5	127.1
41	36.5	18.6	101	90.0	45.9	161	143.5	73.1	221	196.9	100.3	281	250.4	127.6
42	37.4	19.1	102	90.9	46.3	162	144.3	73.5	222	197.8	100.8	282	251.3	128.0
43	38.3	19.5	103	91.8	46.8	163	145.2	74.0	223	198.7	101.2	283	252.2	128.5
44	39.2	20.0	104	92.7	47.2	164	146.1	74.5	224	199.6	101.7	284	253.0	128.9
45	40.1	20.4	105	93.6	47.7	165	147.0	74.9	225	200.5	102.1	285	253.9	129.4
46	41.0	20.9	106	94.4	48.1	166	147.9	75.4	226	201.4	102.6	286	254.8	129.8
47	41.9	21.3	107	95.3	48.6	167	148.8	75.8	227	202.3	103.1	287	255.7	130.3
48	42.8	21.8	108	96.2	49.0	168	149.7	76.3	228	203.1	103.5	288	256.6	130.7
49	43.7	22.2	109	97.1	49.5	169	150.6	76.7	229	204.0	104.0	289	257.5	131.2
50	44.6	22.7	110	98.0	49.9	170	151.5	77.2	230	204.9	104.4	290	258.4	131.7
51	45.4	23.2	111	98.9	50.4	171	152.4	77.6	231	205.8	104.9	291	259.3	132.1
52	46.3	23.6	112	99.8	50.8	172	153.3	78.1	232	206.7	105.3	292	260.2	132.6
53	47.2	24.1	113	100.7	51.3	173	154.1	78.5	233	207.6	105.8	293	261.1	133.0
54	48.1	24.5	114	101.6	51.8	174	155.0	79.0	234	208.5	106.2	294	262.0	133.5
55	49.0	25.0	115	102.5	52.2	175	155.9	79.4	235	209.4	106.7	295	262.8	133.9
56	49.9	25.4	116	103.4	52.7	176	156.8	79.9	236	210.3	107.1	296	263.7	134.4
57	50.8	25.9	117	104.2	53.1	177	157.7	80.4	237	211.2	107.6	297	264.6	134.8
58	51.7	26.3	118	105.1	53.6	178	158.6	80.8	238	212.1	108.0	298	265.5	135.3
59	52.6	26.8	119	106.0	54.0	179	159.5	81.3	239	213.0	108.5	299	266.4	135.7
60	53.5	27.2	120	106.9	54.5	180	160.4	81.7	240	213.8	109.0	300	267.3	136.2
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 63 Degrees. 4h 12m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 28 DEGREES. $1^h\ 52^m$.

Dist	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.9	28.6	121	106.8	56.8	181	159.8	85.0	241	212.8	113.1
2	01.8	00.9	62	54.7	29.1	122	107.7	57.3	182	160.7	85.4	242	213.7	113.6
3	02.6	01.4	63	55.6	29.6	123	108.6	57.7	183	161.6	85.9	243	214.6	114.1
4	03.5	01.9	64	56.5	30.0	124	109.5	58.2	184	162.5	86.4	244	215.4	114.6
5	04.4	02.3	65	57.4	30.5	125	110.4	58.7	185	163.3	86.9	245	216.3	115.0
6	05.3	02.8	66	58.3	31.0	126	111.3	59.2	186	164.2	87.3	246	217.2	115.5
7	06.2	03.3	67	59.2	31.5	127	112.1	59.6	187	165.1	87.8	247	218.1	116.0
8	07.1	03.8	68	60.0	31.9	128	113.0	60.1	188	166.0	88.3	248	219.0	116.4
9	07.9	04.2	69	60.9	32.4	129	113.9	60.6	189	166.9	88.7	249	219.9	116.9
10	08.8	04.7	70	61.8	32.9	130	114.8	61.0	190	167.8	89.2	250	220.7	117.4
11	09.7	05.2	71	62.7	33.3	131	115.7	61.5	191	168.6	89.7	251	221.6	117.8
12	10.6	05.6	72	63.6	33.8	132	116.5	62.0	192	169.5	90.1	252	222.5	118.3
13	11.5	06.1	73	64.5	34.3	133	117.4	62.4	193	170.4	90.6	253	223.4	118.8
14	12.4	06.6	74	65.3	34.7	134	118.3	62.9	194	171.3	91.1	254	224.3	119.2
15	13.2	07.0	75	66.2	35.2	135	119.2	63.4	195	172.2	91.5	255	225.2	119.7
16	14.1	07.5	76	67.1	35.7	136	120.1	63.8	196	173.1	92.0	256	226.0	120.2
17	15.0	08.0	77	68.0	36.1	137	121.0	64.3	197	173.9	92.5	257	226.9	120.7
18	15.9	08.5	78	68.9	36.6	138	121.8	64.8	198	174.8	93.0	258	227.8	121.1
19	16.8	08.9	79	69.8	37.1	139	122.7	65.3	199	175.7	93.4	259	228.7	121.6
20	17.7	09.4	80	70.6	37.6	140	123.6	65.7	200	176.6	93.9	260	229.6	122.1
21	18.5	09.9	81	71.5	38.0	141	124.5	66.2	201	177.5	94.4	261	230.4	122.5
22	19.4	10.3	82	72.4	38.5	142	125.4	66.7	202	178.4	94.8	262	231.3	123.0
23	20.3	10.8	83	73.3	39.0	143	126.3	67.1	203	179.2	95.3	263	232.2	123.5
24	21.2	11.3	84	74.2	39.4	144	127.1	67.6	204	180.1	95.8	264	233.1	123.9
25	22.1	11.7	85	75.1	39.9	145	128.0	68.1	205	181.0	96.2	265	234.0	124.4
26	23.0	12.2	86	75.9	40.4	146	128.9	68.5	206	181.9	96.7	266	234.9	124.9
27	23.8	12.7	87	76.8	40.8	147	129.8	69.0	207	182.8	97.2	267	235.7	125.3
28	24.7	13.1	88	77.7	41.3	148	130.7	69.5	208	183.7	97.7	268	236.6	125.8
29	25.6	13.6	89	78.6	41.8	149	131.6	70.0	209	184.5	98.1	269	237.5	126.3
30	26.5	14.1	90	79.5	42.3	150	132.4	70.4	210	185.4	98.6	270	238.4	126.8
31	27.4	14.6	91	80.3	42.7	151	133.3	70.9	211	186.3	99.1	271	239.3	127.2
32	28.3	15.0	92	81.2	43.2	152	134.2	71.4	212	187.2	99.5	272	240.2	127.7
33	29.1	15.5	93	82.1	43.7	153	135.1	71.8	213	188.1	100.0	273	241.0	128.2
34	30.0	16.0	94	83.0	44.1	154	136.0	72.3	214	189.0	100.5	274	241.9	128.6
35	30.9	16.4	95	83.9	44.6	155	136.9	72.8	215	189.8	100.9	275	242.8	129.1
36	31.8	16.9	96	84.8	45.1	156	137.7	73.2	216	190.7	101.4	276	243.7	129.6
37	32.7	17.4	97	85.6	45.5	157	138.6	73.7	217	191.6	101.9	277	244.6	130.0
38	33.6	17.8	98	86.5	46.0	158	139.5	74.2	218	192.5	102.3	278	245.5	130.5
39	34.4	18.3	99	87.4	46.5	159	140.4	74.6	219	193.4	102.8	279	246.3	131.0
40	35.3	18.8	100	88.3	46.9	160	141.3	75.1	220	194.2	103.3	280	247.2	131.5
41	36.2	19.2	101	89.2	47.4	161	142.2	75.6	221	195.1	103.8	281	248.1	131.9
42	37.1	19.7	102	90.1	47.9	162	143.0	76.1	222	196.0	104.2	282	249.0	132.4
43	38.0	20.2	103	90.9	48.4	163	143.9	76.5	223	196.9	104.7	283	249.9	132.9
44	38.8	20.7	104	91.8	48.8	164	144.8	77.0	224	197.8	105.2	284	250.8	133.3
45	39.7	21.1	105	92.7	49.3	165	145.7	77.5	225	198.7	105.6	285	251.6	133.8
46	40.6	21.6	106	93.6	49.8	166	146.6	77.9	226	199.5	106.1	286	252.5	134.3
47	41.5	22.1	107	94.5	50.2	167	147.5	78.4	227	200.4	106.6	287	253.4	134.7
48	42.4	22.5	108	95.4	50.7	168	148.3	78.9	228	201.3	107.0	288	254.3	135.2
49	43.3	23.0	109	96.2	51.2	169	149.2	79.3	229	202.2	107.5	289	255.2	135.7
50	44.1	23.5	110	97.1	51.6	170	150.1	79.8	230	203.1	108.0	290	256.1	136.1
51	45.0	23.9	111	98.0	52.1	171	151.0	80.3	231	204.0	108.4	291	256.9	136.6
52	45.9	24.4	112	98.9	52.6	172	151.9	80.7	232	204.8	108.9	292	257.8	137.1
53	46 8	24.9	113	99.8	53.1	173	152.7	81.2	233	205.7	109.4	293	258.7	137.6
54	47.7	25.4	114	100.7	53.5	174	153.6	81.7	234	206.6	109.9	294	259.6	138.0
55	48.6	25.8	115	101.5	54.0	175	154.5	82.2	235	207.5	110.3	295	260.5	138.5
56	49.4	26.3	116	102.4	54.5	176	155.4	82.6	236	208.4	110.8	296	261.4	139.0
57	50.3	26.8	117	103.3	54.9	177	156 3	83.1	237	209.3	111.3	297	262.2	139.4
58	51.2	27.2	118	104.2	55.4	178	157.2	83.6	238	210.1	111.7	298	263.1	139.9
59	52.1	27.7	119	105.1	55.9	179	158.0	84.0	239	211.0	112.2	299	264.0	140.4
60	53.0	28.2	120	106.0	56.3	180	158.9	84.5	240	211.9	112.7	300	264.9	140.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 29 DEGREES. 1h 56m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	53.4	29.6	121	105.8	58.7	181	158.3	87.8	241	210.8	116.8
2	01.7	01.0	62	54.2	30.1	122	106.7	59.1	182	159.2	88.2	242	211.7	117.3
3	02.6	01.5	63	55.1	30.5	123	107.6	59.6	183	160.1	88.7	243	212.5	117.8
4	03.5	01.9	64	56.0	31.0	124	108.5	60.1	184	160.9	89.2	244	213.4	118.3
5	04.4	02.4	65	56.9	31.5	125	109.3	60.6	185	161.8	89.7	245	214.3	118.8
6	05.2	02.9	66	57.7	32.0	126	110.2	61.1	186	162.7	90.2	246	215.2	119.3
7	06.1	03.4	67	58.6	32.5	127	111.1	61.6	187	163.6	90.7	247	216.0	119.7
8	07.0	03.9	68	59.5	33.0	128	112.0	62.1	188	164.4	91.1	248	216.9	120.2
9	07.9	04.4	69	60.3	33.5	129	112.8	62.5	189	165.3	91.6	249	217.8	120.7
10	08.7	04.8	70	61.2	33.9	130	113.7	63.0	190	166.2	92.1	250	218.7	121.2
11	09.6	05.3	71	62.1	34.4	131	114.6	63.5	191	167.1	92.6	251	219.5	121.7
12	10.5	05.8	72	63.0	34.9	132	115.4	64.0	192	167.9	93.1	252	220.4	122.2
13	11.4	06.3	73	63.8	35.4	133	116.3	64.5	193	168.8	93.6	253	221.3	122.7
14	12.2	06.8	74	64.7	35.9	134	117.2	65.0	194	169.7	94.1	254	222.2	123.1
15	13.1	07.3	75	65.6	36.4	135	118.1	65.4	195	170.6	94.5	255	223.0	123.6
16	14.0	07.8	76	66.5	36.8	136	118.9	65.9	196	171.4	95.0	256	223.9	124.1
17	14.9	08.2	77	67.3	37.3	137	119.8	66.4	197	172.3	95.5	257	224.8	124.6
18	15.7	08.7	78	68.2	37.8	138	120.7	66.9	198	173.2	96.0	258	225.7	125.1
19	16.6	09.2	79	69.1	38.3	139	121.6	67.4	199	174.0	96.5	259	226.5	125.6
20	17.5	09.7	80	70.0	38.8	140	122.4	67.9	200	174.9	97.0	260	227.4	126.1
21	18.4	10.2	81	70.8	39.3	141	123.3	68.4	201	175.8	97.4	261	228.3	126.5
22	19.2	10.7	82	71.7	39.8	142	124.2	68.8	202	176.7	97.9	262	229.2	127.0
23	20.1	11.2	83	72.6	40.2	143	125.1	69.3	203	177.5	98.4	263	230.0	127.5
24	21.0	11.6	84	73.5	40.7	144	125.9	69.8	204	178.4	98.9	264	230.9	128.0
25	21.9	12.1	85	74.3	41.2	145	126.8	70.3	205	179.3	99.4	265	231.8	128.5
26	22.7	12.6	86	75.2	41.7	146	127.7	70.8	206	180.2	99.9	266	232.6	129.0
27	23.6	13.1	87	76.1	42.2	147	128.6	71.3	207	181.0	100.4	267	233.5	129.4
28	24.5	13.6	88	77.0	42.7	148	129.4	71.8	208	181.9	100.8	268	234.4	129.9
29	25.4	14.1	89	77.8	43.1	149	130.3	72.2	209	182.8	101.3	269	235.3	130.4
30	26.2	14.5	90	78.7	43.6	150	131.2	72.7	210	183.7	101.8	270	236.1	130.9
31	27.1	15.0	91	79.6	44.1	151	132.1	73.2	211	184.5	102.3	271	237.0	131.4
32	28.0	15.5	92	80.5	44.6	152	132.9	73.7	212	185.4	102.8	272	237.9	131.9
33	28.9	16.0	93	81.3	45.1	153	133.8	74.2	213	186.3	103.3	273	238.8	132.4
34	29.7	16.5	94	82.2	45.6	154	134.7	74.7	214	187.2	103.7	274	239.6	132.8
35	30.6	17.0	95	83.1	46.1	155	135.6	75.1	215	188.0	104.2	275	240.5	133.3
36	31.5	17.5	96	84.0	46.5	156	136.4	75.6	216	188.9	104.7	276	241.4	133.8
37	32.4	17.9	97	84.8	47.0	157	137.3	76.1	217	189.8	105.2	277	242.3	134.3
38	33.2	18.4	98	85.7	47.5	158	138.2	76.6	218	190.7	105.7	278	243.1	134.8
39	34.1	18.9	99	86.6	48.0	159	139.1	77.1	219	191.5	106.2	279	244.0	135.3
40	35.0	19.4	100	87.5	48.5	160	139.9	77.6	220	192.4	106.7	280	244.9	135.7
41	35.9	19.9	101	88.3	49.0	161	140.8	78.1	221	193.3	107.1	281	245.8	136.2
42	36.7	20.4	102	89.2	49.5	162	141.7	78.5	222	194.2	107.6	282	246.6	136.7
43	37.6	20.8	103	90.1	49.9	163	142.6	79.0	223	195.0	108.1	283	247.5	137.2
44	38.5	21.3	104	91.0	50.4	164	143.4	79.5	224	195.9	108.6	284	248.4	137.7
45	39.4	21.8	105	91.8	50.9	165	144.3	80.0	225	196.8	109.1	285	249.3	138.2
46	40.2	22.3	106	92.7	51.4	166	145.2	80.5	226	197.7	109.6	286	250.1	138.7
47	41.1	22.8	107	93.6	51.9	167	146.1	81.0	227	198.5	110.1	287	251.0	139.1
48	42.0	23.3	108	94.5	52.4	168	146.9	81.4	228	199.4	110.5	288	251.9	139.6
49	42.9	23.8	109	95.3	52.8	169	147.8	81.9	229	200.3	111.0	289	252.8	140.1
50	43.7	24.2	110	96.2	53.3	170	148.7	82.4	230	201.2	111.5	290	253.6	140.6
51	44.6	24.7	111	97.1	53.8	171	149.6	82.9	231	202.0	112.0	291	254.5	141.1
52	45.5	25.2	112	98.0	54.3	172	150.4	83.4	232	202.9	112.5	292	255.4	141.6
53	46.4	25.7	113	98.8	54.8	173	151.3	83.9	233	203.8	113.0	293	256.3	142.0
54	47.2	26.2	114	99.7	55.3	174	152.2	84.4	234	204.7	113.4	294	257.1	142.5
55	48.1	26.7	115	100.6	55.8	175	153.1	84.8	235	205.5	113.9	295	258.0	143.0
56	49.0	27.1	116	101.5	56.2	176	153.9	85.3	236	206.4	114.4	296	258.9	143.5
57	49.9	27.6	117	102.3	56.7	177	154.8	85.8	237	207.3	114.9	297	259.8	144.0
58	50.7	28.1	118	103.2	57.2	178	155.7	86.3	238	208.2	115.4	298	260.6	144.5
59	51.6	28.6	119	104.1	57.7	179	156.6	86.8	239	209.0	115.9	299	261.5	145.0
60	52.5	29.1	120	105.0	58.2	180	157.4	87.3	240	209.9	116.4	300	262.4	145.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 61 Degrees. 4h 4m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 30 DEGREES. 2h 0m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.8	30.5	121	104.8	60.5	181	156.8	90.5	241	208.7	120.5
2	01.7	01.0	62	53.7	31.0	122	105.7	61.0	182	157.6	91.0	242	209.6	121.0
3	02.6	01.5	63	54.6	31.5	123	106.5	61.5	183	158.5	91.5	243	210.4	121.5
4	03.5	02.0	64	55.4	32.0	124	107.4	62.0	184	159.3	92.0	244	211.3	122.0
5	04.3	02.5	65	56.3	32.5	125	108.3	62.5	185	160.2	92.5	245	212.2	122.5
6	05.2	03.0	66	57.2	33.0	126	109.1	63.0	186	161.1	93.0	246	213.0	123.0
7	06.1	03.5	67	58.0	33.5	127	110.0	63.5	187	161.9	93.5	247	213.9	123 5
8	06.9	04.0	68	58.9	34.0	128	110.9	64.0	188	162.8	94.0	248	214.8	124.0
9	07.8	04.5	69	59.8	34.5	129	111.7	64.5	189	163.7	94.5	249	215.6	124.5
10	08.7	05.0	70	60.6	35.0	130	112.6	65.0	190	164.5	95.0	250	216.5	125.0
11	09.5	05.5	71	61.5	35.5	131	113.4	65.5	191	165.4	95.5	251	217.4	125.5
12	10.4	06.0	72	62.4	36.0	132	114.3	66.0	192	166.3	96.0	252	218.2	126.0
13	11.3	06.5	73	63.2	36.5	133	115.2	66.5	193	167.1	96.5	253	219.1	126.5
14	12.1	07.0	74	64.1	37.0	134	116.0	67.0	194	168.0	97.0	254	220.0	127.0
15	13.0	07.5	75	65.0	37.5	135	116.9	67.5	195	168.9	97.5	255	220.8	127.5
16	13.9	08.0	76	65.8	38.0	136	117.8	68.0	196	169.7	98.0	256	221.7	128.0
17	14.7	08.5	77	66.7	38.5	137	118.6	68.5	197	170.6	98.5	257	222.6	128.5
18	15.6	09.0	78	67.5	39.0	138	119.5	69.0	198	171.5	99.0	258	223.4	129.0
19	16.5	09.5	79	68.4	39.5	139	120.4	69.5	199	172.3	99.5	259	224.3	129.5
20	17.3	10.0	80	69.3	40.0	140	121.2	70.0	200	173.2	100.0	260	225.2	130.0
21	18.2	10.5	81	70.1	40.5	141	122.1	70.5	201	174.1	100.5	261	226.0	130 5
22	19.1	11.0	82	71.0	41.0	142	123.0	71.0	202	174.9	101.0	262	226.9	131.0
23	19.9	11.5	83	71.9	41.5	143	123.8	71.5	203	175.8	101.5	263	227.8	131.5
24	20.8	12.0	84	72.7	42.0	144	124.7	72.0	204	176.7	102.0	264	228.6	132.0
25	21.7	12.5	85	73.6	42.5	145	125.6	72.5	205	177.5	102.5	265	229.5	132.5
26	22.5	13.0	86	74.5	43.0	146	126.4	73.0	206	178.4	103.0	266	230.4	133.0
27	23.4	13.5	87	75.3	43.5	147	127.3	73.5	207	179.3	103.5	267	231.2	133.5
28	24.2	14.0	88	76.2	44.0	148	128.2	74.0	208	180.1	104.0	268	232.1	134.0
29	25.1	14.5	89	77.1	44.5	149	129.0	74.5	209	181.0	104.5	269	233.0	134.5
30	26.0	15.0	90	77.9	45.0	150	129.9	75.0	210	181.9	105.0	270	233.8	135.0
31	26.8	15.5	91	78.8	45.5	151	130.8	75.5	211	182.7	105.5	271	234.7	135.5
32	27.7	16.0	92	79.7	46.0	152	131.6	76.0	212	183.6	106.0	272	235.6	136.0
33	28.6	16.5	93	80.5	46.5	153	132.5	76.5	213	184.5	106.5	273	236.4	136.5
34	29.4	17.0	94	81.4	47.0	154	133.4	77.0	214	185.3	107.0	274	237.3	137.0
35	30.3	17.5	95	82.3	47.5	155	134.2	77.5	215	186.2	107.5	275	238.2	137.5
36	31.2	18.0	96	83.1	48.0	156	135.1	78.0	216	187.1	108.0	276	239.0	138.0
37	32.0	18.5	97	84.0	48.5	157	136.0	78.5	217	187.9	108.5	277	239.9	138.5
38	32.9	19.0	98	84.9	49.0	158	136.8	79.0	218	188.8	109.0	278	240.8	139.0
39	33.8	19.5	99	85.7	49.5	159	137.7	79.5	219	189.7	109.5	279	241.6	139.5
40	34.6	20.0	100	86.6	50.0	160	138.6	80.0	220	190.5	110.0	280	242.5	140.0
41	35.5	20.5	101	87.5	50.5	161	139.4	80.5	221	191.4	110.5	281	243.4	140.5
42	36.4	21.0	102	88.3	51.0	162	140.3	81.0	222	192.3	111.0	282	244.2	141.0
43	37.2	21.5	103	89.2	51.5	163	141.2	81.5	223	193.1	111.5	283	245.1	141.5
44	38.1	22.0	104	90.1	52.0	164	142.0	82.0	224	194.0	112.0	284	246.0	142.0
45	39.0	22.5	105	90.9	52.5	165	142.9	82.5	225	194.9	112.5	285	246.8	142.5
46	39.8	23.0	106	91.8	53.0	166	143.8	83.0	226	195.7	113.0	286	247.7	143.0
47	40.7	23.5	107	92.7	53.5	167	144.6	83.5	227	196.6	113.5	287	248.5	143.5
48	41.6	24.0	108	93.5	54.0	168	145.5	84.0	228	197.5	114.0	288	249.4	144.0
49	42.4	24.5	109	94.4	54.5	169	146.4	84.5	229	198.3	114.5	289	250.3	144.5
50	43.3	25.0	110	95.3	55.0	170	147.2	85.0	230	199.2	115.0	290	251.1	145.0
51	44.2	25.5	111	96.1	55.5	171	148.1	85.5	231	200.1	115.5	291	252.0	145.5
52	45.0	26.0	112	97.0	56.0	172	149.0	86.0	232	200.9	116.0	292	252.9	146.0
53	45 9	26.5	113	97.9	56.5	173	149.8	86.5	233	201.8	116.5	293	253.7	146.5
54	46.8	27.0	114	98.7	57.0	174	150.7	87.0	234	202.6	117.0	294	254.6	147.0
55	47.6	27.5	115	99.6	57.5	175	151.6	87.5	235	203.5	117.5	295	255.5	147.5
56	48.5	28.0	116	100.5	58.0	176	152.4	88.0	236	204.4	118.0	296	256.3	148.0
57	49.4	28.5	117	101.3	58.5	177	153.3	88.5	237	205.2	118.5	297	257.2	148.5
58	50.2	29.0	118	102.2	59.0	178	154.2	89.0	238	206.1	119.0	298	258.1	149.0
59	51.1	29.5	119	103.1	59.5	179	155.0	89.5	239	207.0	119.5	299	258.9	149.5
60	52.0	30.0	120	103.9	60.0	180	155.9	90.0	240	207.8	120.0	300	259.8	150.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 60 Degrees. 4h 0m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 31 DEGREES. 2h 4m

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.9	00.5	61	52.3	31.4	121	103.7	62.3	181	155.1	93.2	241	206.6	124.1
2	01.7	01.0	62	53.1	31.9	122	104.6	62.8	182	156.0	93.7	242	207.4	124.6
3	02.6	01.5	63	54.0	32.4	123	105.4	63.3	183	156.9	94.3	243	208.3	125.2
4	03.4	02.1	64	54.9	33.0	124	106.3	63.9	184	157.7	94.8	244	209.1	125.7
5	04.3	02.6	65	55.7	33.5	125	107.1	64.4	185	158.6	95.3	245	210.0	126.2
6	05.1	03.1	66	56.6	34.0	126	108.0	64.9	186	159.4	95.8	246	210.9	126.7
7	06.0	03.6	67	57.4	34.5	127	108.9	65.4	187	160.3	96.3	247	211.7	127.2
8	06.9	04.1	68	58.3	35.0	128	109.7	65.9	188	161.1	96.8	248	212.6	127.7
9	07.7	04.6	69	59.1	35.5	129	110.6	66.4	189	162.0	97.3	249	213.4	128.2
10	08.6	05.2	70	60.0	36.1	130	111.4	67.0	190	162.9	97.9	250	214.3	128.8
11	09.4	05.7	71	60.9	36.6	131	112.3	67.5	191	163.7	98.4	251	215.1	129.3
12	10.3	06.2	72	61.7	37.1	132	113.1	68.0	192	164.6	98.9	252	216.0	129.8
13	11.1	06.7	73	62.6	37.6	133	114.0	68.5	193	165.4	99.4	253	216.9	130.3
14	12.0	07.2	74	63.4	38.1	134	114.9	69.0	194	166.3	99.9	254	217.7	130.8
15	12.9	07.7	75	64.3	38.6	135	115.7	69.5	195	167.1	100.4	255	218.6	131.3
16	13.7	08.2	76	65.1	39.1	136	116.6	70.0	196	168.0	100.9	256	219.4	131.8
17	14.6	08.8	77	66.0	39.7	137	117.4	70.6	197	168.9	101.5	257	220.3	132.4
18	15.4	09.3	78	66.9	40.2	138	118.3	71.1	198	169.7	102.0	258	221.1	132.9
19	16.3	09.8	79	67.7	40.7	139	119.1	71.6	199	170.6	102.5	259	222.0	133.4
20	17.1	10.3	80	68.6	41.2	140	120.0	72.1	200	171.4	103.0	260	222.9	133.9
21	18.0	10.8	81	69.4	41.7	141	120.9	72.6	201	172.3	103.5	261	223.7	134.4
22	18.9	11.3	82	70.3	42.2	142	121.7	73.1	202	173.1	104.0	262	224.6	134.9
23	19.7	11.8	83	71.1	42.7	143	122.6	73.7	203	174.0	104.6	263	225.4	135.5
24	20.6	12.4	84	72.0	43.3	144	123.4	74.2	204	174.9	105.1	264	226.3	136.0
25	21.4	12.9	85	72.9	43.8	145	124.3	74.7	205	175.7	105.6	265	227.1	136.5
26	22.3	13.4	86	73.7	44.3	146	125.1	75.2	206	176.6	106.1	266	228.0	137.0
27	23.1	13.9	87	74.6	44.8	147	126.0	75.7	207	177.4	106.6	267	228.9	137.5
28	24.0	14.4	88	75.4	45.3	148	126.9	76.2	208	178.3	107.1	268	229.7	138.0
29	24.9	14.9	89	76.3	45.8	149	127.7	76.7	209	179.1	107.6	269	230.6	138.5
30	25.7	15.5	90	77.1	46.4	150	128.6	77.3	210	180.0	108.2	270	231.4	139.1
31	26.6	16.0	91	78.0	46.9	151	129.4	77.8	211	180.9	108.7	271	232.3	139.6
32	27.4	16.5	92	78.9	47.4	152	130.3	78.3	212	181.7	109.2	272	233.1	140.1
33	28.3	17.0	93	79.7	47.9	153	131.1	78.8	213	182.6	109.7	273	234.0	140.6
34	29.1	17.5	94	80.6	48.4	154	132.0	79.3	214	183.4	110.2	274	234.9	141.1
35	30.0	18.0	95	81.4	48.9	155	132.9	79.8	215	184.3	110.7	275	235.7	141.6
36	30.9	18.5	96	82.3	49.4	156	133.7	80.3	216	185.1	111.2	276	236.6	142.2
37	31.7	19.1	97	83.1	50.0	157	134.6	80.9	217	186.0	111.8	277	237.4	142.7
38	32.6	19.6	98	84.0	50.5	158	135.4	81.4	218	186.9	112.3	278	238.3	143.2
39	33.4	20.1	99	84.9	51.0	159	136.3	81.9	219	187.7	112.8	279	239.1	143.7
40	34.3	20.6	100	85.7	51.5	160	137.1	82.4	220	188.6	113.3	280	240.0	144.2
41	35.1	21.1	101	86.6	52.0	161	138.0	82.9	221	189.4	113.8	281	240.9	144.7
42	36.0	21.6	102	87.4	52.5	162	138.9	83.4	222	190.3	114.3	282	241.7	145.2
43	36.9	22.1	103	88.3	53.0	163	139.7	84.0	223	191.1	114.9	283	242.6	145.8
44	37.7	22.7	104	89.1	53.6	164	140.6	84.5	224	192.0	115.4	284	243.4	146.3
45	38.6	23.2	105	90.0	54.1	165	141.4	85.0	225	192.9	115.9	285	244.3	146.8
46	39.4	23.7	106	90.9	54.6	166	142.3	85.5	226	193.7	116.4	286	245.1	147.3
47	40.3	24.2	107	91.7	55.1	167	143.1	86.0	227	194.6	116.9	287	246.0	147.8
48	41.1	24.7	108	92.6	55.6	168	144.0	86.5	228	195.4	117.4	288	246.9	148.3
49	42.0	25.2	109	93.4	56.1	169	144.9	87.0	229	196.3	117.9	289	247.7	148.8
50	42.9	25.8	110	94.3	56.7	170	145.7	87.6	230	197.1	118.5	290	248.6	149.4
51	43.7	26.3	111	95.1	57.2	171	146.6	88.1	231	198.0	119.0	291	249.4	149.9
52	44.6	26.8	112	96.0	57.7	172	147.4	88.6	232	198.9	119.5	292	250.3	150.4
53	45.4	27.3	113	96.9	58.2	173	148.3	89.1	233	199.7	120.0	293	251.2	150.9
54	46.3	27.8	114	97.7	58.7	174	149.1	89.6	234	200.6	120.5	294	252.0	151.4
55	47.1	28.3	115	98.6	59.2	175	150.0	90.1	235	201.4	121.0	295	252.9	151.9
56	48.0	28.8	116	99.4	59.7	176	150.9	90.6	236	202.3	121.5	296	253.7	152.5
57	48.9	29.4	117	100.3	60.3	177	151.7	91.2	237	203.1	122.1	297	254.6	153.0
58	49.7	29.9	118	101.1	60.8	178	152.6	91.7	238	204.0	122.6	298	255.4	153.5
59	50.6	30.4	119	102.0	61.3	179	153.4	92.2	239	204.9	123.1	299	256.3	154.0
60	51.4	30.9	120	102.9	61.8	180	154.3	92.7	240	205.7	123.6	300	257.1	154.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 59 Degrees. 3h 56m

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 32 DEGREES. 2h 8m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.5	61	51.7	32.3	121	102.6	64.1	181	153.5	95.9	241	204.4	127.7
2	01.7	01.1	62	52.6	32.9	122	103.5	64.7	182	154.3	96.4	242	205.2	128.2
3	02.5	01.6	63	53.4	33.4	123	104.3	65.2	183	155.2	97.0	243	206.1	128.8
4	03.4	02.1	64	54.3	33.9	124	105.2	65.7	184	156.0	97.5	244	206.9	129.3
5	04.2	02.6	65	55.1	34.4	125	106.0	66.2	185	156.9	98.0	245	207.8	129.8
6	05.1	03.2	66	56.0	35.0	126	106.9	66.8	186	157.7	98.6	246	208.6	130.4
7	05.9	03.7	67	56.8	35.5	127	107.7	67.3	187	158.6	99.1	247	209.5	130.9
8	06.8	04.2	68	57.7	36.0	128	108.6	67.8	188	159.4	99.6	248	210.3	131.4
9	07.6	04.8	69	58.5	36.6	129	109.4	68.4	189	160.3	100.2	249	211.2	131.9
10	08.5	05.3	70	59.4	37.1	130	110.2	68.9	190	161.1	100.7	250	212.0	132.5
11	09.3	05.8	71	60.2	37.6	131	111.1	69.4	191	162.0	101.2	251	212.9	133.0
12	10.2	06.4	72	61.1	38.2	132	111.9	69.9	192	162.8	101.7	252	213.7	133.5
13	11.0	06.9	73	61.9	38.7	133	112.8	70.5	193	163.7	102.3	253	214.6	134.1
14	11.9	07.4	74	62.8	39.2	134	113.6	71.0	194	164.5	102.8	254	215.4	134.6
15	12.7	07.9	75	63.6	39.7	135	114.5	71.5	195	165.4	103.3	255	216.3	135.1
16	13.6	08.5	76	64.5	40.3	136	115.3	72.1	196	166.2	103.9	256	217.1	135.7
17	14.4	09.0	77	65.3	40.8	137	116.2	72.6	197	167.1	104.4	257	217.9	136.2
18	15.3	09.5	78	66.1	41.3	138	117.0	73.1	198	167.9	104.9	258	218.8	136.7
19	16.1	10.1	79	67.0	41.9	139	117.9	73.7	199	168.8	105.5	259	219.6	137.2
20	17.0	10.6	80	67.8	42.4	140	118.7	74.2	200	169.6	106.0	260	220.5	137.8
21	17.8	11.1	81	68.7	42.9	141	119.6	74.7	201	170.5	106.5	261	221.3	138.3
22	18.7	11.7	82	69.5	43.5	142	120.4	75.2	202	171.3	107.0	262	222.2	138.8
23	19.5	12.2	83	70.4	44.0	143	121.3	75.8	203	172.2	107.6	263	223.0	139.4
24	20.4	12.7	84	71.2	44.5	144	122.1	76.3	204	173.0	108.1	264	223.9	139.9
25	21.2	13.2	85	72.1	45.0	145	123.0	76.8	205	173.8	108.6	265	224.7	140.4
26	22.0	13.8	86	72.9	45.6	146	123.8	77.4	206	174.7	109.2	266	225.6	141.0
27	22.9	14.3	87	73.8	46.1	147	124.7	77.9	207	175.5	109.7	267	226.4	141.5
28	23.7	14.8	88	74.6	46.6	148	125.5	78.4	208	176.4	110.2	268	227.3	142.0
29	24.6	15.4	89	75.5	47.2	149	126.4	79.0	209	177.2	110.8	269	228.1	142.5
30	25.4	15.9	90	76.3	47.7	150	127.2	79.5	210	178.1	111.3	270	229.0	143.1
31	26.3	16.4	91	77.2	48.2	151	128.1	80.0	211	178.9	111.8	271	229.8	143.6
32	27.1	17.0	92	78.0	48.8	152	128.9	80.5	212	179.8	112.3	272	230.7	144.1
33	28.0	17.5	93	78.9	49.3	153	129.8	81.1	213	180.6	112.9	273	231.5	144.7
34	28.8	18.0	94	79.7	49.8	154	130.6	81.6	214	181.5	113.4	274	232.4	145.2
35	29.7	18.5	95	80.6	50.3	155	131.4	82.1	215	182.3	113.9	275	233.2	145.7
36	30.5	19.1	96	81.4	50.9	156	132.3	82.7	216	183.2	114.5	276	234.1	146.3
37	31.4	19.6	97	82.3	51.4	157	133.1	83.2	217	184.0	115.0	277	234.9	146.8
38	32.2	20.1	98	83.1	51.9	158	134.0	83.7	218	184.9	115.5	278	235.8	147.3
39	33.1	20.7	99	84.0	52.5	159	134.8	84.3	219	185.7	116.1	279	236.6	147.8
40	33.9	21.2	100	84.8	53.0	160	135.7	84.8	220	186.6	116.6	280	237.5	148.4
41	34.8	21.7	101	85.7	53.5	161	136.5	85.3	221	187.4	117.1	281	238.3	148.9
42	35.6	22.3	102	86.5	54.1	162	137.4	85.8	222	188.3	117.6	282	239.1	149.4
43	36.5	22.8	103	87.3	54.6	163	138.2	86.4	223	189.1	118.2	283	240.0	150.0
44	37.3	23.3	104	88.2	55.1	164	139.1	86.9	224	190.0	118.7	284	240.8	150.5
45	38.2	23.8	105	89.0	55.6	165	139.9	87.4	225	190.8	119.2	285	241.7	151.0
46	39.0	24.4	106	89.9	56.2	166	140.8	88.0	226	191.7	119.8	286	242.5	151.6
47	39.9	24.9	107	90.7	56.7	167	141.6	88.5	227	192.5	120.3	287	243.4	152.1
48	40.7	25.4	108	91.6	57.2	168	142.5	89.0	228	193.4	120.8	288	244.2	152.6
49	41.6	26.0	109	92.4	57.8	169	143.3	89.6	229	194.2	121.4	289	245.1	153.1
50	42.4	26.5	110	93.3	58.3	170	144.2	90.1	230	195.1	121.9	290	245.9	153.7
51	43.3	27.0	111	94.1	58.8	171	145.0	90.6	231	195.9	122.4	291	246.8	154.2
52	44.1	27.6	112	95.0	59.4	172	145.9	91.1	232	196.7	122.9	292	247.6	154.7
53	44.9	28.1	113	95.8	59.9	173	146.7	91.7	233	197.6	123.5	293	248.5	155.3
54	45.8	28.6	114	96.7	60.4	174	147.6	92.2	234	198.4	124.0	294	249.3	155.8
55	46.6	29.1	115	97.5	60.9	175	148.4	92.7	235	199.3	124.5	295	250.2	156.3
56	47.5	29.7	116	98.4	61.5	176	149.3	93.3	236	200.1	125.1	296	251.0	156.9
57	48.3	30.2	117	99.2	62.0	177	150.1	93.8	237	201.0	125.6	297	251.9	157.4
58	49.2	30.7	118	100.1	62.5	178	151.0	94.3	238	201.8	126.1	298	252.7	157.9
59	50.0	31.3	119	100.9	63.1	179	151.8	94.9	239	202.7	126.7	299	253.6	158.4
60	50.9	31.8	120	101.8	63.6	180	152.6	95.4	240	203.5	127.2	300	254.4	159.0
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 58 Degrees. 3h 52m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 33 DEGREES. $2^h\ 12^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.5	61	51.2	33.2	121	101.5	65.9	181	151.8	98.6	241	202.1	131.3
2	01.7	01.1	62	52.0	33.8	122	102.3	66.4	182	152.6	99.1	242	203.0	131.8
3	02.5	01.6	63	52.8	34.3	123	103.2	67.0	183	153.5	99.7	243	203.8	132.3
4	03.4	02.2	64	53.7	34.9	124	104.0	67.5	184	154.3	100.2	244	204.6	132.9
5	04.2	02.7	65	54.5	35.4	125	104.8	68.1	185	155.2	100.8	245	205.5	133.4
6	05.0	03.3	66	55.4	35.9	126	105.7	68.6	186	156.0	101.3	246	206.3	134.0
7	05.9	03.8	67	56.2	36.5	127	106.5	69.2	187	156.8	101.8	247	207.2	134.5
8	06.7	04.4	68	57.0	37.0	128	107.3	69.7	188	157.7	102.4	248	208.0	135.1
9	07.5	04.9	69	57.9	37.6	129	108.2	70.3	189	158.5	102.9	249	208.8	135.6
10	08.4	05.4	70	58.7	38.1	130	109.0	70.8	190	159.3	103.5	250	209.7	136.2
11	09.2	06.0	71	59.5	38.7	131	109.9	71.3	191	160.2	104.0	251	210.5	136.7
12	10.1	06.5	72	60.4	39.2	132	110.7	71.9	192	161.0	104.6	252	211.3	137.2
13	10.9	07.1	73	61.2	39.8	133	111.5	72.4	193	161.9	105.1	253	212.2	137.8
14	11.7	07.6	74	62.1	40.3	134	112.4	73.0	194	162.7	105.7	254	213.0	138.3
15	12.6	08.2	75	62.9	40.8	135	113.2	73.5	195	163.5	106.2	255	213.9	138.9
16	13.4	08.7	76	63.7	41.4	136	114.1	74.1	196	164.4	106.7	256	214.7	139.4
17	14.3	09.3	77	64.6	41.9	137	114.9	74.6	197	165.2	107.3	257	215.5	140.0
18	15.1	09.8	78	65.4	42.5	138	115.7	75.2	198	166.1	107.8	258	216.4	140.5
19	15.9	10.3	79	66.3	43.0	139	116.6	75.7	199	166.9	108.4	259	217.2	141.1
20	16.8	10.9	80	67.1	43.6	140	117.4	76.2	200	167.7	108.9	260	218.1	141.6
21	17.6	11.4	81	67.9	44.1	141	118.3	76.8	201	168.6	109.5	261	218.9	142.2
22	18.5	12.0	82	68.8	44.7	142	119.1	77.3	202	169.4	110.0	262	219.7	142.7
23	19.3	12.5	83	69.6	45.2	143	119.9	77.9	203	170.3	110.6	263	220.6	143.2
24	20.1	13.1	84	70.4	45.7	144	120.8	78.4	204	171.1	111.1	264	221.4	143.8
25	21.0	13.6	85	71.3	46.3	145	121.6	79.0	205	171.9	111.7	265	222.2	144.3
26	21.8	14.2	86	72.1	46.8	146	122.4	79.5	206	172.8	112.2	266	223.1	144.9
27	22.6	14.7	87	73.0	47.4	147	123.3	80.1	207	173.6	112.7	267	223.9	145.4
28	23.5	15.2	88	73.8	47.9	148	124.1	80.6	208	174.4	113.3	268	224.8	146.0
29	24.3	15.8	89	74.6	48.5	149	125.0	81.2	209	175.3	113.8	269	225.6	146.5
30	25.2	16.3	90	75.5	49.0	150	125.8	81.7	210	176.1	114.4	270	226.4	147.1
31	26.0	16.9	91	76.3	49.6	151	126.6	82.2	211	177.0	114.9	271	227.3	147.6
32	26.8	17.4	92	77.2	50.1	152	127.5	82.8	212	177.8	115.5	272	228.1	148.1
33	27.7	18.0	93	78.0	50.7	153	128.3	83.3	213	178.6	116.0	273	229.0	148.7
34	28.5	18.5	94	78.8	51.2	154	129.2	83.9	214	179.5	116.6	274	229.8	149.2
35	29.4	19.1	95	79.7	51.7	155	130.0	84.4	215	180.3	117.1	275	230.6	149.8
36	30.2	19.6	96	80.5	52.3	156	130.8	85.0	216	181.2	117.6	276	231.5	150.3
37	31.0	20.2	97	81.4	52.8	157	131.7	85.5	217	182.0	118.2	277	232.3	150.9
38	31.9	20.7	98	82.2	53.4	158	132.5	86.1	218	182.8	118.7	278	233.2	151.4
39	32.7	21.2	99	83.0	53.9	159	133.3	86.6	219	183.7	119.3	279	234.0	152.0
40	33.5	21.8	100	83.9	54.5	160	134.2	87.1	220	184.5	119.8	280	234.8	152.5
41	34.4	22.3	101	84.7	55.0	161	135.0	87.7	221	185.3	120.4	281	235.7	153.0
42	35.2	22.9	102	85.5	55.6	162	135.9	88.2	222	186.2	120.9	282	236.5	153.6
43	36.1	23.4	103	86.4	56.1	163	136.7	88.8	223	187.0	121.5	283	237.3	154.1
44	36.9	24.0	104	87.2	56.6	164	137.5	89.3	224	187.9	122.0	284	238.2	154.7
45	37.7	24.5	105	88.1	57.2	165	138.4	89.9	225	188.7	122.5	285	239.0	155.2
46	38.6	25.1	106	88.9	57.7	166	139.2	90.4	226	189.5	123.1	286	239.9	155.8
47	39.4	25.6	107	89.7	58.3	167	140.1	91.0	227	190.4	123.6	287	240.7	156.3
48	40.3	26.1	108	90.6	58.8	168	140.9	91.5	228	191.2	124.2	288	241.5	156.9
49	41.1	26.7	109	91.4	59.4	169	141.7	92.0	229	192.1	124.7	289	242.4	157.4
50	41.9	27.2	110	92.3	59.9	170	142.6	92.6	230	192.9	125.3	290	243.2	157.9
51	42.8	27.8	111	93.1	60.5	171	143.4	93.1	231	193.7	125.8	291	244.1	158.5
52	43.6	28.3	112	93.9	61.0	172	144.3	93.7	232	194.6	126.4	292	244.9	159.0
53	44.4	28.9	113	94.8	61.5	173	145.1	94.2	233	195.4	126.9	293	245.7	159.6
54	45.3	29.4	114	95.6	62.1	174	145.9	94.8	234	196.2	127.4	294	246.6	160.1
55	46.1	30.0	115	96.4	62.6	175	146.8	95.3	235	197.1	128.0	295	247.4	160.7
56	47.0	30.5	116	97.3	63.2	176	147.6	95.9	236	197.9	128.5	296	248.2	161.2
57	47.8	31.0	117	98.1	63.7	177	148.4	96.4	237	198.8	129.1	297	249.1	161.8
58	48.6	31.6	118	99.0	64.3	178	149.3	96.9	238	199.6	129.6	298	249.9	162.3
59	49.5	32.1	119	99.8	64.8	179	150.1	97.5	239	200.4	130.2	299	250.8	162.8
60	50.3	32.7	120	100.6	65.4	180	151.0	98.0	240	201.3	130.7	300	251.6	163.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 57 Degrees. $3^h\ 48^m$.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 34 DEGREES. $2^h\ 16^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.6	34.1	121	100.3	67.7	181	150.1	101.2	241	199.8	134.8
2	01.7	01.1	62	51.4	34.7	122	101.1	68.2	182	150.9	101.8	242	200.6	135.3
3	02.5	01.7	63	52.2	35.2	123	102.0	68.8	183	151.7	102.3	243	201.5	135.9
4	03.3	02.2	64	53.1	35.8	124	102.8	69.3	184	152.5	102.9	244	202.3	136.4
5	04.1	02.8	65	53.9	36.3	125	103.6	69.9	185	153.4	103.5	245	203.1	137.0
6	05.0	03.4	66	54.7	36.9	126	104.5	70.5	186	154.2	104.0	246	203.9	137.6
7	05.8	03.9	67	55.5	37.5	127	105.3	71.0	187	155.0	104.6	247	204.8	138.1
8	06.6	04.5	68	56.4	38.0	128	106.1	71.6	188	155.9	105.1	248	205.6	138.7
9	07.5	05.0	69	57.2	38.6	129	106.9	72.1	189	156.7	105.7	249	206.4	139.2
10	08.3	05.6	70	58.0	39.1	130	107.8	72.7	190	157.5	106.2	250	207.3	139.8
11	09.1	06.2	71	58.9	39.7	131	108.6	73.3	191	158.3	106.8	251	208.1	140.4
12	09.9	06.7	72	59.7	40.3	132	109.4	73.8	192	159.2	107.4	252	208.9	140.9
13	10.8	07.3	73	60.5	40.8	133	110.3	74.4	193	160.0	107.9	253	209.7	141.5
14	11.6	07.8	74	61.3	41.4	134	111.1	74.9	194	160.8	108.5	254	210.6	142.0
15	12.4	08.4	75	62.2	41.9	135	111.9	75.5	195	161.7	109.0	255	211.4	142.6
16	13.3	08.9	76	63.0	42.5	136	112.7	76.1	196	162.5	109.6	256	212.2	143.2
17	14.1	09.5	77	63.8	43.1	137	113.6	76.6	197	163.3	110.2	257	213.1	143.7
18	14.9	10.1	78	64.7	43.6	138	114.4	77.2	198	164.1	110.7	258	213.9	144.3
19	15.8	10.6	79	65.5	44.2	139	115.2	77.7	199	165.0	111.3	259	214.7	144.8
20	16.6	11.2	80	66.3	44.7	140	116.1	78.3	200	165.8	111.8	260	215.5	145.4
21	17.4	11.7	81	67.2	45.3	141	116.9	78.8	201	166.6	112.4	261	216.4	145.9
22	18.2	12.3	82	68.0	45.9	142	117.7	79.4	202	167.5	113.0	262	217.2	146.5
23	19.1	12.9	83	68.8	46.4	143	118.6	80.0	203	168.3	113.5	263	218.0	147.1
24	19.9	13.4	84	69.6	47.0	144	119.4	80.5	204	169.1	114.1	264	218.9	147.6
25	20.7	14.0	85	70.5	47.5	145	120.2	81.1	205	170.0	114.6	265	219.7	148.2
26	21.6	14.5	86	71.3	48.1	146	121.0	81.6	206	170.8	115.2	266	220.5	148.7
27	22.4	15.1	87	72.1	48.6	147	121.9	82.2	207	171.6	115.8	267	221.4	149.3
28	23.2	15.7	88	73.0	49.2	148	122.7	82.8	208	172.4	116.3	268	222.2	149.9
29	24.0	16.2	89	73.8	49.8	149	123.5	83.3	209	173.3	116.9	269	223.0	150.4
30	24.9	16.8	90	74.6	50.3	150	124.4	83.9	210	174.1	117.4	270	223.8	151.0
31	25.7	17.3	91	75.4	50.9	151	125.2	84.4	211	174.9	118.0	271	224.7	151.5
32	26.5	17.9	92	76.3	51.4	152	126.0	85.0	212	175.8	118.5	272	225.5	152.1
33	27.4	18.5	93	77.1	52.0	153	126.8	85.6	213	176.6	119.1	273	226.3	152.7
34	28.2	19.0	94	77.9	52.6	154	127.7	86.1	214	177.4	119.7	274	227.2	153.2
35	29.0	19.6	95	78.8	53.1	155	128.5	86.7	215	178.2	120.2	275	228.0	153.8
36	29.8	20.1	96	79.6	53.7	156	129.3	87.2	216	179.1	120.8	276	228.8	154.3
37	30.7	20.7	97	80.4	54.2	157	130.2	87.8	217	179.9	121.3	277	229.6	154.9
38	31.5	21.2	98	81.2	54.8	158	131.0	88.4	218	180.7	121.9	278	230.5	155.5
39	32.3	21.8	99	82.1	55.4	159	131.8	88.9	219	181.6	122.5	279	231.3	156.0
40	33.2	22.4	100	82.9	55.9	160	132.6	89.5	220	182.4	123.0	280	232.1	156.6
41	34.0	22.9	101	83.7	56.5	161	133.5	90.0	221	183.2	123.6	281	233.0	157.1
42	34.8	23.5	102	84.6	57.0	162	134.3	90.6	222	184.0	124.1	282	233.8	157.7
43	35.6	24.0	103	85.4	57.6	163	135.1	91.1	223	184.9	124.7	283	234.6	158.3
44	36.5	24.6	104	86.2	58.2	164	136.0	91.7	224	185.7	125.3	284	235.4	158.8
45	37.3	25.2	105	87.0	58.7	165	136.8	92.3	225	186.5	125.8	285	236.3	159.4
46	38.1	25.7	106	87.9	59.3	166	137.6	92.8	226	187.4	126.4	286	237.1	159.9
47	39.0	26.3	107	88.7	59.8	167	138.4	93.4	227	188.2	126.9	287	237.9	160.5
48	39.8	26.8	108	89.5	60.4	168	139.3	93.9	228	189.0	127.5	288	238.8	161.0
49	40.6	27.4	109	90.4	61.0	169	140.1	94.5	229	189.8	128.1	289	239.6	161.6
50	41.5	28.0	110	91.2	61.5	170	140.9	95.1	230	190.7	128.6	290	240.4	162.2
51	42.3	28.5	111	92.0	62.1	171	141.8	95.6	231	191.5	129.2	291	241.2	162.7
52	43.1	29.1	112	92.9	62.6	172	142.6	96.2	232	192.3	129.7	292	242.1	163.3
53	43.9	29.6	113	93.7	63.2	173	143.4	96.7	233	193.2	130.3	293	242.9	163.8
54	44.8	30.2	114	94.5	63.7	174	144.3	97.3	234	194.0	130.9	294	243.7	164.4
55	45.6	30.8	115	95.3	64.3	175	145.1	97.9	235	194.8	131.4	295	244.6	165.0
56	46.4	31.3	116	96.2	64.9	176	145.9	98.4	236	195.7	132.0	296	245.4	165.5
57	47.3	31.9	117	97.0	65.4	177	146.7	99.0	237	196.5	132.5	297	246.2	166.1
58	48.1	32.4	118	97.8	66.0	178	147.6	99.5	238	197.3	133.1	298	247.1	166.6
59	48.9	33.0	119	98.7	66.5	179	148.4	100.1	239	198.1	133.6	299	247.9	167.2
60	49.7	33.6	120	99.5	67.1	180	149.2	100.7	240	199.0	134.2	300	248.7	167.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 56 Degrees. $3^h\ 44^m$.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 35 DEGREES. 2h 02m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	50.0	35.0	121	99.1	69.4	181	148.3	103.8	241	197.4	138.2
2	01.6	01.1	62	50.8	35.6	122	99.9	70.0	182	149.1	104.4	242	198.2	138.8
3	02.5	01.7	63	51.6	36.1	123	100.8	70.5	183	149.9	105.0	243	199.1	139.4
4	03.3	02.3	64	52.4	36.7	124	101.6	71.1	184	150.7	105.5	244	199.9	140.0
5	04.1	02.9	65	53.2	37.3	125	102.4	71.7	185	151.5	106.1	245	200.7	140.5
6	04.9	03.4	66	54.1	37.9	126	103.2	72.3	186	152.4	106.7	246	201.5	141.1
7	05.7	04.0	67	54.9	38.4	127	104.0	72.8	187	153.2	107.3	247	202.3	141.7
8	06.6	04.6	68	55.7	39.0	128	104.9	73.4	188	154.0	107.8	248	203.1	142.2
9	07.4	05.2	69	56.5	39.6	129	105.7	74.0	189	154.8	108.4	249	204.0	142.8
10	08.2	05.7	70	57.3	40.2	130	106.5	74.6	190	155.6	109.0	250	204.8	143.4
11	09.0	06.3	71	58.2	40.7	131	107.3	75.1	191	156.5	109.6	251	205.6	144.0
12	09.8	06.9	72	59.0	41.3	132	108.1	75.7	192	157.3	110.1	252	206.4	144.5
13	10.6	07.5	73	59.8	41.9	133	108.9	76.3	193	158.1	110.7	253	207.2	145.1
14	11.5	08.0	74	60.6	42.4	134	109.8	76.9	194	158.9	111.3	254	208.1	145.7
15	12.3	08.6	75	61.4	43.0	135	110.6	77.4	195	159.7	111.8	255	208.9	146.3
16	13.1	09.2	76	62.3	43.6	136	111.4	78.0	196	160.6	112.4	256	209.7	146.8
17	13.9	09.8	77	63.1	44.2	137	112.2	78.6	197	161.4	113.0	257	210.5	147.4
18	14.7	10.3	78	63.9	44.7	138	113.0	79.2	198	162.2	113.6	258	211.3	148.0
19	15.6	10.9	79	64.7	45.3	139	113.9	79.7	199	163.0	114.1	259	212.2	148.6
20	16.4	11.5	80	65.5	45.9	140	114.7	80.3	200	163.8	114.7	260	213.0	149.1
21	17.2	12.0	81	66.4	46.5	141	115.5	80.9	201	164.6	115.3	261	213.8	149.7
22	18.0	12.6	82	67.2	47.0	142	116.3	81.4	202	165.5	115.9	262	214.6	150.3
23	18.8	13.2	83	68.0	47.6	143	117.1	82.0	203	166.3	116.4	263	215.4	150.9
24	19.7	13.8	84	68.8	48.2	144	118.0	82.6	204	167.1	117.0	264	216.3	151.4
25	20.5	14.3	85	69.6	48.8	145	118.8	83.2	205	167.9	117.6	265	217.1	152.0
26	21.3	14.9	86	70.4	49.3	146	119.6	83.7	206	168.7	118.2	266	217.9	152.6
27	22.1	15.5	87	71.3	49.9	147	120.4	84.3	207	169.6	118.7	267	218.7	153.1
28	22.9	16.1	88	72.1	50.5	148	121.2	84.9	208	170.4	119.3	268	219.5	153.7
29	23.8	16.6	89	72.9	51.0	149	122.1	85.5	209	171.2	119.9	269	220.4	154.3
30	24.6	17.2	90	73.7	51.6	150	122.9	86.0	210	172.0	120.5	270	221.2	154.9
31	25.4	17.8	91	74.5	52.2	151	123.7	86.6	211	172.8	121.0	271	222.0	155.4
32	26.2	18.4	92	75.4	52.8	152	124.5	87.2	212	173.7	121.6	272	222.8	156.0
33	27.0	18.9	93	76.2	53.3	153	125.3	87.8	213	174.5	122.2	273	223.6	156.6
34	27.9	19.5	94	77.0	53.9	154	126.1	88.3	214	175.3	122.7	274	224.4	157.2
35	28.7	20.1	95	77.8	54.5	155	127.0	88.9	215	176.1	123.3	275	225.3	157.7
36	29.5	20.6	96	78.6	55.1	156	127.8	89.5	216	176.9	123.9	276	226.1	158.3
37	30.3	21.2	97	79.5	55.6	157	128.6	90.1	217	177.8	124.5	277	226.9	158.9
38	31.1	21.8	98	80.3	56.2	158	129.4	90.6	218	178.6	125.0	278	227.7	159.5
39	31.9	22.4	99	81.1	56.8	159	130.2	91.2	219	179.4	125.6	279	228.5	160.0
40	32.8	22.9	100	81.9	57.4	160	131.1	91.8	220	180.2	126.2	280	229.4	160.6
41	33.6	23.5	101	82.7	57.9	161	131.9	92.3	221	181.0	126.8	281	230.2	161.2
42	34.4	24.1	102	83.6	58.5	162	132.7	92.9	222	181.9	127.3	282	231.0	161.7
43	35.2	24.7	103	84.4	59.1	163	133.5	93.5	223	182.7	127.9	283	231.8	162.3
44	36.0	25.2	104	85.2	59.7	164	134.3	94.1	224	183.5	128.5	284	232.6	162.9
45	36.9	25.8	105	86.0	60.2	165	135.2	94.6	225	184.3	129.1	285	233.5	163.5
46	37.7	26.4	106	86.8	60.8	166	136.0	95.2	226	185.1	129.6	286	234.3	164.0
47	38.5	27.0	107	87.6	61.4	167	136.8	95.8	227	185.9	130.2	287	235.1	164.6
48	39.3	27.5	108	88.5	61.9	168	137.6	96.4	228	186.8	130.8	288	235.9	165.2
49	40.1	28.1	109	89.3	62.5	169	138.4	96.9	229	187.6	131.3	289	236.7	165.8
50	41.0	28.7	110	90.1	63.1	170	139.3	97.5	230	188.4	131.9	290	237.6	166.3
51	41.8	29.3	111	90.9	63.7	171	140.1	98.1	231	189.2	132.5	291	238.4	166.9
52	42.6	29.8	112	91.7	64.2	172	140.9	98.7	232	190.0	133.1	292	239.2	167.5
53	43.4	30.4	113	92.6	64.8	173	141.7	99.2	233	190.9	133.6	293	240.0	168.1
54	44.2	31.0	114	93.4	65.4	174	142.5	99.8	234	191.7	134.2	294	240.8	168.6
55	45.1	31.5	115	94.2	66.0	175	143.4	100.4	235	192.5	134.8	295	241.6	169.2
56	45.9	32.1	116	95.0	66.5	176	144.2	100.9	236	193.3	135.4	296	242.5	169.8
57	46.7	32.7	117	95.8	67.1	177	145.0	101.5	237	194.1	135.9	297	243.3	170.4
58	47.5	33.3	118	96.7	67.7	178	145.8	102.1	238	195.0	136.5	298	244.1	170.9
59	48.3	33.8	119	97.5	68.3	179	146.6	102.7	239	195.8	137.1	299	244.9	171.5
60	49.1	34.4	120	98.3	68.8	180	147.4	103.2	240	196.6	137.7	300	245.7	172.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 55 Degrees. 3h 40m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 36 DEGREES. 2h 24m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	49.4	35.9	121	97.9	71.1	181	146.4	106.4	241	195.0	141.7
2	01.6	01.2	62	50.2	36.4	122	98.7	71.7	182	147.2	107.0	242	195.8	142.2
3	02.4	01.8	63	51.0	37.0	123	99.5	72.3	183	148.1	107.6	243	196.6	142.8
4	03.2	02.4	64	51.8	37.6	124	100.3	72.9	184	148.9	108.2	244	197.4	143.4
5	04.0	02.9	65	52.6	38.2	125	101.1	73.5	185	149.7	108.7	245	198.2	144.0
6	04.9	03.5	66	53.4	38.8	126	101.9	74.1	186	150.5	109.3	246	199.0	144.6
7	05.7	04.1	67	54.2	39.4	127	102.7	74.6	187	151.3	109.9	247	199.8	145.2
8	06.5	04.7	68	55.0	40.0	128	103.6	75.2	188	152.1	110.5	248	200.6	145.8
9	07.3	05.3	69	55.8	40.6	129	104.4	75.8	189	152.9	111.1	249	201.4	146.4
10	08.1	05.9	70	56.6	41.1	130	105.2	76.4	190	153.7	111.7	250	202.3	146.9
11	08.9	06.5	71	57.4	41.7	131	106.0	77.0	191	154.5	112.3	251	203.1	147.5
12	09.7	07.1	72	58.2	42.3	132	106.8	77.6	192	155.3	112.9	252	203.9	148.1
13	10.5	07.6	73	59.1	42.9	133	107.6	78.2	193	156.1	113.4	253	204.7	148.7
14	11.3	08.2	74	59.9	43.5	134	108.4	78.8	194	156.9	114.0	254	205.5	149.3
15	12.1	08.8	75	60.7	44.1	135	109.2	79.4	195	157.8	114.6	255	206.3	149.9
16	12.9	09.4	76	61.5	44.7	136	110.0	79.9	196	158.6	115.2	256	207.1	150.5
17	13.8	10.0	77	62.3	45.3	137	110.8	80.5	197	159.4	115.8	257	207.9	151.1
18	14.6	10.6	78	63.1	45.8	138	111.6	81.1	198	160.2	116.4	258	208.7	151.6
19	15.4	11.2	79	63.9	46.4	139	112.5	81.7	199	161.0	117.0	259	209.5	152.2
20	16.2	11.8	80	64.7	47.0	140	113.3	82.3	200	161.8	117.6	260	210.3	152.8
21	17.0	12.3	81	65.5	47.6	141	114.1	82.9	201	162.6	118.1	261	211.2	153.4
22	17.8	12.9	82	66.3	48.2	142	114.9	83.5	202	163.4	118.7	262	212.0	154.0
23	18.6	13.5	83	67.1	48.8	143	115.7	84.1	203	164.2	119.3	263	212.8	154.6
24	19.4	14.1	84	68.0	49.4	144	116.5	84.6	204	165.0	119.9	264	213.6	155.2
25	20.2	14.7	85	68.8	50.0	145	117.3	85.2	205	165.8	120.5	265	214.4	155.8
26	21.0	15.3	86	69.6	50.5	146	118.1	85.8	206	166.7	121.1	266	215.2	156.4
27	21.8	15.9	87	70.4	51.1	147	118.9	86.4	207	167.5	121.7	267	216.0	156.9
28	22.7	16.5	88	71.2	51.7	148	119.7	87.0	208	168.3	122.3	268	216.8	157.5
29	23.5	17.0	89	72.0	52.3	149	120.5	87.6	209	169.1	122.8	269	217.6	158.1
30	24.3	17.6	90	72.8	52.9	150	121.4	88.2	210	169.9	123.4	270	218.4	158.7
31	25.1	18.2	91	73.6	53.5	151	122.2	88.8	211	170.7	124.0	271	219.2	159.3
32	25.9	18.8	92	74.4	54.1	152	123.0	89.3	212	171.5	124.6	272	220.1	159.9
33	26.7	19.4	93	75.2	54.7	153	123.8	89.9	213	172.3	125.2	273	220.9	160.5
34	27.5	20.0	94	76.0	55.3	154	124.6	90.5	214	173.1	125.8	274	221.7	161.1
35	28.3	20.6	95	76.9	55.8	155	125.4	91.1	215	173.9	126.4	275	222.5	161.6
36	29.1	21.2	96	77.7	56.4	156	126.2	91.7	216	174.7	127.0	276	223.3	162.2
37	29.9	21.7	97	78.5	57.0	157	127.0	92.3	217	175.6	127.5	277	224.1	162.8
38	30.7	22.3	98	79.3	57.6	158	127.8	92.9	218	176.4	128.1	278	224.9	163.4
39	31.6	22.9	99	80.1	58.2	159	128.6	93.5	219	177.2	128.7	279	225.7	164.0
40	32.4	23.5	100	80.9	58.8	160	129.4	94.0	220	178.0	129.3	280	226.5	164.6
41	33.2	24.1	101	81.7	59.4	161	130.3	94.6	221	178.8	129.9	281	227.3	165.2
42	34.0	24.7	102	82.5	60.0	162	131.1	95.2	222	179.6	130.5	282	228.1	165.8
43	34.8	25.3	103	83.3	60.5	163	131.9	95.8	223	180.4	131.1	283	229.0	166.3
44	35.6	25.9	104	84.1	61.1	164	132.7	96.4	224	181.2	131.7	284	229.8	166.9
45	36.4	26.5	105	84.9	61.7	165	133.5	97.0	225	182.0	132.3	285	230.6	167.5
46	37.2	27.0	106	85.8	62.3	166	134.3	97.6	226	182.8	132.8	286	231.4	168.1
47	38.0	27.6	107	86.6	62.9	167	135.1	98.2	227	183.6	133.4	287	232.2	168.7
48	38.8	28.2	108	87.4	63.5	168	135.9	98.7	228	184.5	134.0	288	233.0	169.3
49	39.6	28.8	109	88.2	64.1	169	136.7	99.3	229	185.3	134.6	289	233.8	169.9
50	40.5	29.4	110	89.0	64.7	170	137.5	99.9	230	186.1	135.2	290	234.6	170.5
51	41.3	30.0	111	89.8	65.2	171	138.3	100.5	231	186.9	135.8	291	235.4	171.0
52	42.1	30.6	112	90.6	65.8	172	139.2	101.1	232	187.7	136.4	292	236.2	171.6
53	42.9	31.2	113	91.4	66.4	173	140.0	101.7	233	188.5	137.0	293	237.0	172.2
54	43.7	31.7	114	92.2	67.0	174	140.8	102.3	234	189.3	137.5	294	237.9	172.8
55	44.5	32.3	115	93.0	67.6	175	141.6	102.9	235	190.1	138.1	295	238.7	173.4
56	45.3	32.9	116	93.8	68.2	176	142.4	103.5	236	190.9	138.7	296	239.5	174.0
57	46.1	33.5	117	94.7	68.8	177	143.2	104.0	237	191.7	139.3	297	240.3	174.6
58	46.9	34.1	118	95.5	69.4	178	144.0	104.6	238	192.5	139.9	298	241.1	175.2
59	47.7	34.7	119	96.3	69.9	179	144.8	105.2	239	193.4	140.5	299	241.9	175.7
60	48.5	35.3	120	97.1	70.5	180	145.6	105.8	240	194.2	141.1	300	242.7	176.3
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 54 Degrees.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 37 DEGREES. 2h 28m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.7	36.7	121	96.6	72.8	181	144.6	108.9	241	192.5	145.0
2	01.6	01.2	62	49.5	37.3	122	97.4	73.4	182	145.4	109.5	242	193.3	145.6
3	02.4	01.8	63	50.3	37.9	123	98.2	74.0	183	146.2	110.1	243	194.1	146.2
4	03.2	02.4	64	51.1	38.5	124	99.0	74.6	184	146.9	110.7	244	194.9	146.8
5	04.0	03.0	65	51.9	39.1	125	99.8	75.2	185	147.7	111.3	245	195.7	147.4
6	04.8	03.6	66	52.7	39.7	126	100.6	75.8	186	148.5	111.9	246	196.5	148.0
7	05.6	04.2	67	53.5	40.3	127	101.4	76.4	187	149.3	112.5	247	197.3	148.6
8	06.4	04.8	68	54.3	40.9	128	102.2	77.0	188	150.1	113.1	248	198.1	149.3
9	07.2	05.4	69	55.1	41.5	129	103.0	77.6	189	150.9	113.7	249	198.9	149.9
10	08.0	06.0	70	55.9	42.1	130	103.8	78.2	190	151.7	114.3	250	199.7	150.5
11	08.8	06.6	71	56.7	42.7	131	104.6	78.8	191	152.5	114.9	251	200.5	151.1
12	09.6	07.2	72	57.5	43.3	132	105.4	79.4	192	153.3	115.5	252	201.3	151.7
13	10.4	07.8	73	58.3	43.9	133	106.2	80.0	193	154.1	116.2	253	202.1	152.3
14	11.2	08.4	74	59.1	44.5	134	107.0	80.6	194	154.9	116.8	254	202.9	152.9
15	12.0	09.0	75	59.9	45.1	135	107.8	81.2	195	155.7	117.4	255	203.7	153.5
16	12.8	09.6	76	60.7	45.7	136	108.6	81.8	196	156.5	118.0	256	204.5	154.1
17	13.6	10.2	77	61.5	46.3	137	109.4	82.4	197	157.3	118.6	257	205.2	154.7
18	14.4	10.8	78	62.3	46.9	138	110.2	83.1	198	158.1	119.2	258	206.0	155.3
19	15.2	11.4	79	63.1	47.5	139	111.0	83.7	199	158.9	119.8	259	206.8	155.9
20	16.0	12.0	80	63.9	48.1	140	111.8	84.3	200	159.7	120.4	260	207.6	156.5
21	16.8	12.6	81	64.7	48.7	141	112.6	84.9	201	160.5	121.0	261	208.4	157.1
22	17.6	13.2	82	65.5	49.3	142	113.4	85.5	202	161.3	121.6	262	209.2	157.7
23	18.4	13.8	83	66.3	50.0	143	114.2	86.1	203	162.1	122.2	263	210.0	158.3
24	19.2	14.4	84	67.1	50.6	144	115.0	86.7	204	162.9	122.8	264	210.8	158.9
25	20.0	15.0	85	67.9	51.2	145	115.8	87.3	205	163.7	123.4	265	211.6	159.5
26	20.8	15.6	86	68.7	51.8	146	116.6	87.9	206	164.5	124.0	266	212.4	160.1
27	21.6	16.2	87	69.5	52.4	147	117.4	88.5	207	165.3	124.6	267	213.2	160.7
28	22.4	16.9	88	70.3	53.0	148	118.2	89.1	208	166.1	125.2	268	214.0	161.3
29	23.2	17.5	89	71.1	53.6	149	119.0	89.7	209	166.9	125.8	269	214.8	161.9
30	24.0	18.1	90	71.9	54.2	150	119.8	90.3	210	167.7	126.4	270	215.6	162.5
31	24.8	18.7	91	72.7	54.8	151	120.6	90.9	211	168.5	127.0	271	216.4	163.1
32	25.6	19.3	92	73.5	55.4	152	121.4	91.5	212	169.3	127.6	272	217.2	163.7
33	26.4	19.9	93	74.3	56.0	153	122.2	92.1	213	170.1	128.2	273	218.0	164.3
34	27.2	20.5	94	75.1	56.6	154	123.0	92.7	214	170.9	128.8	274	218.8	164.9
35	28.0	21.1	95	75.9	57.2	155	123.8	93.3	215	171.7	129.4	275	219.6	165.5
36	28.8	21.7	96	76.7	57.8	156	124.6	93.9	216	172.5	130.0	276	220.4	166.1
37	29.5	22.3	97	77.5	58.4	157	125.4	94.5	217	173.3	130.6	277	221.2	166.7
38	30.3	22.9	98	78.3	59.0	158	126.2	95.1	218	174.1	131.2	278	222.0	167.3
39	31.1	23.5	99	79.1	59.6	159	127.0	95.7	219	174.9	131.8	279	222.8	167.9
40	31.9	24.1	100	79.9	60.2	160	127.8	96.3	220	175.7	132.4	280	223.6	168.5
41	32.7	24.7	101	80.7	60.8	161	128.6	96.9	221	176.5	133.0	281	224.4	169.1
42	33.5	25.3	102	81.5	61.4	162	129.4	97.5	222	177.3	133.6	282	225.2	169.7
43	34.3	25.9	103	82.3	62.0	163	130.2	98.1	223	178.1	134.2	283	226.0	170.3
44	35.1	26.5	104	83.1	62.6	164	131.0	98.7	224	178.9	134.8	284	226.8	170.9
45	35.9	27.1	105	83.9	63.2	165	131.8	99.3	225	179.7	135.4	285	227.6	171.5
46	36.7	27.7	106	84.7	63.8	166	132.6	99.9	226	180.5	136.0	286	228.4	172.1
47	37.5	28.3	107	85.5	64.4	167	133.4	100.5	227	181.3	136.6	287	229.2	172.7
48	38.3	28.9	108	86.3	65.0	168	134.2	101.1	228	182.1	137.2	288	230.0	173.3
49	39.1	29.5	109	87.1	65.6	169	135.0	101.7	229	182.9	137.8	289	230.8	173.9
50	39.9	30.1	110	87.8	66.2	170	135.8	102.3	230	183.7	138.4	290	231.6	174.5
51	40.7	30.7	111	88.6	66.8	171	136.6	102.9	231	184.5	139.0	291	232.4	175.1
52	41.5	31.3	112	89.4	67.4	172	137.4	103.5	232	185.3	139.6	292	233.2	175.7
53	42.3	31.9	113	90.2	68.0	173	138.2	104.1	233	186.1	140.2	293	234.0	176.3
54	43.1	32.5	114	91.0	68.6	174	139.0	104.7	234	186.9	140.8	294	234.8	176.9
55	43.9	33.1	115	91.8	69.2	175	139.8	105.3	235	187.7	141.4	295	235.6	177.5
56	44.7	33.7	116	92.6	69.8	176	140.6	105.9	236	188.5	142.0	296	236.4	178.1
57	45.5	34.3	117	93.4	70.4	177	141.4	106.5	237	189.3	142.6	297	237.2	178.7
58	46.3	34.9	118	94.2	71.0	178	142.2	107.1	238	190.1	143.2	298	238.0	179.3
59	47.1	35.5	119	95.0	71.6	179	143.0	107.7	239	190.9	143.8	299	238.8	179.9
60	47.9	36.1	120	95.8	72.2	180	143.8	108.3	240	191.7	144.4	300	239.6	180.5
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 53 Degrees. 3h 32m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 38 DEGREES. 2h 32m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	48.1	37.6	121	95.3	74.5	181	142.6	111.4	241	189.9	148.4
2	01.6	01.2	62	48.9	38.2	122	96.1	75.1	182	143.4	112.1	242	190.7	149.0
3	02.4	01.8	63	49.6	38.8	123	96.9	75.7	183	144.2	112.7	243	191.5	149.6
4	03.2	02.5	64	50.4	39.4	124	97.7	76.3	184	145.0	113.3	244	192.3	150.2
5	03.9	03.1	65	51.2	40.0	125	98.5	77.0	185	145.8	113.9	245	193.1	150.8
6	04.7	03.7	66	52.0	40.6	126	99.3	77.6	186	146.6	114.5	246	193.9	151.5
7	05.5	04.3	67	52.8	41.2	127	100.1	78.2	187	147.4	115.1	247	194.6	152.1
8	06.3	04.9	68	53.6	41.9	128	100.9	78.8	188	148.1	115.7	248	195.4	152.7
9	07.1	05.5	69	54.4	42.5	129	101.7	79.4	189	148.9	116.4	249	196.2	153.3
10	07.9	06.2	70	55.2	43.1	130	102.4	80.0	190	149.7	117.0	250	197.0	153.9
11	08.7	06.8	71	55.9	43.7	131	103.2	80.7	191	150.5	117.6	251	197.8	154.5
12	09.5	07.4	72	56.7	44.3	132	104.0	81.3	192	151.3	118.2	252	198.6	155.1
13	10.2	08.0	73	57.5	44.9	133	104.8	81.9	193	152.1	118.8	253	199.4	155.8
14	11.0	08.6	74	58.3	45.6	134	105.6	82.5	194	152.9	119.4	254	200.2	156.4
15	11.8	09.2	75	59.1	46.2	135	106.4	83.1	195	153.7	120.1	255	200.9	157.0
16	12.6	09.9	76	59.9	46.8	136	107.2	83.7	196	154.5	120.7	256	201.7	157.6
17	13.4	10.5	77	60.7	47.4	137	108.0	84.3	197	155.2	121.3	257	202.5	158.2
18	14.2	11.1	78	61.5	48.0	138	108.7	85.0	198	156.0	121.9	258	203.3	158.8
19	15.0	11.7	79	62.3	48.6	139	109.5	85.6	199	156.8	122.5	259	204.1	159.5
20	15.8	12.3	80	63.0	49.3	140	110.3	86.2	200	157.6	123.1	260	204.9	160.1
21	16.5	12.9	81	63.8	49.9	141	111.1	86.8	201	158.4	123.7	261	205.7	160.7
22	17.3	13.5	82	64.6	50.5	142	111.9	87.4	202	159.2	124.4	262	206.5	161.3
23	18.1	14.2	83	65.4	51.1	143	112.7	88.0	203	160.0	125.0	263	207.2	161.9
24	18.9	14.8	84	66.2	51.7	144	113.5	88.7	204	160.8	125.6	264	208.0	162.5
25	19.7	15.4	85	67.0	52.3	145	114.3	89.3	205	161.5	126.2	265	208.8	163.2
26	20.5	16.0	86	67.8	52.9	146	115.0	89.9	206	162.3	126.8	266	209.6	163.8
27	21.3	16.6	87	68.6	53.6	147	115.8	90.5	207	163.1	127.4	267	210.4	164.4
28	22.1	17.2	88	69.3	54.2	148	116.6	91.1	208	163.9	128.1	268	211.2	165.0
29	22.9	17.9	89	70.1	54.8	149	117.4	91.7	209	164.7	128.7	269	212.0	165.6
30	23.6	18.5	90	70.9	55.4	150	118.2	92.3	210	165.5	129.3	270	212.8	166.2
31	24.4	19.1	91	71.7	56.0	151	119.0	93.0	211	166.3	129.9	271	213.6	166.8
32	25.2	19.7	92	72.5	56.6	152	119.8	93.6	212	167.1	130.5	272	214.3	167.5
33	26.0	20.3	93	73.3	57.3	153	120.6	94.2	213	167.8	131.1	273	215.1	168.1
34	26.8	20.9	94	74.1	57.9	154	121.4	94.8	214	168.6	131.8	274	215.9	168.7
35	27.6	21.5	95	74.9	58.5	155	122.1	95.4	215	169.4	132.4	275	216.7	169.3
36	28.4	22.2	96	75.6	59.1	156	122.9	96.0	216	170.2	133.0	276	217.5	169.9
37	29.2	22.8	97	76.4	59.7	157	123.7	96.7	217	171.0	133.6	277	218.3	170.5
38	29.9	23.4	98	77.2	60.3	158	124.5	97.3	218	171.8	134.2	278	219.1	171.2
39	30.7	24.0	99	78.0	61.0	159	125.3	97.9	219	172.6	134.8	279	219.9	171.8
40	31.5	24.6	100	78.8	61.6	160	126.1	98.5	220	173.4	135.4	280	220.6	172.4
41	32.3	25.2	101	79.6	62.2	161	126.9	99.1	221	174.2	136.1	281	221.4	173.0
42	33.1	25.9	102	80.4	62.8	162	127.7	99.7	222	174.9	136.7	282	222.2	173.6
43	33.9	26.5	103	81.2	63.4	163	128.4	100.4	223	175.7	137.3	283	223.0	174.2
44	34.7	27.1	104	82.0	64.0	164	129.2	101.0	224	176.5	137.9	284	223.8	174.8
45	35.5	27.7	105	82.7	64.6	165	130.0	101.6	225	177.3	138.5	285	224.6	175.5
46	36.2	28.3	106	83.5	65.3	166	130.8	102.2	226	178.1	139.1	286	225.4	176.1
47	37.0	28.9	107	84.3	65.9	167	131.6	102.8	227	178.9	139.8	287	226.2	176.7
48	37.8	29.6	108	85.1	66.5	168	132.4	103.4	228	179.7	140.4	288	226.9	177.3
49	38.6	30.2	109	85.9	67.1	169	133.2	104.0	229	180.5	141.0	289	227.7	177.9
50	39.4	30.8	110	86.7	67.7	170	134.0	104.7	230	181.2	141.6	290	228.5	178.5
51	40.2	31.4	111	87.5	68.3	171	134.7	105.3	231	182.0	142.2	291	229.3	179.2
52	41.0	32.0	112	88.3	69.0	172	135.5	105.9	232	182.8	142.8	292	230.1	179.8
53	41.8	32.6	113	89.0	69.6	173	136.3	106.5	233	183.6	143.4	293	230.9	180.4
54	42.6	33.2	114	89.8	70.2	174	137.1	107.1	234	184.4	144.1	294	231.7	181.0
55	43.3	33.9	115	90.6	70.8	175	137.9	107.7	235	185.2	144.7	295	232.5	181.6
56	44.1	34.5	116	91.4	71.4	176	138.7	108.4	236	186.0	145.3	296	233.3	182.2
57	44.9	35.1	117	92.2	72.0	177	139.5	109.0	237	186.8	145.9	297	234.0	182.9
58	45.7	35.7	118	93.0	72.6	178	140.3	109.6	238	187.5	146.5	298	234.8	183.5
59	46.5	36.3	119	93.8	73.3	179	141.1	110.2	239	188.3	147.1	299	235.6	184.1
60	47.3	36.9	120	94.6	73.9	180	141.8	110.8	240	189.1	147.8	300	236.4	184.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 52 Degrees. 3h 28m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 39 DEGREES. 2h 36m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	47.4	38.4	121	94.0	76.1	181	140.7	113.9	241	187.3	151.7
2	01.6	01.3	62	48.2	39.0	122	94.8	76.8	182	141.4	114.5	242	188.1	152.3
3	02.3	01.9	63	49.0	39.6	123	95.6	77.4	183	142.2	115.2	243	188.8	152.9
4	03.1	02.5	64	49.7	40.3	124	96.4	78.0	184	143.0	115.8	244	189.6	153.6
5	03.9	03.1	65	50.5	40.9	125	97.1	78.7	185	143.8	116.4	245	190.4	154.2
6	04.7	03.8	66	51.3	41.5	126	97.9	79.3	186	144.5	117.1	246	191.2	154.8
7	05.4	04.4	67	52.1	42.2	127	98.7	79.9	187	145.3	117.7	247	192.0	155.4
8	06.2	05.0	68	52.8	42.8	128	99.5	80.6	188	146.1	118.3	248	192.7	156.1
9	07.0	05.7	69	53.6	43.4	129	100.3	81.2	189	146.9	118.9	249	193.5	156.7
10	07.8	06.3	70	54.4	44.1	130	101.0	81.8	190	147.7	119.6	250	194.3	157.3
11	08.5	06.9	71	55.2	44.7	131	101.8	82.4	191	148.4	120.2	251	195.1	158.0
12	09.3	07.6	72	56.0	45.3	132	102.6	83.1	192	149.2	120.8	252	195.8	158.6
13	10.1	08.2	73	56.7	45.9	133	103.4	83.7	193	150.0	121.5	253	196.6	159.2
14	10.9	08.8	74	57.5	46.6	134	104.1	84.3	194	150.8	122.1	254	197.4	159.8
15	11.7	09.4	75	58.3	47.2	135	104.9	85.0	195	151.5	122.7	255	198.2	160.5
16	12.4	10.1	76	59.1	47.8	136	105.7	85.6	196	152.3	123.3	256	198.9	161.1
17	13.2	10.7	77	59.8	48.5	137	106.5	86.2	197	153.1	124.0	257	199.7	161.7
18	14.0	11.3	78	60.6	49.1	138	107.2	86.8	198	153.9	124.6	258	200.5	162.4
19	14.8	12.0	79	61.4	49.7	139	108.0	87.5	199	154.7	125.2	259	201.3	163.0
20	15.5	12.6	80	62.2	50.3	140	108.8	88.1	200	155.4	125.9	260	202.1	163.6
21	16.3	13.2	81	62.9	51.0	141	109.6	88.7	201	156.2	126.5	261	202.8	164.3
22	17.1	13.8	82	63.7	51.6	142	110.4	89.4	202	157.0	127.1	262	203.6	164.9
23	17.9	14.5	83	64.5	52.2	143	111.1	90.0	203	157.8	127.8	263	204.4	165.5
24	18.7	15.1	84	65.3	52.9	144	111.9	90.6	204	158.5	128.4	264	205.2	166.1
25	19.4	15.7	85	66.1	53.5	145	112.7	91.3	205	159.3	129.0	265	205.9	166.8
26	20.2	16.4	86	66.8	54.1	146	113.5	91.9	206	160.1	129.6	266	206.7	167.4
27	21.0	17.0	87	67.6	54.8	147	114.2	92.5	207	160.9	130.3	267	207.5	168.0
28	21.8	17.6	88	68.4	55.4	148	115.0	93.1	208	161.6	130.9	268	208.3	168.7
29	22.5	18.3	89	69.2	56.0	149	115.8	93.8	209	162.4	131.5	269	209.1	169.3
30	23.3	18.9	90	69.9	56.6	150	116.6	94.4	210	163.2	132.2	270	209.8	169.9
31	24.1	19.5	91	70.7	57.3	151	117.3	95.0	211	164.0	132.8	271	210.6	170.5
32	24.9	20.1	92	71.5	57.9	152	118.1	95.7	212	164.8	133.4	272	211.4	171.2
33	25.6	20.8	93	72.3	58.5	153	118.9	96.3	213	165.5	134.0	273	212.2	171.8
34	26.4	21.4	94	73.1	59.2	154	119.7	96.9	214	166.3	134.7	274	212.9	172.4
35	27.2	22.0	95	73.8	59.8	155	120.5	97.5	215	167.1	135.3	275	213.7	173.1
36	28.0	22.7	96	74.6	60.4	156	121.2	98.2	216	167.9	135.9	276	214.5	173.7
37	28.8	23.3	97	75.4	61.0	157	122.0	98.8	217	168.6	136.6	277	215.3	174.3
38	29.5	23.9	98	76.2	61.7	158	122.8	99.4	218	169.4	137.2	278	216.0	175.0
39	30.3	24.5	99	76.9	62.3	159	123.6	100.1	219	170.2	137.8	279	216.8	175.6
40	31.1	25.2	100	77.7	62.9	160	124.3	100.7	220	171.0	138.5	280	217.6	176.2
41	31.9	25.8	101	78.5	63.6	161	125.1	101.3	221	171.7	139.1	281	218.4	176.8
42	32.6	26.4	102	79.3	64.2	162	125.9	101.9	222	172.5	139.7	282	219.2	177.5
43	33.4	27.1	103	80.0	64.8	163	126.7	102.6	223	173.3	140.3	283	219.9	178.1
44	34.2	27.7	104	80.8	65.4	164	127.5	103.2	224	174.1	141.0	284	220.7	178.7
45	35.0	28.3	105	81.6	66.1	165	128.2	103.8	225	174.9	141.6	285	221.5	179.4
46	35.7	28.9	106	82.4	66.7	166	129.0	104.5	226	175.6	142.2	286	222.3	180.0
47	36.5	29.6	107	83.2	67.3	167	129.8	105.1	227	176.4	142.9	287	223.0	180.6
48	37.3	30.2	108	83.9	68.0	168	130.6	105.7	228	177.2	143.5	288	223.8	181.2
49	38.1	30.8	109	84.7	68.6	169	131.3	106.4	229	178.0	144.1	289	224.6	181.9
50	38.9	31.5	110	85.5	69.2	170	132.1	107.0	230	178.7	144.7	290	225.4	182.5
51	39.6	32.1	111	86.3	69.9	171	132.9	107.6	231	179.5	145.4	291	226.1	183.1
52	40.4	32.7	112	87.0	70.5	172	133.7	108.2	232	180.3	146.0	292	226.9	183.8
53	41.2	33.4	113	87.8	71.1	173	134.4	108.9	233	181.1	146.6	293	227.7	184.4
54	42.0	34.0	114	88.6	71.7	174	135.2	109.5	234	181.9	147.3	294	228.5	185.0
55	42.7	34.6	115	89.4	72.4	175	136.0	110.1	235	182.6	147.9	295	229.3	185.6
56	43.5	35.2	116	90.1	73.0	176	136.8	110.8	236	183.4	148.5	296	230.0	186.3
57	44.3	35.9	117	90.9	73.6	177	137.6	111.4	237	184.2	149.1	297	230.8	186.9
58	45.1	36.5	118	91.7	74.3	178	138.3	112.0	238	185.0	149.8	298	231.6	187.5
59	45.9	37.1	119	92.5	74.9	179	139.1	112.6	239	185.7	150.4	299	232.4	188.2
60	46.6	37.8	120	93.3	75.5	180	139.9	113.3	240	186.5	151.0	300	233.1	188.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 51 Degrees. 3h 24m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 40 DEGREES. $2^h\ 40^m$

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.6	61	46.7	39.2	121	92.7	77.8	181	138.7	116.3	241	184.6	154.9
2	01.5	01.3	62	47.5	39.9	122	93.5	78.4	182	139.4	117.0	242	185.4	155.6
3	02.3	01.9	63	48.3	40.5	123	94.2	79.1	183	140.2	117.6	243	186.1	156.2
4	03.1	02.6	64	49.0	41.1	124	95.0	79.7	184	141.0	118.3	244	186.9	156.8
5	03.8	03.2	65	49.8	41.8	125	95.8	80.3	185	141.7	118.9	245	187.7	157.5
6	04.6	03.9	66	50.6	42.4	126	96.5	81.0	186	142.5	119.6	246	188.4	158.1
7	05.4	04.5	67	51.3	43.1	127	97.3	81.6	187	143.3	120.2	247	189.2	158.8
8	06.1	05.1	68	52.1	43.7	128	98.1	82.3	188	144.0	120.8	248	190.0	159.4
9	06.9	05.8	69	52.9	44.4	129	98.8	82.9	189	144.8	121.5	249	190.7	160.1
10	07.7	06.4	70	53.6	45.0	130	99.6	83.6	190	145.5	122.1	250	191.5	160.7
11	08.4	07.1	71	54.4	45.6	131	100.4	84.2	191	146.3	122.8	251	192.3	161.3
12	09.2	07.7	72	55.2	46.3	132	101.1	84.8	192	147.1	123.4	252	193.0	162.0
13	10.0	08.4	73	55.9	46.9	133	101.9	85.5	193	147.8	124.1	253	193.8	162.6
14	10.7	09.0	74	56.7	47.6	134	102.6	86.1	194	148.6	124.7	254	194.6	163.3
15	11.5	09.6	75	57.5	48.2	135	103.4	86.8	195	149.4	125.3	255	195.3	163.9
16	12.3	10.3	76	58.2	48.9	136	104.2	87.4	196	150.1	126.0	256	196.1	164.6
17	13.0	10.9	77	59.0	49.5	137	104.9	88.1	197	150.9	126.6	257	196.9	165.2
18	13.8	11.6	78	59.8	50.1	138	105.7	88.7	198	151.7	127.3	258	197.6	165.8
19	14.6	12.2	79	60.5	50.8	139	106.5	89.3	199	152.4	127.9	259	198.4	166.5
20	15.3	12.9	80	61.3	51.4	140	107.2	90.0	200	153.2	128.6	260	199.2	167.1
21	16.1	13.5	81	62.0	52.1	141	108.0	90.6	201	154.0	129.2	261	199.9	167.8
22	16.9	14.1	82	62.8	52.7	142	108.8	91.3	202	154.7	129.8	262	200.7	168.4
23	17.6	14.8	83	63.6	53.4	143	109.5	91.9	203	155.5	130.5	263	201.5	169.1
24	18.4	15.4	84	64.3	54.0	144	110.3	92.6	204	156.3	131.1	264	202.2	169.7
25	19.2	16.1	85	65.1	54.6	145	111.1	93.2	205	157.0	131.8	265	203.0	170.3
26	19.9	16.7	86	65.9	55.3	146	111.8	93.8	206	157.8	132.4	266	203.8	171.0
27	20.7	17.4	87	66.6	55.9	147	112.6	94.5	207	158.6	133.1	267	204.5	171.6
28	21.4	18.0	88	67.4	56.6	148	113.4	95.1	208	159.3	133.7	268	205.3	172.3
29	22.2	18.6	89	68.2	57.2	149	114.1	95.8	209	160.1	134.3	269	206.1	172.9
30	23.0	19.3	90	68.9	57.9	150	114.9	96.4	210	160.9	135.0	270	206.8	173.6
31	23.7	19.9	91	69.7	58.5	151	115.7	97.1	211	161.6	135.6	271	207.6	174.2
32	24.5	20.6	92	70.5	59.1	152	116.4	97.7	212	162.4	136.3	272	208.4	174.8
33	25.3	21.2	93	71.2	59.8	153	117.2	98.3	213	163.2	136.9	273	209.1	175.5
34	26.0	21.9	94	72.0	60.4	154	118.0	99.0	214	163.9	137.6	274	209.9	176.1
35	26.8	22.5	95	72.8	61.1	155	118.7	99.6	215	164.7	138.2	275	210.7	176.8
36	27.6	23.1	96	73.5	61.7	156	119.5	100.3	216	165.5	138.8	276	211.4	177.4
37	28.3	23.8	97	74.3	62.4	157	120.3	100.9	217	166.2	139.5	277	212.2	178.1
38	29.1	24.4	98	75.1	63.0	158	121.0	101.6	218	167.0	140.1	278	213.0	178.7
39	29.9	25.1	99	75.8	63.6	159	121.8	102.2	219	167.8	140.8	279	213.7	179.3
40	30.6	25.7	100	76.6	64.3	160	122.6	102.8	220	168.5	141.4	280	214.5	180.0
41	31.4	26.4	101	77.4	64.9	161	123.3	103.5	221	169.3	142.1	281	215.3	180.6
42	32.2	27.0	102	78.1	65.6	162	124.1	104.1	222	170.1	142.7	282	216.0	181.3
43	32.9	27.6	103	78.9	66.2	163	124.9	104.8	223	170.8	143.3	283	216.8	181.9
44	33.7	28.3	104	79.7	66.8	164	125.6	105.4	224	171.6	144.0	284	217.6	182.6
45	34.5	28.9	105	80.4	67.5	165	126.4	106.1	225	172.4	144.6	285	218.3	183.2
46	35.2	29.6	106	81.2	68.1	166	127.2	106.7	226	173.1	145.3	286	219.1	183.8
47	36.0	30.2	107	82.0	68.8	167	127.9	107.3	227	173.9	145.9	287	219.9	184.5
48	36.8	30.9	108	82.7	69.4	168	128.7	108.0	228	174.7	146.6	288	220.6	185.1
49	37.5	31.5	109	83.5	70.1	169	129.5	108.6	229	175.4	147.2	289	221.4	185.8
50	38.3	32.1	110	84.3	70.7	170	130.2	109.3	230	176.2	147.8	290	222.2	186.4
51	39.1	32.8	111	85.0	71.3	171	131.0	109.9	231	177.0	148.5	291	222.9	187.1
52	39.8	33.4	112	85.8	72.0	172	131.8	110.6	232	177.7	149.1	292	223.7	187.7
53	40.6	34.1	113	86.6	72.6	173	132.5	111.2	233	178.5	149.8	293	224.5	188.3
54	41.4	34.7	114	87.3	73.3	174	133.3	111.8	234	179.3	150.4	294	225.2	189.0
55	42.1	35.4	115	88.1	73.9	175	134.1	112.5	235	180.0	151.1	295	226.0	189.6
56	42.9	36.0	116	88.9	74.6	176	134.8	113.1	236	180.8	151.7	296	226.7	190.3
57	43.7	36.6	117	89.6	75.2	177	135.6	113.8	237	181.6	152.3	297	227.5	190.9
58	44.4	37.3	118	90.4	75.8	178	136.4	114.4	238	182.3	153.0	298	228.3	191.6
59	45.2	37.9	119	91.2	76.5	179	137.1	115.1	239	183.1	153.6	299	229.0	192.2
60	46.0	38.6	120	91.9	77.1	180	137.9	115.7	240	183.9	154.3	300	229.8	192.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 41 DEGREES. 2h 44m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.8	00.7	61	46.0	40.0	121	91.3	79.4	181	136.6	118.7	241	181.9	158.1
2	01.5	01.3	62	46.8	40.7	122	92.1	80.0	182	137.4	119.4	242	182.6	158.8
3	02.3	02.0	63	47.5	41.3	123	92.8	80.7	183	138.1	120.1	243	183.4	159.4
4	03.0	02.6	64	48.3	42.0	124	93.6	81.4	184	138.9	120.7	244	184.1	160.1
5	03.8	03.3	65	49.1	42.6	125	94.3	82.0	185	139.6	121.4	245	184.9	160.7
6	04.5	03.9	66	49.8	43.3	126	95.1	82.7	186	140.4	122.0	246	185.7	161.4
7	05.3	04.6	67	50.6	44.0	127	95.8	83.3	187	141.1	122.7	247	186.4	162.0
8	06.0	05.2	68	51.3	44.6	128	96.6	84.0	188	141.9	123.3	248	187.2	162.7
9	06.8	05.9	69	52.1	45.3	129	97.4	84.6	189	142.6	124.0	249	187.9	163.4
10	07.5	06.6	70	52.8	45.9	130	98.1	85.3	190	143.4	124.7	250	188.7	164.0
11	08.3	07.2	71	53.6	46.6	131	98.9	85.9	191	144.1	125.3	251	189.4	164.7
12	09.1	07.9	72	54.3	47.2	132	99.6	86.6	192	144.9	126.0	252	190.2	165.3
13	09.8	08.5	73	55.1	47.9	133	100.4	87.3	193	145.7	126.6	253	190.9	166.0
14	10.6	09.2	74	55.8	48.5	134	101.1	87.9	194	146.4	127.3	254	191.7	166.6
15	11.3	09.8	75	56.6	49.2	135	101.9	88.6	195	147.2	127.9	255	192.5	167.3
16	12.1	10.5	76	57.4	49.9	136	102.6	89.2	196	147.9	128.6	256	193.2	168.0
17	12.8	11.2	77	58.1	50.5	137	103.4	89.9	197	148.7	129.2	257	194.0	168.6
18	13.6	11.8	78	58.9	51.2	138	104.1	90.5	198	149.4	129.9	258	194.7	169.3
19	14.3	12.5	79	59.6	51.8	139	104.9	91.2	199	150.2	130.6	259	195.5	169.9
20	15.1	13.1	80	60.4	52.5	140	105.7	91.8	200	150.9	131.2	260	196.2	170.6
21	15.8	13.8	81	61.1	53.1	141	106.4	92.5	201	151.7	131.9	261	197.0	171.2
22	16.6	14.4	82	61.9	53.8	142	107.2	93.2	202	152.5	132.5	262	197.7	171.9
23	17.4	15.1	83	62.6	54.5	143	107.9	93.8	203	153.2	133.2	263	198.5	172.5
24	18.1	15.7	84	63.4	55.1	144	108.7	94.5	204	154.0	133.8	264	199.2	173.2
25	18.9	16.4	85	64.2	55.8	145	109.4	95.1	205	154.7	134.5	265	200.0	173.9
26	19.6	17.1	86	64.9	56.4	146	110.2	95.8	206	155.5	135.1	266	200.8	174.5
27	20.4	17.7	87	65.7	57.1	147	110.9	96.4	207	156.2	135.8	267	201.5	175.2
28	21.1	18.4	88	66.4	57.7	148	111.7	97.1	208	157.0	136.5	268	202.3	175.8
29	21.9	19.0	89	67.2	58.4	149	112.5	97.8	209	157.7	137.1	269	203.0	176.5
30	22.6	19.7	90	67.9	59.0	150	113.2	98.4	210	158.5	137.8	270	203.8	177.1
31	23.4	20.3	91	68.7	59.7	151	114.0	99.1	211	159.2	138.4	271	204.5	177.8
32	24.2	21.0	92	69.4	60.4	152	114.7	99.7	212	160.0	139.1	272	205.3	178.4
33	24.9	21.6	93	70.2	61.0	153	115.5	100.4	213	160.8	139.7	273	206.0	179.1
34	25.7	22.3	94	70.9	61.7	154	116.2	101.0	214	161.5	140.4	274	206.8	179.8
35	26.4	23.0	95	71.7	62.3	155	117.0	101.7	215	162.3	141.1	275	207.5	180.4
36	27.2	23.6	96	72.5	63.0	156	117.7	102.3	216	163.0	141.7	276	208.3	181.1
37	27.9	24.3	97	73.2	63.6	157	118.5	103.0	217	163.8	142.4	277	209.1	181.7
38	28.7	24.9	98	74.0	64.3	158	119.2	103.7	218	164.5	143.0	278	209.8	182.4
39	29.4	25.6	99	74.7	64.9	159	120.0	104.3	219	165.3	143.7	279	210.6	183.0
40	30.2	26.2	100	75.5	65.6	160	120.8	105.0	220	166.0	144.3	280	211.3	183.7
41	30.9	26.9	101	76.2	66.3	161	121.5	105.6	221	166.8	145.0	281	212.1	184.4
42	31.7	27.6	102	77.0	66.9	162	122.3	106.3	222	167.5	145.6	282	212.8	185.0
43	32.5	28.2	103	77.7	67.6	163	123.0	106.9	223	168.3	146.3	283	213.6	185.7
44	33.2	28.9	104	78.5	68.2	164	123.8	107.6	224	169.1	147.0	284	214.3	186.3
45	34.0	29.5	105	79.2	68.9	165	124.5	108.2	225	169.8	147.6	285	215.1	187.0
46	34.7	30.2	106	80.0	69.5	166	125.3	108.9	226	170.6	148.3	286	215.8	187.6
47	35.5	30.8	107	80.8	70.2	167	126.0	109.6	227	171.3	148.9	287	216.6	188.3
48	36.2	31.5	108	81.5	70.9	168	126.8	110.2	228	172.1	149.6	288	217.4	188.9
49	37.0	32.1	109	82.3	71.5	169	127.5	110.9	229	172.8	150.2	289	218.1	189.6
50	37.7	32.8	110	83.0	72.2	170	128.3	111.5	230	173.6	150.9	290	218.9	190.3
51	38.5	33.5	111	83.8	72.8	171	129.1	112.2	231	174.3	151.5	291	219.6	190.9
52	39.2	34.1	112	84.5	73.5	172	129.8	112.8	232	175.1	152.2	292	220.4	191.6
53	40.0	34.8	113	85.3	74.1	173	130.6	113.5	233	175.8	152.9	293	221.1	192.2
54	40.8	35.4	114	86.0	74.8	174	131.3	114.2	234	176.6	153.5	294	221.9	192.9
55	41.5	36.1	115	86.8	75.4	175	132.1	114.8	235	177.4	154.2	295	222.6	193.5
56	42.3	36.7	116	87.5	76.1	176	132.8	115.5	236	178.1	154.8	296	223.4	194.2
57	43.0	37.4	117	88.3	76.8	177	133.6	116.1	237	178.9	155.5	297	224.1	194.8
58	43.8	38.1	118	89.1	77.4	178	134.3	116.8	238	179.6	156.1	298	224.9	195.5
59	44.5	38.7	119	89.8	78.1	179	135.1	117.4	239	180.4	156.8	299	225.7	196.2
60	45.3	39.4	120	90.6	78.7	180	135.8	118.1	240	181.1	157.5	300	226.4	196.8
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 49 Degrees. 3h 16m

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 42 DEGREES. 2h 48m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	45.3	40.8	121	89.9	81.0	181	134.5	121.1	241	179.1	161.3
2	01.5	01.3	62	46.1	41.5	122	90.7	81.6	182	135.3	121.8	242	179.8	161.9
3	02.2	02.0	63	46.8	42.2	123	91.4	82.3	183	136.0	122.5	243	180.6	162.6
4	03.0	02.7	64	47.6	42.8	124	92.1	83.0	184	136.7	123.1	244	181.3	163.3
5	03.7	03.3	65	48.3	43.5	125	92.9	83.6	185	137.5	123.8	245	182.1	163.9
6	04.5	04.0	66	49.0	44.2	126	93.6	84.3	186	138.2	124.5	246	182.8	164.6
7	05.2	04.7	67	49.8	44.8	127	94.4	85.0	187	139.0	125.1	247	183.6	165.3
8	05.9	05.4	68	50.5	45.5	128	95.1	85.6	188	139.7	125.8	248	184.3	165.9
9	06.7	06.0	69	51.3	46.2	129	95.9	86.3	189	140.5	126.5	249	185.0	166.6
10	07.4	06.7	70	52.0	46.8	130	96.6	87.0	190	141.2	127.1	250	185.8	167.3
11	08.2	07.4	71	52.8	47.5	131	97.4	87.7	191	141.9	127.8	251	186.5	168.0
12	08.9	08.0	72	53.5	48.2	132	98.1	88.3	192	142.7	128.5	252	187.3	168.6
13	09.7	08.7	73	54.2	48.8	133	98.8	89.0	193	143.4	129.1	253	188.0	169.3
14	10.4	09.4	74	55.0	49.5	134	99.6	89.7	194	144.2	129.8	254	188.8	170.0
15	11.1	10.0	75	55.7	50.2	135	100.3	90.3	195	144.9	130.5	255	189.5	170.6
16	11.9	10.7	76	56.5	50.9	136	101.1	91.0	196	145.7	131.1	256	190.2	171.3
17	12.6	11.4	77	57.2	51.5	137	101.8	91.7	197	146.4	131.8	257	191.0	172.0
18	13.4	12.0	78	58.0	52.2	138	102.6	92.3	198	147.1	132.5	258	191.7	172.6
19	14.1	12.7	79	58.7	52.9	139	103.3	93.0	199	147.9	133.2	259	192.5	173.3
20	14.9	13.4	80	59.5	53.5	140	104.0	93.7	200	148.6	133.8	260	193.2	174.0
21	15.6	14.1	81	60.2	54.2	141	104.8	94.3	201	149.4	134.5	261	194.0	174.6
22	16.3	14.7	82	60.9	54.9	142	105.5	95.0	202	150.1	135.2	262	194.7	175.3
23	17.1	15.4	83	61.7	55.5	143	106.3	95.7	203	150.9	135.8	263	195.4	176.0
24	17.8	16.1	84	62.4	56.2	144	107.0	96.4	204	151.6	136.5	264	196.2	176.7
25	18.6	16.7	85	63.2	56.9	145	107.8	97.0	205	152.3	137.2	265	196.9	177.3
26	19.3	17.4	86	63.9	57.5	146	108.5	97.7	206	153.1	137.8	266	197.7	178.0
27	20.1	18.1	87	64.7	58.2	147	109.2	98.4	207	153.8	138.5	267	198.4	178.7
28	20.8	18.7	88	65.4	58.9	148	110.0	99.0	208	154.6	139.2	268	199.2	179.3
29	21.6	19.4	89	66.1	59.6	149	110.7	99.7	209	155.3	139.8	269	199.9	180.0
30	22.3	20.1	90	66.9	60.2	150	111.5	100.4	210	156.1	140.5	270	200.6	180.7
31	23.0	20.7	91	67.6	60.9	151	112.2	101.0	211	156.8	141.2	271	201.4	181.3
32	23.8	21.4	92	68.4	61.6	152	113.0	101.7	212	157.5	141.9	272	202.1	182.0
33	24.5	22.1	93	69.1	62.2	153	113.7	102.4	213	158.3	142.5	273	202.9	182.7
34	25.3	22.8	94	69.9	62.9	154	114.4	103.0	214	159.0	143.2	274	203.6	183.3
35	26.0	23.4	95	70.6	63.6	155	115.2	103.7	215	159.8	143.9	275	204.4	184.0
36	26.8	24.1	96	71.3	64.2	156	115.9	104.4	216	160.5	144.5	276	205.1	184.7
37	27.5	24.8	97	72.1	64.9	157	116.7	105.1	217	161.3	145.2	277	205.9	185.3
38	28.2	25.4	98	72.8	65.6	158	117.4	105.7	218	162.0	145.9	278	206.6	186.0
39	29.0	26.1	99	73.6	66.2	159	118.2	106.4	219	162.7	146.5	279	207.3	186.7
40	29.7	26.8	100	74.3	66.9	160	118.9	107.1	220	163.5	147.2	280	208.1	187.4
41	30.5	27.4	101	75.1	67.6	161	119.6	107.7	221	164.2	147.9	281	208.8	188.0
42	31.2	28.1	102	75.8	68.3	162	120.4	108.4	222	165.0	148.5	282	209.6	188.7
43	32.0	28.8	103	76.5	68.9	163	121.1	109.1	223	165.7	149.2	283	210.3	189.4
44	32.7	29.4	104	77.3	69.6	164	121.9	109.7	224	166.5	149.9	284	211.1	190.0
45	33.4	30.1	105	78.0	70.3	165	122.6	110.4	225	167.2	150.6	285	211.8	190.7
46	34.2	30.8	106	78.8	70.9	166	123.4	111.1	226	168.0	151.2	286	212.5	191.4
47	34.9	31.4	107	79.5	71.6	167	124.1	111.7	227	168.7	151.9	287	213.3	192.0
48	35.7	32.1	108	80.3	72.3	168	124.8	112.4	228	169.4	152.6	288	214.0	192.7
49	36.4	32.8	109	81.0	72.9	169	125.6	113.1	229	170.2	153.2	289	214.8	193.4
50	37.2	33.5	110	81.7	73.6	170	126.3	113.8	230	170.9	153.9	290	215.5	194.0
51	37.9	34.1	111	82.5	74.3	171	127.1	114.4	231	171.7	154.6	291	216.3	194.7
52	38.6	34.8	112	83.2	74.9	172	127.8	115.1	232	172.4	155.2	292	217.0	195.4
53	39.4	35.5	113	84.0	75.6	173	128.6	115.8	233	173.2	155.9	293	217.7	196.1
54	40.1	36.1	114	84.7	76.3	174	129.3	116.4	234	173.9	156.6	294	218.5	196.7
55	40.9	36.8	115	85.5	77.0	175	130.1	117.1	235	174.6	157.2	295	219.2	197.4
56	41.6	37.5	116	86.2	77.6	176	130.8	117.8	236	175.4	157.9	296	220.0	198.1
57	42.4	38.1	117	86.9	78.3	177	131.5	118.4	237	176.1	158.6	297	220.7	198.7
58	43.1	38.8	118	87.7	79.0	178	132.3	119.1	238	176.9	159.3	298	221.5	199.4
59	43.8	39.5	119	88.4	79.6	179	133.0	119.8	239	177.6	159.9	299	222.2	200.1
60	44.6	40.1	120	89.2	80.3	180	133.8	120.4	240	178.4	160.6	300	222.9	200.7
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat

For 48 Degrees. 3h 12m.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 43 DEGREES. 2h 52m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	44.6	41.6	121	88.5	82.5	181	132.4	123.4	241	176.3	164.4
2	01.5	01.4	62	45.3	42.3	122	89.2	83.2	182	133.1	124.1	242	177.0	165.0
3	02.2	02.0	63	46.1	43.0	123	90.0	83.9	183	133.8	124.8	243	177.7	165.7
4	02.9	02.7	64	46.8	43.6	124	90.7	84.6	184	134.6	125.5	244	178.5	166.4
5	03.7	03.4	65	47.5	44.3	125	91.4	85.2	185	135.3	126.2	245	179.2	167.1
6	04.4	04.1	66	48.3	45.0	126	92.2	85.9	186	136.0	126.9	246	179.9	167.8
7	05.1	04.8	67	49.0	45.7	127	92.9	86.6	187	136.8	127.5	247	180.6	168.5
8	05.9	05.5	68	49.7	46.4	128	93.6	87.3	188	137.5	128.2	248	181.4	169.1
9	06.6	06.1	69	50.5	47.1	129	94.3	88.0	189	138.2	128.9	249	182.1	169.8
10	07.3	06.8	70	51.2	47.7	130	95.1	88.7	190	139.0	129.6	250	182.8	170.5
11	08.0	07.5	71	51.9	48.4	131	95.8	89.3	191	139.7	130.3	251	183.6	171.2
12	08.8	08.2	72	52.7	49.1	132	96.5	90.0	192	140.4	130.9	252	184.3	171.9
13	09.5	08.9	73	53.4	49.8	133	97.3	90.7	193	141.2	131.6	253	185.0	172.5
14	10.2	09.5	74	54.1	50.5	134	98.0	91.4	194	141.9	132.3	254	185.8	173.2
15	11.0	10.2	75	54.9	51.1	135	98.7	92.1	195	142.6	133.0	255	186.5	173.9
16	11.7	10.9	76	55.6	51.8	136	99.5	92.8	196	143.3	133.7	256	187.2	174.6
17	12.4	11.6	77	56.3	52.5	137	100.2	93.4	197	144.1	134.4	257	188.0	175.3
18	13.2	12.3	78	57.0	53.2	138	100.9	94.1	198	144.8	135.0	258	188.7	176.0
19	13.9	13.0	79	57.8	53.9	139	101.7	94.8	199	145.5	135.7	259	189.4	176.6
20	14.6	13.6	80	58.5	54.6	140	102.4	95.5	200	146.3	136.4	260	190.2	177.3
21	15.4	14.3	81	59.2	55.2	141	103.1	96.2	201	147.0	137.1	261	190.9	178.0
22	16.1	15.0	82	60.0	55.9	142	103.9	96.8	202	147.7	137.8	262	191.6	178.7
23	16.8	15.7	83	60.7	56.6	143	104.6	97.5	203	148.5	138.4	263	192.3	179.4
24	17.6	16.4	84	61.4	57.3	144	105.3	98.2	204	149.2	139.1	264	193.1	180.0
25	18.3	17.0	85	62.2	58.0	145	106.0	98.9	205	149.9	139.8	265	193.8	180.7
26	19.0	17.7	86	62.9	58.7	146	106.8	99.6	206	150.7	140.5	266	194.5	181.4
27	19.7	18.4	87	63.6	59.3	147	107.5	100.3	207	151.4	141.2	267	195.3	182.1
28	20.5	19.1	88	64.4	60.0	148	108.2	100.9	208	152.1	141.9	268	196.0	182.8
29	21.2	19.8	89	65.1	60.7	149	109.0	101.6	209	152.9	142.5	269	196.7	183.5
30	21.9	20.5	90	65.8	61.4	150	109.7	102.3	210	153.6	143.2	270	197.5	184.1
31	22.7	21.1	91	66.6	62.1	151	110.4	103.0	211	154.3	143.9	271	198.2	184.8
32	23.4	21.8	92	67.3	62.7	152	111.2	103.7	212	155.0	144.6	272	198.9	185.5
33	24.1	22.5	93	68.0	63.4	153	111.9	104.3	213	155.8	145.3	273	199.7	186.2
34	24.9	23.2	94	68.7	64.1	154	112.6	105.0	214	156.5	145.9	274	200.4	186.9
35	25.6	23.9	95	69.5	64.8	155	113.4	105.7	215	157.2	146.6	275	201.1	187.5
36	26.3	24.6	96	70.2	65.5	156	114.1	106.4	216	158.0	147.3	276	201.9	188.2
37	27.1	25.2	97	70.9	66.2	157	114.8	107.1	217	158.7	148.0	277	202.6	188.9
38	27.8	25.9	98	71.7	66.8	158	115.6	107.8	218	159.4	148.7	278	203.3	189.6
39	28.5	26.6	99	72.4	67.5	159	116.3	108.4	219	160.2	149.4	279	204.0	190.3
40	29.3	27.3	100	73.1	68.2	160	117.0	109.1	220	160.9	150.0	280	204.8	191.0
41	30.0	28.0	101	73.9	68.9	161	117.7	109.8	221	161.6	150.7	281	205.5	191.6
42	30.7	28.6	102	74.6	69.6	162	118.5	110.5	222	162.4	151.4	282	206.2	192.3
43	31.4	29.3	103	75.3	70.2	163	119.2	111.2	223	163.1	152.1	283	207.0	193.0
44	32.2	30.0	104	76.1	70.9	164	119.9	111.8	224	163.8	152.8	284	207.7	193.7
45	32.9	30.7	105	76.8	71.6	165	120.7	112.5	225	164.6	153.4	285	208.4	194.4
46	33.6	31.4	106	77.5	72.3	166	121.4	113.2	226	165.3	154.1	286	209.2	195.1
47	34.4	32.1	107	78.3	73.0	167	122.1	113.9	227	166.0	154.8	287	209.9	195.7
48	35.1	32.7	108	79.0	73.7	168	122.9	114.6	228	166.7	155.5	288	210.6	196.4
49	35.8	33.4	109	79.7	74.3	169	123.6	115.3	229	167.5	156.2	289	211.4	197.1
50	36.6	34.1	110	80.4	75.0	170	124.3	115.9	230	168.2	156.9	290	212.1	197.8
51	37.3	34.8	111	81.2	75.7	171	125.1	116.6	231	168.9	157.5	291	212.8	198.5
52	38.0	35.5	112	81.9	76.4	172	125.8	117.3	232	169.7	158.2	292	213.6	199.1
53	38.8	36.1	113	82.6	77.1	173	126.5	118.0	233	170.4	158.9	293	214.3	199.8
54	39.5	36.8	114	83.4	77.7	174	127.3	118.7	234	171.1	159.6	294	215.0	200.5
55	40.2	37.5	115	84.1	78.4	175	128.0	119.3	235	171.9	160.3	295	215.7	201.2
56	41.0	38.2	116	84.8	79.1	176	128.7	120.0	236	172.6	161.0	296	216.5	201.9
57	41.7	38.9	117	85.6	79.8	177	129.4	120.7	237	173.3	161.6	297	217.2	202.6
58	42.4	39.6	118	86.3	80.5	178	130.2	121.4	238	174.1	162.3	298	217.9	203.2
59	43.1	40.2	119	87.0	81.2	179	130.9	122.1	239	174.8	163.0	299	218.7	203.9
60	43.9	40.9	120	87.8	81.8	180	131.6	122.8	240	175.5	163.7	300	219.4	204.6
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 47 Degrees. 3h 8m.

TABLE II.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 44 DEGREES. $2^h\ 58^m$.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.9	42.4	121	87.0	84.1	181	130.2	125.7	241	173.4	167.4
2	01.4	01.4	62	44.6	43.1	122	87.8	84.7	182	130.9	126.4	242	174.1	168.1
3	02.2	02.1	63	45.3	43.8	123	88.5	85.4	183	131.6	127.1	243	174.8	168.8
4	02.9	02.8	64	46.0	44.5	124	89.2	86.1	184	132.4	127.8	244	175.5	169.5
5	03.6	03.5	65	46.8	45.2	125	89.9	86.8	185	133.1	128.5	245	176.2	170.2
6	04.3	04.2	66	47.5	45.8	126	90.6	87.5	186	133.8	129.2	246	177.0	170.9
7	05.0	04.9	67	48.2	46.5	127	91.4	88.2	187	134.5	129.9	247	177.7	171.6
8	05.8	05.6	68	48.9	47.2	128	92.1	88.9	188	135.2	130.6	248	178.4	172.3
9	06.5	06.3	69	49.6	47.9	129	92.8	89.6	189	136.0	131.3	249	179.1	173.0
10	07.2	06.9	70	50.4	48.6	130	93.5	90.3	190	136.7	132.0	250	179.8	173.7
11	07.9	07.6	71	51.1	49.3	131	94.2	91.0	191	137.4	132.7	251	180.6	174.4
12	08.6	08.3	72	51.8	50.0	132	95.0	91.7	192	138.1	133.4	252	181.3	175.1
13	09.4	09.0	73	52.5	50.7	133	95.7	92.4	193	138.8	134.1	253	182.0	175.7
14	10.1	09.7	74	53.2	51.4	134	96.4	93.1	194	139.6	134.8	254	182.7	176.4
15	10.8	10.4	75	54.0	52.1	135	97.1	93.8	195	140.3	135.5	255	183.4	177.1
16	11.5	11.1	76	54.7	52.8	136	97.8	94.5	196	141.0	136.2	256	184.2	177.8
17	12.2	11.8	77	55.4	53.5	137	98.5	95.2	197	141.7	136.8	257	184.9	178.5
18	12.9	12.5	78	56.1	54.2	138	99.3	95.9	198	142.4	137.5	258	185.6	179.2
19	13.7	13.2	79	56.8	54.9	139	100.0	96.6	199	143.1	138.2	259	186.3	179.9
20	14.4	13.9	80	57.5	55.6	140	100.7	97.3	200	143.9	138.9	260	187.0	180.6
21	15.1	14.6	81	58.3	56.3	141	101.4	97.9	201	144.6	139.6	261	187.7	181.3
22	15.8	15.3	82	59.0	57.0	142	102.1	98.6	202	145.3	140.3	262	188.5	182.0
23	16.5	16.0	83	59.7	57.7	143	102.9	99.3	203	146.0	141.0	263	189.2	182.7
24	17.3	16.7	84	60.4	58.4	144	103.6	100.0	204	146.7	141.7	264	189.9	183.4
25	18.0	17.4	85	61.1	59.0	145	104.3	100.7	205	147.5	142.4	265	190.6	184.1
26	18.7	18.1	86	61.9	59.7	146	105.0	101.4	206	148.2	143.1	266	191.3	184.8
27	19.4	18.8	87	62.6	60.4	147	105.7	102.1	207	148.9	143.8	267	192.1	185.5
28	20.1	19.5	88	63.3	61.1	148	106.5	102.8	208	149.6	144.5	268	192.8	186.2
29	20.9	20.1	89	64.0	61.8	149	107.2	103.5	209	150.3	145.2	269	193.5	186.9
30	21.6	20.8	90	64.7	62.5	150	107.9	104.2	210	151.1	145.9	270	194.2	187.6
31	22.3	21.5	91	65.5	63.2	151	108.6	104.9	211	151.8	146.6	271	194.9	188.3
32	23.0	22.2	92	66.2	63.9	152	109.3	105.6	212	152.5	147.3	272	195.7	188.9
33	23.7	22.9	93	66.9	64.6	153	110.1	106.3	213	153.2	148.0	273	196.4	189.6
34	24.5	23.6	94	67.6	65.3	154	110.8	107.0	214	153.9	148.7	274	197.1	190.3
35	25.2	24.3	95	68.3	66.0	155	111.5	107.7	215	154.7	149.4	275	197.8	191.0
36	25.9	25.0	96	69.1	66.7	156	112.2	108.4	216	155.4	150.0	276	198.5	191.7
37	26.6	25.7	97	69.8	67.4	157	112.9	109.1	217	156.1	150.7	277	199.3	192.4
38	27.3	26.4	98	70.5	68.1	158	113.7	109.8	218	156.8	151.4	278	200.0	193.1
39	28.1	27.1	99	71.2	68.8	159	114.4	110.5	219	157.5	152.1	279	200.7	193.8
40	28.8	27.8	100	71.9	69.5	160	115.1	111.1	220	158.3	152.8	280	201.4	194.5
41	29.5	28.5	101	72.7	70.2	161	115.8	111.8	221	159.0	153.5	281	202.1	195.2
42	30.2	29.2	102	73.4	70.9	162	116.5	112.5	222	159.7	154.2	282	202.9	195.9
43	30.9	29.9	103	74.1	71.5	163	117.3	113.2	223	160.4	154.9	283	203.6	196.6
44	31.7	30.6	104	74.8	72.2	164	118.0	113.9	224	161.1	155.6	284	204.3	197.3
45	32.4	31.3	105	75.5	72.9	165	118.7	114.6	225	161.9	156.3	285	205.0	198.0
46	33.1	32.0	106	76.3	73.6	166	119.4	115.3	226	162.6	157.0	286	205.7	198.7
47	33.8	32.6	107	77.0	74.3	167	120.1	116.0	227	163.3	157.7	287	206.5	199.4
48	34.5	33.3	108	77.7	75.0	168	120.8	116.7	228	164.0	158.4	288	207.2	200.1
49	35.2	34.0	109	78.4	75.7	169	121.6	117.4	229	164.7	159.1	289	207.9	200.8
50	36.0	34.7	110	79.1	76.4	170	122.3	118.1	230	165.4	159.8	290	208.6	201.5
51	36.7	35.4	111	79.8	77.1	171	123.0	118.8	231	166.2	160.5	291	209.3	202.1
52	37.4	36.1	112	80.6	77.8	172	123.7	119.5	232	166.9	161.2	292	210.0	202.8
53	38.1	36.8	113	81.3	78.5	173	124.4	120.2	233	167.6	161.9	293	210.8	203.5
54	38.8	37.5	114	82.0	79.2	174	125.2	120.9	234	168.3	162.6	294	211.5	204.2
55	39.6	38.2	115	82.7	79.9	175	125.9	121.6	235	169.0	163.2	295	212.2	204.9
56	40.3	38.9	116	83.4	80.6	176	126.6	122.3	236	169.8	163.9	296	212.9	205.6
57	41.0	39.6	117	84.2	81.3	177	127.3	123.0	237	170.5	164.6	297	213.6	206.3
58	41.7	40.3	118	84.9	82.0	178	128.0	123.6	238	171.2	165.3	298	214.4	207.0
59	42.4	41.0	119	85.6	82.7	179	128.8	124.3	239	171.9	166.0	299	215.1	207.7
60	43.2	41.7	120	86.3	83.4	180	129.5	125.0	240	172.6	166.7	300	215.8	208.4
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

For 46 Degrees. $8^h\ 4^m$.

DIFFERENCE OF LATITUDE AND DEPARTURE FOR 45 DEGREES. 3h 0m.

Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.	Dist.	Lat.	Dep.
1	00.7	00.7	61	43.1	43.1	121	85.6	85.6	181	128.0	128.0	241	170.4	170.4
2	01.4	01.4	62	43.8	43.8	122	86.3	86.3	182	128.7	128.7	242	171.1	171.1
3	02.1	02.1	63	44.5	44.5	123	87.0	87.0	183	129.4	129.4	243	171.8	171.8
4	02.8	02.8	64	45.3	45.3	124	87.7	87.7	184	130.1	130.1	244	172.5	172.5
5	03.5	03.5	65	46.0	46.0	125	88.4	88.4	185	130.8	130.8	245	173.2	173.2
6	04.2	04.2	66	46.7	46.7	126	89.1	89.1	186	131.5	131.5	246	173.9	173.9
7	04.9	04.9	67	47.4	47.4	127	89.8	89.8	187	132.2	132.2	247	174.7	174.7
8	05.7	05.7	68	48.1	48.1	128	90.5	90.5	188	132.9	132.9	248	175.4	175.4
9	06.4	06.4	69	48.8	48.8	129	91.2	91.2	189	133.6	133.6	249	176.1	176.1
10	07.1	07.1	70	49.5	49.5	130	91.9	91.9	190	134.4	134.4	250	176.8	176.8
11	07.8	07.8	71	50.2	50.2	131	92.6	92.6	191	135.1	135.1	251	177.5	177.5
12	08.5	08.5	72	50.9	50.9	132	93.3	93.3	192	135.8	135.8	252	178.2	178.2
13	09.2	09.2	73	51.6	51.6	133	94.0	94.0	193	136.5	136.5	253	178.9	178.9
14	09.9	09.9	74	52.3	52.3	134	94.8	94.8	194	137.2	137.2	254	179.6	179.6
15	10.6	10.6	75	53.0	53.0	135	95.5	95.5	195	137.9	137.9	255	180.3	180.3
16	11.3	11.3	76	53.7	53.7	136	96.2	96.2	196	138.6	138.6	256	181.0	181.0
17	12.0	12.0	77	54.4	54.4	137	96.9	96.9	197	139.3	139.3	257	181.7	181.7
18	12.7	12.7	78	55.2	55.2	138	97.6	97.6	198	140.0	140.0	258	182.4	182.4
19	13.4	13.4	79	55.9	55.9	139	98.3	98.3	199	140.7	140.7	259	183.1	183.1
20	14.1	14.1	80	56.6	56.6	140	99.0	99.0	200	141.4	141.4	260	183.8	183.8
21	14.8	14.8	81	57.3	57.3	141	99.7	99.7	201	142.1	142.1	261	184.6	184.6
22	15.6	15.6	82	58.0	58.0	142	100.4	100.4	202	142.8	142.8	262	185.3	185.3
23	16.3	16.3	83	58.7	58.7	143	101.1	101.1	203	143.5	143.5	263	186.0	186.0
24	17.0	17.0	84	59.4	59.4	144	101.8	101.8	204	144.2	144.2	264	186.7	186.7
25	17.7	17.7	85	60.1	60.1	145	102.5	102.5	205	145.0	145.0	265	187.4	187.4
26	18.4	18.4	86	60.8	60.8	146	103.2	103.2	206	145.7	145.7	266	188.1	188.1
27	19.1	19.1	87	61.5	61.5	147	103.9	103.9	207	146.4	146.4	267	188.8	188.8
28	19.8	19.8	88	62.2	62.2	148	104.7	104.7	208	147.1	147.1	268	189.5	189.5
29	20.5	20.5	89	62.9	62.9	149	105.4	105.4	209	147.8	147.8	269	190.2	190.2
30	21.2	21.2	90	63.6	63.6	150	106.1	106.1	210	148.5	148.5	270	190.9	190.9
31	21.9	21.9	91	64.3	64.3	151	106.8	106.8	211	149.2	149.2	271	191.6	191.6
32	22.6	22.6	92	65.1	65.1	152	107.5	107.5	212	149.9	149.9	272	192.3	192.3
33	23.3	23.3	93	65.8	65.8	153	108.2	108.2	213	150.6	150.6	273	193.0	193.0
34	24.0	24.0	94	66.5	66.5	154	108.9	108.9	214	151.3	151.3	274	193.7	193.7
35	24.7	24.7	95	67.2	67.2	155	109.6	109.6	215	152.0	152.0	275	194.5	194.5
36	25.5	25.5	96	67.9	67.9	156	110.3	110.3	216	152.7	152.7	276	195.2	195.2
37	26.2	26.2	97	68.6	68.6	157	111.0	111.0	217	153.4	153.4	277	195.9	195.9
38	26.9	26.9	98	69.3	69.3	158	111.7	111.7	218	154.1	154.1	278	196.6	196.6
39	27.6	27.6	99	70.0	70.0	159	112.4	112.4	219	154.9	154.9	279	197.3	197.3
40	28.3	28.3	100	70.7	70.7	160	113.1	113.1	220	155.6	155.6	280	198.0	198.0
41	29.0	29.0	101	71.4	71.4	161	113.8	113.8	221	156.3	156.3	281	198.7	198.7
42	29.7	29.7	102	72.1	72.1	162	114.6	114.6	222	157.0	157.0	282	199.4	199.4
43	30.4	30.4	103	72.8	72.8	163	115.3	115.3	223	157.7	157.7	283	200.1	200.1
44	31.1	31.1	104	73.5	73.5	164	116.0	116.0	224	158.4	158.4	284	200.8	200.8
45	31.8	31.8	105	74.2	74.2	165	116.7	116.7	225	159.1	159.1	285	201.5	201.5
46	32.5	32.5	106	75.0	75.0	166	117.4	117.4	226	159.8	159.8	286	202.2	202.2
47	33.2	33.2	107	75.7	75.7	167	118.1	118.1	227	160.5	160.5	287	202.9	202.9
48	33.9	33.9	108	76.4	76.4	168	118.8	118.8	228	161.2	161.2	288	203.6	203.6
49	34.6	34.6	109	77.1	77.1	169	119.5	119.5	229	161.9	161.9	289	204.4	204.4
50	35.4	35.4	110	77.8	77.8	170	120.2	120.2	230	162.6	162.6	290	205.1	205.1
51	36.1	36.1	111	78.5	78.5	171	120.9	120.9	231	163.3	163.3	291	205.8	205.8
52	36.8	36.8	112	79.2	79.2	172	121.6	121.6	232	164.0	164.0	292	206.5	206.5
53	37.5	37.5	113	79.9	79.9	173	122.3	122.3	233	164.8	164.8	293	207.2	207.2
54	38.2	38.2	114	80.6	80.6	174	123.0	123.0	234	165.5	165.5	294	207.9	207.9
55	38.9	38.9	115	81.3	81.3	175	123.7	123.7	235	166.2	166.2	295	208.6	208.6
56	39.6	39.6	116	82.0	82.0	176	124.5	124.5	236	166.9	166.9	296	209.3	209.3
57	40.3	40.3	117	82.7	82.7	177	125.2	125.2	237	167.6	167.6	297	210.0	210.0
58	41.0	41.0	118	83.4	83.4	178	125.9	125.9	238	168.3	168.3	298	210.7	210.7
59	41.7	41.7	119	84.1	84.1	179	126.6	126.6	239	169.0	169.0	299	211.4	211.4
60	42.4	42.4	120	84.9	84.9	180	127.3	127.3	240	169.7	169.7	300	212.1	212.1
Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.	Dist.	Dep.	Lat.

TABLE III.

MERIDIONAL PARTS.

M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	M.
0	0	60	120	180	240	300	361	421	482	542	603	664	725	787	0
1	1	61	121	181	241	301	362	422	483	543	604	665	726	788	1
2	2	62	122	182	242	302	363	423	484	544	605	666	727	789	2
3	3	63	123	183	243	303	364	424	485	545	606	667	728	790	3
4	4	64	124	184	244	304	365	425	486	546	607	668	729	791	4
5	5	65	125	185	245	305	366	426	487	547	608	669	730	792	5
6	6	66	126	186	246	306	367	427	488	548	609	670	731	793	6
7	7	67	127	187	247	307	368	428	489	549	610	671	732	794	7
8	8	68	128	188	248	308	369	429	490	550	611	672	734	795	8
9	9	69	129	189	249	309	370	430	491	551	612	673	735	796	9
10	10	70	130	190	250	310	371	431	492	552	613	674	736	797	10
11	11	71	131	191	251	311	372	432	493	553	614	675	737	798	11
12	12	72	132	192	252	312	373	433	494	554	615	676	738	799	12
13	13	73	133	193	253	313	374	434	495	555	616	677	739	800	13
14	14	74	134	194	254	314	375	435	496	556	617	678	740	801	14
15	15	75	135	195	255	315	376	436	497	557	618	679	741	802	15
16	16	76	136	196	256	316	377	437	498	558	619	680	742	803	16
17	17	77	137	197	257	317	378	438	499	559	620	681	743	804	17
18	18	78	138	198	258	318	379	439	500	560	621	682	744	805	18
19	19	79	139	199	259	319	380	440	501	561	622	683	745	806	19
20	20	80	140	200	260	320	381	441	502	562	623	684	746	807	20
21	21	81	141	201	261	321	382	442	503	564	624	685	747	808	21
22	22	82	142	202	262	322	383	443	504	565	625	687	748	809	22
23	23	83	143	203	263	323	384	444	505	566	626	688	749	810	23
24	24	84	144	204	264	324	385	445	506	567	627	689	750	811	24
25	25	85	145	205	265	325	386	446	507	568	628	690	751	812	25
26	26	86	146	206	266	326	387	447	508	569	629	691	752	813	26
27	27	87	147	207	267	327	388	448	509	570	631	692	753	815	27
28	28	88	148	208	268	328	389	449	510	571	632	693	754	816	28
29	29	89	149	209	269	330	390	450	511	572	633	694	755	817	29
30	30	90	150	210	270	331	391	451	512	573	634	695	756	818	30
31	31	91	151	211	271	332	392	452	513	574	635	696	757	819	31
32	32	92	152	212	272	333	393	453	514	575	636	697	758	820	32
33	33	93	153	213	273	334	394	454	515	576	637	698	759	821	33
34	34	94	154	214	274	335	395	455	516	577	638	699	760	822	34
35	35	95	155	215	275	336	396	456	517	578	639	700	761	823	35
36	36	96	156	216	276	337	397	457	518	579	640	701	762	824	36
37	37	97	157	217	277	338	398	458	519	580	641	702	763	825	37
38	38	98	158	218	278	339	399	459	520	581	642	703	764	826	38
39	39	99	159	219	279	340	400	460	521	582	643	704	765	827	39
40	40	100	160	220	280	341	401	461	522	583	644	705	766	828	40
41	41	101	161	221	281	342	402	462	523	584	645	706	767	829	41
42	42	102	162	222	282	343	403	463	524	585	646	707	768	830	42
43	43	103	163	223	283	344	404	464	525	586	647	708	769	831	43
44	44	104	164	224	284	345	405	465	526	587	648	709	770	832	44
45	45	105	165	225	285	346	406	466	527	588	649	710	771	833	45
46	46	106	166	226	286	347	407	467	528	589	650	711	772	834	46
47	47	107	167	227	287	348	408	468	529	590	651	712	773	835	47
48	48	108	168	228	288	349	409	469	530	591	652	713	774	836	48
49	49	109	169	229	289	350	410	470	531	592	653	714	775	837	49
50	50	110	170	230	290	351	411	471	532	593	654	715	777	838	50
51	51	111	171	231	291	352	412	472	533	594	655	716	778	839	51
52	52	112	172	232	292	353	413	473	534	595	656	717	779	840	52
53	53	113	173	233	293	354	414	474	535	596	657	718	780	841	53
54	54	114	174	234	294	355	415	476	536	597	658	719	781	842	54
55	55	115	175	235	295	356	416	477	537	598	659	720	782	843	55
56	56	116	176	236	296	357	417	478	538	599	660	721	783	844	56
57	57	117	177	237	297	358	418	479	539	600	661	722	784	845	57
58	58	118	178	238	298	359	419	480	540	601	662	723	785	846	58
59	59	119	179	239	299	360	420	481	541	602	663	724	786	847	59
M.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	M.

TABLE III.

MERIDIONAL PARTS.

M.	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	M.
0	848	910	973	1035	1098	1161	1225	1289	1354	1419	1484	1550	1616	1684	0
1	850	911	974	1036	1099	1163	1226	1290	1355	1420	1485	1551	1618	1685	1
2	851	913	975	1037	1100	1164	1227	1291	1356	1421	1486	1552	1619	1686	2
3	852	914	976	1038	1101	1165	1228	1292	1357	1422	1487	1553	1620	1687	3
4	853	915	977	1039	1102	1166	1229	1293	1358	1423	1488	1554	1621	1688	4
5	854	916	978	1041	1103	1167	1230	1295	1359	1424	1490	1556	1622	1689	5
6	855	917	979	1042	1105	1168	1232	1296	1360	1425	1491	1557	1623	1690	6
7	856	918	980	1043	1106	1169	1233	1297	1361	1426	1492	1558	1624	1691	7
8	857	919	981	1044	1107	1170	1234	1298	1362	1427	1493	1559	1625	1693	8
9	858	920	982	1045	1108	1171	1235	1299	1363	1428	1494	1560	1626	1694	9
10	859	921	983	1046	1109	1172	1236	1300	1364	1430	1495	1561	1628	1695	10
11	860	922	984	1047	1110	1173	1237	1301	1366	1431	1496	1562	1629	1696	11
12	861	923	985	1048	1111	1174	1238	1302	1367	1432	1497	1563	1630	1697	12
13	862	924	996	1049	1112	1175	1239	1303	1368	1433	1498	1564	1631	1698	13
14	863	925	987	1050	1113	1176	1240	1304	1369	1434	1499	1565	1632	1699	14
15	864	926	988	1051	1114	1177	1241	1305	1370	1435	1500	1567	1633	1700	15
16	865	927	989	1052	1115	1178	1242	1306	1371	1436	1502	1568	1634	1701	16
17	866	928	990	1053	1116	1179	1243	1307	1372	1437	1503	1569	1635	1703	17
18	867	929	991	1054	1117	1181	1244	1308	1373	1438	1504	1570	1637	1704	18
19	868	930	993	1055	1118	1182	1245	1310	1374	1439	1505	1571	1638	1705	19
20	869	931	994	1056	1119	1183	1246	1311	1375	1440	1506	1572	1639	1706	20
21	870	932	995	1057	1120	1184	1248	1312	1376	1441	1507	1573	1640	1707	21
22	871	933	996	1058	1121	1185	1249	1313	1377	1443	1508	1574	1641	1708	22
23	872	934	997	1059	1122	1186	1250	1314	1379	1444	1509	1575	1642	1709	23
24	873	935	998	1060	1123	1187	1251	1315	1380	1445	1510	1577	1643	1711	24
25	874	936	999	1061	1125	1188	1252	1316	1381	1446	1511	1578	1644	1712	25
26	875	937	1000	1063	1126	1189	1253	1317	1382	1447	1513	1579	1645	1713	26
27	876	938	1001	1064	1127	1190	1254	1318	1383	1448	1514	1580	1647	1714	27
28	877	939	1002	1065	1128	1191	1255	1319	1384	1449	1515	1581	1648	1715	28
29	878	941	1003	1066	1129	1192	1256	1320	1385	1450	1516	1582	1649	1716	29
30	879	942	1004	1067	1130	1193	1257	1321	1386	1451	1517	1583	1650	1717	30
31	880	943	1005	1068	1131	1194	1258	1322	1387	1452	1518	1584	1651	1718	31
32	882	944	1006	1069	1132	1195	1259	1324	1388	1453	1519	1585	1652	1720	32
33	883	945	1007	1070	1133	1196	1260	1325	1389	1455	1520	1586	1653	1721	33
34	884	946	1008	1071	1134	1198	1261	1326	1390	1456	1521	1588	1654	1722	34
35	885	947	1009	1072	1135	1199	1262	1327	1392	1457	1522	1589	1656	1723	35
36	886	948	1010	1073	1136	1200	1264	1328	1393	1458	1524	1590	1657	1724	36
37	887	949	1011	1074	1137	1201	1265	1329	1394	1459	1525	1591	1658	1725	37
38	888	950	1012	1075	1138	1202	1266	1330	1395	1460	1526	1592	1659	1726	38
39	889	951	1013	1076	1139	1203	1267	1331	1396	1461	1527	1593	1660	1727	39
40	890	952	1014	1077	1140	1204	1268	1332	1397	1462	1528	1594	1661	1729	40
41	891	953	1015	1078	1141	1205	1269	1333	1398	1463	1529	1595	1662	1730	41
42	892	954	1016	1079	1142	1206	1270	1334	1399	1464	1530	1596	1663	1731	42
43	893	955	1018	1080	1144	1207	1271	1335	1400	1465	1531	1598	1664	1732	43
44	894	956	1019	1081	1145	1208	1272	1336	1401	1467	1532	1599	1666	1733	44
45	895	957	1020	1082	1146	1209	1273	1338	1402	1468	1533	1600	1667	1734	45
46	896	958	1021	1084	1147	1210	1274	1339	1403	1469	1535	1601	1668	1735	46
47	897	959	1022	1085	1148	1211	1275	1340	1405	1470	1536	1602	1669	1736	47
48	898	960	1023	1086	1148	1212	1276	1341	1406	1471	1537	1603	1670	1738	48
49	899	961	1024	1087	1150	1213	1277	1342	1407	1472	1538	1604	1671	1739	49
50	900	962	1025	1088	1151	1215	1278	1343	1408	1473	1539	1605	1672	1740	50
51	901	963	1026	1089	1152	1216	1280	1344	1409	1474	1540	1606	1673	1741	51
52	902	964	1027	1090	1153	1217	1281	1345	1410	1475	1541	1608	1675	1742	52
53	903	965	1028	1091	1154	1218	1282	1346	1411	1476	1542	1609	1676	1743	53
54	904	966	1029	1092	1155	1219	1283	1347	1412	1477	1543	1610	1677	1744	54
55	905	968	1030	1093	1156	1220	1284	1348	1413	1479	1544	1611	1678	1746	55
56	906	969	1031	1094	1157	1221	1285	1349	1414	1480	1546	1612	1679	1747	56
57	907	970	1032	1095	1158	1222	1286	1350	1415	1481	1547	1613	1680	1748	57
58	908	971	1033	1096	1159	1223	1287	1352	1416	1482	1548	1614	1681	1749	58
59	909	972	1034	1097	1160	1224	1288	1353	1418	1483	1549	1615	1682	1750	59
M.	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	26°	27°	M.

TABLE III.

MERIDIONAL PARTS.

M.	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	40°	41°	M.
0	1751	1819	1888	1958	2028	2100	2171	2244	2318	2393	2468	2545	2623	2702	0
1	1752	1821	1890	1959	2030	2101	2173	2246	2319	2394	2470	2546	2624	2703	1
2	1753	1822	1891	1960	2031	2102	2174	2247	2320	2395	2471	2548	2625	2704	2
3	1755	1823	1892	1962	2032	2103	2175	2248	2322	2396	2472	2549	2627	2706	3
4	1756	1824	1893	1963	2033	2104	2176	2249	2323	2398	2473	2550	2628	2707	4
5	1757	1825	1894	1964	2034	2105	2178	2250	2324	2399	2475	2551	2629	2708	5
6	1758	1826	1895	1965	2035	2107	2179	2252	2325	2400	2476	2553	2631	2710	6
7	1759	1827	1896	1966	2037	2108	2180	2253	2327	2401	2477	2554	2632	2711	7
8	1760	1829	1898	1967	2038	2109	2181	2254	2328	2403	2478	2555	2633	2712	8
9	1761	1830	1899	1969	2039	2110	2182	2255	2329	2404	2480	2557	2634	2714	9
10	1762	1831	1900	1970	2040	2111	2184	2257	2330	2405	2481	2558	2636	2715	10
11	1764	1832	1901	1971	2041	2113	2185	2258	2332	2406	2482	2559	2637	2716	11
12	1765	1833	1902	1972	2043	2114	2186	2259	2333	2408	2484	2560	2638	2718	12
13	1766	1834	1903	1973	2044	2115	2187	2260	2334	2409	2485	2562	2640	2719	13
14	1767	1835	1905	1974	2045	2116	2188	2261	2335	2410	2486	2563	2641	2720	14
15	1768	1837	1906	1976	2046	2117	2190	2263	2337	2411	2487	2564	2642	2722	15
16	1769	1838	1907	1977	2047	2119	2191	2264	2338	2413	2489	2566	2644	2723	16
17	1770	1839	1908	1978	2048	2120	2192	2265	2339	2414	2490	2567	2645	2724	17
18	1772	1840	1909	1979	2050	2121	2193	2266	2340	2415	2491	2568	2646	2726	18
19	1773	1841	1910	1980	2051	2122	2194	2268	2342	2416	2492	2569	2648	2727	19
20	1774	1842	1912	1981	2052	2123	2196	2269	2343	2418	2494	2571	2649	2728	20
21	1775	1843	1913	1983	2053	2125	2197	2270	2344	2419	2495	2572	2650	2729	21
22	1776	1845	1914	1984	2054	2126	2198	2271	2345	2420	2496	2573	2651	2731	22
23	1777	1846	1915	1985	2056	2127	2199	2272	2346	2422	2498	2575	2653	2732	23
24	1778	1847	1916	1986	2057	2128	2200	2274	2348	2423	2499	2576	2654	2733	24
25	1780	1848	1917	1987	2058	2129	2202	2275	2349	2424	2500	2577	2655	2735	25
26	1781	1849	1918	1988	2059	2131	2203	2276	2350	2425	2501	2578	2657	2736	26
27	1782	1850	1920	1990	2060	2132	2204	2277	2351	2427	2503	2580	2658	2737	27
28	1783	1852	1921	1991	2061	2133	2205	2279	2353	2428	2504	2581	2659	2739	28
29	1784	1853	1922	1992	2063	2134	2207	2280	2354	2429	2505	2582	2661	2740	29
30	1785	1854	1923	1993	2064	2135	2208	2281	2355	2430	2506	2584	2662	2742	30
31	1786	1855	1924	1994	2065	2137	2209	2282	2356	2432	2508	2585	2663	2743	31
32	1787	1856	1925	1995	2066	2138	2210	2283	2358	2433	2509	2586	2665	2744	32
33	1789	1857	1927	1997	2067	2139	2211	2285	2359	2334	2510	2588	2666	2746	33
34	1790	1858	1928	1998	2069	2140	2213	2286	2360	2335	2512	2589	2667	2747	34
35	1791	1860	1929	1999	2070	2141	2214	2287	2361	2437	2513	2590	2669	2748	35
36	1792	1861	1930	2000	2071	2143	2215	2288	2363	2438	2514	2591	2670	2750	36
37	1793	1862	1931	2001	2072	2144	2216	2290	2364	2439	2515	2593	2671	2751	37
38	1794	1863	1932	2002	2073	2145	2217	2291	2365	2440	2517	2594	2673	2752	38
39	1795	1864	1934	2004	2075	2146	2219	2292	2366	2442	2518	2595	2674	2754	39
40	1797	1865	1935	2005	2076	2147	2220	2293	2368	2443	2519	2597	2675	2755	40
41	1798	1866	1936	2006	2077	2149	2221	2295	2369	2444	2521	2598	2676	2756	41
42	1799	1868	1937	2007	2078	2150	2222	2296	2370	2445	2522	2599	2678	2758	42
43	1800	1869	1938	2008	2079	2151	2224	2297	2371	2447	2523	2601	2679	2759	43
44	1801	1870	1939	2010	2080	2152	2225	2298	2373	2448	2524	2602	2680	2760	44
45	1802	1871	1941	2011	2082	2153	2226	2299	2374	2449	2526	2603	2682	2762	45
46	1803	1872	1942	2012	2083	2155	2227	2301	2375	2451	2527	2604	2683	2763	46
47	1805	1873	1943	2013	2084	2156	2228	2302	2376	2452	2528	2606	2684	2764	47
48	1806	1875	1944	2014	2085	2157	2230	2303	2378	2453	2530	2607	2686	2766	48
49	1807	1876	1945	2015	2086	2158	2231	2304	2379	2454	2531	2608	2687	2767	49
50	1808	1877	1946	2017	2088	2159	2232	2306	2380	2456	2532	2610	2688	2768	50
51	1809	1878	1948	2018	2089	2161	2233	2307	2381	2457	2533	2611	2690	2770	51
52	1810	1879	1949	2019	2090	2162	2235	2308	2383	2458	2535	2612	2691	2771	52
53	1811	1880	1950	2020	2091	2163	2236	2309	2384	2459	2536	2614	2692	2772	53
54	1813	1881	1951	2021	2092	2164	2237	2311	3385	2461	2537	2615	2694	2774	54
55	1814	1883	1952	2022	2094	2165	2238	2312	2386	2462	2538	2616	2695	2775	55
56	1815	1884	1953	2024	2095	2167	2239	2313	2388	2463	2540	2617	2696	2776	56
57	1816	1885	1955	2025	2096	2168	2241	3314	2389	2464	2541	2619	2698	2778	57
58	1817	1886	1956	2026	2097	2169	2242	1316	2390	2466	2542	2620	2699	2779	58
59	1818	1887	1957	2027	2098	2170	2243	2317	2391	2467	2544	2621	2700	2780	59
M.	28°	29°	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	40°	41°	M.

TABLE III.

MERIDIONAL PARTS.

M.	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	52°	53°	54°	55°	M.
0	2782	2863	2946	3030	3116	3203	3292	3382	3474	3569	3665	3764	3865	3968	0
1	783	864	947	031	117	204	293	384	476	570	667	765	866	970	1
2	784	866	949	033	118	206	295	385	478	572	668	767	868	971	2
3	786	867	950	034	120	207	296	387	479	574	670	769	870	973	3
4	787	869	951	036	121	209	298	388	481	575	672	770	871	975	4
5	2788	2870	2953	3037	3123	3210	3299	3390	3482	3577	3673	3772	3873	3977	5
6	790	871	954	038	124	212	301	391	484	578	675	774	875	978	6
7	791	873	956	040	126	213	302	393	485	580	677	775	877	980	7
8	792	874	957	041	127	214	303	394	487	582	678	777	878	982	8
9	794	875	958	043	129	216	305	396	488	583	680	779	880	984	9
10	2795	2877	2960	3044	3130	3217	3306	3397	3490	3585	3681	3780	3882	3985	10
11	797	878	961	046	131	219	308	399	492	586	683	782	883	987	11
12	798	880	963	047	133	220	309	400	493	588	685	784	885	989	12
13	799	881	964	048	134	222	311	402	495	590	686	785	887	991	13
14	801	882	965	050	136	223	312	403	496	591	688	787	889	992	14
15	2802	2884	2967	3051	3137	3225	3314	3405	3498	3593	3690	3789	3890	3994	15
16	803	885	968	053	139	226	316	407	499	594	691	790	892	996	16
17	805	886	970	054	140	228	317	408	501	596	693	792	894	998	17
18	806	888	971	055	142	229	319	410	503	598	695	794	895	999	18
19	807	889	972	057	143	231	320	411	504	599	696	795	897	4001	19
20	2809	2891	2974	3058	3144	3232	3322	3413	3506	3601	3698	3797	3899	4003	20
21	810	892	975	060	146	334	323	414	507	602	699	799	901	005	21
22	811	893	976	061	147	235	325	416	509	604	701	800	902	006	22
23	813	895	978	063	149	237	326	417	510	606	703	802	904	008	23
24	814	896	979	064	150	238	328	419	512	607	704	804	906	010	24
25	2815	2897	2981	3065	3152	3240	3329	3420	3514	3609	3706	3806	3907	4012	25
26	817	899	982	067	153	241	331	422	515	610	708	807	909	014	26
27	818	900	983	068	155	242	332	423	517	612	709	809	911	015	27
28	820	902	985	070	156	244	334	425	518	614	711	811	913	017	28
29	821	903	986	071	157	245	335	427	520	615	713	812	914	019	29
30	2822	2904	2988	3073	3159	3247	3337	3428	3521	3617	3714	3814	3916	4021	30
31	824	906	989	074	160	248	338	430	523	618	716	816	918	022	31
32	825	907	991	075	162	250	340	431	525	620	717	817	919	024	32
33	826	908	992	077	163	251	341	433	526	622	719	819	921	026	33
34	828	910	993	078	165	253	343	434	528	623	721	821	923	028	34
35	2829	2911	2995	3080	3166	3254	3344	3436	3529	3625	3722	3822	3925	4029	35
36	830	913	996	081	168	256	346	437	531	626	724	824	926	031	36
37	832	914	998	083	169	257	347	439	532	628	726	826	928	033	37
38	833	915	999	084	171	259	349	440	534	630	727	827	930	035	38
39	834	917	3000	085	172	260	350	442	536	631	729	829	932	037	39
40	2836	2918	3002	3087	3173	3262	3352	3443	3537	3633	3731	3831	3933	4038	40
41	837	919	003	088	175	263	353	445	539	634	732	832	935	040	41
42	839	921	005	090	176	265	355	447	540	636	734	834	937	042	42
43	840	922	006	091	178	266	356	448	542	638	736	836	938	044	43
44	841	924	007	093	179	268	358	450	543	639	737	838	940	045	44
45	2843	2925	3009	3094	3181	3269	3359	3451	3545	3641	3739	3839	3942	4047	45
46	844	926	010	095	182	271	361	453	547	643	741	841	944	049	46
47	845	928	012	097	184	272	362	454	548	644	742	843	945	051	47
48	847	929	013	098	185	274	364	456	550	646	744	844	947	052	48
49	848	931	014	100	187	275	365	457	551	647	746	846	949	054	49
50	2849	2932	3016	3101	3188	3277	3367	3459	3553	3649	3747	3848	3951	4056	50
51	851	933	017	103	190	278	368	460	555	651	749	849	952	058	51
52	852	935	019	104	191	280	370	462	556	652	750	851	954	060	52
53	854	936	020	105	192	281	371	464	558	654	752	853	956	061	53
54	855	937	021	107	194	283	373	465	559	655	754	854	958	063	54
55	2856	2939	3023	3108	3195	3284	3374	3467	3561	3657	3755	3856	3959	4065	55
56	858	940	024	110	197	286	376	468	562	659	757	858	961	067	56
57	859	942	026	111	198	287	378	470	564	660	759	860	963	069	57
58	860	943	027	113	200	289	379	471	566	662	760	861	964	070	58
59	862	944	029	114	201	290	381	473	567	664	762	863	966	072	59
M.	42°	43°	44°	45°	46°	47°	48°	49°	50°	51°	52°	53°	54°	55°	M.

TABLE III.

MERIDIONAL PARTS.

M.	56°	57°	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	M.
0	4074	4183	4294	4409	4527	4649	4775	4905	5039	5179	5324	5474	5631	5795	0
1	076	184	296	411	529	651	777	907	042	181	326	477	633	797	1
2	077	186	298	413	531	653	779	909	044	184	328	479	636	800	2
3	079	188	300	415	533	655	781	912	046	186	331	482	639	803	3
4	081	190	302	417	535	657	784	914	049	188	333	484	742	806	4
5	4083	4192	4304	4419	4537	4660	4786	4916	5051	5191	5336	5487	5644	5809	5
6	085	194	306	421	539	662	788	918	053	193	338	489	647	811	6
7	086	195	308	423	541	664	790	920	055	195	341	492	650	814	7
8	088	197	309	425	543	666	792	923	058	198	343	495	652	817	8
9	090	199	311	427	545	668	794	925	060	200	346	497	655	820	9
10	4092	4201	4313	4429	4547	4670	4796	4927	5062	5203	5348	5500	5658	5823	10
11	094	203	315	431	549	672	798	929	065	205	351	502	660	825	11
12	095	205	317	433	551	674	801	931	067	207	353	505	663	828	12
13	097	207	319	434	553	676	803	934	069	210	356	507	666	831	13
14	099	208	321	436	555	678	805	936	071	212	358	510	668	834	14
15	4101	4210	4323	4438	4557	4680	4807	4938	5074	5214	5361	5513	5671	5837	15
16	103	212	325	440	559	682	809	940	076	217	363	515	674	839	16
17	104	214	327	442	562	684	811	943	078	219	366	518	676	842	17
18	106	216	328	444	564	687	814	945	081	222	368	520	679	845	18
19	108	218	330	446	566	689	816	947	083	224	371	523	682	848	19
20	4110	4220	4332	4448	4568	4691	4818	4949	5085	5226	5373	5526	5685	5851	20
21	112	221	334	450	570	693	820	951	088	229	376	528	687	854	21
22	113	223	336	452	572	695	822	954	090	231	378	531	690	856	22
23	115	225	338	454	574	697	824	956	092	234	380	533	693	859	23
24	117	227	340	456	576	699	826	958	095	236	383	536	695	862	24
25	4119	4229	4342	4458	4578	4701	4829	4960	5097	5238	5385	5539	5698	5865	25
26	121	231	344	460	580	703	831	963	099	241	388	541	701	868	26
27	122	232	346	462	582	705	833	965	102	243	390	544	704	871	27
28	124	234	347	464	584	707	835	967	104	246	393	546	706	874	28
29	126	236	349	466	586	710	837	969	106	248	395	549	709	876	29
30	4128	4238	4351	4468	4588	4712	4839	4972	5108	5250	5398	5552	5712	5879	30
31	130	240	353	470	590	714	842	974	111	253	401	554	715	882	31
32	132	242	355	472	592	716	844	976	113	255	403	557	717	885	32
33	133	244	357	474	594	718	846	978	115	258	406	559	720	888	33
34	135	246	359	476	596	720	848	981	118	260	408	562	723	891	34
35	4137	4247	4361	4478	4598	4722	4850	4983	5120	5263	5411	5565	5725	5894	35
36	139	249	363	480	600	724	852	985	122	265	413	567	728	896	36
37	141	251	365	482	602	726	855	987	125	267	416	570	731	899	37
38	142	253	367	484	604	728	857	990	127	270	418	573	734	902	38
39	144	255	369	486	606	731	859	992	129	272	421	575	736	905	39
40	4146	4257	4370	4488	4608	4733	4861	4994	5132	5275	5423	5578	5739	5908	40
41	148	259	372	490	610	735	863	996	134	277	426	580	742	911	41
42	150	260	374	492	612	737	865	999	136	280	428	583	745	914	42
43	152	262	376	494	614	739	868	5001	139	282	431	586	747	917	43
44	153	264	378	495	616	741	870	503	141	284	433	588	750	919	44
45	4155	4266	4380	4497	4618	4743	4872	5005	5143	5287	5436	5591	5753	5922	45
46	157	268	382	499	620	745	874	008	146	289	438	594	756	925	46
47	159	270	384	501	623	747	876	000	148	292	441	596	758	928	47
48	161	272	386	503	625	750	879	012	151	294	443	599	761	931	48
49	162	274	388	505	627	752	881	014	153	297	446	602	764	934	49
50	4164	4275	4390	4507	4629	4754	4883	5017	5155	5299	5448	5604	5767	5937	50
51	166	277	392	509	631	756	885	019	158	301	451	607	770	940	51
52	168	279	394	511	633	758	887	021	160	304	454	610	772	943	52
53	170	281	396	513	635	760	890	023	162	306	456	612	775	946	53
54	172	283	398	515	637	762	892	026	165	309	459	615	778	948	54
55	4173	4285	4399	4517	4639	4764	4894	5028	5167	5311	5461	5617	5781	5951	55
56	175	287	401	519	641	766	896	030	169	314	464	620	783	954	56
57	177	289	403	521	643	769	898	033	172	316	466	623	786	957	57
58	179	291	405	523	645	771	901	035	174	319	469	625	789	960	58
59	181	292	407	525	647	773	903	037	176	321	471	628	792	963	59
M.	56°	57°	58°	59°	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	M.

TABLE III.

MERIDIONAL PARTS.

M.	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	80°	81°	82°	83°	M.
0	5966	6146	6335	6534	6746	6970	7210	7467	7745	8046	8375	8739	9145	9606	0
1	969	149	338	538	749	974	214	472	749	051	381	745	153	614	1
2	972	152	341	541	753	978	218	476	754	056	387	752	160	622	2
3	975	155	345	545	757	982	222	481	759	061	393	758	167	631	3
4	978	158	348	548	760	986	227	485	764	067	398	765	174	639	4
5	5981	6161	6351	6552	6764	6990	7231	7490	7769	8072	8404	8771	9182	9647	5
6	984	164	354	555	768	994	235	494	774	077	410	788	189	655	6
7	986	167	358	558	771	997	239	498	778	083	416	784	196	664	7
8	989	170	361	562	775	7001	243	503	783	088	422	791	203	672	8
9	992	173	364	565	779	005	247	507	788	093	427	797	211	680	9
10	5995	6177	6367	6569	6782	7009	7252	7512	7793	8099	8433	8804	9218	9689	10
11	998	180	371	572	786	013	256	516	798	104	439	810	225	697	11
12	6001	183	374	576	790	017	260	521	803	109	445	817	233	706	12
13	004	186	377	579	793	021	264	525	808	115	451	823	240	714	13
14	007	189	380	583	797	025	268	530	813	120	457	830	248	723	14
15	6010	6192	6384	6586	6801	7029	7273	7535	7817	8125	8463	8836	9255	9731	15
16	013	195	387	590	804	033	277	539	822	131	469	843	262	740	16
17	016	198	390	593	808	037	281	544	827	136	474	849	270	748	17
18	019	201	394	597	812	041	285	548	832	141	480	856	277	757	18
19	022	205	397	600	815	045	289	553	837	147	486	863	285	765	19
20	6025	6208	6400	6603	6819	7048	7294	7557	7842	8152	8492	8869	9292	9774	20
21	028	211	403	607	823	052	298	562	847	158	498	876	300	783	21
22	031	214	407	610	826	056	302	566	852	163	504	883	307	791	22
23	034	217	410	614	830	060	306	571	857	168	510	889	315	800	23
24	037	220	413	617	834	064	311	576	862	174	516	896	322	809	24
25	6040	6223	6417	6621	6838	7068	7315	7580	7867	8179	8522	8903	9330	9817	25
26	043	226	420	624	841	072	319	585	872	185	528	909	337	826	26
27	046	230	423	628	845	076	323	589	877	190	534	916	345	835	27
28	049	233	427	631	849	080	328	594	882	196	540	923	353	844	28
29	052	236	430	635	853	084	832	599	887	201	546	930	360	852	29
30	6055	6239	6433	6639	6856	7088	7336	7603	7892	8207	8552	8936	9368	9861	30
31	058	242	437	642	860	092	341	608	897	212	558	943	376	870	31
32	061	245	440	646	864	096	345	612	902	218	565	950	383	879	32
33	064	249	443	649	868	100	349	617	907	223	571	957	391	888	33
34	067	252	447	653	671	104	353	622	912	229	577	963	399	897	34
35	6070	6255	6450	6656	6875	7108	7358	7626	7917	8234	8583	8970	9407	9906	35
36	073	258	453	660	879	112	362	631	922	240	589	977	414	915	36
37	076	261	457	663	883	116	366	636	927	245	595	984	432	924	37
38	079	264	460	667	886	120	371	640	932	251	601	991	430	933	38
39	082	268	463	670	890	124	375	645	937	256	607	998	438	942	39
40	6085	6271	6467	6674	6894	7128	7379	7650	7942	8262	8614	9005	9445	9951	40
41	088	274	470	677	898	132	384	654	948	267	620	012	453	960	41
42	091	277	473	681	901	136	388	659	953	273	626	018	461	969	42
43	094	280	477	685	905	140	392	664	958	279	632	025	469	978	43
44	097	283	480	688	909	145	397	668	963	284	638	032	477	987	44
45	6100	6287	6483	6692	6913	7149	7401	7673	7968	8290	8644	9039	9485	9996	45
46	103	290	487	695	917	153	406	678	973	295	651	046	493	10005	46
47	106	293	490	699	920	157	410	683	978	301	657	053	501	015	47
48	109	296	494	702	924	161	414	687	983	307	663	060	509	024	48
49	112	299	497	706	928	165	419	692	989	312	669	067	517	033	49
50	6115	6303	6500	6710	6932	7169	7423	7697	7994	8318	8676	9074	9525	10043	50
51	118	306	004	713	936	173	427	702	999	324	682	081	533	052	51
52	121	309	007	717	940	177	432	706	8004	329	688	088	541	061	52
53	124	312	011	720	943	181	436	711	009	335	695	096	549	071	53
54	127	315	014	724	947	185	441	716	014	341	701	103	557	080	54
55	6130	6319	6517	6728	6951	7189	7445	7721	8020	8347	8707	9110	9565	10089	55
56	133	322	521	731	955	194	449	725	025	352	714	117	573	099	56
57	136	325	524	735	959	198	454	730	030	358	720	124	581	108	57
58	140	328	528	738	963	202	458	735	035	364	726	131	589	118	58
59	143	332	531	742	966	206	463	740	040	369	733	138	598	127	59
M.	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	80°	81°	82°	83°	M.

TABLE IV.

MEAN REFRACTION.

App. Alt.	Refrac.	App. Alt.	Refrac.	App. Alt.	Refrac.	App. Alt.	Refrac.	App. Alt.	Refrac.
° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″	° ′	′ ″
0 0	34 17	10 0	5 20	20 0	2 39	30 0	1 41	50 0	0 49
10	32 15	10	5 15	10	2 37	20	1 39	30	0 48
20	30 23	20	5 10	20	2 36	40	1 38	51 0	0 47
30	28 40	30	5 6	30	2 35	31 0	1 37	30	0 46
40	27 27	40	5 1	40	2 33	20	1 35	52 0	0 45
50	25 41	50	4 56	50	2 32	40	1 34	30	0 44
1 0	24 22	11 0	4 52	21 0	2 31	32 0	1 33	53 0	0 44
10	23 9	10	4 48	10	2 29	20	1 32	30	0 43
20	22 2	20	4 44	20	2 28	40	1 31	54 0	0 42
30	21 0	30	4 40	30	2 27	33 0	1 30	30	0 41
40	20 2	40	4 36	40	2 26	20	1 28	55 0	0 40
50	19 9	50	4 32	50	2 25	40	1 27	30	0 40
2 0	18 20	12 0	4 28	22 0	2 24	34 0	1 26	56 0	0 39
10	17 34	10	4 25	10	2 22	20	1 25	30	0 39
20	16 51	20	4 21	20	2 21	40	1 24	57 0	0 38
30	16 11	30	4 18	30	2 20	35 0	1 23	30	0 38
40	15 34	40	4 14	40	2 19	20	1 22	58 0	0 37
50	14 59	50	4 11	50	2 18	40	1 21	30	0 36
3 0	14 26	13 0	4 8	23 0	2 17	36 0	1 20	59 0	0 35
10	13 55	10	4 5	10	2 15	20	1 19	30	0 34
20	13 27	20	4 2	20	2 14	40	1 18	60 0	0 33
30	13 0	30	3 59	30	2 13	37 0	1 17	30	0 33
40	12 34	42	3 56	40	2 12	20	1 16	61 0	0 32
50	12 10	50	3 53	50	2 11	40	1 15	30	0 32
4 0	11 47	14 0	3 50	24 0	2 10	38 0	1 14	62 0	0 31
10	11 26	10	3 47	10	2 9	20	1 14	30	0 31
20	11 5	20	3 45	20	2 8	40	1 13	63 0	0 30
30	10 46	30	3 42	30	2 7	39 0	1 12	30	0 29
40	10 28	40	3 40	40	2 6	20	1 11	64 0	0 28
50	10 10	50	3 37	50	2 5	40	1 10	30	0 28
5 0	9 54	15 0	3 35	25 0	2 5	40 0	1 9	65 0	0 27
10	9 38	10	3 32	10	2 4	20	1 9	30	0 27
20	9 23	20	3 30	20	2 3	40	1 8	66 0	0 26
30	9 9	30	3 28	30	2 2	41 0	1 7	30	0 25
40	8 55	40	3 25	40	2 1	20	1 7	67 0	0 24
50	8 42	50	3 23	50	2 0	40	1 6	30	0 24
6 0	8 30	16 0	3 21	26 0	1 59	42 0	1 5	68 0	0 23
10	8 18	10	3 19	10	1 58	20	1 4	30	0 22
20	8 6	20	3 17	20	1 57	40	1 3	69 0	0 21
30	7 56	30	3 15	30	1 56	43 0	1 2	70 0	0 20
40	7 45	40	3 13	40	1 56	20	1 2	71 0	0 19
50	7 35	50	3 11	50	1 55	40	1 1	72 0	0 18
7 0	7 25	17 0	3 9	27 0	1 54	44 0	1 0	73 0	0 17
10	7 16	10	3 7	10	1 53	20	1 0	74 0	0 16
20	7 7	20	3 5	20	1 52	40	0 59	75 0	0 15
30	6 59	30	3 3	30	1 51	45 0	0 58	76 0	0 14
40	6 50	40	3 1	40	1 51	20	0 58	77 0	0 13
50	6 42	50	2 59	50	1 50	40	0 57	78 0	0 12
8 0	6 35	18 0	2 58	28 0	1 49	46 0	0 56	79 0	0 11
10	6 27	10	2 56	10	1 49	20	0 56	80 0	0 10
20	6 20	20	2 54	20	1 48	40	0 55	81 0	0 9
30	6 13	30	2 53	30	1 47	47 0	0 54	82 0	0 8
40	6 6	40	2 51	40	1 47	20	0 54	83 0	0 7
50	6 0	50	2 50	50	1 46	40	0 53	84 0	0 6
9 0	5 54	19 0	2 48	29 0	1 45	48 0	0 52	85 0	0 5
10	5 48	10	2 47	10	1 45	20	0 52	86 0	0 4
20	5 42	20	2 45	20	1 44	40	0 51	87 0	0 3
30	5 36	30	2 44	30	1 43	49 0	0 50	88 0	0 2
40	5 31	40	2 42	40	1 43	20	0 50	89 0	0 1
50	5 25	50	2 40	50	1 42	40	0 49	90 0	0 0

TABLE V.

DIP OF THE HORIZON.

Height in Feet.	Dip.	Height in Feet.	Dip.	Height in Feet.	Dip.
	′ ″		′ ″		′ ″
1	0.58	28	5.10	125	10.56
2	1.22	30	5.21	130	11. 9
3	1.40	32	5.31	135	11.22
4	1.55	34	5.40	140	11.35
5	2. 9	36	5.50	145	11.47
6	2.22	38	6.00	150	11.59
7	2.33	40	6.10	155	12.11
8	2.44	42	6.19	160	12.23
9	2.54	44	6.28	165	12.34
10	3.03	46	6.37	170	12.45
11	3.12	48	6.45	175	12.56
12	3.21	50	6.53	180	13. 7
13	3.29	55	7.11	185	13.18
14	3.37	60	7.29	190	13.29
15	3.45	65	7.47	195	13.40
16	3.53	70	8. 5	200	13.50
17	4. 1	75	8.23	210	14.10
18	4. 8	80	8.40	220	14.30
19	4.15	85	8.57	230	14.50
20	4.22	90	9.14	240	15. 9
21	4.28	95	9.30	250	15.27
22	4.34	100	9.46	260	15.44
23	4.40	105	10. 1	270	16. 0
24	4.46	110	10.16	280	16.16
25	4.52	115	10.30	290	16.31
26	4.58	120	10.43	300	16.46

TABLE VII.

MOON'S AUGMENTATION.

☽'s App. Alt.	☽'s Semidiameter by the Nautical Almanac.						
	′ ″ 14.40	′ ″ 15.00	′ ″ 15.20	′ ″ 15.40	′ ″ 16.00	′ ″ 16.20	′ ″ 16.40
°	″	″	″	″	″	″	″
0	0	0	0	0	0	0	0
3	1	1	1	1	1	1	1
6	2	2	2	2	2	2	2
9	2	2	3	3	3	3	3
12	3	3	3	3	4	4	4
15	4	4	4	4	4	5	5
18	4	5	5	5	5	5	6
21	5	5	6	6	6	6	7
24	6	6	6	7	7	7	7
27	6	7	7	7	8	8	8
30	7	7	8	8	8	9	9
33	8	8	8	8	9	9	10
36	8	8	9	9	10	10	11
39	9	9	10	10	11	11	11
42	9	10	10	11	11	12	12
45	10	10	11	11	12	12	13
48	10	11	11	12	12	13	13
51	11	12	12	12	13	13	14
54	11	12	12	13	13	14	14
57	12	13	13	13	14	14	15
60	12	13	13	14	14	15	16
65	13	14	14	15	15	16	16
70	13	14	14	15	16	16	17
75	14	14	15	15	16	16	17
80	14	14	15	16	16	17	18
90	14	15	15	16	17	17	18

TABLE VI.

SUN'S PARALLAX IN ALTITUDE.

Altitude.	Parallax.
°	″
0	9
10	9
20	8
30	8
40	7
50	6
60	5
70	4
80	2
90	0

TABLE VIII.

DIP OF THE HORIZON—AT DIFFERENT DISTANCES FROM THE OBSERVER.

Distance of Land in Miles.	Height of the Eye in Feet.									
	5	10	15	20	25	30	35	40	45	50
M.	′	′	′	′	′	′	′		′	′
0.1	28	56	84	112	140	169	197	225	252	280
0.2	14	28	42	56	70	85	99	113	126	140
0.3	9	19	28	37	47	56	65	75	84	93
0.4	7	14	21	28	35	42	49	56	63	70
0.5	6	11	17	22	28	34	39	45	50	56
0.6	5	9	14	19	23	28	33	37	42	47
0.7	4	8	12	16	20	24	28	32	36	40
0.8	4	7	10	14	17	21	25	28	31	35
0.9	3	6	9	12	15	19	22	25	28	31
1.0	3	6	8	11	14	17	20	23	25	27
1.2	3	5	7	9	12	14	16	19	21	23
1.4	3	4	6	8	10	12	14	16	18	20
1.6	3	4	5	7	9	11	13	14	16	18
1.8	2	3	5	6	8	10	12	13	14	16
2.0	2	3	5	6	7	9	11	12	13	15
2.2	2	3	5	6	7	8	10	11	12	14
2.4	2	3	5	6	7	8	9	11	12	13
2.6	2	3	4	5	6	8	9	10	11	12
2.8	2	3	4	5	6	7	8	9	10	11
3.0	2	3	4	5	6	7	8	8	9	10
3.5	2	3	4	5	6	6	7	8	9	9
4.0	2	3	4	4	5	6	7	7	8	8
4.5	2	3	4	4	5	5	6	6	7	8
5.0	2	3	4	4	5	5	6	6	7	7
6.0	2	3	4	4	5	5	6	6	7	7
7.0	2	3	4	4	5	5	6	6	7	7

TABLE IX.

FOR CORRECTING THE OBSERVED ALTITUDE OF THE SUN'S LOWER LIMB, WHEN TAKEN BY A FORE OBSERVATION.

Obs. Alt.	HEIGHT OF THE EYE ABOVE THE SEA IN FEET.															
	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
° ′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
5 0	3.8	3.5	3.1	2.8	2.5	2.3	2.1	1.8	1.6	1.4	1.2	1.0	0.8	0.6	0.5	0.3
5 20	4.3	4.0	3.6	3.3	3.1	2.8	2.6	2.3	2.1	1.9	1.7	1.5	1.3	1.1	1.0	0.8
5 40	4.8	4.5	4.1	3.8	3.5	3.3	3.1	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.5	1.3
6 0	5.3	4.9	4.6	4.3	4.0	3.7	3.5	3.3	3.0	2.8	2.6	2.4	2.2	2.1	1.9	1.7
6 20	5.7	5.4	5.0	4.7	4.4	4.1	3.9	3.7	3.3	3.2	3.0	2.8	2.6	2.5	2.3	2.0
6 40	6.0	5.7	5.3	5.0	4.7	4.5	4.3	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.7	2.3
7 0	6.4	6.0	5.7	5.4	5.1	4.8	4.6	4.4	4.1	3.9	3.7	3.5	3.3	3.2	3.0	2.7
7 20	6.7	6.3	6.0	5.7	5.4	5.1	4.9	4.7	4.4	4.2	4.0	3.8	3.6	3.5	3.3	3.1
7 40	6.9	6.6	6.2	5.9	5.7	5.4	5.2	4.9	4.7	4.5	4.3	4.1	3.9	3.8	3.6	3.4
8 0	7.2	6.8	6.5	6.2	5.9	5.7	5.4	5.3	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7
8 20	7.5	7.1	6.7	6.5	6.2	5.9	5.7	5.5	5.2	5.0	4.8	4.6	4.4	4.3	4.1	3.9
8 40	7.7	7.3	7.0	6.7	6.4	6.1	5.9	5.7	5.5	5.2	5.0	4.8	4.7	4.5	4.3	4.1
9 0	7.9	7.5	7.2	6.9	6.6	6.4	6.1	5.9	5.7	5.5	5.3	5.1	4.9	4.7	4.5	4.4
9 20	8.1	7.7	7.4	7.1	6.8	6.6	6.3	6.1	5.9	5.7	5.5	5.3	5.1	4.9	4.7	4.6
9 40	8.3	7.9	7.6	7.3	7.0	6.7	6.5	6.3	6.1	5.8	5.6	5.4	5.3	5.1	4.9	4.7
10 0	8.5	8.1	7.8	7.5	7.2	6.9	6.7	6.5	6.2	6.0	5.8	5.6	5.4	5.3	5.1	4.9
10 30	8.7	8.3	8.0	7.7	7.4	7.2	6.9	6.7	6.5	6.3	6.1	5.9	5.7	5.5	5.4	5.2
11 0	8.9	8.6	8.2	7.9	7.6	7.4	7.2	6.9	6.7	6.5	6.3	6.1	5.9	5.7	5.6	5.4
11 30	9.1	8.8	8.4	8.1	7.8	7.6	7.4	7.1	6.9	6.7	6.5	6.3	6.1	5.9	5.8	5.6
12 0	9.3	9.0	8.7	8.3	8.0	7.8	7.6	7.3	7.1	6.9	6.7	6.5	6.3	6.2	6.0	5.8
13 0	9.6	9.3	9.0	8.7	8.4	8.1	7.9	7.7	7.4	7.2	7.0	6.8	6.6	6.5	6.3	6.1
14 0	9.9	9.6	9.2	8.9	8.7	8.4	8.2	7.9	7.7	7.5	7.3	7.1	6.9	6.8	6.6	6.4
15 0	10.2	9.8	9.5	9.2	8.9	8.7	8.4	8.2	8.0	7.8	7.6	7.4	7.2	7.0	6.9	6.7
16 0	10.4	10.1	9.7	9.4	9.1	8.9	8.7	8.4	8.2	8.0	7.8	7.6	7.4	7.2	7.1	6.9
17 0	10.6	10.3	9.9	9.6	9.3	9.1	8.9	8.6	8.3	8.2	8.0	7.8	7.6	7.4	7.3	7.1
18 0	10.8	10.4	10.1	9.8	9.5	9.3	9.0	8.8	8.6	8.4	8.2	8.0	7.8	7.6	7.5	7.3
19 0	11.0	10.6	10.3	10.0	9.7	9.4	9.2	9.0	8.8	8.5	8.3	8.1	8.0	7.8	7.6	7.4
20 0	11.1	10.7	10.4	10.1	9.8	9.6	9.3	9.1	8.9	8.7	8.5	8.2	8.1	7.9	7.7	7.6
21 0	11.2	10.9	10.5	10.2	10.0	9.7	9.5	9.2	9.0	8.8	8.6	8.4	8.2	8.1	7.9	7.7
22 0	11.4	11.0	10.7	10.4	10.1	9.8	9.6	9.4	9.1	8.9	8.7	8.5	8.3	8.2	8.0	7.8
23 0	11.5	11.1	10.8	10.5	10.2	9.9	9.7	9.5	9.2	9.0	8.8	8.6	8.4	8.3	8.1	7.9
24 0	11.6	11.2	10.9	10.6	10.3	10.0	9.8	9.6	9.3	9.1	8.9	8.7	8.5	8.4	8.2	8.0
25 0	11.7	11.3	11.0	10.7	10.4	10.1	9.9	9.7	9.4	9.2	9.0	8.8	8.6	8.5	8.3	8.1
26 0	11.7	11.4	11.0	10.7	10.5	10.2	10.0	9.7	9.5	9.3	9.1	8.9	8.7	8.6	8.4	8.2
27 0	11.8	11.5	11.1	10.8	10.5	10.3	10.1	9.8	9.6	9.4	9.2	9.0	8.8	8.6	8.5	8.3
28 0	11.9	11.6	11.2	10.9	10.6	10.4	10.2	9.9	9.7	9.5	9.3	9.1	8.9	8.7	8.5	8.4
30 0	12.0	11.7	11.3	11.0	10.8	10.5	10.3	10.0	9.8	9.6	9.4	9.2	9.0	8.9	8.7	8.5
32 0	12.2	11.8	11.5	11.2	10.9	10.6	10.4	10.2	9.9	9.7	9.5	9.3	9.1	9.0	8.8	8.6
34 0	12.3	11.9	11.6	11.3	11.0	10.7	10.5	10.3	10.1	9.9	9.6	9.4	9.2	9.1	8.9	8.7
36 0	12.4	12.0	11.7	11.4	11.1	10.8	10.6	10.4	10.2	9.9	9.7	9.5	9.3	9.2	9.0	8.8
38 0	12.5	12.1	11.8	11.5	11.2	10.9	10.7	10.5	10.2	10.0	9.8	9.6	9.4	9.3	9.1	8.9
40 0	12.5	12.2	11.8	11.5	11.3	11.0	10.8	10.5	10.3	10.1	9.9	9.7	9.5	9.4	9.2	9.0
42 0	12.6	12.2	11.9	11.6	11.3	11.1	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.4	9.3	9.1
44 0	12.7	12.3	12.0	11.7	11.4	11.1	10.9	10.7	10.5	10.2	10.1	9.8	9.7	9.5	9.3	9.1
46 0	12.7	12.4	12.0	11.7	11.5	11.2	11.0	10.7	10.5	10.3	10.2	9.9	9.7	9.6	9.4	9.2
48 0	12.8	12.4	12.1	11.8	11.5	11.3	11.0	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.5	9.3
50 0	12.8	12.5	12.2	11.9	11.6	11.3	11.1	10.9	10.6	10.4	10.3	10.0	9.8	9.7	9.5	9.3
52 0	12.9	12.5	12.2	11.9	11.6	11.4	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.7	9.6	9.4
54 0	13.0	12.6	12.3	12.0	11.7	11.4	11.2	11.0	10.7	10.5	10.3	10.1	9.9	9.8	9.6	9.4
56 0	13.0	12.6	12.3	12.0	11.7	11.5	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8	9.7	9.5
58 0	13.0	12.7	12.3	12.0	11.7	11.5	11.3	11.0	10.8	10.6	10.4	10.2	10.0	9.9	9.7	9.5
60 0	13.1	12.7	12.4	12.1	11.8	11.6	11.3	11.1	10.9	10.6	10.4	10.2	10.1	9.9	9.7	9.5
62 0	13.1	12.8	12.4	12.1	11.8	11.6	11.4	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.8	9.6
64 0	13.2	12.8	12.5	12.2	11.9	11.6	11.4	11.2	10.9	10.7	10.5	10.3	10.1	10.0	9.8	9.6
66 0	13.2	12.8	12.5	12.2	11.9	11.7	11.4	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8	9.7
70 0	13.3	12.9	12.6	12.3	12.0	11.8	11.5	11.3	11.0	10.8	10.6	10.4	10.2	10.1	9.9	9.7
80 0	13.4	13.1	12.7	12.4	12.1	11.9	11.7	11.4	11.2	11.0	10.8	10.6	10.4	10.2	10.1	9.9
90 0	13.6	13.2	12.9	12.6	12.3	12.0	11.8	11.6	11.3	11.1	10.9	10.7	10.5	10.4	10.2	10.0

Month.	Jan.	Feb.	Mar.	April,	May,	June,	July,	Aug.	Sept.	Oct.	Nov.	Dec.
Correction,	+0′.3	+0′.2	+0′.1	0′.0	−0′.2	−0′.2	−0′.3	−0′.2	−0′.1	+0′.1	+0′.2	+0′.2

TABLE X.

SUN'S DECLINATION FOR THE YEAR 1854 FOR APPARENT NOON AT GREENWICH.

DAYS.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPT.	OCT.	NOV.	DEC
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 1S	17 6S	7 35S	4 32N	15 4N	22 3N	23 8N	18 4N	8 19N	3 10S	14 26S	21 49S
2	22 56	16 49	7 12	4 55	15 22	22 11	23 4	17 48	7 57	3 33	14 45	21 58
3	22 50	16 31	6 49	5 18	15 40	22 19	22 59	17 33	7 35	3 56	15 4	22 7
4	22 44	16 13	6 26	5 41	15 57	22 26	22 54	17 17	7 13	4 20	15 23	22 15
5	22 38	15 55	6 3	6 4	16 14	22 33	22 49	17 1	6 51	4 43	15 41	22 23
6	22 30	15 37	5 40	6 26	16 31	22 40	22 43	16 45	6 29	5 6	15 59	22 31
7	22 23	15 18	5 17	6 49	16 48	22 46	22 37	16 28	6 6	5 29	16 17	22 38
8	22 15	14 59	4 53	7 11	17 5	22 51	22 30	16 11	5 44	5 52	16 35	22 44
9	22 7	14 40	4 30	7 34	17 21	22 56	22 24	15 54	5 21	6 15	16 52	22 50
10	21 58	14 21	4 7	7 56	17 37	23 1	22 16	15 37	4 59	6 38	17 9	22 56
11	21 49	14 1	3 43	8 18	17 52	23 6	22 8	15 19	4 36	7 0	17 26	23 1
12	21 39	13 41	3 19	8 40	18 7	23 10	22 0	15 1	4 13	7 23	17 42	23 6
13	21 29	13 21	2 56	9 2	18 22	23 13	21 52	14 43	3 50	7 45	17 58	23 10
14	21 19	13 1	2 32	9 24	18 37	23 17	21 43	14 25	3 27	8 8	18 14	23 14
15	21 8	12 41	2 9	9 45	18 51	23 19	21 34	14 6	3 4	8 30	18 30	23 17
16	20 57	12 20	1 45	10 6	19 5	23 22	21 24	13 47	2 41	8 52	18 45	23 20
17	20 45	11 59	1 21	10 28	19 19	23 24	21 14	13 28	2 17	8 14	19 0	23 23
18	20 33	11 38	0 57	10 49	19 33	23 25	21 4	13 9	1 54	8 36	19 14	23 24
19	20 20	11 17	0 34	11 9	19 46	23 26	20 53	12 49	1 31	9 58	19 28	23 26
20	20 8	10 55	0 10S	11 30	19 58	23 27	20 42	12 30	1 8	10 20	19 42	23 27
21	19 54	10 34	0 14N	11 51	20 11	23 28	20 31	12 10	0 44	10 41	19 56	23 28
22	19 41	10 12	0 37	12 11	20 23	23 27	20 19	11 50	0 21N	11 3	20 9	23 28
23	19 27	9 50	1 1	12 31	20 34	23 27	20 7	11 29	0 3S	11 24	21 22	23 27
24	19 13	9 28	1 25	12 51	20 46	23 26	19 55	11 9	0 26	11 45	20 34	23 26
25	18 58	9 5	1 48	13 11	20 57	23 25	19 42	10 48	0 49	12 6	20 46	23 25
26	18 43	8 43	2 12	13 30	21 7	23 23	19 29	10 27	1 13	12 26	20 57	23 23
27	18 28	8 21	2 35	13 49	21 18	23 21	19 15	10 6	1 36	12 47	21 9	29 21
28	18 12	7 58	2 59	14 8	21 28	23 18	19 2	9 45	2 0	13 7	21 19	23 18
29	17 56		3 22	14 27	21 37	23 15	18 48	9 24	2 23	13 27	21 30	23 15
30	17 40		3 45	14 46	21 46	23 12	18 33	9 3	2 46	13 47	21 40	23 11
31	17 23		4 9		21 55		18 19	8 41		14 6		23 7

SUN'S DECLINATION FOR THE YEAR 1855.

DAYS.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 2S	17 11S	7 41S	4 25N	14 59N	22 1N	23 9N	18 8N	8 25N	3 3S	14 21S	21 47S
2	22 57	16 53	7 19	4 49	15 17	22 9	23 5	17 53	8 3	3 27	14 40	21 56
3	22 52	16 36	6 56	5 12	15 35	22 17	22 1	17 37	7 42	3 50	14 59	22 5
4	22 46	16 18	6 33	5 35	15 52	22 24	22 56	17 21	7 19	4 13	15 17	22 13
5	22 39	16 0	6 10	5 57	16 10	22 31	22 50	17 5	6 57	4 36	15 36	22 21
6	22 32	15 42	5 46	6 20	16 27	22 38	22 45	16 49	6 35	4 59	15 54	22 29
7	22 25	15 23	5 23	6 43	16 44	22 44	22 39	16 33	6 13	5 23	16 12	22 36
8	22 17	15 5	5 0	7 5	17 0	22 50	22 32	16 16	5 50	5 46	16 30	22 42
9	22 9	14 46	4 36	7 28	17 16	22 55	22 25	15 59	5 27	6 8	16 46	22 49
10	22 0	14 26	4 13	7 50	17 32	23 0	22 18	15 41	5 5	6 31	17 4	22 54
11	21 51	14 7	3 49	8 12	17 48	23 4	22 10	15 24	4 42	6 54	17 21	23 0
12	21 42	13 47	3 26	8 34	18 3	23 9	22 2	15 6	4 19	7 17	17 38	23 4
13	21 32	13 27	3 2	8 56	18 18	23 12	21 54	14 48	3 56	7 39	17 54	23 9
14	21 22	13 7	2 39	9 18	18 33	23 16	21 45	14 30	3 33	8 2	18 10	23 13
15	21 11	12 46	2 15	9 39	18 47	23 19	21 36	14 11	3 10	8 24	18 25	23 16
16	21 0	12 25	1 51	10 1	19 2	23 21	21 27	13 52	2 47	8 46	18 41	23 19
17	20 48	12 5	1 28	10 22	19 15	23 23	21 17	13 33	2 24	9 8	18 56	23 22
18	20 36	11 44	1 4	10 43	19 29	23 25	21 7	13 14	2 1	9 30	19 10	23 24
19	20 24	11 22	0 40	11 4	19 42	23 26	20 56	12 55	1 37	9 52	19 24	23 25
20	20 11	11 1	0 17S	11 24	19 55	23 27	20 45	12 35	1 14	10 14	19 38	23 27
21	19 58	10 39	0 7N	11 45	20 7	23 27	20 34	12 15	0 51	10 35	19 52	23 28
22	19 44	10 18	0 31	12 5	20 19	23 27	20 22	11 55	0 27	11 57	20 5	23 27
23	19 31	9 56	0 54	12 25	20 31	23 27	20 10	11 35	0 4N	11 18	20 18	23 27
24	19 16	9 34	1 18	12 45	20 43	23 26	19 58	11 14	0 20S	11 39	20 30	23 26
25	19 2	9 12	1 42	13 5	20 54	23 25	19 45	10 54	0 43	12 0	20 42	23 25
26	18 47	8 49	2 5	13 25	21 4	23 23	19 32	10 33	1 6	12 21	20 54	23 23
27	18 32	8 27	2 29	13 44	21 15	23 21	19 19	10 12	1 30	12 41	21 5	23 21
28	18 16	8 4	2 52	14 3	21 25	23 19	19 5	9 51	1 53	13 1	21 16	23 19
29	18 0		3 16	14 22	21 34	23 16	18 51	9 30	2 17	13 22	21 27	23 16
30	17 44		3 39	14 40	21 44	23 13	18 37	9 9	2 40	13 41	21 37	23 12
31	17 27		4 2		21 52		18 23	8 47		14 1		23 8

This Table will answer very nearly for every four years afterwards, but if greater accuracy is required, a correction must be taken from Table XII.

TABLE X.

SUN'S DECLINATION FOR THE YEAR 1856 FOR APPARENT NOON AT GREENWICH.

DAYS.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPT.	OCT.	NOV.	DEC.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 3S	17 15S	7 25S	4 42N	15 12N	22 7N	23 6N	17 57N	8 9N	3 20S	14 35S	21 53S
2	22 59	16 58	7 2	5 5	15 30	22 15	23 2	17 41	7 47	3 44	14 54	22 2
3	22 53	16 41	6 39	5 28	15 48	22 22	22 57	17 26	7 25	4 7	15 12	22 11
4	22 47	16 23	6 16	5 51	16 5	22 29	22 52	17 10	7 3	4 30	15 31	22 19
5	22 41	16 5	5 53	6 14	16 22	22 36	22 46	16 54	6 41	4 53	15 49	22 27
6	22 34	15 47	5 29	6 37	16 39	22 42	22 40	16 37	6 19	5 16	16 7	22 34
7	22 27	15 28	5 6	6 59	16 56	22 28	22 34	16 20	6 56	5 39	16 25	22 41
8	22 19	15 10	4 43	7 22	17 12	22 53	22 27	16 3	5 34	6 2	16 42	22 47
9	22 11	14 51	4 19	7 44	17 28	22 59	22 20	15 46	5 11	6 25	17 0	22 53
10	22 3	14 31	3 56	8 6	17 44	23 3	22 13	15 28	4 48	6 48	17 17	22 58
11	21 54	14 12	3 32	8 28	17 59	23 7	22 05	15 11	4 25	7 11	17 33	23 3
12	21 44	13 52	3 9	8 50	18 14	23 11	21 56	14 53	4 2	7 33	17 49	23 8
13	21 35	13 32	2 45	9 12	18 29	23 15	21 48	14 34	3 39	7 56	18 5	23 12
14	21 24	13 12	2 21	9 33	18 44	23 18	21 39	14 16	3 16	8 18	18 21	23 15
15	21 14	12 52	1 58	9 55	18 58	23 20	21 29	13 57	2 53	8 40	18 37	23 18
16	21 3	12 31	1 34	10 16	19 12	23 23	21 20	13 38	2 30	9 02	18 52	23 21
17	20 51	12 10	1 10	10 37	19 25	23 24	21 9	13 19	2 7	9 24	19 6	23 23
18	20 39	11 49	0 47	10 58	19 38	23 26	20 59	13 0	1 44	9 46	19 21	23 25
19	20 27	11 28	0 23S	11 19	19 51	23 27	20 48	12 40	1 20	10 08	19 35	23 26
20	20 14	11 7	0 1N	11 39	20 4	23 27	20 37	12 20	0 57	10 30	19 48	23 27
21	20 1	10 45	0 24	12 0	20 16	23 27	20 25	12 0	0 34	10 51	20 2	23 27
22	19 48	10 23	0 48	12 20	20 28	23 27	20 13	11 40	0 10N	11 12	20 14	23 27
23	19 34	10 2	1 12	12 40	20 40	23 26	20 1	11 20	0 13S	11 33	20 27	23 27
24	19 20	9 40	1 35	13 0	20 51	23 25	19 49	10 59	0 37	11 54	20 39	23 25
25	19 6	9 17	1 59	13 19	21 1	23 24	19 36	10 39	1 0	12 15	20 51	23 24
26	18 51	8 55	2 22	13 39	21 12	23 22	19 23	10 18	1 23	12 36	21 2	23 22
27	18 36	8 33	2 46	13 58	21 22	23 20	19 9	9 57	1 47	12 56	21 13	29 19
28	18 20	8 10	3 9	14 17	21 32	27 17	18 55	9 36	2 10	13 16	21 24	23 16
29	18 5	7 48	3 33	14 35	21 41	23 14	18 41	9 14	2 34	13 36	21 34	23 13
30	17 48		3 56	14 54	21 50	23 10	18 27	8 53	2 57	13 56	21 44	23 9
31	17 32		4 19		21 59		18 12	8 31		14 15		23 5

SUN'S DECLINATION FOR THE YEAR 1857.

DAYS.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
	° ′	′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1	23 0S	17 2S	7 30S	4 37N	15 8N	22 5N	23 7N	18 0N	8 15N	3 15S	14 30S	21 51S
2	22 54	16 45	7 7	5 0	15 26	22 13	23 3	17 45	7 53	3 38	14 49	22 0
3	22 49	16 27	6 44	5 23	15 43	22 20	22 58	17 30	7 31	4 1	15 8	22 9
4	22 43	16 10	6 21	5 46	16 1	22 28	22 53	17 14	7 9	4 24	15 26	22 17
5	22 36	15 51	5 58	6 8	16 18	22 34	22 48	16 58	6 46	4 48	15 45	22 25
6	22 29	15 33	5 35	6 31	16 35	22 41	22 42	16 41	6 24	5 11	16 3	22 32
7	22 21	15 14	5 12	6 54	16 51	22 47	22 36	16 24	6 2	5 34	16 21	22 39
8	22 13	14 55	4 48	7 16	17 8	22 52	22 29	16 8	5 39	5 57	16 38	22 45
9	22 5	14 36	4 25	7 38	17 24	22 57	22 22	15 50	5 16	6 20	16 56	22 51
10	21 56	14 17	4 1	8 1	17 40	23 2	22 14	15 33	4 54	6 42	17 13	22 57
11	21 47	13 57	3 38	8 23	17 55	23 6	22 7	15 15	4 31	7 5	17 29	23 2
12	21 37	13 37	3 14	8 45	18 10	23 10	21 58	14 57	4 8	7 28	17 46	23 7
13	21 27	13 17	2 51	9 6	18 25	23 14	21 50	14 39	3 45	7 50	18 2	23 11
14	21 16	12 57	2 27	9 28	18 40	23 17	21 41	14 21	3 22	8 13	18 17	23 14
15	21 5	12 36	2 4	9 50	18 54	23 20	21 32	14 2	2 59	8 35	18 33	23 18
16	20 54	12 15	1 40	10 11	19 8	23 22	21 22	13 43	2 36	8 57	18 48	23 21
17	20 42	11 54	1 16	10 32	19 22	23 24	21 12	13 24	2 12	9 19	19 3	23 23
18	20 30	11 33	0 52	10 53	19 35	23 25	21 2	13 5	1 49	9 41	19 17	23 25
19	20 18	11 12	0 29	11 14	19 48	23 26	20 51	12 45	1 26	10 3	19 31	23 26
20	20 5	10 50	0 5S	11 34	20 1	23 27	20 40	12 25	1 3	10 24	19 45	23 27
21	19 51	10 29	0 19N	11 55	20 13	23 27	20 28	12 5	0 39	10 46	19 58	23 27
22	19 38	10 7	0 42	12 15	20 25	23 27	20 16	11 45	0 16N	11 7	20 11	23 27
23	19 24	9 45	1 6	12 35	20 37	23 27	20 4	11 25	0 08S	11 28	20 24	23 27
24	19 9	9 23	1 30	12 55	20 48	23 26	19 52	11 4	0 31	11 49	20 36	23 26
25	18 55	9 1	1 53	13 15	20 59	26 24	19 39	10 44	0 54	12 10	20 48	23 24
26	18 40	8 38	2 17	13 34	21 9	23 22	19 26	10 23	1 18	12 31	21 0	23 22
27	18 24	8 16	2 40	13 53	21 20	23 20	19 12	10 2	1 41	12 51	21 11	23 20
28	18 8	7 53	3 4	14 12	21 29	23 18	18 59	9 41	2 5	13 11	21 21	23 17
29	17 52		3 27	14 31	21 39	23 14	18 45	9 19	2 28	13 31	21 32	23 14
30	17 36		3 50	14 49	21 48	23 11	18 30	8 58	2 51	13 51	21 42	23 10
31	17 19		4 14		21 57		18 15	8 36		14 11		23 6

This Table will answer very nearly for every four years afterwards, but if greater accuracy is required, a correction must be taken from Table XII.

TABLE XI.

CORRECTION OF THE SUN'S DECLINATION AT SEA FOR LONGITUDE AND FOR TIME.

Long.	DECLINATION.																			TIME FROM NOON.
	° 0	° 2	° 4	° 6	° 8	° 10	° 12	° 14	° 16	° 17	° 18	° 19	° 20	° 21	° 21½	° 22	° 22½	° 23	° 23½	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	H. M.
0	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0·	0· 0
10	0·7	0·7	0·7	0·6	0·6	0·6	0·6	0·5	0·5	0·5	0·4	0·4	0·3	0·3	0·3	0·2	0·2	0·2	0·1	0·40
20	1·3	1·3	1·3	1·3	1·2	1·2	1·1	1·0	1·0	0·9	0·9	0·8	0·7	0·6	0·6	0·5	0·4	0·3	0·2	1·20
30	2·0	2·0	1·9	1·0	1·8	1·8	1·7	1·6	1·5	1.4	1·3	1·2	1·0	0·9	0·8	0·7	0·6	0·4	0·3	2· 0
40	2·6	2·6	2·6	2·5	2·5	2·4	2·3	2·1	2·0	1·8	1·7	1·6	1·4	1·2	1·0	0·9	0·8	0·5	0·4	2·40
50	3·3	3·3	3·3	3·2	3·1	3·0	2·8	2·7	2·4	2·3	2·1	2·0	1·7	1·5	1·3	1·1	1·0	0·6	0·4	3·20
60	3·9	3·9	3·9	3·8	3·7	3·6	3·4	3·2	2·9	2·8	2·6	2·4	2·1	1·8	1·6	1·4	1·2	0·8	0.5	4. 0
70	4·6	4·6	4·5	4·5	4·3	4·2	4·0	3·7	3·4	3·2	3·0	2·8	2·4	2·1	1·8	1·6	1·4	0·9	0.6	4.40
80	5·2	5·2	5·1	5·1	5·0	4·8	4·5	4·2	3·9	3·7	3.4	3·2	2·8	2·4	2·1	1·9	1·6	1·0	0.7	5.20
90	5·9	5·9	5·8	5·7	5·6	5·4	5·1	4·8	4·4	4·1	3·9	3·6	3·2	2·7	2·4	2·1	1·8	1·1	0.8	6. 0
100	6·5	6·5	6·4	6·3	6·2	6·0	5·7	5·3	4·8	4·6	4·3	3·9	3·6	3·0	2·7	2·3	2·0	1·3	0.9	6.40
10	7·2	7·2	7·1	7·0	6·8	6·6	6·3	5·9	5·3	5·0	4·8	4·3	3·9	3·3	3·0	2·5	2·2	1·4	0·9	7·20
120	7·8	7·8	7·7	7·6	7·4	7·2	6·8	6·4	5·8	5·5	5·2	4·7	4·3	3·6	3·2	2·8	2·4	1·5	1·0	8· 0
130	8·5	8·5	8·4	8·3	8·0	7·8	7·4	7·0	6·2	5·9	5·6	5·1	4·6	3·9	3·5	3·0	2·6	1·6	1·1	8·40
140	9·1	9·1	9·0	8·9	8·7	8·3	8·0	7·5	6·7	6·4	6·0	5·5	5·0	4·2	3·8	3·3	2·8	1·8	1·2	9·20
150	9·8	9·8	9·7	9·5	9·3	9·0	8·5	8·0	7·2	6·8	6·5	5·9	5·3	4·4	4·1	3·5	3·0	1·9	1·3	10· 0
160	10·5	10·4	10·3	10·2	9·9	9.6	9.1	8·6	7·7	7·3	6·9	6·3	5·7	4·7	4·4	3·7	3·2	2·0	1·4	10·40
170	11·1	11·1	11·0	10·8	10·5	10.2	9.7	9·1	8·2	7·8	7·4	6·7	6·0	5·1	4·6	4·0	3·4	2·2	1·5	11·20
180	11·8	11·7	11·6	11·4	11·1	10.8	10.3	9·6	8·8	8·3	7·9	7·2	6·4	5·5	4·9	4·3	3·6	2·3	1·6	12· 0

IN WEST LONGITUDE.	IN EAST LONGITUDE.
When the Declina. is { Increasing, Add. / Decreasing, Subtract	When the Declina. is { Increasing, Subtract. / Decreasing, Add.
TIME BEFORE NOON.	**TIME AFTERNOON.**
When the Declina. is { Increasing, Subtract / Decreasing, Add.	When the Declina. is { Increasing, Add. / Decreasing, Subtract.

TABLE XII.

CORRECTION OF THE SUN'S DECLINATION IN TABLE X., AFTER THE YEARS FOLLOWING 1854. 1855. 1856, AND 1857.

1854 1855 1856 1857	1858 1859 1860 1861	1862 1863 1864 1865	1866 1867 1868 1869	1870 1871 1872 1873	1874 1875 1876 1877	1878 1879 1880 1881
	SUB. ′	SUB. ′	SUB. ′	SUB. ′	SUB. ′	SUB. ′
JANUARY 1	0.1	0·3	0·4	0·6	0·7	0·9
10	0.2	0.5	0·8	1·0	1·3	1·6
20	0.4	0·7	1·1	1·4	1·8	2·2
30	0.5	1·0	1·5	2·0	2·5	3·0
FEB'RY 10	0·6	1·1	1·6	2·2	2·8	3·4
20	0·6	1·2	1·9	2·5	3·1	3·7
28	0·7	1·3	2·0	2·6	3·3	4·0
MARCH 10	0·7	1·4	2·1	2·8	3·5	4·2
20	0·7	1·4	2·1	2·8	3·6	4·3
	ADD.	ADD.	ADD.	ADD.	ADD.	ADD.
30	0·7	1·4	2·1	2·8	3·5	4·2
APRIL 10	0·7	1·4	2·1	2·7	3·4	4·1
20	0·6	1·3	1·9	2·5	3·2	3·9
30	0·6	1·1	1·7	2·3	2·8	3·4
MAY 10	0·5	0·9	1·5	2·0	2·5	3·0
20	0·4	0·8	1·2	1·6	1·9	2·3
30	0·3	0·5	0·8	1·0	1·4	1·7
JUNE 10	0·2	0·3	0·4	0·5	0·7	0·9
20	0·0	0·0	0·1	0·1	0·1	0·1
	SUB.	SUB.	SUB.	SUB.	SUB.	SUB.
30	0·1	0·3	0·4	0·6	0·7	0·8

1854 1855 1856 1857	1858 1859 1860 1861	1862 1863 1864 1865	1866 1867 1868 1869	1870 1871 1872 1873	1874 1875 1876 1877	1878 1879 1880 1881
	SUB. ′	SUB. ′	SUB. ′	SUB. ′	SUB. ′	SUB. ′
JUNE 30	0·1	0·3	0·4	0·6	0·7	0·8
JULY 10	0·2	0·5	0·8	1·0	1·3	1·6
20	0·4	0·7	1·1	1·4	1·8	2·2
30	0·5	1·0	1·5	2·0	2·5	3·0
AUGUST 10	0·5	1·1	1·7	2·3	2·8	3·4
20	0·6	1·3	1·9	2·5	3·2	3·9
30	0·7	1·4	2·0	2·7	3·4	4·1
SEPT. 10	0·7	1·4	2·1	2·8	3·5	4·2
20	0·7	1·4	2·1	2·9	3·6	4·3
	ADD.	ADD.	ADD.	ADD.	ADD.	ADD.
30	0·7	1·4	2·1	2·8	3·5	4·2
OCT. 10	0·7	1·4	2·0	2·7	3·4	4·1
20	0·6	1·3	1·9	2·5	3·2	3·9
30	0·5	1·1	1·6	2·2	2·8	3·4
NOV. 10	0·5	1·0	1·4	1·9	2·4	2·8
20	0·4	0·8	1·2	1·5	2·0	2·5
30	0·2	0·5	0·7	1·0	1·3	1·6
DEC. 10	0·2	0·3	0·4	0·6	0·7	0·8
20	0·0	0·0	0·1	0·1	0·2	0·3
	SUB.	SUB.	SUB.	SUB.	SUB.	SUB.
30	0·1	0·3	0·4	0·6	0·7	0·9

To apply the Correction in Table XII Reduce the proposed year by Subtracting any number of *Fours* until it corresponds to one of the years for which the Declination is given in Table X., and take out the Declination for that year against the day of the month, and take out the Correction from Table XII., found opposite the same day of the month, and under the proposed year, which is expressed in minutes and tenths; if the tenths are more than 5 increase the minutes by 1, but if less, throw them away. This applied as directed in the above Table, (add or subtract) to or from the Declination taken from Table X., will give the correct Declination for the proposed year until the year 1881.

TABLE XIII.—SUN'S RIGHT ASCENSION.

DAYS.	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPT.	OCT.	NOV.	DEC.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
1	18.47	20.59	22.49	0.42	2.33	4.36	6.40	8.45	10.41	12.29	14.25	16.29
2	18.52	21 3	22.52	0.46	2.37	4.40	6.44	8.49	10.45	12.33	14.29	16.34
3	18.56	21. 8	22.56	0.49	2.41	4.44	6.49	8.53	10.48	12.37	14.33	16.38
4	19. 0	21.12	23. 0	0.53	2.45	4.48	6.53	8.57	10.52	12.40	14.37	16.42
5	19. 5	21.16	23. 3	0.57	2.49	4.52	6.57	9. 1	10.56	12.44	14.41	16.47
6	19. 9	21.20	23. 7	1. 0	2.53	4.57	7. 1	9. 4	10.59	12.47	14.45	16.51
7	19.13	21.24	23.11	1. 4	2.56	5. 1	7. 5	9. 8	11. 3	12.51	14.49	16.55
8	19.18	21.28	23.15	1. 8	3. 0	5. 5	7. 9	9.12	11. 7	12.55	14.53	17. 0
9	19.22	21.32	23.18	1.11	3. 4	5. 9	7.13	9.16	11.10	12.58	14.57	17. 4
10	19.27	21.36	23.22	1.15	3. 8	5.13	7.17	9.20	11.14	13. 2	15. 1	17. 9
11	19.31	21.39	23.26	1.19	3.12	5.17	7.21	9.23	11.17	13. 6	15. 5	17.13
12	19.35	21.43	23.29	1.22	3.16	5.21	7.25	9.27	11.21	13. 9	15. 9	17.17
13	19.40	21.47	23.33	1.26	3.20	5.26	7.30	9.31	11.24	13.13	15.13	17.22
14	19.44	21.51	23.37	1.30	3.24	5.30	7.34	9.35	11.28	13.17	15.18	17.26
15	19.48	21.55	23.40	1.33	3.28	5.34	7.38	9.39	11.32	13.21	15.22	17.31
16	19.52	21.59	23.44	1.37	3.32	5.38	7.42	9.42	11.35	13.24	15.26	17.35
17	19.57	22. 3	23.48	1.41	3.36	5.42	7.46	9.46	11.39	13.28	15.30	17.39
18	20. 1	22. 7	23.51	1.44	3.40	5.46	7.50	9.50	11.42	13.32	15.34	17.44
19	20. 5	22.11	23.55	1.48	3.43	5.50	7.54	9.53	11.46	13.36	15.38	17.48
20	20.10	22.14	23.58	1.52	3.47	5.55	7.58	9.57	11.50	13.39	15.42	17.53
21	20.14	22.18	0. 2	1.56	8.51	5.59	8. 2	10. 1	11.53	13.43	15.47	17.57
22	20.18	22.22	0. 6	1.59	3.55	6. 3	8. 6	10. 5	11.57	13.47	15.51	18. 2
23	20.22	22.26	0. 9	2. 3	4. 0	6. 7	8.10	10. 8	12. 0	13.51	15.55	18. 6
24	20.26	22.30	0.13	2. 7	4. 4	6.11	8.14	10.12	12. 4	13.55	15.59	18.11
25	20.31	22.33	0.17	2.11	4. 8	6.15	8.18	10.16	12. 8	13.58	16. 4	18.15
26	20.35	22.37	0.20	2.14	4.12	6.20	8.22	10.19	12.11	14. 2	16. 8	18.19
27	20.39	22.41	0.24	2.18	4.16	6.24	8.26	10.23	12.15	14. 6	16.12	18.24
28	20.43	22.45	0.28	2.22	4.20	6.28	8.30	10.27	12.18	14.10	16.16	18.28
29	20.47		0.31	2.26	4.24	6.32	8.33	10.30	12.22	14.14	16.21	18.33
30	20.51		0.35	2.30	4.28	6.36	8.37	10.34	12.26	14.18	16.25	18.37
31	20.56		0.38		4.32		8.41	10.38		14.22		18.42

The Right Ascension given in this Table is for the year 1854, and will answer approximately for several years afterwards, but where accuracy is required, it must be taken from the Nautical Almanac.

TABLE XIV.

EQUATION OF TIME FOR APPARENT NOON AT GREENWICH, FOR THE YEAR 1854, AND WILL ANSWER NEARLY FOR 1858, 1862, AND 1866.

DAYS.	JAN.	FEB.	MAR.	APRIL.		MAY.	JUNE.		JULY.	AUG.	SEPT.	OCT.	NOV.	DECEMBER.	
	ADD	ADD	ADD			SUB.			ADD	ADD	SUB.	SUB.	SUB.		
	M. S.	M. S.	M. S.		M. S.	H. M.		M. S.	M. S.	M. S.	M. S.	M. S.	M. S.		M. S.
1	3.51	13.55	12.37	ADD.	4. 0	3. 1	SUB.	2.32	3.26	6. 3	0. 5	10.17	16.16	SUB.	10.47
2	4.20	14. 2	12.25		3.42	3. 9		2.23	3.38	6. 0	0.24	10.36	16.18		10.25
3	4.48	14. 9	12.12		3.24	3.16		2.13	3.49	5.55	0.43	10.54	16.18		10. 1
4	5.15	14.15	11.59		3. 6	3.22		2. 4	4.00	5.50	1. 2	11.13	16.17		9.37
5	5.42	14.20	11.46		2.48	3.28		1.53	4.11	5.45	1.22	11.31	16.16		9.12
6	6. 9	14.24	11.32		2.31	3.33		1.43	4.21	5.38	1.42	11.49	16.14		8.47
7	6.35	14.27	11.17		2.13	3.37		1.32	4.31	5.32	2. 2	12. 6	16.11		8.22
8	7. 1	14.30	11. 2		1.56	3.42		1.21	4.40	5.24	2.23	12.23	16. 7		7.55
9	7.26	14.31	10.47		1.39	3.45		1.10	4.50	5.16	2.43	12.39	16. 2		7.29
10	7.50	14.32	10.32		1.22	3.48		0.58	4.58	5. 8	3. 4	12.55	15.57		7. 2
11	8.14	14.33	10.16		1. 6	3.51		0.46	5. 7	4.59	3.25	13.11	15.50		6.34
12	8.38	14.32	9.59		0.50	3.52		0.34	5.14	4.49	3.45	13.26	15.43		6. 6
13	9. 0	14.31	9.43		0.34	3.54		0.22	5.22	4.39	4. 6	13.40	15.35		5.38
14	9.22	14.29	9.26		0.18	3.54		0.10	5.29	4.28	4.27	13.54	15.25		5. 9
15	9.44	14.26	9. 9		0. 3	3.54	ADD.	0. 3	5.35	4.17	4.50	14. 8	15.16		4.40
16	10. 5	14.22	8.51	SUB.	0.12	3.53		0.16	5.41	4. 5	5.10	14.21	15. 5		4.11
17	10.25	14.18	8.34		0.26	3.51		0.28	5.47	3.53	5.31	14.33	14.53		3.41
18	10.44	14.13	8.16		0.40	3.49		0.41	5.52	3.40	5.52	14.44	14.41		3.11
19	11. 2	14. 7	7.58		0.54	3.46		0.54	5.56	3.27	6.13	14.55	14.27		2.42
20	11.20	14. 1	7.40		1. 7	3.43		1. 7	6. 0	3.13	6.34	15 6	14.13		2.12
21	11.38	13.54	7.22		1.20	3 39		1.20	6. 4	2.59	6.55	15.15	13.58		1.42
22	11.54	13.46	7. 4		1.32	3.34		1.34	6. 7	2.44	7.16	15.25	13.42		1.12
23	12.10	13.38	6.45		1.44	3.29		1.47	6. 9	2.29	7 36	15.33	13.26		0.41
24	12.24	13.29	6.27		1.56	3.24		2. 0	6.11	2.14	7 57	15.41	13. 9		0.11
25	12.39	13.20	6. 8		2. 7	3.18		2.12	6.12	1.58	8.18	15.48	12.51	ADD.	0.19
26	12.52	13.10	5.50		2.17	3.11		2.25	6.12	1.41	8.38	15.54	12.32		0.49
27	13. 4	13. 0	5.32		2.27	3. 4		2.38	6.12	1.25	8.58	16. 0	12.12		1.18
28	13.16	12.49	5.13		2.36	2.57		2.50	6.12	1. 8	9.18	16. 4	11.52		1.48
29	13.27		4.55		2.45	2.49		3. 3	6.11	0.50	9.38	16. 9	11.31		2.17
30	13.37		4.36		2.54	2.41		3.15	6. 9	0.32	9.57	16.12	11.10		2.46
31	13.46		4.18						6. 6	0.14		16.15			3.15

TABLE XIV.

EQUATION OF TIME FOR APPARENT NOON AT GREENWICH, FOR THE YEAR 1855, AND WILL ANSWER NEARLY FOR 1859, 1863, AND 1867.

DAYS.	JAN.	FEB.	MAR.	APRIL.		MAY.	JUNE.		JULY.	AUG.	SEPT.	OCT.	NOV.	DECEMBER.	
	ADD	ADD	ADD			SUB.			ADD	ADD	SUB.	SUB.	SUB.		
	M. S.	M. S.	M. S.		M. S.	M. S.		M. S.	M. S.	M. S.	M. S.	M. S.	M. S.		M. S.
1	3.44	13.52	12.40	ADD.	4. 4	2.59	SUB.	2.34	3.23	6. 3	0. 0	10.12	16.15	SUB.	10.52
2	4.12	14. 0	12.28		3.46	3. 7		2.25	3.34	6. 0	0.19	10.31	16.17		10.30
3	4.40	14. 7	12.15		3.28	3.14		2.16	3.46	5.56	0.38	10.49	16.17		10. 6
4	5. 8	14.13	12. 2		3.11	3.20		2. 6	3.57	5.51	0.57	11. 8	16.17		9.42
5	5.35	14.18	11.49		2.53	3.26		1.56	4. 8	5.46	1.17	11.26	16.16		9.18
6	6. 2	14.23	11.35		2.35	3.31		1.46	4.18	5.40	1.37	11.44	16.14		8.53
7	6.28	14.26	11.21		2.18	3.36		1.35	4.28	5.33	1.57	12. 1	16.11		8.27
8	6.54	14.29	11. 6		2. 1	3.40		1.24	4.38	5.26	2.17	12.18	16. 7		8. 1
9	7.20	14.31	10.51		1.44	3.44		1.13	4.47	5.18	2.38	12.35	16. 3		7.35
10	7.44	14.32	10.36		1.27	3.47		1. 1	4.56	5.10	2.58	12.51	15.57		7. 8
11	8. 8	14.33	10.20		1.10	3.49		0.49	5. 4	5. 1	3.19	13. 6	15.51		6.40
12	8.32	14.32	10. 4		0.54	3.51		0.37	5.12	4.51	3.40	13.21	15.44		6.12
13	8.55	14.31	9.47		0.38	3.53		0.25	5.20	4.41	4. 1	13.36	15.36		5.44
14	9.17	14.29	9.30		0.23	3.54		0.13	5.27	4.30	4.22	13.50	15.27		5.16
15	9.38	14.26	9.13		0. 7	3.54		0. 0	5.33	4.19	4.43	14. 4	15.18		4.47
16	9.59	14.23	8.56	SUB.	0. 8	3.54	ADD.	0.12	5.39	4. 8	5. 4	14.17	15. 7		4.18
17	10.20	14.19	8.39		0.22	3.53		0.25	5.45	3.55	5.26	14.29	14.56		3.48
18	10.39	14.14	8.21		0.36	3.51		0.38	5.50	3.43	5.47	14.41	14.44		3.19
19	10.58	14. 9	8. 3		0.50	3.49		0.51	5.54	3.30	6. 8	14.52	14.30		2.49
20	11.16	14. 2	7.45		1. 4	3.47		1. 4	5.59	3.16	6.29	15. 3	14.17		2.19
21	11.33	13.56	7.27		1.16	3 44		1.17	6. 2	3. 2	6.50	15.13	14. 2		1.49
22	11.50	13.48	7. 8		1.29	3.40		1.30	6. 5	2.47	7.11	15.22	13.46		1.19
23	12. 5	13.40	6.50		1.41	3.36		1.43	6. 7	2.32	7.31	15.31	13.30		0.49
24	12.20	13.31	6.32		1.53	3.31		1.56	6. 9	2.17	7.52	15.39	13.13		0.19
25	12.35	13.22	6.13		2. 4	3.25		2. 8	6.11	2. 1	8.12	15.46	12.55	ADD.	0.11
26	12.48	13.12	5.55		2.14	3.20		2.21	6.11	1.45	8.33	15.52	12.36		0.41
27	13. 1	13. 2	5.36		2.24	3.13		2.34	6.12	1.28	8.53	15.58	12.17		1.11
28	13.13	12.51	5.18		2.34	3. 6		2.46	6.11	1.11	9.13	16. 3	11.57		1.41
29	13.24		4.59		2.43	2.59		2.59	6.10	0.54	9.33	16. 7	11.36		2.10
30	13.34		4.41		2.51	2.51		3.11	6. 8	0.36	9.52	16.11	11.14		2.40
31	13.43		4.23			2.43			6. 6	0.18		16.13			3. 9

EQUATION OF TIME FOR THE YEAR 1856, AND WHICH WILL ANSWER NEARLY FOR 1860, 1864, AND 1868.

DAYS.	JAN.	FEB.	MAR.	APRIL.		MAY.	JUNE.		JULY.	AUG.	SEPT.	OCT.	NOV.	DECEMBER.	
	ADD.	ADD	ADD			SUB.			ADD.	ADD.	SUB.	SUB.	SUB.		
	M. S.	M. S.	M. S.		M. S.	M. S.		M. S.	M. S.	M. S.	M. S.	M. S.	M. S.		M. S.
1	3·36	13·50	12·31	ADD.	3·51	3· 5	SUB.	2·28	3·31	6· 0	0·14	10·25	16·16	SUB.	10·36
2	4· 4	13·58	12·19		3·33	3·12		2·19	3·42	5·56	0·33	10·44	16·17		30·13
3	4·33	14· 5	12· 6		3·16	3·19		2· 9	3·53	5·52	0·52	11· 3	16·17		9·49
4	5· 0	14·11	11·53		2·58	3·25		1·59	4· 4	5·47	1·12	11·21	16·16		9·24
5	5·28	14·17	11·39		2·40	3·30		1·49	4·15	5·41	1·31	11·38	16·14		8·59
6	5·55	14·22	11·25		2·23	3·35		1·38	4·25	5·35	1·51	11·56	16·11		8·34
7	6·21	14·26	11·11		2· 6	3·39		1·27	4·35	5·28	2·11	12·13	16· 8		8· 8
8	6·47	14·29	10·56		1·49	3·43		1·16	4·44	5·20	2·32	12·30	16· 4		7·42
9	7·13	14·31	10·40		1·32	3·46		1· 4	4·53	5·12	2·52	12·46	15·58		7·15
10	7·38	14·33	10·25		1·15	3·49		0·53	5· 2	5· 3	3·13	13· 2	15·52		6·47
11	8· 2	14·33	10· 9		0·59	3·51		0·41	5·10	4·54	3·34	13·17	15·46		6·20
12	8·26	14·33	9·52		0·43	3·52		0·29	5·17	4·44	3·55	13·32	15·38		5·52
13	8·49	14·32	9·36		0·27	3·53		0·16	5·25	4·34	4·16	13·46	15·30		5·23
14	9·11	14·31	9·19		0·12	3·54		0· 4	5·31	4·23	4·37	14· 0	15·20		4·55
15	9·33	14·28	9· 2	SUB.	0· 3	3·54	ADD.	0· 9	5·38	4·11	4·58	14·13	15·10		4·26
16	9·54	14·25	8·44		0·18	3·53		0·21	5·43	3·59	5·19	14·26	14·59		3·56
17	10·15	14·21	8·26		0·32	3·52		0·34	5·48	3·46	5·41	14·38	14·47		3·27
18	10·34	14·16	8· 9		0·46	3·50		0·47	5·53	3·33	6· 2	14·49	14·34		2·57
19	10·53	14·11	7·51		0·59	3·47		1· 0	5·57	3·20	6·23	15· 0	14·21		2·37
20	11·12	14· 5	7·32		1·13	3·45		1·13	6· 1	3· 6	6·44	15·10	14· 6		1·57
21	11·29	13·58	7·14		1·25	3·41		1·26	6· 4	2·51	7· 5	15·20	13·51		1·27
22	11·46	13·51	6·56		1·38	3·37		1·39	6· 6	2·36	7·26	15·29	13·35		0·57
23	12· 2	13·43	6·37		1·49	3·32		1·52	6· 8	2·21	7·46	15·37	13·18		0·27
24	12·17	13·35	6·19		2· 1	3·27		2· 4	6·10	2· 5	8· 7	15·44	13· 0	ADD.	0. 3
25	12·31	13·25	6· 0		2·11	3·22		2·17	6·11	1·49	8·27	15·51	12·42		0·33
26	12·45	13·16	5·42		2·22	3·15		2·30	6·11	1·33	8·48	15·57	12·22		1· 3
27	12·58	13· 5	5·23		2·31	3· 9		2·42	6·11	1·16	9· 8	16· 2	12· 2		1·33
28	13·10	12·55	5· 5		2·41	3· 2		2·55	6·10	0·58	9·27	16 6	11·42		2· 2
29	13·21	14·43	4·46		2·49	2·54		3· 7	6· 8	0·41	9·47	16 10	11·20		2·32
30	13·31		4·28		2·57	2·46		3·19	6· 6	0·23	10· 6	16·13	10·58		3· 1
31	13·41		4·10			2·37			6. 4	0. 5		16·15			3·29

TABLE XIV.

EQUATION OF TIME FOR APPARENT NOON AT GREENWICH, FOR THE YEAR 1857, AND WILL ANSWER NEARLY FOR 1861, 1865, AND 1869.

DAYS.	JAN.	FEB.	MAR.	APRIL.		MAY.	JUNE.		JULY.	AUG.	SEPT.	OCT.	NOV.	DECEMBER.	
	ADD	ADD	ADD			SUB.			ADD	ADD	SUB.	SUB.	SUB.		
	M. S.	M. S.	M. S.		M. S.	M. S.		M. S.	M. S.	M. S.	M. S.	M. S.	M. S.		M. S.
1	3.58	13.56	12.35	ADD.	3.56	3. 3	SUB.	2.31	3.27	6. 1	0.10	10.21	16.16	SUB.	10.41
2	4.26	14. 4	12.22		3.38	3.11		2.22	3.39	5.57	0.29	10.39	16.17		10.18
3	4.54	14.10	12.10		3.20	3.17		2.13	3.50	5.52	0.48	10.58	16.17		9.54
4	5.21	14.16	11.56		3. 2	3.24		2. 3	4. 1	5.47	1. 7	11.16	16.16		9.30
5	5.48	14.20	11.43		2.44	3.29		1.53	4.11	5.42	1.27	11.34	16.14		9. 5
6	6.15	14.24	11.28		2.26	3.35		1.42	4.21	5.35	1.47	11.52	16.12		8.40
7	6.41	14.27	11.14		2. 9	3.39		1.31	4.31	5.28	2. 7	12. 9	16. 8		8.14
8	7. 6	14.30	10.59		1.52	3.43		1.20	4.40	5.21	2.28	12.26	16. 4		7.48
9	7.31	14.31	10.43		1.35	3.47		1. 9	4.49	5.13	2.48	12.42	15.59		7.21
10	7.55	14.32	10.28		1.18	3.50		0.57	4.58	5. 4	3. 9	12.58	15.53		6.53
11	8.19	14.32	10.12		1. 2	3.52		0.45	5. 6	4.55	3.29	13.13	15.47		6.26
12	8.42	14.31	9.55		0.46	3.54		0.33	5.14	4.46	3.50	13.28	15.39		5.58
13	9. 5	14.30	9.39		0.30	3.55		0.21	5.22	4.35	4.11	13.42	15.31		5.29
14	9.27	14.28	9.22		0.15	3.55		0. 8	5.28	4.25	4.32	13.56	15.21		5. 0
15	9.48	14.25	9. 5	SUB.	0. 1	3.55	ADD.	0. 4	5.35	4.13	4.53	14. 9	15.11		4.31
16	10. 9	14.21	8.47		0.15	3.54		0.17	5.41	4. 2	5.14	14.22	15. 0		4. 2
17	10.29	14.17	8.30		0.30	3.53		0.30	5.46	3.49	5.35	14.34	14.48		3.32
18	10.48	14.12	8.12		0.43	3.51		0.43	5.51	3.37	5.56	14.45	14.35		3. 3
19	11. 6	14. 6	7.54		0.57	3.49		0.56	5.56	3.23	6.17	14.56	14.22		2.33
20	11.24	14. 0	7.36		1.10	3.46		1. 9	6. 0	3.10	6.38	15. 6	14. 8		2. 3
21	11.41	13.53	7.18		1.23	3 42		1.22	6. 3	2.55	6.59	15.16	13.53		1.33
22	11.58	13.45	7. 0		1.35	3.38		1.35	6. 6	2.41	7.20	15.25	13.37		1. 3
23	12.13	13.37	6.42		. 47	3.34		1.48	6. 8	2.25	7.40	15.33	13.20		0.33
24	12.28	13.28	6.23		1.58	3.29		2. 1	6.10	2.10	8. 1	15.41	13. 3		0. 3
25	12.42	13.18	6. 5		2. 9	3.23		2.14	6.11	1.54	8.21	15.48	12.45	ADD.	0.27
26	12.55	13. 8	5.46		2.19	3.17		2.27	6.11	1.37	8.42	15.54	12.26		0.57
27	13. 7	12.58	5.28		2.29	3.10		2.39	6.11	1.20	9. 2	15.59	12. 6		1.26
28	13.19	12.46	5.10		2.38	3. 3		2.52	6.10	1. 3	9.22	16. 4	11.46		1.56
29	13.29		4.51		2.47	2.56		3. 4	6. 9	0.45	9.42	16. 8	11.25		2.25
30	13.39		4.33		2.55	2.48		3.16	6. 7	0.27	10. 1	16.11	11. 3		2.54
31	13.48		4.14			2.40			6. 4	0. 9		16.14			3.23

TABLE FOR CORRECTING THE EQUATION OF TIME TAKEN FROM THE ABOVE TABLE FOR LONGITUDE AND FOR TIME.

LONG.	DAILY CHANGE OF THE EQUATION.																TIME FROM NOON.
	0	S. 2	S. 4	S. 6	S. 8	S. 10	S. 12	S. 14	S. 16	S. 18	S. 20	S. 22	S. 24	S. 26	S. 28	S. 30	H. M.
0°	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 0
		S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	S.	
10	0	0·1	0·1	0·2	0·2	0·3	0·3	0·4	0·4	0·5	0·6	0·6	0·7	0·7	0·8	0·8	0.40
20	0	0·1	0·2	0·3	0·4	0·6	0·7	0·8	0·9	1·0	1·1	1·2	1.3	1·4	1·5	1·7	1·20
30	0	0·2	0·3	0·5	0·7	0·8	1·0	1·2	1·3	1·5	1·7	1·8	2·0	2·2	2·3	2·5	2· 0
40	0	0·2	0·4	0·7	0·9	1·1	1·3	1·6	1·8	2·0	2·2	2·4	2·7	2·9	3.1	3·3	2·40
50	0	0·3	0·6	0·8	1·1	1·4	1·7	1·9	2·2	2·5	2·8	3·1	3·3	3·6	3·9	4·2	3·20
60	0	0·3	0·7	1·0	1·3	1·7	2·0	2·3	2·7	3·0	3·3	3·7	4·0	4·3	4.7	5·0	4· 0
70	0	0·4	0·8	1·2	1·6	1·9	2·3	2·7	3·1	3·5	3·9	4·3	4·7	5·1	5·4	5·8	4·40
80	0	0·4	0·9	1·3	1·8	2·2	2·7	3·1	3·6	4 0	4·4	4·9	5·3	5·8	6·2	6·7	5·20
90	0	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5	5·0	5·5	6·0	6·5	7·0	7·4	6· 0
100	0	0·6	1·1	1·7	2·2	2·8	3·3	3·9	4·4	5·0	5·6	6·1	6·7	7·2	7·8	8·3	6·40
110	0	0·6	1·2	1·8	2·4	3·1	3·7	4·3	4·9	5·5	6·1	6·7	7·3	7·9	8·6	9·2	7·20
120	0	0·7	1·3	2·0	2·7	3·3	4·0	4·7	5·3	6·0	6·7	7·3	8·0	8·7	9.3	10·0	8· 0
130	0	0·7	1·4	2·2	2·9	3·6	4·3	5·1	5·8	6·5	7·2	7·9	8·7	9·4	10·1	10·8	8·40
140	0	0·8	1·6	2·3	3·1	3·9	4·7	5·4	6·2	7·0	7·8	8·6	9·3	10·1	10·9	11·7	9·20
150	0	0·8	1·7	2·5	3·3	4·2	5·0	5·8	6·7	7·5	8·2	9·2	10·0	10·8	11·7	12·5	10· 0
160	0	0·9	1·8	2·7	3·6	4·4	5·3	6·2	7·1	8·0	8·9	9·8	10·7	11·6	12·4	13·3	10·40
170	0	0·9	1·9	2·8	3·8	4·7	5·7	6·6	7·6	8·5	9·4	10.4	11·3	12·3	13·2	14·2	11·20
180	0	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0	13·0	14·0	15·0	12· 0

IN WEST LONGITUDE.	IN EAST LONGITUDE.
When the Equa. is { Increasing, Add. / Decreasing, Subtract.	When the Equa. is { Increasing, Subtract. / Decreasing, Add.
TIME BEFORE NOON.	**TIME AFTERNOON.**
When the Equa. is { Increasing, Subtract. / Decreasing, Add.	When the Equa. is { Increasing, Add. / Decreasing, Subtract.

TABLE XV.—Part First.

LOGARITHM OF THE SUN'S HOUR ANGLE, OR THE TIME FROM NOON EXTENDING TO 64′ 30″.

Minutes. Seconds.	Log.	Minutes. Seconds.	Log.	Minutes. Seconds.	Log.	Minutes. Seconds.	Log.	Minutes. Seconds.	Log.	Minutes. Seconds.	Log.
1.	4.677	7.40	6.446	14.20	6.990	21.	7.322	30. 20	7.641	45.	7.982
10	811	50	465	30	7.000	10	328	40	650	30	992
20	927	8.	483	40	010	20	335	31.	660	46.	8.001
30	5.030	10	501	50	019	30	342	20	669	30	010
40	121	20	519	15.	029	40	349	40	678	47.	020
50	204	30	536	10	039	50	355	32.	687	30	029
2.	279	40	553	20	048	22.	362	20	696	48.	038
10	349	50	569	30	058	10	368	40	705	30	047
20	414	9.	586	40	067	20	375	33.	714	49.	056
30	473	10	602	50	076	30	382	20	723	30	065
40	530	20	617	16.	085	40	388	40	731	50.	074
50	582	30	633	10	094	50	394	34.	740	30	082
3.	632	40	648	20	103	23.	400	20	748	51.	090
10	678	50	663	30	112	10	407	40	757	30	099
20	723	10.	677	40	121	20	413	35.	765	52.	107
30	766	10	692	50	130	30	419	20	773	30	116
40	806	20	706	17.	138	40	425	40	781	53.	124
50	845	30	720	10	147	50	431	36.	789	30	132
4.	881	40	734	20	155	24.	438	20	797	54.	140
10	917	50	747	30	163	10	444	40	805	30	148
20	951	11.	760	40	172	20	449	37.	813	55.	156
30	984	10	773	50	180	30	455	20	821	30	164
40	6.015	20	786	18.	188	40	461	40	829	56.	172
50	046	30	798	10	196	50	467	38.	836	30	179
5.	075	40	811	20	204	25.	473	20	844	57.	187
10	103	50	824	30	212	20	484	40	851	30	194
20	132	12.	836	40	219	40	496	39.	859	58.	202
30	158	10	848	50	227	26.	507	20	866	30	209
40	182	20	860	19.	235	20	518	40	873	59.	217
50	209	30	871	10	242	40	529	40.	881	30	224
6.	234	40	883	20	250	27.	540	20	888	60.	231
10	258	50	894	30	257	20	550	40	895	30	238
20	281	13.	905	40	264	40	561	41.	902	61.	246
30	303	10	916	50	272	28.	571	30	912	30	253
40	325	20	927	20.	279	20	582	42.	923	62.	259
50	347	30	938	10	286	40	592	30	933	30	267
7.	367	40	949	20	294	29.	602	43.	943	63.	274
10	388	50	959	30	301	20	612	30	953	30	280
20	408	14.	969	40	308	40	622	44.	963	64.	287
30	427	10	980	50	315	30.	631	30	973	30	294

TABLE XV.—Part Second.

LOGARITHMS OF THE LATITUDE AND DECLINATION WHEN THEY ARE OF THE SAME NAME.

	DECLINATION.													
Lat.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	Lat.
°														°
0						1.359	1.279	1.212	1.153	1.101	1.055	1.012	0.974	0
1							358	278	211	152	100	053	1.011	1
2								357	277	209	151	098	051	2
3									356	276	208	149	097	3
4										354	274	206	147	4
5	1.359										352	272	204	5
6	279	1.358										350	270	6
7	212	278	1.357										348	7
8	153	211	277	1.356										8
9	101	152	209	276	1.354									9
10	055	100	151	208	272	1.352								10
11	1.012	1.053	1.098	1.149	1.206	1.272	1.350							11
12	0.974	011	051	097	147	204	270	1.348						12
13	938	0.972	009	051	094	145	201	267	1.345					13
14	904	936	0.970	007	047	092	142	199	264	1.342				14
15	873	902	934	0.967	004	045	089	139	196	261	1.339			15
16	844	871	900	931	0.965	00.2	042	086	136	193	258	1.336		16
17	816	841	868	897	928	0.962	0.999	039	083	133	189	254	1.332	17
18	789	813	839	866	895	925	959	0.995	035	080	129	185	250	18
19	764	787	811	836	863	891	922	956	0.992	032	076	125	181	19
20	740	761	784	807	833	859	888	919	952	0.988	028	072	121	20
21	0.717	0.737	0.758	0.781	0.804	0.829	0.856	0.884	0.915	0.948	0.984	1.023	1.067	21
22	695	714	734	755	777	801	825	852	880	911	944	0.980	019	22
23	673	691	710	730	752	773	807	821	848	876	906	939	0.975	23
24	652	670	688	707	727	747	769	793	817	844	871	902	934	24
25	632	649	666	684	703	723	743	765	788	813	839	867	897	25
26	613	629	645	662	680	699	718	739	760	783	808	834	861	26
27	594	609	625	641	658	676	694	714	734	756	778	803	828	27
28	575	590	605	620	637	653	671	689	709	729	750	773	797	28
29	557	571	586	600	616	632	649	666	684	703	724	745	767	29
30	540	553	567	581	596	611	627	643	661	679	698	718	739	30
31	0.522	0.535	0.548	0.562	0.576	0.591	0.606	0.622	0.638	0.655	0.673	0.692	0.712	31
32	505	518	530	543	557	571	585	600	616	632	649	667	686	32
33	489	500	513	525	538	551	565	580	594	610	626	643	661	33
34	472	483	495	507	519	532	546	559	574	588	604	620	636	34
35	456	467	478	489	501	514	526	540	553	567	582	597	612	35
36	440	450	461	472	484	495	508	520	533	548	560	575	590	36
37	424	434	445	455	466	478	489	501	514	526	540	553	568	37
38	408	418	428	438	449	460	471	482	494	507	519	532	546	38
39	393	402	412	422	432	442	453	464	475	487	499	512	525	39
40	377	386	396	405	415	425	435	447	457	468	480	492	504	40
41	0.362	0.371	0.380	0.389	0.398	0.408	0.418	0.428	0.438	0.449	0.460	0.472	0.484	41
42	347	355	364	373	382	391	400	410	420	431	441	452	464	42
43	331	340	348	358	365	374	383	393	402	412	422	433	444	43
44	316	324	332	340	349	357	366	375	384	394	404	414	424	44
45	301	309	316	324	333	341	349	358	367	376	385	395	405	45
46	286	293	301	308	316	324	332	341	349	358	367	376	386	46
47	271	278	285	292	300	308	315	323	331	340	349	358	367	47
48	255	262	269	276	284	291	299	306	314	322	331	339	348	48
49	240	247	254	260	267	275	282	289	297	305	312	321	329	49
50	225	231	238	244	251	258	265	272	279	287	294	302	310	50
51	209	0.216	0.222	0.228	0.235	0.241	0.248	0.255	0.262	0.269	0.276	0.284	0.291	51
52	194	200	206	212	218	225	231	238	244	251	258	265	273	52
53	178	184	190	196	202	208	214	220	227	233	240	247	254	53
54	162	168	173	179	185	191	197	203	209	215	222	228	235	54
55	146	152	157	162	168	174	179	185	191	197	204	210	216	55
56	130	135	140	146	151	156	162	168	173	179	185	191	197	56
57	114	118	124	129	134	139	144	150	155	160	166	172	178	57
58	097	100	106	111	116	121	126	131	137	142	148	153	159	58
59	080	084	089	094	098	103	108	113	118	123	128	134	139	59
60	062	067	071	076	080	085	090	094	099	104	109	114	119	60

TABLE XV.—Part Second.

LOGARITHMS OF THE LATITUDE AND DECLINATION WHEN THEY ARE OF THE SAME NAME.

	DECLINATION.													
Lat.	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	Lat.
°														°
0	0.938	0.904	0.873	0.844	0.816	0.789	0.764	0.740	0.717	0.695	0.673	0.652	0.632	0
1	972	936	902	871	841	813	787	761	737	714	691	660	649	1
2	1.009	970	934	900	868	839	811	784	758	734	710	687	666	2
3	049	1.007	967	931	897	866	836	807	781	755	730	707	683	3
4	094	047	1.004	965	928	895	863	832	804	777	751	726	703	4
5	145	092	045	1.002	962	925	891	859	829	801	773	747	722	5
6	201	142	089	042	999	959	922	888	856	825	797	770	743	6
7	267	199	139	086	1.039	995	956	919	884	852	821	793	765	7
8	345	264	196	136	083	1.035	992	952	915	880	848	818	788	8
9		342	261	191	133	080	1.032	988	948	911	876	844	813	9
10			339	258	189	129	076	1.028	984	944	906	871	838	10
11				1.336	1.254	1.185	1.125	1.072	1.023	0.980	0.939	0.902	0.866	11
12					332	250	181	121	067	1.019	975	934	896	12
13						328	246	177	116	063	1.014	970	929	13
14							323	242	172	112	058	1.009	964	14
15								319	237	167	106	053	1.003	15
16									314	232	162	101	047	16
17										308	226	157	095	17
18	1.328										303	221	150	18
19	246	1.323										298	215	19
20	177	242	1.319										291	20
21	1.116	1.172	1.237	1.314										21
22	063	112	167	232	1.308									22
23	014	058	106	162	226	1.303								23
24	0.970	009	052	101	156	221	1.297							24
25	929	0.965	004	047	095	151	215	1.291						25
26	890	924	0.959	0.998	041	090	144	208	1.285					26
27	856	886	918	953	0.992	035	083	138	202	1.278				27
28	823	850	880	912	947	0.986	028	076	131	195	1.271			28
29	791	817	844	874	906	940	0.979	021	069	124	188	1.264		29
30	761	785	811	838	867	899	934	0.972	014	062	117	181	1.256	30
31	0.733	0.755	0.779	0.804	0.831	0.860	0.892	0.926	0.965	1.007	1.055	1.109	171	31
32	706	726	748	772	797	824	853	885	919	0.957	0.999	046	100	32
33	679	699	720	742	765	790	817	846	877	911	949	0.992	038	33
34	654	672	692	712	734	757	782	809	838	869	903	941	0.983	34
35	630	647	665	685	705	727	750	774	801	829	861	894	931	35
36	606	622	640	658	677	697	719	742	766	792	821	852	885	36
37	583	598	615	632	650	669	689	710	733	758	784	812	842	37
38	560	575	591	607	624	642	661	681	702	724	749	775	803	38
39	538	552	567	582	599	615	633	652	672	693	715	740	765	39
40	517	530	544	559	574	590	607	624	643	662	683	706	729	40
41	0.496	0.509	0.522	0.536	0.550	0.565	0.581	0.597	0.615	0.633	0.653	0.674	696	41
42	475	487	500	513	527	541	556	572	588	605	623	643	663	42
43	455	466	478	491	504	517	532	546	562	578	595	613	632	43
44	435	446	457	469	482	494	508	522	536	552	568	585	602	44
45	415	426	436	448	460	472	484	498	511	526	541	557	573	45
46	395	405	416	427	438	449	461	474	487	501	515	530	545	46
47	376	386	396	406	416	427	439	451	463	476	490	504	518	47
48	357	366	375	385	395	406	417	428	440	452	465	479	492	48
49	337	346	355	365	374	384	395	405	417	428	440	453	407	49
50	318	327	335	344	354	362	373	383	394	405	416	428	440	50
51	0.299	0.307	0.316	0.324	0.333	0.342	0.351	0.361	0.371	0.381	0.392	0.404	0.415	51
52	280	288	296	304	312	321	330	339	349	359	369	379	390	52
53	261	269	276	284	292	300	309	317	326	336	346	355	365	53
54	242	249	257	264	271	279	287	296	304	313	322	332	341	54
55	223	230	236	244	251	258	266	274	282	291	299	309	318	55
56	204	210	217	223	230	237	245	252	260	268	277	286	294	56
57	184	190	197	203	210	216	223	231	238	246	254	262	270	57
58	164	170	176	183	189	195	202	209	216	223	231	238	246	58
59	145	150	156	162	168	174	180	187	194	201	208	215	222	59
60	125	130	135	141	147	153	159	165	171	178	185	192	198	60

LOGARITHMS OF THE LATITUDE AND DECLINATION WHEN THEY ARE OF CONTRARY NAMES.

	DECLINATION.													
Lat.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	Lat.
°														°
0						1.359	1.279	1.212	1.153	1.101	1.055	1.012	0.979	0
1					1.360	280	213	154	102	056	014	0.975	931	1
2				1.360	281	213	155	103	057	015	0.976	941	907	2
3			1.360	281	213	155	104	058	016	0.977	942	909	878	3
4		1.360	280	213	155	104	058	016	0.978	943	910	879	850	4
5	1.359	280	213	155	104	058	016	0.978	943	910	880	851	824	5
6	279	213	155	104	058	016	0.979	943	911	880	852	825	799	6
7	219	154	103	058	016	0.978	943	911	881	851	825	800	776	7
8	153	102	057	016	0.978	943	911	881	852	825	800	776	753	8
9	101	056	015	0.977	943	910	880	852	825	800	776	754	732	9
10	055	014	0.976	942	910	880	852	825	800	776	754	732	711	10
11	1.012	0.975	0.941	0.909	0.879	0.851	0.825	0.800	0.776	0.754	0.732	0.711	0.692	11
12	0.974	939	907	878	850	824	799	775	753	732	711	692	673	12
13	938	906	876	849	823	798	775	752	731	711	691	672	654	13
14	904	875	847	822	797	774	751	730	710	691	672	654	636	14
15	873	846	820	795	772	750	729	709	690	671	653	636	619	15
16	844	818	794	772	749	728	708	689	670	653	635	619	603	16
17	816	792	769	747	726	706	687	669	651	634	617	602	586	17
18	789	767	745	724	705	686	668	650	633	617	601	586	571	18
19	764	743	722	703	684	666	648	632	615	600	584	570	555	19
20	740	720	700	682	664	646	630	614	598	583	568	554	540	20
21	0.717	0.698	0.679	0.661	0.644	0.628	0.612	0.596	0.581	0.567	0.553	0.539	0.525	21
22	695	676	659	642	625	609	594	579	565	551	537	524	511	22
23	673	656	639	623	607	592	577	563	549	535	522	509	497	23
24	652	636	621	604	589	575	560	547	533	520	508	495	483	24
25	632	616	601	586	572	558	544	531	518	505	493	481	469	25
26	613	598	583	569	555	541	528	515	503	491	479	467	456	26
27	594	579	565	551	538	525	512	500	488	476	465	454	442	27
28	575	561	548	535	522	509	497	485	473	462	451	440	429	28
29	557	544	531	518	506	494	482	470	459	448	437	427	416	29
30	540	527	514	502	490	478	467	456	445	434	425	414	403	30
31	0.522	0.510	0.498	0.486	0.474	0.463	0.452	0.442	0.431	0.421	0.411	0.401	0.391	31
32	505	493	482	470	459	448	438	427	417	407	397	388	378	32
33	489	477	466	455	444	434	423	413	403	394	384	375	366	33
34	472	461	450	440	429	419	409	399	390	380	371	362	353	34
35	456	445	435	424	414	405	395	386	376	367	358	349	341	35
36	440	429	419	410	400	390	381	372	363	354	345	337	328	36
37	424	414	404	395	385	376	367	358	350	341	333	324	316	37
38	408	399	389	380	371	362	353	345	336	328	320	312	304	38
39	393	384	374	365	357	348	340	331	323	315	307	299	291	39
40	377	368	360	351	342	334	326	318	310	302	294	287	279	40
41	0.362	0.353	0.345	0.336	0.328	0.320	0.312	0.304	0.297	0.289	0.282	0.274	0.267	41
42	347	338	330	322	314	306	299	291	284	276	269	262	255	42
43	331	323	315	308	300	292	285	278	270	263	256	249	242	43
44	316	308	301	293	286	279	271	264	257	250	243	237	230	44
45	301	294	286	279	272	265	258	251	244	237	231	224	217	45
46	286	279	271	264	257	251	244	237	231	224	218	211	205	46
47	271	264	257	250	243	237	230	224	217	211	205	198	192	47
48	255	249	242	235	229	223	216	210	204	198	191	185	179	48
49	240	234	227	221	215	208	202	196	190	184	178	172	167	49
50	225	219	212	206	200	194	188	182	176	171	165	159	154	50
51	0.209	0.203	0.197	0.191	0.185	0.180	0.174	0.168	0.163	0.157	0.151	0.145	0.140	51
52	194	188	182	175	171	165	160	154	149	143	138	132	127	52
53	178	172	167	161	156	150	145	140	134	129	124	119	114	53
54	162	157	151	146	141	136	130	125	120	115	110	105	100	54
55	146	141	136	131	125	120	115	110	105	101	096	091	086	55
56	130	125	120	115	110	105	100	095	091	086	081	077	072	56
57	114	109	104	099	094	090	085	080	076	071	066	062	057	57
58	097	092	087	083	078	074	069	065	060	056	051	047	043	58
59	080	075	071	066	062	058	053	049	045	040	036	032	028	59
60	062	058	054	050	045	041	037	033	029	024	020	016	012	60

LOGARITHMS OF THE LATITUDE AND DECLINATION WHEN THEY ARE OF CONTRARY NAMES.

	DECLINATION.													
Lat.	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°	25°	Lat.
°														°
0	0.938	0.904	0.873	0.844	0.816	0.789	0.764	0.740	0.717	0.695	0.673	0.653	0.632	0
1	906	875	846	818	792	767	743	720	698	676	656	636	616	1
2	876	847	820	794	769	745	722	700	679	659	639	620	604	2
3	849	821	795	771	747	724	703	682	661	642	623	604	586	3
4	823	797	772	749	726	705	684	664	644	625	607	589	571	4
5	798	774	750	728	706	686	666	646	628	609	592	574	557	5
6	775	751	729	708	687	668	648	630	612	594	577	561	544	6
7	752	730	709	689	669	650	632	614	596	579	563	547	531	7
8	731	710	690	670	651	633	615	598	581	565	549	534	518	8
9	711	691	671	653	634	617	600	583	567	551	535	521	505	9
10	691	672	653	635	618	601	584	568	553	537	522	508	493	10
11	0.672	0.654	0.636	0.619	0.602	0.586	0.570	0.554	0.539	0.524	0.509	0.495	0.481	11
12	654	636	619	603	586	571	555	540	525	511	497	483	469	12
13	637	620	603	587	571	556	541	527	512	498	485	471	457	13
14	620	603	587	572	557	542	527	513	499	486	473	460	446	14
15	602	587	572	557	542	528	514	500	487	474	461	449	435	15
16	587	572	557	542	528	515	501	488	475	462	449	438	424	16
17	571	557	542	528	515	501	488	475	463	450	438	427	413	17
18	556	542	528	515	501	488	475	463	451	438	426	416	402	18
19	541	527	514	501	488	475	463	451	439	427	415	405	392	19
20	527	513	500	488	475	463	451	439	427	416	404	394	382	20
21	0.512	0.499	0.487	0.475	0.462	0.451	0.439	0.427	0.416	0.405	0.393	0.383	0.372	21
22	498	486	474	462	450	438	427	416	405	394	383	372	362	22
23	485	472	461	449	438	426	415	404	393	383	372	361	352	23
24	471	459	448	437	425	414	404	393	382	372	362	351	342	24
25	458	446	435	424	413	403	392	382	372	361	351	341	332	25
26	445	434	423	412	402	391	381	371	361	351	341	331	322	26
27	432	421	410	400	390	380	370	360	350	340	331	321	312	27
28	419	408	398	388	378	368	358	349	339	330	320	311	302	28
29	406	396	386	376	367	357	347	338	329	320	310	302	292	29
30	394	384	374	364	355	346	336	327	318	309	300	293	283	30
31	0.381	0.372	0.362	0.353	0.344	0.335	0.326	0.317	0.308	0.299	0.290	0.282	0.273	31
32	369	359	350	341	332	323	315	306	297	289	280	272	263	32
33	356	347	338	330	321	312	304	295	287	278	270	262	253	33
34	344	335	327	318	310	301	293	285	276	268	260	252	243	34
35	332	324	315	307	298	290	282	275	266	258	250	242	233	35
36	320	312	303	295	287	279	271	263	256	248	240	232	224	36
37	308	300	292	284	276	268	260	253	245	237	230	222	214	37
38	296	288	280	272	265	257	250	242	235	227	220	212	204	38
39	284	276	269	261	254	246	239	231	224	217	210	202	194	39
40	272	264	257	250	242	235	228	221	214	207	199	192	185	40
41	0.260	0.252	0.245	0.238	0.231	0.224	0.217	0.210	0.203	0.196	0.188	0.182	0.175	41
42	247	240	233	227	220	213	206	199	192	186	178	172	165	42
43	235	228	222	215	208	202	195	188	182	175	168	162	155	43
44	223	216	210	203	197	190	184	177	171	164	158	152	145	44
45	211	204	198	192	185	179	173	166	160	154	147	142	135	45
46	198	192	186	180	174	167	161	155	149	143	136	132	125	46
47	186	180	174	168	162	156	150	144	138	132	126	121	114	47
48	173	168	162	156	150	144	138	132	127	121	115	110	103	48
49	161	155	149	144	138	132	126	121	115	109	104	099	092	49
50	148	142	137	131	126	120	115	109	104	098	093	087	081	50
51	0.135	0.130	0.124	0.119	0.113	0.108	0.103	0.097	0.092	0.086	0.081.	0.076	0.070	51
52	122	117	111	106	101	096	090	085	080	075	069	064	058	52
53	108	103	098	093	088	083	078	073	068	063	058	052	047	53
54	095	090	085	080	075	070	065	060	055	051	046	041	035	54
55	081	076	072	067	062	057	052	048	043	038	033	029	024	55
56	067	063	058	053	049	044	039	035	030	025	021	017	011	56
57	053	048	044	039	035	030	026	021	017	012	008	004	9.998	57
58	038	034	030	025	021	017	013	008	003	9.999	9.995	9.990	985	58
59	023	019	015	011	007	002	9.998	9.994	9.990	985	981	977	972	59
60	008	004	000	9.996	9.992	9.988	984	980	976	971	967	963	959	60

TABLE XV.

PART FOURTH.

CONTAINING THE SUM OF THE TWO LOGS AND THE CORRECTION FOR ALTITUDE.

Correction for Altitude.	Sum of the two Logs.	Correction for Altitude.	Sum of the two Logs.	Correction for Altitude.	Sum of the two Logs.
° ′		° ′		° ′	
0. 1	6.464	0.51	8.171	1.41	8.468
2	765	52	180	1.42	472
3	941	53	189	1.43	476
4	7.066	54	196	1.44	481
5	163	55	204	1.45	485
6	242	56	212	1.46	489
7	309	57	220	1.47	493
8	367	58	227	1.48	497
9	418	59	235	1.49	501
10	464	1. 0	242	1.50	505
11	505	1. 1	249	1.51	509
12	543	1. 2	256	1.52	513
13	578	1. 3	263	1.53	516
14	610	1. 4	270	1.54	521
15	640	1. 5	277	1.55	524
16	668	1. 6	283	1.56	528
17	694	1. 7	290	1.57	532
18	719	1. 8	296	1.58	536
19	742	1. 9	303	1.59	539
20	765	1.10	309	2. 0	543
21	786	1.11	315	2. 1	546
22	806	1.12	321	2. 2	549
23	825	1.13	327	2. 3	553
24	844	1.14	333	2. 4	557
25	862	1.15	339	2. 5	560
26	879	1.16	345	2. 6	564
27	895	1.17	350	2. 7	567
28	911	1.18	356	2. 8	571
29	926	1.19	361	2. 9	574
30	941	1.20	367	2.10	578
31	955	1.21	372	2.11	581
32	969	1.22	377	2.12	584
33	982	1.23	383	2.13	587
34	995	1.24	389	2.14	591
35	8.008	1.25	393	2.15	594
36	020	1.26	398	2.16	597
37	032	1.27	403	2.17	600
38	044	1.28	408	2.18	603
39	054	1.29	413	2.19	606
40	066	1.30	419	2.20	610
41	077	1.31	423	2.21	613
42	087	1.32	427	2.22	616
43	097	1.33	432	2.23	619
44	107	1.34	437	2.24	622
45	117	1.35	441	2.25	625
46	126	1.36	446	2.26	628
47	136	1.37	450	2.27	631
48	145	1.38	455	2.28	634
49	154	1.39	459	2.29	637
50	163	1.40	464	2.30	640

PART FIFTH.

CONTAINING THE LIMITS OF THE TIME FROM NOON AT WHICH THE OBSERVATION SHOULD BE MADE.

DEC. OF THE SAME NAME AS THE LATITUDE.

Lat	0°	5°	10°	15°	20°	24°
°	h m	h m	h m	h m	h m	h m
0	0. 0	0. 4	0. 6	0. 9	0.12	0.15
5	3	1	4	6	9	12
10	6	4	1	5	7	10
15	9	7	4	2	4	8
20	12	10	7	5	2	5
25	16	13	10	8	5	2
30	19	16	13	12	9	6
35	24	21	18	15	13	10
40	28	25	22	20	17	15
44	32	29	26	24	21	20
48	36	33	30	30	27	25
52	44	41	36	36	34	32
56	55	47	44	42	38	36
60	58	54	52	50	47	44

DECLINATION OF THE CONTRARY NAME TO THE LATITUDE.

Lat	0°	5°	10°	15°	20°	24°
	h m	h m	h m	h m	h m	h m
0	0. 0	0. 4	0. 7	0.10	0.13	0.16
5	3	7	9	13	16	18
10	7	10	13	17	19	21
15	10	13	17	20	21	24
20	13	16	19	23	25	28
25	18	20	23	26	28	31
30	21	23	26	30	32	35
35	25	27	30	34	36	39
40	30	32	33	38	40	43
44	34	37	38	43	46	48
48	38	42	45	48	51	53
52	44	48	52	55	58	1. 0
56	50	54	57	1. 0	1. 3	1. 5
60	58	57	1. 4	1. 6	1. 9	1.12

TABLE XVI.

APPARENT TIME OF THE SUN'S RISING AND SETTING.

Latitude.	DECLINATION OF THE SAME NAME AS THE LATITUDE.													
	0°		2°		4°		6°		8°		9°		10°	
	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
0	6.0	6.0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0
2	6.0	6.0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	5.59	6. 1	5.59	6. 1	5.59	6. 1
4	6.0	6.0	6. 0	6. 0	5.59	6. 1	5.59	6. 1	5.58	6. 2	5.58	6. 2	5.57	6. 3
6	6.0	6.0	6. 0	6. 0	5.58	6. 2	5.58	6. 2	5.57	6. 3	5.57	6. 3	5.56	6. 4
8	6.0	6.0	5.59	6. 1	5.58	6. 2	5.57	6. 3	5.56	6. 4	5.55	6. 5	5.55	6. 5
10	6.0	6.0	5.59	6. 1	5.57	6. 3	5.56	6. 4	5.54	6. 6	5.54	6. 6	5.53	6. 7
12	6.0	6.0	5.58	6. 2	5.57	6. 3	5.55	6. 5	5.53	6. 7	5.53	6. 7	5.52	6. 8
14	6.0	6.0	5.58	6. 2	5.56	6. 4	5.54	6. 6	5.52	6. 8	5.51	6. 9	5.51	6. 9
16	6.0	6.0	5.58	6. 2	5.55	6. 5	5.53	6. 7	5.51	6. 9	5.50	6.10	5.48	6.12
18	6.0	6.0	5.58	6. 2	5.55	6. 5	5.52	6. 8	5.50	6.10	5.48	6.12	5.47	6.13
20	6.0	6.0	5.57	6. 3	5.54	6. 6	5.51	6. 9	5.48	6.12	5.47	6.13	5.45	6.13
21	6.0	6.0	5.57	6. 3	5.54	6. 6	5.51	6. 9	5.48	6.12	5.46	6.14	5.44	6.16
22	6.0	6.0	5.57	6. 3	5.54	6. 6	5.50	6.10	5.47	6.13	5.45	6.15	5.44	6.16
23	6.0	6.0	5.57	6. 3	5.53	6. 7	5.50	6.10	5.46	6.14	5.44	6.16	5.43	6.17
24	6.0	6.0	5.57	6. 3	5.53	6. 7	5.49	6.11	5.46	6.14	5.43	6.17	5.42	6.18
25	6.0	6.0	5.56	6. 4	5.53	6. 7	5.49	6.11	5.45	6.15	5.42	6.18	5.41	6.19
26	6.0	6.0	5.56	6. 4	5.52	6. 8	5.48	6.12	5.44	6.16	5.41	6.19	5.40	6.20
27	6.0	6.0	5.56	6. 4	5.52	6. 8	5.48	6.12	5.44	6.16	5.41	6.19	5.39	6.21
28	6.0	6.0	5.56	6. 4	5.51	6. 9	5.47	6.13	5.43	6.17	5.40	6.20	5.38	6.22
29	6.0	6.0	5.56	6. 4	5.51	6. 9	5.47	6.13	5.42	6.18	5.39	6.21	5.38	6.22
30	6.0	6.0	5.55	6. 5	5.51	6. 9	5.46	6.14	5.41	6.19	5.38	6.22	5.37	6.23
31	6.0	6.0	5.55	6. 5	5.50	6.10	5.46	6.14	5.41	6.19	5.37	6.23	5.36	6.24
32	6.0	6.0	5.55	6. 5	5.50	6.10	5.45	6.15	5.40	6.20	5.36	6.24	5.35	6.25
33	6.0	6.0	5.55	6. 5	5.50	6.10	5.44	6.16	5.39	6.21	5.35	6.25	5.34	6.26
34	6.0	6.0	5.55	6. 5	5.49	6.11	5.44	6.16	5.38	6.22	5.35	6.25	5.33	6.27
35	6.0	6.0	5.55	6. 5	5.49	6.11	5.43	6.17	5.37	6.23	5.34	6.26	5.32	6.28
36	6.0	6.0	5.55	6. 5	5.48	6.12	5.42	6.18	5.37	6.23	5.33	6.27	5.31	6.29
37	6.0	6.0	5.55	6. 5	5.48	6.12	5.42	6.18	5.36	6.24	5.32	6.28	5.29	6.31
38	6.0	6.0	5.55	6. 5	5.47	6.13	5.41	6.19	5.35	6.25	5.31	6.29	5.28	6.32
39	6.0	6.0	5.55	6. 5	5.47	6.13	5.40	6.20	5.34	6.26	5.29	6.31	5.27	6.33
40	6.0	6.0	5.54	6. 6	5.47	6.13	5.40	6.20	5.33	6.27	5.28	6.32	5.26	6.34
41	6.0	6.0	5.54	6. 6	5.46	6.14	5.39	6.21	5.32	6.28	5.27	6.33	5.25	6.35
42	6.0	6.0	5.54	6. 6	5.46	6.14	5.38	6.22	5.31	6.29	5.26	6.34	5.23	6.37
43	6.0	6.0	5.53	6. 7	5.45	6.15	5.38	6.22	5.30	6.30	5.25	6.35	5.22	6.38
44	6.0	6.0	5.53	6. 7	5.45	6.15	5.37	6.23	5.29	6.31	5.24	6.36	5.21	6.39
45	6.0	6.0	5.52	6. 8	5.44	6.16	5.36	6.24	5.28	6.32	5.22	6.38	5.19	6.41
46	6.0	6.0	5.52	6. 8	5.43	6.17	5.35	6.25	5.27	6.33	5.21	6.39	5.18	6.42
47	6.0	6.0	5.51	6. 9	5.43	6.17	5.34	6.26	5.25	6.35	5.19	6.41	5.16	6.44
48	6.0	6.0	5.51	6. 9	5.42	6.18	5.33	6.27	5.24	6.36	5.18	6.42	5.15	6.45
49	6.0	6.0	5.51	6. 9	5.42	6.18	5.32	6.28	5.23	6.37	5.16	6.44	5.13	6.47
50	6.0	6.0	5.50	6.10	5.41	6.19	5.31	6.29	5.21	6.39	5.15	6.45	5.11	6.49
51	6.0	6.0	5.50	6.10	5.40	6.20	5.30	6.30	5.20	6.40	5.13	6.47	5.10	6.50
52	6.0	6.0	5.50	6.10	5.39	6.21	5.29	6.31	5.19	6.41	5.11	6.49	5. 8	6.52
53	6.0	6.0	5.49	6.11	5.39	6.21	5.28	6.32	5.17	6.43	5.10	6.50	5. 6	6.54
54	6.0	6.0	5.49	6.11	5.38	6.22	5.27	6.33	5.15	6.45	5. 8	6.52	5. 4	6.56
55	6.0	6.0	5.49	6.11	5.37	6.23	5.25	6.35	5.14	6.46	5. 6	6.54	5. 2	6.58
56	6.0	6.0	5.48	6.12	5.36	6.24	5.24	6.36	5.12	6.48	5. 5	6.55	4.59	7. 1
57	6.0	6.0	5.48	6.12	5.35	6.25	5.23	6.37	5.10	6.50	5. 4	6.56	4.57	7. 3
58	6.0	6.0	5.47	6.13	5.34	6.26	5.21	6.39	5. 8	6.52	5. 0	6.58	4.54	7. 6
59	6.0	6.0	5.47	6.13	5.33	6.27	5.20	6.40	5. 6	6.54	4.59	7. 1	4.52	7. 8
60	6.0	6.0	5.46	6.14	5.32	6.28	5.18	6.40	5. 4	6.56	4.56	7. 4	4.49	7.11
61	6.0	6.0	5.46	6.14	5.31	6.29	5.16	6.44	5. 1	6.59	4.54	7. 6	4.46	7.14
62	6.0	6.0	5.45	6.15	5.30	6.30	5.14	6.46	4.59	7. 1	4.51	7. 9	4.43	7.17
63	6.0	6.0	5.44	6.16	5.28	6.32	5.12	6.48	4.56	7. 4	4.48	7.12	4.39	7.21
64	6.0	6.0	5.44	6.16	5.27	6.33	5.10	6.50	4.53	7. 7	4.44	7.16	4.35	7.25
65	6.0	6.0	5.43	6.17	5.26	6.34	5. 8	6.52	4.50	7.10	4.41	7.19	4.31	7.29
66	6.0	6.0	5.42	6.18	5.24	6.35	5. 5	6.54	4.47	7.13	4.37	7.23	4.27	7.33
66½	6.0	6.0	5.42	6.18	5.23	6.36	5. 4	6.56	4.44	7.16	4.34	7.26	4.24	7.36
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.
	LATITUDE AND DECLINATION OF CONTRARY NAMES.													

TABLE XVI.

APPARENT TIME OF THE SUN'S RISING AND SETTING.

Latitude.	DECLINATION OF THE SAME NAME AS THE LATITUDE.													
	11°		12°		13°		14°		15°		16°		17°	
	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.
°	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0
2	5.59	6. 1	5.58	6. 2	5.58	6. 2	5.58	6. 2	5.58	6. 2	5.58	6. 2	5.58	6. 2
4	5.57	6. 3	5.57	6. 3	5.56	6. 4	5.56	6. 4	5.56	6. 4	5.56	6. 4	5.55	6. 5
6	5.56	6. 4	5.55	6. 5	5.55	6. 5	5.54	6. 6	5.54	6. 6	5.53	6. 7	5.53	6. 7
8	5.54	6. 6	5.53	6. 7	5.53	6. 7	5.52	6. 8	5.51	6. 9	5.51	6. 9	5.50	6.10
10	5.52	6. 8	5.52	6. 8	5.51	6. 9	5.50	6.10	5.49	6.11	5.49	6.12	5.48	6.12
12	5.51	6. 9	5.50	6.10	5.49	6.11	5.48	6.12	5.47	6.13	5.46	6.14	5.45	6.15
14	5.50	6.10	5.48	6.12	5.48	6.12	5.46	6.14	5.45	6.15	5.44	6.16	5.43	6.17
16	5.47	6.13	5.46	6.14	5.45	6.15	5.44	6.16	5.42	6.18	5.41	6.19	5.40	6.20
18	5.46	6.14	5.44	6.16	5.43	6.17	5.41	6.19	5.40	6.20	5.39	6.21	5.37	6.23
20	5.44	6.16	5.42	6.18	5.41	6.19	5.39	6.21	5.38	6.22	5.36	6.24	5.34	6.26
21	5.43	6.17	5.41	6.19	5.40	6.20	5.38	6.22	5.36	6.24	5.35	6.25	5.33	6.27
22	5.42	6.18	5.40	6.20	5.39	6.21	5.37	6.23	5.35	6.25	5.33	6.27	5.32	6.28
23	5.41	6.19	5.39	6.21	5.38	6.22	5.36	6.24	5.34	6.26	5.32	6.28	5.30	6.30
24	5.40	6.20	5.38	6.22	5.36	6.24	5.34	6.26	5.33	6.27	5.31	6.29	5.29	6.31
25	5.39	6.21	5.37	6.23	5.35	6.25	5.33	6.27	5.31	6.29	5.29	6.31	5.27	6.33
26	5.38	6.22	5.36	6.24	5.34	6.26	5.32	6.28	5.30	6.30	5.28	6.32	5.26	6.34
27	5.37	6.23	5.35	6.25	5.33	6.27	5.31	6.29	5.29	6.31	5.26	6.34	5.24	6.36
28	5.36	6.24	5.34	6.26	5.32	6.28	5.30	6.30	5.27	6.33	5.25	6.35	5.23	6.37
29	5.35	6.25	5.33	6.27	5.31	6.29	5.28	6.32	5.26	6.34	5.23	6.37	5.21	6.39
30	5.34	6.26	5.32	6.28	5.29	6.31	5.27	6.33	5.24	6.36	5.22	6.38	5.19	6.41
31	5.33	6.27	5.31	6.29	5.28	6.32	5.26	6.34	5.23	6.37	5.20	6.40	5.18	6.42
32	5.32	6.28	5.29	6.31	5.27	6.34	5.24	6.36	5.21	6.39	5.19	6.41	5.16	6.44
33	5.31	6.29	5.28	6.32	5.24	6.36	5.23	6.37	5.20	6.40	5.17	6.43	5.14	6.46
34	5.30	6.30	5.27	6.33	5.23	6.37	5.21	6.39	5.18	6.42	5.15	6.45	5.12	6.48
35	5.29	6.31	5.26	6.34	5.21	6.39	5.20	6.40	5.17	6.43	5.14	6.46	5.11	6.49
36	5.28	6.32	5.24	6.36	5.20	6.40	5.18	6.42	5.15	6.45	5.12	6.48	5. 9	6.51
37	5.26	6.34	5.25	6.37	5.18	6.42	5.17	6.43	5.13	6.47	5.10	6.50	5. 7	6.53
38	5.25	6.35	5.22	6.38	5.17	6.43	5.15	6.45	5.12	6.48	5. 8	6.52	5 5	6.55
39	5.24	6.36	5.20	6.40	5.15	6.45	5.13	6.47	5.10	6.50	5. 6	6.54	5, 3	6.57
40	5.22	6.38	5.19	6.41	5.14	6.46	5.12	6.48	5. 8	6.52	5. 4	6.56	5. 1	6.59
41	5.21	6.39	5.17	6.43	5.12	6.48	5.10	6.50	5. 6	6.54	5. 2	6.58	4.48	7. 2
42	5.20	6.40	5.16	6.44	5.10	6.50	5. 8	6.52	5. 4	6.56	5. 0	7. 0	4.56	7. 4
43	5.18	6.42	5.14	6.46	5. 8	6.52	5. 6	6.54	5. 2	6.58	4.48	7. 2	4.54	7. 6
44	5.17	6.43	5.13	6.47	5. 7	6.53	5. 4	6.56	5. 0	7. 0	4.56	7. 4	4.51	7. 9
45	5.15	6.45	5.11	6.49	5. 5	6.55	5. 2	6.58	4.58	7. 2	4.53	7. 7	4.49	7.11
46	5.14	6.46	5. 9	6.51	5. 4	6.56	5. 0	7. 0	4.56	7. 4	4.51	7. 9	4.46	7.14
47	5.12	6.48	5. 7	6.53	5. 3	6.57	4.58	7. 2	4.53	7. 7	4.48	7.12	4.43	7.17
48	5.10	6.50	5. 5	6.55	5. 1	6.59	4.56	7. 4	4.51	7. 9	4.46	7.14	4.41	7.19
49	5. 8	6.52	5. 3	6.57	4.58	7. 2	4.53	7. 7	4.48	7.12	4.43	7.17	4.38	7.22
50	5. 6	6.54	5. 1	6.59	4.56	7. 4	4.51	7. 9	4.46	7.14	4.40	7.20	4.35	7.25
51	5. 4	6.56	4.59	7. 1	4.54	7. 6	4.58	7.12	4.43	7.17	4.37	7.23	4.31	7.29
52	5. 2	6.58	4.57	7. 3	4.51	7. 9	4.46	7.14	4.40	7.20	4.34	7.26	4.28	7.32
53	5. 0	7. 0	4.54	7. 6	4.49	7.11	4.43	7.17	4.37	7.23	4.31	7.29	4.24	7.36
54	4.58	7. 2	4.52	7. 8	4.46	7.14	4.40	7.20	4.33	7.27	4.27	7.33	4.20	7.40
55	4.56	7. 4	4.49	7.11	4.43	7.17	4.37	7.23	4.30	7.30	4.23	7.37	4.16	7.44
56	4.53	7. 7	4.47	7.13	4.40	7.20	4.33	7.27	4.26	7.34	4.19	7.41	4.12	7.48
57	4.50	7.10	4.44	7.16	4.37	7.23	4.30	7.30	4.23	7.37	4.15	7.45	4. 8	7.52
58	4.47	7.13	4.40	7.20	4.33	7.27	4.26	7.34	4.18	7.42	4.11	7.49	4. 3	7.57
59	4.44	7.16	4.37	7.23	4.30	7.30	4.22	7.38	4.14	7.46	4. 6	7.54	3.58	8. 2
60	4.41	7.19	4.34	7.26	4.26	7.34	4.18	7.42	4. 9	7.51	4. 1	7.59	3.52	8. 8
61	4.38	7.22	4.30	7.30	4.22	7.38	4.13	7.47	4. 4	7.56	3.55	8. 5	3.46	8.14
62	4.34	7.26	4.26	7.34	4.17	7.43	4. 8	7.52	3.59	8. 1	3.49	8.11	3.40	8.20
63	4.30	7.30	4.21	7.39	4.12	7.48	4. 3	7.57	3.53	8. 7	3.43	8.17	3.33	8.27
64	4.26	7.34	4.17	7.43	4. 7	7.53	3.57	8. 3	3.47	8.13	3.36	8.24	3.25	8.35
65	4.21	7.39	4.12	7.48	4. 1	7.59	3.51	8. 9	3.40	8.20	3.28	8.32	3.16	8.44
66	4.18	7.42	4. 6	7.54	3.55	8. 5	3.44	8.16	3.32	8.28	3.20	8.40	3. 7	8.53
66½	4.14	7.46	4. 3	7.57	3.52	8. 8	3.40	8.20	3.28	8.32	3.15	8.45	3. 1	8.59
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.
	LATITUDE AND DECLINATION OF CONTRARY NAMES.													

TABLE XVI.

APPARENT TIME OF THE SUN'S RISING AND SETTING.

Latitude.	DECLINATION OF THE SAME NAME AS THE LATITUDE.													
	18°		19°		20°		21°		22°		23°		23½°	
	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.
°	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0	6. 0
2	5.58	6. 2	5.58	6. 2	5.58	6. 2	5.57	6. 3	5.57	6. 3	5.57	6. 3	5.57	6. 3
4	5.55	6. 5	5.55	6. 5	5.55	6. 5	5.54	6. 6	5.54	6. 6	5.53	6. 7	5.53	6. 7
6	5.52	6. 8	5.52	6. 8	5.52	6. 8	5.51	6. 9	5.51	6. 9	5.50	6.10	5.50	6.10
8	5.50	6.10	5.49	6.11	5.49	6.12	5.48	6.12	5.47	6.12	5.47	6.13	5.46	6.14
10	5.47	6.13	5.46	6.14	5.46	6.15	5.45	6.16	5.44	6.16	5.43	6.17	5.43	6.17
12	5.44	6.16	5.44	6.17	5.43	6.18	5.42	6.19	5.41	6.20	5.40	6.20	5.39	6.21
14	5.41	6.19	5.40	6.20	5.39	6.21	5.38	6.22	5.37	6.23	5.36	6.24	5.35	6.25
16	5.39	6.21	5.37	6.23	5.36	6.24	5.35	6.25	5.33	6.27	5.32	6.28	5.31	6.29
18	5.36	6.24	5.34	6.26	5.33	6.27	5.31	6.29	5.30	6.30	5.28	6.32	5.28	6.32
20	5.33	6.27	5.31	6.29	5.30	6.30	5.28	6.32	5.26	6.34	5.24	6.36	5.24	6.36
21	5.31	6.29	5.30	6.30	5.28	6.32	5.26	6.34	5.24	6.36	5.22	6.38	5.22	6.38
22	5.30	6.30	5.28	6.32	5.26	6.34	5.24	6.36	5.22	6.38	5.21	6.39	5.20	6.40
23	5.28	6.32	5.26	6.34	5.24	6.36	5.22	6.38	5.21	6.39	5.19	6.41	5.18	6.42
24	5.27	6.33	5.25	6.35	5.23	6.37	5.21	6.39	5.19	6.41	5.16	6.44	5.15	6.45
25	5.25	6.35	5.23	6.37	5.21	6.39	5.19	6.41	5.17	6.43	5.14	6.46	5.13	6.47
26	5.24	6.36	5.21	6.39	5.19	6.41	5.17	6.43	5.15	6.45	5.12	6.48	5.11	6.49
27	5.22	6.38	5.20	6.40	5.17	6.43	5.15	6.45	5.12	6.48	5.10	6.50	5. 9	6.51
28	5.20	6.40	5.18	6.42	5.15	6.45	5.13	6.47	5.10	6.50	5. 8	6.52	5. 7	6.53
29	5.18	6.42	5.16	6.44	5.13	6.47	5.11	6.49	5. 8	6.52	5. 6	6.54	5. 4	6.56
30	5.17	6.43	5.14	6.46	5.11	6.49	5. 9	6.51	5. 6	6.54	5. 3	6.57	5. 2	6.58
31	5.15	6.45	5.12	6.48	5. 9	6.51	5. 7	6.53	5. 4	6.56	5. 1	6.59	5. 0	7. 0
32	5.13	6.47	5.10	6.50	5. 7	6.53	5. 4	6.56	5. 2	6.58	4.59	7. 1	4.57	7. 3
33	5.11	6.49	5. 8	6.52	5. 5	6.55	5. 2	6.58	4.59	7. 1	4.56	7. 4	4.55	7. 5
34	5. 9	6.51	5. 6	6.54	5. 3	6.57	5. 0	7. 0	4.57	7. 3	4.53	7. 7	4.52	7. 8
35	5. 7	6.53	5. 4	6.56	5. 1	6.59	4.58	7. 2	4.54	7. 6	4.51	7. 9	4.49	7.11
36	5. 5	6.55	5. 2	6.58	4.59	7. 1	4.55	7. 5	4.52	7. 8	4.48	7.12	4.46	7.14
37	5. 3	6.58	5. 0	7. 0	4.56	7. 4	4.53	7. 7	4.49	7.11	4.45	7.15	4.44	7.16
38	5. 1	6.59	4.58	7. 2	4.53	7. 7	4.50	7.10	4.46	7.14	4.43	7.17	4.41	7.19
39	4.59	7. 1	4.55	7. 5	4.51	7. 9	4.48	7.12	4.44	7.16	4.40	7.20	4.38	7.22
40	4.57	7. 3	4.53	7. 7	4.49	7.11	4.45	7.15	4.41	7.19	4.37	7.23	4.35	7.25
41	4.54	7. 6	4.50	7.10	4.46	7.14	4.42	7.18	4.38	7.22	4.33	7.27	4.31	7.29
42	4.52	7. 8	4.48	7.12	4.43	7.17	4.39	7.21	4.35	7.25	4.30	7.30	4.28	7.32
43	4.49	7.11	4.45	7.15	4.41	7.19	4.36	7.24	4.31	7.29	4.27	7.33	4.24	7.36
44	4.47	7.13	4.42	7.18	4.38	7.22	4.33	7.27	4.28	7.32	4.23	7.37	4.21	7.39
45	4.44	7.16	4.39	7.21	4.35	7.25	4.30	7.30	4.25	7.35	4.20	7.40	4.17	7.43
46	4.41	7.19	4.36	7.24	4.31	7.29	4.26	7.34	4.21	7.39	4.16	7.44	4.13	7.47
47	4.38	7.22	4.33	7.27	4.28	7.32	4.23	7.37	4.17	7.43	4.12	7.48	4. 9	7.51
48	4.35	7.25	4.30	7.30	4.25	7.35	4.19	7.41	4.13	7.47	4. 7	7.53	4. 5	7.55
49	4.32	7.28	4.27	7.33	4.21	7.39	4.15	7.45	4. 9	7.51	4. 3	7.57	4. 0	8. 0
50	4.29	7.31	4.23	7.37	4.17	7.43	4.11	7.49	4. 5	7.55	3.58	8. 2	3.55	8. 5
51	4.25	7.35	4.19	7.41	4.13	7.47	4. 7	7.53	4. 0	8. 0	3.54	8. 6	3.50	8.10
52	4.22	7.38	4.15	7.45	4. 9	7.51	4. 2	7.58	3.55	8. 5	3.48	8.12	3.45	8.15
53	4.18	7.42	4.11	7.49	4. 4	7.56	3.58	8. 2	3.50	8.10	3.43	8.17	3.39	8.21
54	4.14	7.46	4. 7	7.53	4. 0	8. 0	3.52	8. 8	3.45	8.15	3.37	8.23	3.33	8.27
55	4. 9	7.51	4. 2	7.58	3.55	8. 5	3.47	8.13	3.39	8.21	3.31	8.29	3.27	8.33
56	4. 5	7.55	3.57	8. 3	3.49	8.11	3.41	8.19	3.33	8.27	3.24	8.36	3.20	8.40
57	4. 0	8. 0	3.52	8. 8	3.44	8.16	3.35	8.25	3.26	8.34	3.17	8.43	3.12	8.48
58	3.55	8. 5	3.46	8.14	3.38	8.22	3.28	8.32	3.19	8.41	3. 9	8.51	3. 4	8.56
59	3.49	8.11	3.40	8.20	3.31	8.29	3.21	8.39	3.11	8.49	2. 0	9. 0	2.55	9. 5
60	3.43	8.17	3.34	8.26	3.24	8.36	3.13	8.47	3. 2	8.58	2.51	9. 9	2.45	9.15
61	3.36	8.24	3.26	8.34	3.16	8.44	3. 5	8.55	2.53	9. 7	2.40	9.20	2.34	9.26
62	3.29	8.31	3.18	8.42	3. 7	8.53	2.55	9. 5	2.42	9.18	2.28	9.32	2.21	9.39
63	3.22	8.38	3.10	8.50	2.58	9. 2	2.44	9.16	2.30	9.30	2.14	9.46	2. 6	9.54
64	3.13	8.47	3. 0	9. 0	2.47	9.13	2.32	9.28	2.16	9.44	1.58	10. 2	1.48	10.12
65	3. 3	8.57	2.50	9.10	2.35	9.25	2.18	9.42	2. 0	10. 0	1.38	10.22	1.26	10.34
66	2.53	9. 7	2.37	9.23	2.21	9.39	2. 2	9.58	1.39	10.21	1.10	10.50	0.51	11. 9
66½	2.46	9.14	2.30	9.30	2.12	9.48	1.51	10. 9	1.26	10.34	0.48	11.12	0. 0	12.
Lat.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.	Sett.	Ris.
	LATITUDE AND DECLINATION OF CONTRARY NAMES.													

TABLE XVII.

ALTITUDES BY WHICH THE APPARENT TIME MAY BE FOUND WITH THE GREATEST ACCURACY.

	DECLINATION OF THE OBJECT, OF THE SAME NAME AS THE LATITUDE.																				
Lat.	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	40°	Lat.
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	30	14	10	7	6	5	4	4	3	3	3	2	2	2	2	2	2	2	2	2	1
2	90	30	19	15	12	10	8	7	6	6	5	5	5	4	4	4	4	3	3	3	2
3	42	49	30	22	18	15	12	11	10	9	8	7	7	6	6	6	5	5	5	5	3
4	30	90	42	30	24	20	17	15	13	12	11	10	9	9	8	8	7	7	7	6	4
5	24	53	56	39	30	25	21	18	16	15	13	12	11	11	10	9	9	9	8	8	5
6	20	42	90	49	37	30	26	22	20	18	16	15	14	13	12	11	11	10	10	9	6
7	17	35	59	61	45	36	30	26	23	21	19	17	16	15	14	13	13	12	11	11	7
8	15	30	49	90	53	42	35	30	27	24	22	20	19	17	16	15	14	14	13	13	8
9	12	26	42	63	64	49	40	34	30	27	25	23	21	20	18	17	16	15	15	14	9
10	11	24	37	53	90	57	46	39	34	30	28	25	23	22	20	19	18	17	16	16	10
11	10	22	33	47	66	67	52	44	38	34	31	28	26	24	22	21	20	19	18	17	11
12	10	20	30	42	59	90	59	49	42	37	34	31	28	26	25	23	22	21	20	19	12
13	9	18	28	38	51	68	68	55	47	41	37	34	31	29	27	25	24	23	21	20	13
14	8	17	26	35	46	59	90	61	52	45	40	37	33	31	29	27	26	24	23	22	14
15	8	16	24	33	42	53	69	70	57	49	44	40	36	34	31	29	28	26	25	24	15
16	7	15	22	30	39	49	61	90	63	54	47	43	39	36	33	31	30	28	27	25	16
17	7	14	21	28	36	45	56	71	71	59	51	46	42	39	36	34	32	30	28	27	17
18	6	13	20	27	34	42	52	63	90	65	56	49	45	41	38	36	34	32	30	29	18
19	6	12	19	25	32	40	48	58	72	72	60	53	48	44	41	38	36	34	32	30	19
20	6	12	18	24	31	37	45	54	65	90	66	57	51	47	43	40	38	36	34	32	20
21	6	11	17	23	29	35	42	50	60	73	73	62	55	50	46	43	40	38	36	34	21
22	5	11	16	22	28	34	40	47	56	66	90	67	59	53	49	45	42	40	38	36	22
23	5	10	16	21	26	32	38	45	52	61	73	74	63	57	51	48	44	42	39	37	23
24	5	10	15	20	25	31	36	43	49	57	67	90	68	60	54	50	47	44	41	39	24
25	5	9	14	19	24	29	35	41	47	54	62	74	75	64	58	53	49	46	43	41	25
26	5	9	14	19	23	28	33	39	45	51	59	68	90	69	61	56	52	48	45	43	26
27	4	9	13	18	22	27	32	37	43	49	56	64	75	76	65	59	54	51	48	45	27
28	4	9	13	17	22	26	31	36	41	47	53	60	69	90	70	62	57	53	50	47	28
29	4	8	12	17	21	25	30	35	40	45	51	57	65	76	76	66	60	56	52	49	29
30	4	8	12	16	20	25	29	34	38	43	49	54	61	70	90	71	64	58	54	51	30
31	4	8	12	16	20	24	28	33	37	42	47	52	58	66	76	77	67	61	57	53	31
32	4	8	11	15	19	23	27	32	36	40	45	50	56	62	71	90	71	64	60	56	32
33	4	7	11	15	19	22	26	31	35	39	43	48	54	60	67	77	77	68	62	58	33
34	4	7	11	14	18	22	26	30	34	38	42	47	52	57	63	72	90	72	65	61	34
35	3	7	10	14	18	21	25	29	33	37	41	45	50	55	61	68	77	78	69	63	35
36	3	7	10	14	17	21	24	28	32	36	40	44	48	53	58	65	72	90	73	66	36
37	3	7	10	13	17	20	24	27	31	35	39	43	47	51	56	62	68	78	78	70	37
38	3	7	10	13	16	20	23	27	30	34	38	41	45	50	54	59	65	73	90	74	38
39	3	6	10	13	16	19	23	26	29	33	37	40	44	48	53	57	62	69	78	78	39
40	3	6	9	12	16	19	22	25	29	32	36	39	43	47	51	55	60	66	73	90	40
42	3	6	9	12	15	18	21	24	28	31	34	37	41	45	48	52	57	62	67	74	42
44	3	6	9	12	15	17	20	23	26	29	33	36	39	43	46	50	54	58	62	68	44
46	3	6	8	11	14	17	20	23	25	28	31	34	38	41	44	48	51	55	59	63	46
48	3	5	8	11	14	16	19	22	24	27	30	33	36	39	42	46	49	52	56	60	48
50	3	5	8	10	13	16	18	21	24	27	29	32	35	38	41	44	47	50	54	57	50
52	3	5	8	10	13	15	18	20	23	26	28	31	34	37	39	42	45	48	51	55	52
54	2	5	7	10	12	15	17	20	22	25	28	30	33	36	38	41	43	46	49	53	54
56	2	5	7	10	12	15	17	19	22	24	27	29	32	35	37	40	42	45	48	51	56
58	2	5	7	9	12	14	17	19	21	24	26	29	31	34	36	39	41	44	47	49	58
60	2	5	7	9	12	14	16	19	21	23	26	28	30	33	35	38	40	43	45	48	60
62	2	5	7	9	11	14	16	18	20	23	25	27	30	32	35	37	39	42	44	47	62
64	2	4	7	9	11	13	16	18	20	22	25	27	29	31	34	36	39	41	43	46	64
66	2	4	7	9	11	13	15	18	20	22	24	26	29	31	33	35	38	40	42	45	66
68	2	4	6	9	11	13	15	17	19	22	24	26	28	30	33	35	37	39	42	44	68
70	2	4	6	9	11	13	15	17	19	21	23	26	28	30	32	34	36	39	41	43	70
72	2	4	6	8	11	13	15	17	19	21	23	25	28	30	32	34	35	38	40	42	72
74	2	4	6	8	10	12	15	17	19	21	23	25	27	29	31	33	35	38	40	42	74
76	2	4	6	8	10	12	14	16	19	21	23	25	27	29	31	33	35	37	39	42	76
80	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	35	37	39	41	80
	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	32°	34°	36°	38°	40°	

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

JANUARY.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	6.20	6.12	5.58	5.45	5.32	5.19	5. 6	4.54	4.41	4.29	4.16
Achernar, ...	6.46	6.38	6.24	6.11	5.58	5.45	5.32	5.20	5. 7	4.55	4.42
Aldebaran, . . .	9.42	9.34	9.20	9. 7	8.54	8.41	8.28	8.16	8. 3	7.51	7.38
Capella, ...	10.20	10.12	9.58	9.45	9.32	9.19	9. 6	8.54	8.41	8.29	8.16
Rigel, ...	10.22	10.14	10. 0	9.47	9.34	9.21	9. 8	8.56	8.43	8.31	8.18
Betelguese, . . .	11. 1	10.53	10.39	10.26	10.13	10. 0	9.47	9.35	9.22	9.10	8.57
Canopus, ...	11.35	11.27	11.13	11. 0	10.47	10.34	10.21	10. 9	9.56	9.44	9.31
Sirius, ...	11.53	11.45	11.31	11.18	11. 5	10.52	10.39	10.27	10.14	10. 2	9.49
Castor, ...	12.39	12.31	12.17	12. 4	11.51	11.38	11.25	11.13	11. 0	10.48	10.35
Pollux, ...	12.50	12.42	12.28	12.15	12·02	11.49	11.36	11.24	11.11	10.59	10.46
Argus, ...	14.25	14.16	14. 3	13.50	13.37	13.24	13.11	12.59	12.46	12.34	13.21
Regulus, ...	15.15	15. 6	14.53	14.40	14.27	14.14	14. 1	13.49	13.36	13.24	13.11
Dubhe, ...	16. 9	16. 0	15.47	15.34	15.21	15. 8	14.55	14.43	14.30	14.18	14. 5
Cross, foot Star.	17.33	17.25	17.11	16.58	16.45	16.32	16.19	16. 7	15.54	15.42	15.29
Spica, ...	18.31	18.23	18. 9	17.56	17.43	17.30	17.17	17. 5	16.52	16.40	16.27
Arcturus, ...	19.23	19.14	19. 1	18.48	18.35	18.22	18. 9	17.57	17.44	17.32	17.19
Antares, ...	21.34	21.25	21.12	20.59	20.46	20.33	20.20	20. 8	19.55	19.43	19.30
Vega, ...	23.46	23.37	23.24	23.11	22.58	22.45	22.32	22.20	22. 7	21.55	21.42
Altair, ...	0.58	0.49	0.36	0.23	0.10	23.57	23.44	23.32	23.19	23. 7	22.54
Pavonis, ...	1.28	1.19	1. 6	0.53	0.40	0.27	0.14	0. 2	23.49	23.37	23.24
Cygni, ...	1.50	1.41	1.28	1.15	1. 2	0.49	0.36	0.24	0.11	23.59	23.46
Gruis, ...	3.14	3. 5	2.52	2.39	2.26	2.13	2. 0	1.48	1.35	1.23	1.10
Fomalhaut, . . .	4. 4	3.55	3.42	3.29	3.16	3. 3	2.50	2.38	2.25	2.13	2. 0
Pegasi, ...	4.12	4. 3	3.50	3.37	3.24	3.11	2.58	2.46	2.33	2.21	2. 8

FEBRUARY.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	4. 8	4. 0	3.48	3.36	3.24	3.12	3. 1	2.49	2.38	2.26	0. 0
Achernar, ...	4.34	4.26	4.14	4. 2	3.50	3.38	3.27	3.15	3. 4	2.52	0. 0
Aldebaran, . . .	7.30	7.22	7.10	6.58	6.46	6.34	6.23	6.11	6. 0	5.48	0. 0
Capella, ...	8. 8	8. 0	7.48	7.36	7.24	7.12	7. 1	6.49	6.38	6.26	
Rigel, ...	8.10	8. 2	7.50	7.38	7.26	7.14	7. 3	6.51	6.40	6.28	
Betelguese, . . .	8.49	8.41	8.29	8.17	8. 5	7.53	7.42	7.30	7.19	7. 7	
Canopus, ...	9.23	9.15	9. 3	8.51	8.39	8.27	8.16	8. 4	7.53	7.41	
Sirius, ...	9.41	9.33	9.21	9. 9	8.57	8.45	8.34	8.22	8.11	7.59	
Castor, ...	10.27	10.19	10. 7	9.55	9.43	9.31	9.20	9. 8	8.57	8.45	
Pollux, ...	10.38	10.30	10.18	10. 6	9.54	9.42	9.31	9.19	9. 8	8.56	
Argus, ...	12.14	12. 6	11.54	11.42	11.30	11.18	11. 7	10.55	10.44	10.32	
Regulus, ...	13. 3	12.55	12.43	12.31	12.19	12. 7	11.56	11.44	11.33	11.21	
Dubhe, ...	13.57	13.49	13.37	13.25	13.13	13. 1	12.50	12.38	12.27	12.15	
Cross, foot Star,	15.21	15.13	15. 1	14.49	14.37	14.25	14.14	14. 2	13.51	13 39	
Spica, ...	16.19	16.11	15.59	15.47	15.35	15.23	15.12	15. 0	14.49	14.37	
Arcturus, ...	17.11	17. 3	16.51	16.39	16.27	16.15	16. 4	15.52	15.41	15.29	
Antares, ...	19.22	19.14	19. 2	18.50	18.38	18.26	18.15	18. 3	17.52	17.40	
Vega, ...	21.34	21.26	21.14	21. 2	20.50	20.38	20.27	20.15	20. 4	19.52	
Altair, ...	22.46	22.38	22.26	22.14	22. 2	21.50	21.39	21.27	21.16	21. 4	
Pavonis, ...	23.16	23. 8	22.56	22.44	22.32	22.20	22. 9	21.57	21.46	21.34	
Cygni, ...	23.38	23.30	23.18	23. 6	22.54	22.42	22.31	22.19	22. 8	21.56	
Gruis, ...	1. 1	0.53	0.41	0.29	0.17	0. 5	23.54	23.42	23.31	23.19	
Fomalhaut, . . .	1.52	1.44	1.32	1.20	1. 8	0.56	0.45	0.33	0.22	0.10	
Pegasi, ...	2. 0	1.52	1.40	1.28	1.16	1. 4	0.53	0.41	0.30	0.18	

TABLE XVIII.

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

MARCH.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	2.18	2.10	1.59	1.48	1.37	1.26	1.15	1. 4	0.53	0.43	0.32
Achernar, ...	2.44	2.36	2.25	2.14	2. 3	1.52	1.41	1.30	1.19	1. 9	0.58
Aldebaran, . . .	5.39	5.31	5.20	5. 9	4.58	4.47	4.36	4.25	4.14	4. 4	3.53
Capella, ...	6.17	6. 9	5.58	5.47	5.36	5.25	5.14	5. 3	4.52	4.42	4.31
Rigel, ...	6.19	6.11	6. 0	5.49	5.38	5.27	5.16	5. 5	4.54	4.44	4.33
Betelguese, . . .	6.56	6.48	6.37	6.27	6.15	6. 4	5.53	5.42	5.31	5.21	5.10
Canopus, ...	7.30	7.22	7.11	7. 1	6.49	6.38	6.27	6.16	6. 5	5.55	5.44
Sirius, ...	7.48	7.40	7.29	7.19	7. 7	6.56	6.45	6.34	6.23	6.13	6. 2
Castor, ...	8.34	8.26	8.15	8. 4	7.53	7.42	7.31	7.20	7. 9	6.59	6.48
Pollux, ...	8.45	8.37	8.26	8.15	8. 4	7.53	7.42	7.31	7.20	7.10	6.59
Argus, ...	10.21	10.13	10. 2	9.51	9.40	9.29	9.18	9. 7	8.56	8.46	8.35
Regulus, ...	11.13	11. 5	10.54	10.43	10.32	10.21	10.10	9.59	9.49	9.38	9.27
Dubhe, ...	12. 7	11.59	11.48	11.37	11.26	11.15	11. 4	10.53	10.42	10.32	10.21
Cross, foot Star,	13.31	13.23	13.12	13. 1	12.50	12.39	12.28	12.17	12. 6	11.56	11.45
Spica, ...	14.29	14.21	14.10	13.59	13.48	13.37	13.26	13.15	13. 4	12.54	12.43
Arcturus, ...	15.21	15.13	15. 2	14.51	14.40	14.29	14.18	14. 7	13.56	13.46	13.35
Antares, ...	17.33	17.25	17.14	17. 3	16.52	16.41	16.30	16.19	16. 8	15.58	15.47
Vega, ...	19.45	19.37	19.26	19.15	19. 4	18.53	18.42	18.31	18.20	18.10	17.59
Altair, ...	20.57	20.49	20.38	20.27	20.16	20. 5	19.54	19.43	19.32	19.22	19.11
Pavonis, ...	20.27	21.19	21. 8	20.57	20.46	20.35	20.24	20.13	20. 2	19.52	19.41
Cygni, ...	21.49	21.41	21.30	21.19	21. 8	20.57	20.46	20.35	20.24	20.14	20. 3
Gruis, ...	23.12	23. 4	22.53	22.42	22.31	22.20	22. 9	21.58	21.47	21.37	21.26
Fomalhaut, . . .	0. 3	23.55	23.44	23.33	23.22	23.11	23. 0	22.49	22.38	22.28	22.17
Pegasi, ...	0.11	0. 3	23.52	23.41	23.30	23.19	23. 8	22.57	22.46	22.36	22.25

APRIL.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	0.24	0.17	0. 6	23.55	23.44	23.33	23.22	23.11	23. 0	22.48	22.37
Achernar, ...	0.50	0.43	0.32	0.21	0.10	23.59	23.48	23.37	23.26	23.14	23. 3
Aldebaram, . . .	3.46	3.39	3.28	3.17	3. 6	2.55	2.44	2.33	2.22	2.10	1.59
Capella, ...	4.24	4.17	4. 6	3.55	3.44	3.33	3.22	3.11	3. 0	2.48	2.37
Rigel, ...	4.26	4.19	4. 8	3.57	3.46	3.35	3.24	3.13	3. 2	2.50	2.39
Betelguese, . . .	5. 5	4.58	4.47	4.36	4.25	4.14	4. 3	3.52	3.41	3.29	3.18
Canopus, ...	5.39	5.32	5.21	5.10	4.59	4.48	4.37	4.26	4.15	4. 3	3.52
Sirius, ...	5.57	5.50	5.39	5.28	5.17	5. 6	4.55	4.44	4.33	4.21	4.10
Castor, ...	6.43	6.36	6.25	6.14	6. 3	5.52	5.41	5.30	5.19	5. 7	5.56
Pollux, ...	6.54	6.47	6.36	6.25	6.14	6. 3	5.52	5.41	5.30	5.18	5. 7
Argus, ...	8.30	8.23	8.12	8. 1	7.50	7.39	7.28	7.17	7. 6	6.54	6.43
Regulus, ...	9.19	9.12	9. 1	8.50	8.39	8.28	8.17	8. 6	7.55	7.43	7.32
Dubhe, ...	10.13	10. 6	9.55	9.44	9.33	9.22	9.11	9. 0	8.49	8.37	8.26
Cross, foot Star,	11.37	11.30	11.19	11. 8	10.57	10.46	10.35	10.24	10.13	10. 1	9.50
Spica, ...	12.35	12.28	12.17	12. 6	11.55	11.44	11.33	11.22	11.11	10.59	10.48
Arcturus, ...	13.27	13.20	13. 9	12.58	12.47	12.36	12.25	12.14	12. 3	11.51	11.40
Antares, ...	15.38	15.31	15.20	15. 9	14.58	14.47	14.36	14.25	14.14	14. 2	13.51
Vega, ...	17.50	17.43	17.32	17.21	17.10	16.59	16.48	16.37	16.26	16.14	16. 3
Altair, ...	19. 2	18.55	18.44	18.32	18.22	18.11	18. 0	17.49	17.38	17.26	17.15
Pavonis, ...	19.32	19.25	19.14	19. 3	18.52	18.41	18.30	18.19	18. 8	17.56	17.45
Cygni, ...	19.54	19.47	19.36	19.25	19.14	19. 3	18.52	18.41	18.30	18.18	18. 7
Gruis, ...	21.17	21.10	20.59	20.48	20.37	20.26	20.15	20. 4	19.53	19.41	19.30
Fomalhaut, . . .	22. 7	22. 0	21.49	21.38	21.27	21.16	21. 5	20.54	20.43	20.31	20.20
Pegasi, ...	22.15	22. 8	21.57	21.46	21.35	21.24	21.13	21. 2	20.52	20.39	20.28

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

MAY.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	22.33	22.26	22.14	22. 2	21.51	21.39	21.27	21.15	21. 3	20.51	20.39
Achernar, ...	22.59	22.52	22.40	22.28	22.17	22.05	21.53	21.41	21.29	21.17	21.05
Aldebaran, . . .	1.55	1.48	1.36	1.24	1.13	1.01	0.49	0.37	0.25	0.13	0.01
Capella, ...	2.33	2.26	2.14	2. 2	1.5	1.39	1.27	1.15	1. 3	0.51	0.39
Rigel, ...	2.35	2.28	2.16	2. 4	1.53	1.41	1.29	1.17	1. 5	0.53	0.41
Betelguese, . . .	3.14	3. 7	2.55	2.43	2.32	2.20	2. 8	1.56	1.44	1.32	1.20
Canopus, ...	3.48	3.41	3.29	3.17	3. 6	2.54	2.42	2.30	2.18	2. 6	1.54
Sirius, ...	4. 6	3.59	3.47	3.35	3.24	3.12	3. 0	2.58	2.46	2.34	2.22
Castor, ...	4.52	4.45	4.33	4.21	4.10	3.58	3.46	2.34	2.22	2.10	1.58
Pollux, ...	5. 3	4.56	4.44	4.30	4.21	4. 9	3.57	3.45	3.33	3.21	3. 9
Argus, ...	6.39	6.32	6.20	6. 8	5.57	5.45	5.33	5.21	5. 9	4.57	4.45
Regulus, ...	7.28	7.21	7. 9	6.57	6.46	6.34	6.22	6.10	5.58	5.46	5.34
Dubhe, ...	8.22	8.15	8. 3	7.51	7.40	7.28	7.16	7. 4	6.52	6.40	6.28
Cross, foot Star.	9.46	9.39	9.27	9.15	9. 4	8.52	8.40	8.28	8.16	8. 4	7.52
Spica, ...	10.44	10.37	10.25	10.13	10. 2	9.50	9.38	9.26	9.14	9. 2	8.50
Arcturus, ...	11.36	11.29	11.17	11. 5	10.54	10.42	10.30	10.18	10. 6	9.54	9.42
Antares, ...	13.47	13.40	13.28	13.16	13. 5	12.53	12.41	12.29	12.17	12. 5	11.53
Vega, ...	15.59	15.52	15.40	15.28	15.17	15. 5	14.53	14.41	14.29	14.17	14. 5
Altair, ...	17.11	17. 4	16.52	16.40	16.29	16.17	16. 5	15.53	15.41	15.29	15.17
Pavonis, ...	17.41	17.34	17.22	17.10	16.59	16.47	16.35	16.23	16.11	15.59	15.47
Cygni, ...	18. 3	17.56	17.34	17.22	17.11	16.59	16.47	16.35	16.23	16.11	15.59
Gruis, ...	19.26	19.19	19. 7	18.55	18.44	18.32	18.20	18. 8	17.56	17.44	17.32
Fomalhaut, . . .	20.17	20.10	19.58	19.46	19.35	19.23	19.11	18.59	18.47	18.35	18.23
Pegasi, ...	20.25	20.18	20. 6	19.54	19.43	19.31	19.19	19. 7	18.55	18.43	18.31

JUNE.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	20.31	20.22	20.10	19.58	19.45	19.33	19.20	19. 8	18.55	18.43	18.30
Achernar, ...	20.57	20.48	20.36	20.24	20.11	19.59	19.46	19.34	19.21	19. 9	18.56
Aldebaran, . . .	23.53	23.44	23.32	23.22	23. 9	22.57	22.44	22.32	22.19	22. 7	21.54
Capella, ...	0.31	0.22	0.10	23.58	23.45	23.33	23.20	23. 8	22.55	22.43	22.30
Rigel, ...	0.33	0.24	0.12	0. 0	23.49	23.37	23.24	23.12	22.59	22.47	22.34
Betelguese, . . .	1.12	1. 3	0.51	0.39	0.26	0.14	0. 1	23.59	23.46	23.34	23.21
Canopus, ...	1.46	1.39	1.25	1.13	1. 0	0.48	0.35	0.23	0.10	23.48	23.35
Sirius, ...	2. 4	1.55	1.43	1.31	1.18	1. 6	0.53	0.41	0.28	0.16	0. 3
Castor, ...	2.50	2.41	2.29	2.17	2. 4	1.52	1.39	1.27	1.14	1. 2	0.49
Pollux, ...	3. 1	2.52	2.40	2.28	2.15	2. 3	1.50	1.38	1.25	1.13	1. 0
Argus, ...	4.37	4.28	4.16	4. 4	3.51	3.39	3.26	3.14	3. 1	2.49	2.36
Regulus, ...	5.26	5.17	5. 5	4.53	4.40	4.28	4.15	4. 3	3.50	3.38	3.25
Dubhe, ...	6.20	6.11	5.59	5.47	5.34	5.22	5. 9	4.57	4.44	4.32	4.19
Cross, foot Star,	7.44	7.35	7.23	7.11	6.58	6.46	6.33	6.21	6. 8	5.56	5.43
Spica, ...	8.42	8.33	8.21	8. 9	7.56	7.44	7.31	7.19	7. 6	6.54	6.41
Arcturus, ...	9.34	9.25	9.13	9. 1	8.58	8.46	8.33	8.21	8. 8	7.56	7.43
Antares, ...	11.45	11.36	11.24	11.12	10.59	10.47	10.34	10.22	10.10	9.57	9.44
Vega, ...	13.57	13.48	13.36	13 24	13.11	12.59	12.46	12.34	12.21	12. 9	11.56
Altair, ...	15. 9	15. 0	14.48	14.36	14.23	14.11	13.58	13.46	13.33	13.21	13. 8
Pavonis, ...	15.39	15.30	15.18	15. 6	14.53	14.41	14.28	14.16	14. 3	13.51	13.38
Cygni, ...	16. 1	15.52	15.40	15.28	15.15	15. 3	14.50	14.38	14.25	14.13	14. 0
Gruis, ...	17.24	17.15	17. 3	16.51	16.38	16.26	16.13	16. 1	15.48	15.36	15.23
Fomalhaut, . . .	18.15	18. 6	17.54	17.42	17.29	17.17	17. 4	16.52	16.39	16.27	16.14
Pegasi, ...	18.23	18.14	18. 2	17.50	17.37	17.25	17.12	17. 0	16.47	16.35	16.22

TABLE XVIII.

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

JULY.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	18.26	18.18	18. 6	17.53	17.41	17.29	17.17	17. 5	16.53	16.41	16.29
Achernar, ...	18.52	18.44	18.32	18.19	18. 7	17.55	17.43	17.31	17.19	17. 7	16.55
Aldebaran, . . .	21.48	21.40	21.28	21.15	21. 3	20.51	20.39	20.27	20.15	20. 3	19.51
Capella, ...	22.26	22.18	22. 6	21.53	21.41	21.29	21.17	21.05	20.53	20.41	20.29
Rigel, ...	22.28	22.20	22. 8	21 55	21.43	21.31	21.19	21. 7	20.55	20.43	20.31
Betelguese, . . .	23. 7	22.59	22.47	22.34	22.22	22.10	21.58	21.46	21.34	21.22	21.10
Canopus, ...	23.41	23.33	23.21	23. 8	22.56	22.44	22.32	22.20	22. 8	21.56	21.44
Sirius, ...	23.59	23.51	23.39	23.26	23.14	23. 2	22.50	22.38	22.26	22.14	22. 2
Castor, ...	0.45	0.37	0.25	0.12	0. 0	23.48	23.36	23.24	23.12	23. 0	22.48
Pollux, ...	0.56	0.48	0.36	0.23	0.11	23.59	23.47	23.35	23.23	23.11	22.59
Argus, ...	2.32	2.24	2.12	1.59	1.47	1.35	1.23	1.11	0.59	0.47	0.35
Regulus, ...	3.21	3.13	3. 1	2.48	2.36	2.24	2.12	2. 0	1.48	1.36	1.24
Dubhe, ...	4.17	4. 9	3.57	3.44	3.32	3.20	3. 8	2.56	2.44	2.32	2.20
Cross, foot Star,	5.39	5.31	5.19	5. 6	4.54	4.42	4.30	4.18	4. 6	3.54	3.42
Spica, ...	6.37	6.29	6.17	6. 4	5.52	5.40	5.28	5.16	5. 4	4.52	4.40
Arcturus, ...	7.29	7.21	7. 9	6.56	6.44	6.32	6.20	6. 8	5.56	5.44	5.32
Antares, ...	9.40	9.32	9.20	9. 7	8.55	8.43	8.31	8.19	8. 7	7.55	7.43
Vega, ...	11.52	11.44	11.32	11.19	11. 7	10.55	10.43	10.31	10.19	10. 7	9.55
Altair, ...	13. 4	12.56	12.44	12.31	12.19	12. 7	11.55	11.43	11.31	11.19	11. 7
Pavonis, ...	13.34	13.26	13.14	13. 1	12.49	12.37	12.25	12.13	12. 1	11.49	11.37
Cygni, ...	13.56	13.48	13.36	13.23	13.11	12.59	12.47	12.35	12.23	12.11	11.59
Gruis, ...	15.19	15.11	14.59	14.46	14.34	14.22	14.10	13.58	13.46	13.34	13.22
Fomalhaut, . . .	16.10	16. 2	15.50	15.37	15.25	15.13	15. 1	14.49	14.37	14.25	14.13
Pegasi, ...	16.18	16. 8	15.56	15.43	15.31	15.19	15. 7	14.55	14.43	14.31	14.19

AUGUST.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	16.21	16.14	16. 2	15.51	15.39	15.28	15.17	15. 6	14.54	14.44	14.34
Achernar, ...	16.47	16.40	16.28	16.17	16. 5	15.54	15.43	15.32	15.20	15. 9	14.59
Aldebaran, . . .	19.43	19.36	19.24	19.13	19.01	18.50	18.39	18.28	18.16	18.05	17.54
Capella, ...	20.21	20.14	20. 2	19.51	19.39	19.28	19.17	19. 6	18.54	18.44	18.34
Rigel, ...	20.23	20.16	20. 4	19.53	19.41	19.30	19.19	19. 8	18.56	18.45	18.35
Betelguese, . . .	21. 2	20.55	20.43	20.32	20.20	20. 9	19.58	19.47	19.35	19.24	19.14
Canopus, ...	21.36	21.29	21.17	21. 6	20.54	20.43	20.32	20.21	20. 9	19.58	19.48
Sirius, ...	21.54	21.47	21.35	21.24	21.12	21. 1	20.50	20.39	20.27	20.16	20. 6
Castor, ...	22.40	22.33	22.21	22.10	21.58	21.47	21.36	21.25	21.13	21. 2	20.52
Pollux, ...	22.51	22.44	22.32	22.21	22. 9	21.58	21.47	21.36	21.24	21.13	21. 3
Argus, ...	0.27	0.20	0. 8	23.57	23.45	23.34	23.23	23.12	23. 0	22.49	22.39
Regulus, ...	1.16	1. 9	0.57	0.46	0.34	0.23	0.12	0. 1	23.49	23.38	23.28
Dubhe, ...	2.10	2. 3	1.51	1.40	1.28	1.17	1. 6	0.55	0.43	0.32	0.22
Cross, foot Star,	3.34	3.27	3.15	3. 4	2.52	2.41	2.30	2.19	2. 7	1.56	1.46
Spica, ...	4.32	4.25	4.13	4. 2	3.50	3.39	3.28	2.17	2. 5	1.54	1.44
Arcturus, ...	5.24	5.17	5. 5	4.54	4.42	4.31	4.20	4. 9	3.57	3.46	3.36
Antares, ...	7.35	7.28	7.16	7. 5	6.53	6.42	6.31	6.20	6. 8	5.57	5.47
Vega, ...	9.47	9.40	9.28	9.17	9. 5	8.54	8.43	8.32	8.20	8. 9	7.59
Altair, ...	10.59	10.52	10.40	10.29	10.17	10. 6	9.55	9.44	9.32	9.21	9.11
Pavonis, ...	11.29	11.22	11.10	10.59	10.47	10.36	10.25	10.14	10. 2	9.51	9.41
Cygni, ...	11.51	11.44	11.32	11.21	11. 9	10.58	10.47	10.36	10.24	10.13	10. 3
Gruis, ...	13.14	13. 7	12.55	12.44	12.32	12.21	12.10	11.59	11.47	11.36	11.26
Fomalhaut, . . .	14. 5	13.58	13.46	13.35	13.23	13.12	13. 1	12.50	11.38	11.27	11.17
Pegasi, ...	14.13	14. 6	13.54	13.43	13.31	13.20	13. 9	12.58	12.46	12.35	12.25

TABLE XVIII.

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

SEPTEMBER.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	14.25	14.18	14. 7	13.56	13.46	13.35	13.24	13.13	13. 2	12.52	12.41
Achernar, ...	14.51	14.44	14.33	14.22	14.12	14. 1	13.50	13.39	13.28	13.18	13. 7
Aldebaran, . . .	17.47	17.40	17.29	17.18	17. 8	16.57	16.46	16.35	16.24	16.14	16. 3
Capella, ...	18.25	18.18	18. 7	17.56	17.46	17.35	17.24	17.13	17. 2	16.52	16.41
Rigel, ...	18.27	18.20	18. 9	17.58	17.48	17.37	17.26	17.15	17. 4	16.54	16.43
Betelguese, . . .	19. 6	18.59	18.48	18.37	18.27	18.16	18. 5	17.54	17.43	17.33	17.22
Canopus, ...	19.40	19.33	19.22	19.11	19. 1	18.50	18.39	18.28	18.17	18. 7	17.56
Sirius, ...	19.58	19.51	19.40	19.29	19.19	19. 8	18.57	18.46	18.35	18.25	18.14
Castor, ...	20.44	20.37	20.26	20.15	20. 5	19.54	19.43	19.32	19.21	19.11	19. 0
Pollux, ...	20.55	20.48	20.37	20.26	20.16	20. 5	19.54	19.43	19.32	19.22	19.11
Argus, ...	22.32	22.24	22.13	22. 2	21.52	21.41	21.30	21.19	21. 8	20.58	20.47
Regulus, ...	23.20	23.13	23. 2	22.51	22.41	22.30	22.19	22. 8	21.57	21.47	21.36
Dubhe, ...	0.14	0. 7	23.56	23.45	23.35	23.24	23.13	23. 2	22.51	22.41	22.30
Cross, foot Star.	1.38	1.31	1.20	1. 9	0.59	0.48	0.37	0.26	0.15	0. 5	23.54
Spica, ...	2.36	2.29	2.18	2. 7	1.57	1.46	1.35	1.24	1.13	1. 3	0.52
Arcturus, ...	3.28	3.21	3.10	2.59	2.49	2.38	2.27	2.16	2. 5	1.55	1.44
Antares, ...	5.39	5.32	5.21	5.10	5. 0	4.49	4.38	4.27	4.16	4. 6	3.55
Vega, ...	7.51	7.44	7.33	7.22	7.12	7. 1	6.50	6.39	6.28	6.18	6. 7
Altair, ...	9. 3	8.56	8.45	8.34	8.24	8.13	8. 2	7.51	7.40	7.30	7.19
Pavonis, ...	9.33	9.26	9.15	9. 4	8.54	8.43	8.32	8.21	8.10	8. 0	7.49
Cygni, ...	9.55	9.48	9.37	9.26	9.16	9. 5	8.54	8.43	8.32	8.22	8.11
Gruis, ...	11.18	11.11	11. 0	10.49	10.39	10.28	10.17	10. 6	9.55	9.45	9.34
Fomalhaut, . . .	12. 9	12. 2	11.51	11.40	11.30	11.19	11. 8	10.57	10.46	10.36	10.25
Pegasi, ...	12.17	12.10	11.59	11.48	11.38	11.27	11.16	11. 5	10.54	10.44	10.33

OCTOBER.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	12.37	12.30	12.19	12. 8	11.57	11.46	11.35	11.23	11.12	11. 0	10.49
Achernar, ...	13. 3	12.56	12.45	12.34	12.23	12.12	12. 1	11.49	11.38	11.26	11.15
Aldebaran, . . .	15.59	15.52	15.41	15.30	15.19	15. 8	14.57	14.45	14.34	14.22	14.11
Capella, ...	16.37	16.30	16.19	16. 8	15.57	15.46	15.35	15.23	15.12	15. 0	14.49
Rigel, ...	16.39	16.32	16.21	16.10	15.59	15.48	15.37	15.25	15.14	15. 2	14.51
Betelguese, . . .	17.18	17.11	17. 0	16.49	16.38	16.27	16.16	16. 4	15.53	15.41	15.30
Canopus, ...	17.52	17.45	17.34	17.23	17.12	17. 1	16.50	16.38	16.27	16.15	16. 4
Sirius, ...	18.10	18. 3	17.52	17.41	17.30	17.19	17. 8	16.56	16.45	16.33	16.22
Castor, ...	18.56	18.49	18.38	18.27	18.16	18. 5	17.54	17.42	17.31	17.19	17. 8
Pollux, ...	19. 7	19. 0	18.49	18.38	18.27	18.16	18. 5	17.53	17.42	17.30	17.19
Argus, ...	20.43	20.36	20.25	20.14	20. 3	19.52	19.41	19.29	19.18	19. 6	18.55
Regulus, ...	21.32	21.25	21.14	21. 3	20.52	20.41	20.30	20.18	20. 7	19.55	19.44
Dubhe, ...	22.26	22.19	22. 8	21.57	21.46	21.35	21.24	21.12	21. 1	20.49	20.38
Cross, foot Star,	23.50	23.43	23.32	23.21	23.10	22.59	22.48	22.36	22.25	22.13	22. 2
Spica, ...	0.48	0.41	0.30	0.19	0. 8	23.57	23.46	23.34	23.23	23.11	23. 0
Arcturus, ...	1.40	1.33	1.22	1.11	1. 0	0.49	0.38	0.26	0.15	0. 3	23.52
Antares, ...	3.51	3.44	3.33	3.22	3.11	3. 0	2.49	2.37	2.26	2.14	2. 3
Vega, ...	6. 3	5.56	5.45	5.34	5.23	5.12	5. 1	4.49	4.38	4.26	4.15
Altair, ...	7.15	7. 8	6.57	6.46	6.35	6.24	6.13	6. 1	5.50	5.38	5.27
Pavonis, ...	7.45	7.38	7.27	7.16	7. 5	6.54	6.43	6.31	6.20	6. 8	5.57
Cygni, ...	8. 7	8. 7	7.56	7.45	7.34	7.23	7.12	7. 0	6.49	6.37	6.26
Gruis, ...	9.30	9.23	9.12	9. 1	8.50	8.39	8.28	8.16	8. 5	7.53	7.42
Fomalhaut, . . .	10.21	10.14	10. 3	9.52	9.41	9.30	9.19	9. 7	8.56	8.44	8.33
Pegasi, ...	10.29	10.22	10.11	10. 0	9.49	9.38	9.27	9.15	9. 4	8.52	8.41

TABLE XVIII.

FOR FINDING THE APPARENT TIME OF 24 OF THE PRINCIPAL STARS PASSING THE MERIDIAN THROUGHOUT THE YEAR.

NOVEMBER.

NAMES.	DAY. 1	DAY. 3	DAY. 6	DAY. 9	DAY. 12	DAY. 15	DAY. 18	DAY. 21	DAY. 24	DAY. 27	DAY. 30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	10.41	10.33	10.21	10. 9	9.57	9.45	9.32	9.20	9. 7	8.54	8.41
Achernar, ...	11. 7	10.59	10.47	10.35	10.23	10.11	9.58	9.46	9.33	9.20	9. 7
Aldebaran, . . .	14. 3	13.55	13.43	13.31	13.19	13. 7	12.54	12.42	12.29	12.16	12. 3
Capella, ...	14.41	14.33	14.21	14. 9	13.57	13.45	13.32	13.20	13. 7	12.54	12.41
Rigel, ...	14.43	14.35	14.23	14.11	13.59	13.47	13.34	13.22	13. 9	12.56	12.43
Betelguese, . . .	15.22	15.14	15. 2	14.50	14.38	14.26	14.13	14. 1	13.48	13.35	13.22
Canopus, ...	15.56	15.48	15.36	15.24	15.12	15. 0	14.47	14.35	14.22	14. 9	13.56
Sirius, ...	16.14	16. 6	15.54	15.42	15.30	15.18	15. 5	14.53	14.40	14.27	14.14
Castor, ...	17. 0	16.52	16.40	16.28	16.16	16. 4	15.51	15.39	15.26	15.13	15. 0
Pollux, ...	17.11	17. 3	16.51	16.39	16.27	16.15	16. 2	15.50	15.37	15.24	15.11
Argus, ...	18.47	18.39	18.27	18.15	18. 3	17.51	17.38	17.26	17.13	17. 0	16.47
Regulus, ...	19.36	19.28	19.16	19. 4	18.52	18.40	18.27	18.15	18. 2	17.49	17.36
Dubhe, ...	20.30	20.22	20.10	19.58	19.46	19.34	19.21	19. 9	18.56	18.43	18.30
Cross, foot Star,	21.54	21.46	21.34	21.22	21.10	20.58	20.45	20.33	20.20	20.07	19.54
Spica, ...	22.52	22.44	22.32	22.20	22. 8	21.56	21.43	21.31	21.18	21. 5	20.52
Arcturus, ...	23.44	23.36	23.24	23.12	23. 0	22.48	22.35	22.23	22.10	21.57	21.44
Antares, ...	1.55	1.47	1.35	1.23	1.11	0.59	0.46	0.34	0.21	0. 8	23.55
Vega, ...	4. 7	3.59	3.47	3.35	3.23	3.11	2.58	2.46	2.33	2.20	2. 7
Altair, ...	5.19	5.11	4.59	4.47	4.35	4.23	4.10	3.58	3.45	3.32	3.19
Pavonis, ...	5.49	5.41	5.29	5.17	5. 5	4.53	4.40	4.28	4.15	4. 2	3.49
Cygni, ...	6.11	6. 3	5.51	5.39	5.27	5.15	5. 2	4.50	4.37	4.24	4.11
Gruis, ...	7.34	7.26	7.14	7. 2	6.50	6.38	6.25	6.13	6. 0	5.47	5.34
Fomalhaut, . . .	8.25	8.17	8. 5	7.53	7.41	7.29	7.16	7. 4	6.51	6.38	6.25
Pegasi, ...	8.33	8.25	8.13	8. 1	7.49	7.37	7.24	7.12	6.59	6.46	6.33

DECEMBER.

NAMES.	1	3	6	9	12	15	18	21	24	27	30
	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.	H. M.
Polar Star, . . .	8.37	8.29	8.15	8. 2	7.49	7.36	7.23	7. 9	6.56	6.43	6.29
Achernar, ...	9. 3	8.55	8.41	8.28	8.15	8. 2	7.49	7.35	7.22	7. 9	6.55
Aldebaran, . . .	11.59	11.51	11.37	11.24	11.11	10.58	10.45	10.31	10.18	10. 5	9.51
Capella, ...	12.37	12.29	12.15	12. 2	11.49	11.36	11.23	11. 9	10.56	10.43	10.29
Rigel, ...	12.39	12.31	12.17	12. 4	11.51	11.38	11.25	11.11	10.58	10.45	10.31
Betelguese, . . .	13.18	13.10	12.56	12.43	12.30	12.17	12. 4	11.50	11.37	11.24	11.10
Canopus, ...	13.52	13.44	13.30	13.17	13. 4	12.51	12.38	12.24	12.11	11.58	11.44
Sirius, ...	14.10	14. 2	13.48	13.35	13.22	13. 9	12.56	12.42	12.29	12.16	12. 2
Castor, ...	14.56	14.48	14.34	14.21	14. 8	13.55	13.42	13.28	13.15	13. 2	12.48
Pollux, ...	15. 7	14.59	14.45	14.32	14.19	14. 6	13.53	13.39	13.26	13.13	12.59
Argus, ...	16.43	16.35	16.21	16. 8	15.55	15.42	15.29	15.15	15. 2	14.49	14.35
Regulus, ...	17.32	17.24	17.10	16.57	16.44	16.31	16.18	16. 4	15.51	15.38	15.24
Dubhe, ...	18.26	18.18	18. 4	17.51	17.38	17.25	17.12	17.00	16.46	16.33	16.20
Cross, foot Star,	19.50	19.42	19.28	19.15	19. 2	18.49	18.36	18.22	18. 9	17.56	17.42
Spica, ...	20.48	20.40	20.26	20.13	20. 0	19.47	19.34	19.20	19. 7	18.54	18.40
Arcturus, ...	21.40	21.32	21.18	21. 5	20.52	20.39	20.26	20.12	19.59	19.46	19.32
Antares, ...	23.51	23.43	23.29	23.16	23. 3	22.50	22.37	22.23	22.10	21.57	21.43
Vega, ...	2. 3	1.55	1.41	1.28	1.15	1. 2	0.49	0.35	0.22	0. 9	23.55
Altair, ...	3.15	3. 7	2.53	2.40	2.27	2.14	2. 1	1.47	1.34	1.21	1. 7
Pavonis, ...	3.45	3.37	3.23	3.10	2.57	2.44	2.31	2.17	2. 4	1.51	1.37
Cygni, ...	4. 7	3.59	3.45	3.32	3.19	3. 6	2.53	2.39	2.26	2.13	1.59
Gruis, ...	5.30	5.22	5. 8	4.55	4.42	4.29	4.16	4. 2	3.49	3.36	3.22
Fomalhaut, . . .	6.21	6.13	5.59	5.46	5.33	5.20	5. 7	4.53	4.40	4.27	4.13
Pegasi, ...	6.29	6.21	6. 7	5.54	5.41	5.28	5.15	5. 1	4.48	4.35	4.21

TABLE XIX.

PLACES OF 24 OF THE PRINCIPAL FIXED STARS, FOR THE YEAR 1854.

MAG.	NAME.	RIGHT ASCENSION.	ANNUAL VAR.	DECLINATION.	ANNUAL VAR.
		H. M. S.	S.	° ′	″
2	Polar Star, ...	1 6 3	+17.83	88 32 N.	+19·3
1	Achernar, ...	1 32 15	2·23	57 59 S.	—18·5
1	Aldebaran, ...	4 27 32	3·43	16 13 N.	+ 7·9
1	Capella, ...	5 5 55	4·41	45 51 N.	+ 4·8
1	Rigel, ...	5 7 31	2·88	8 23 S.	— 4·6
1	Betelguese, ...	5 47 17	3·24	7 22 N.	+ 1·2
1	Canopus, ...	6 20 44	1·33	52 37 S.	+ 1·8
1	Sirius, ...	6 38 43	2·65	16 31 S.	+ 4·5
1	Castor, ...	7 25 17	3·86	32 12 N.	— 7·2
1	Pollux, ...	7 36 21	3·68	28 22 N.	— 8·1
2	Argus, ...	9 11 37	0·73	69 4 S.	—14·8
1	Regulus, ...	10 0 35	3·22	12 41 N.	—17·4
1	Dubhe, ...	10 54 50	3·81	62 32 N.	—19·2
1	Cross, foot Star, ...	12 18 31	3·27	62 17 S.	+20·0
1	Spica, ...	13 17 29	3·15	10 24 S.	+18·9
1	Arcturus, ...	14 8 59	2·73	19 57 N.	—19·9
1	Antares, ...	16 20 24	3·66	26 6 S.	+ 8·5
1	Vega, ...	18 31 57	2·01	38 39 N.	+ 2·8
1	Altair, ...	19 43 37	2·93	8 29 N.	+ 8·4
1	Pavonis, ...	20 14 0	4·81	57 12 S.	—11·0
2	Cygni, ...	20 36 27	2·04	44 46 N.	+12·6
1	Gruis, ...	21 59 3	3·82	47 40 S.	—17·3
1	Fomalhaut, ...	22 49 32	3·31	30 25 S.	—19·1
2	Pegasi, ...	22 57 30	2·98	14 25 N.	+19·3

Sign + means *add*. Sign — means *subtract*.

TABLE XX.

CORRECTION TO BE SUBTRACTED FROM THE OBSERVED ALTITUDE OF A FIXED STAR, OR A PLANET, TO FIND THE TRUE ALTITUDE.

✱'s Obs. Alt.	HEIGHT OF THE EYE ABOVE THE SEA IN FEET.														✱'s Obs. Alt.
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	
°	′	′	′	′	′	′	′	′	′	′	′	′	′	′	°
5	11.8	12.2	12.6	12.9	13.2	13.5	13.7	14.0	14.2	14.4	14.6	14.8	15.0	15.1	5
6	10.4	10.8	11.2	11.5	11.8	12.1	12.3	12.6	12.8	13.0	13.2	13.4	13.6	13.7	6
7	9.3	9.7	10.1	10.4	10.7	11.0	11.2	11.5	11.7	11.9	12.1	12.3	12.5	12.6	7
8	8.4	8.8	9.2	9.5	9.8	10.1	10.3	10.6	10.8	11.0	11.2	11.4	11.6	11.7	8
9	7.7	8.1	8.5	8.8	9.1	9.4	9.6	9.9	10.1	10.3	10.5	10.7	10.9	11.0	9
10	7.2	7.6	8.0	8.3	8.6	8.9	9.1	9.4	9.6	9.8	10.0	10.2	10.4	10.5	10
11	6.7	7.1	7.5	7.8	8.1	8.4	8.6	8.9	9.1	9.3	9.5	9.7	9.9	10.0	11
12	6.3	6.7	7.1	7.4	7.7	8.0	8.2	8.5	8.7	8.9	9.1	9.3	9.5	9.6	12
14	5.7	6.1	6.5	6.8	7.1	7.4	7.6	7.9	8.1	8.3	8.5	8.7	8.9	9.0	14
16	5.2	5.6	6.0	6.3	6.6	6.9	7.1	7.4	7.6	7.8	8.0	8.2	8.4	8.5	16
18	4.8	5.2	5.6	5.9	6.2	6.5	6.7	7.0	7.2	7.4	7.6	7.8	8.0	8.1	18
20	4.5	4.9	5.3	5.6	5.9	6.2	6.4	6.7	6.9	7.1	7.3	7.5	7.7	7.8	20
22	4.3	4.7	5.1	5.4	5.7	6.0	6.2	6.5	6.7	6.9	7.1	7.3	7.5	7.6	22
26	3.9	4.3	4.7	5.0	5.3	5.6	5.8	6.1	6.3	6.5	6.7	6.9	7.1	7.2	26
30	3.6	4.0	4.4	4.7	5.0	5.3	5.5	5.8	6.0	6.2	6.4	6.6	6.8	6.9	30
35	3.3	3.7	4.1	4.4	4.7	5.0	5.2	5.5	5.7	5.9	6.1	6.3	6.5	6.6	35
40	3.1	3.5	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.7	5.9	6.1	6.3	6.4	40
45	2.9	3.3	3.7	4.0	4.3	4.6	4.8	5.1	5.3	5.5	5.7	5.9	6.1	6.3	45
50	2.7	3.1	3.5	3.8	4.1	4.4	4.6	4.9	5.1	5.3	5.5	5.7	5.9	6.1	50
55	2.6	3.0	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.4	5.6	5.8	6.0	55
60	2.5	2.9	3.3	3.6	3.9	4.2	4.4	4.7	4.9	5.1	5.3	5.5	5.7	5.9	60
65	2.4	2.8	3.2	3.5	3.8	4.1	4.3	4.6	4.8	5.0	5.2	5.4	5.6	5.8	65
70	2.3	2.7	3.1	3.4	3.7	4.0	4.2	4.5	4.7	4.9	5.1	5.3	5.5	5.7	70
80	2.1	2.5	2.9	3.2	3.6	3.8	4.0	4.3	4.5	4.7	4.9	5.1	5.3	5.5	80
90	1.9	2.3	2.7	3.0	3.3	3.6	3.8	4.1	4.3	4.5	4.7	4.9	5.1	5.3	90

TABLE XXI.

TO FIND THE LATITUDE BY AN ALTITUDE OF THE POLAR STAR.

When the Right Ascension of the Meridian is found in this column, the correction is Subtractive.		EXPLANATION OF THE TABLE, WHICH IS CALCULATED FOR THE YEAR 1854. Enter the side column, with the Right Ascension of the Meridian and the Altitude of the Star at the top, and at the angle of meeting will be the required correction.						When the Right Ascension of the Meridian is found in this column, the correction is Additive.		VARIATION OF THE CORRECTION IN 10 YEARS.
R. A. M.		APPARENT ALTITUDE OF THE POLAR STAR.						R. A. M.		
H. M.	H. M.	10°	20°	30°	40°	50°	60°	H. M.	H. M.	SUB.
		° ′	° ′	° ′	° ′	° ′	° ′			′
1 0	1 0	1 28	1 28	1 28	1 28	1 28	1 28	13 0	13 0	3
1 30	0 30	1 27	1 27	1 27	1 27	1 27	1 27	12 30	13 30	3
2 0	24 0	1 25	1 25	1 24	1 24	1 24	1 24	12 0	14 0	3
2 20	23 40	1 23	1 23	1 23	1 22	1 22	1 22	11 40	14 20	3
2 40	23 20	1 20	1 20	1 20	1 20	1 19	1 19	11 20	14 40	3
3 0	23 0	1 16	1 16	1 16	1 16	1 15	1 15	11 10	15 0	3
3 10	22 50	1 14	1 14	1 14	1 14	1 13	1 13	10 50	15 10	3
3 20	22 40	1 12	1 12	1 12	1 12	1 11	1 10	10 40	15 20	3
3 30	22 30	1 10	1 9	1 9	1 9	1 8	1 7	10 30	15 30	3
3 40	22 20	1 8	1 8	1 8	1 8	1 7	1 5	10 20	15 40	2
3 50	22 10	1 6	1 5	1 5	1 4	1 3	1 1	10 10	15 50	2
4 0	22 0	1 3	1 2	1 2	1 2	1 1	1 1	10 0	16 0	2
4 10	21 50	1 0	1 0	1 0	1 0	1 0	0 59	9 50	16 10	2
4 20	21 40	0 57	0 57	0 57	0 57	0 56	0 55	9 40	16 20	2
4 30	21 30	0 54	0 54	0 54	0 54	0 53	0 52	9 30	16 30	2
4 40	21 20	0 51	0 51	0 51	0 51	0 50	0 49	9 20	16 40	2
4 50	21 10	0 48	0 48	0 48	0 48	0 47	0 46	9 10	16 50	2
5 0	21 0	0 45	0 44	0 44	0 44	0 44	0 42	9 0	17 0	2
5 10	20 50	0 41	0 41	0 40	0 40	0 40	0 39	8 50	17 10	2
5 20	20 40	0 38	0 37	0 37	0 37	0 37	0 35	8 40	17 20	1
5 30	20 30	0 35	0 34	0 34	0 33	0 33	0 31	8 30	17 30	1
5 40	20 20	0 31	0 30	0 30	0 29	0 29	0 27	8 20	17 40	1
5 50	20 10	0 27	0 26	0 26	0 25	0 25	0 24	8 10	17 50	1
6 0	20 0	0 23	0 22	0 22	0 21	0 21	0 20	8 0	18 0	1
6 10	19 50	0 19	0 18	0 18	0 17	0 17	0 16	7 50	18 10	1
6 20	19 40	0 15	0 14	0 14	0 13	0 13	0 12	7 40	18 20	1
6 30	19 30	0 12	0 11	0 11	0 10	0 10	0 9	7 30	18 30	0
6 40	19 20	0 8	0 7	0 7	0 6	0 6	0 5	7 20	18 40	0
6 50	19 10	0 4	0 3	0 3	0 2	0 2	0 1	7 10	18 50	0
6 55	19 5	0 1	0 2	0 2	0 2	0 3	0 4	7 0	19 0	0

TABLE XXII.

CORRECTION OF THE TIME OF THE MOON'S MERIDIAN PASSAGE, OVER THE MERIDIAN OF GREENWICH, TO THE TIME OF HER PASSAGE OVER ANY OTHER MERIDIAN.

LONGITUDE.	DAILY VARIATION OF THE MOON'S PASSING THE MERIDIAN.													
	M. 40	M. 42	M. 44	M. 46	M. 48	M. 50	M. 52	M. 54	M. 56	M. 58	M. 60	M. 62	M. 64	M. 66
°	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.	M.
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	1	1	1	1	1	1	1	1	2	2	2	2	2
20	2	2	2	2	3	3	3	3	3	3	3	3	3	4
30	3	3	4	4	4	4	4	4	4	5	5	5	5	5
40	4	4	5	5	5	5	6	6	6	6	6	7	7	7
50	5	6	6	6	6	7	7	7	7	8	8	8	9	9
60	6	7	7	7	8	8	8	9	9	9	10	10	10	11
70	7	8	8	9	9	9	10	10	10	11	11	12	12	12
80	9	9	10	10	10	11	11	12	12	12	13	13	14	14
90	10	10	11	11	12	12	13	13	13	14	14	15	15	16
100	11	12	12	12	13	13	14	14	15	15	16	17	17	18
110	12	13	13	14	14	15	15	16	16	17	18	18	19	19
120	13	14	14	15	15	16	17	17	18	19	19	20	20	21
130	14	15	15	16	17	17	18	19	19	20	21	21	22	23
140	15	16	17	17	18	19	20	20	21	22	22	23	24	25
150	16	17	18	19	19	20	21	22	22	23	24	25	26	26
160	17	18	19	20	21	21	22	23	24	25	26	26	27	28
170	18	19	20	21	22	23	24	25	25	26	27	28	29	30
180	19	20	21	22	23	24	25	26	27	28	29	30	31	32

The Sums taken from this Table must be added to the time of the Moon's Meridian Passage in the Nautical Almanac, in West Longitude, and subtracted in East, will give the Mean Time of her Meridian Passage at the Ship.

TABLE XXIII.

FOR REDUCING THE MOON'S DECLINATION TO THE GREENWICH TIME OF THE OBSERVATION.

Diff. of Moon's Declination in 12 hours.	HOURS FROM NOON OR MIDNIGHT.											FOR ODD MINUTES.			
	1	2	3	4	5	6	7	8	9	10	11	M. 12	M. 24	M. 36	M. 48
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	′	′	′	′
0 5	0 0	0 1	0 1	0 2	0 2	0 2	0 3	0 3	0 4	0 4	0 5	0	0	0	0
0 10	0 1	0 2	0 2	0 3	0 4	0 5	0 6	0 7	0 7	0 8	0 9	0	0	0	1
0 15	0 1	0 2	0 4	0 5	0 6	0 7	0 9	0 10	0 11	0 12	0 14	0	0	1	1
0 20	0 2	0 3	0 5	0 7	0 8	0 10	0 12	0 13	0 15	0 17	0 18	0	1	1	1
0 25	0 2	0 4	0 6	0 8	0 10	0 12	0 15	0 17	0 19	0 21	0 23	0	1	1	2
0 30	0 2	0 5	0 7	0 10	0 12	0 15	0 17	0 20	0 22	0 25	0 27	0	1	1	2
0 35	0 3	0 6	0 9	0 12	0 15	0 17	0 20	0 23	0 26	0 29	0 32	1	1	2	2
0 40	0 3	0 7	0 10	0 13	0 17	0 20	0 23	0 27	0 30	0 33	0 37	1	1	2	3
0 45	0 4	0 7	0 11	0 15	0 19	0 22	0 26	0 30	0 34	0 37	0 41	1	1	2	3
0 50	0 4	0 8	0 12	0 17	0 21	0 25	0 29	0 33	0 37	0 42	0 46	1	2	2	3
0 55	0 5	0 9	0 14	0 18	0 23	0 27	0 32	0 37	0 41	0 46	0 51	1	2	3	4
1 0	0 5	0 10	0 15	0 20	0 25	0 30	0 35	0 40	0 45	0 50	0 55	1	2	3	4
1 5	0 5	0 11	0 16	0 22	0 27	0 32	0 38	0 43	0 49	0 54	1 0	1	2	3	4
1 10	0 6	0 12	0 17	0 23	0 29	0 35	0 41	0 47	0 52	0 58	1 4	1	2	3	5
1 15	0 6	0 12	0 19	0 25	0 31	0 37	0 44	0 50	0 56	1 2	1 9	1	2	4	5
1 20	0 7	0 13	0 20	0 27	0 33	0 40	0 47	0 53	1 0	1 7	1 13	1	3	4	5
1 25	0 7	0 14	0 21	0 28	0 35	0 42	0 50	0 57	1 4	1 11	1 18	1	3	4	6
1 30	0 7	0 15	0 22	0 30	0 37	0 45	0 52	1 0	1 7	1 15	1 22	1	3	4	6
1 35	0 8	0 16	0 24	0 32	0 40	0 47	0 55	1 3	1 11	1 19	1 27	2	3	5	6
1 40	0 8	0 17	0 25	0 33	0 42	0 50	0 58	1 7	1 15	1 23	1 32	2	3	5	7
1 45	0 9	0 17	0 26	0 35	0 44	0 52	1 1	1 10	1 19	1 27	1 36	2	3	5	7
1 50	0 9	0 18	0 27	0 37	0 46	0 55	1 4	1 13	1 22	1 32	1 42	2	4	5	7
1 55	0 10	0 19	0 29	0 38	0 48	0 57	1 7	1 17	1 26	1 36	1 45	2	4	6	8
2 0	0 10	0 20	0 30	0 40	0 50	1 0	1 10	1 20	1 30	1 40	1 50	2	4	6	8
2 5	0 10	0 21	0 31	0 42	0 52	1 2	1 13	1 23	1 34	1 44	1 55	2	4	6	8
2 10	0 11	0 22	0 32	0 43	0 54	1 5	1 16	1 27	1 37	1 48	1 59	2	4	6	9
2 15	0 11	0 22	0 34	0 45	0 56	1 7	1 19	1 30	1 41	1 52	2 4	2	4	7	9
2 20	0 12	0 23	0 35	0 47	0 58	1 10	1 22	1 33	1 45	1 57	2 8	2	5	7	9
2 25	0 12	0 24	0 36	0 48	1 0	1 12	1 25	1 37	1 49	2 1	2 13	2	5	7	10
2 30	0 12	0 25	0 37	0 50	1 2	1 15	1 27	1 40	1 52	2 5	2 17	2	5	7	10
2 35	0 13	0 26	0 39	0 52	1 5	1 17	1 30	1 43	1 56	2 9	2 22	3	5	8	10
2 40	0 13	0 27	0 40	0 53	1 7	1 20	1 33	1 47	2 0	2 13	2 27	3	5	8	11
2 45	0 14	0 27	0 41	0 55	1 9	1 22	1 36	1 50	2 4	2 17	2 31	3	5	8	11
2 50	0 14	0 28	0 42	0 57	1 11	1 25	1 39	1 53	2 7	2 22	2 36	3	6	8	11
2 55	0 15	0 29	0 44	0 58	1 13	1 27	1 42	1 57	2 11	2 26	2 40	3	6	9	12
3 0	0 15	0 30	0 45	1 0	1 15	1 30	1 45	2 0	2 15	2 30	2 45	3	6	9	12
3 5	0 15	0 31	0 46	1 2	1 17	1 32	1 48	2 3	2 19	2 34	2 50	3	6	9	12
3 10	0 16	0 32	0 47	1 3	1 19	1 35	1 51	2 7	2 22	2 38	2 54	3	6	9	13
3 15	0 16	0 32	0 49	1 5	1 21	1 37	1 54	2 10	2 26	2 42	2 59	3	6	10	13
3 20	0 17	0 33	0 50	1 7	1 23	1 40	1 57	2 13	2 30	2 47	3 3	3	7	10	13
3 25	0 17	0 34	0 51	1 8	1 25	1 42	2 0	2 17	2 34	2 51	3 8	3	7	10	14
3 30	0 17	0 35	0 52	1 10	1 27	1 45	2 2	2 20	2 37	2 55	3 12	3	7	10	14
3 35	0 18	0 36	0 54	1 12	1 30	1 47	2 5	2 23	2 41	2 59	3 17	4	7	11	14
3 40	0 18	0 37	0 55	1 13	1 32	1 50	2 8	2 27	2 45	3 3	3 22	4	7	11	15
3 45	0 19	0 37	0 56	1 15	1 34	1 52	2 11	2 39	2 49	3 7	3 26	4	7	11	15

NOTE.—This Table is constructed upon the following principle:—*Rule.* Say as 12 hours is to the difference or change in the Moon's Declination in 12 hours, so is the time past Greenwich Noon or Midnight to the Correction, which must be applied to the Declination at the preceding Noon or Midnight, according as it is increasing or decreasing.

TABLE XXIV.

CORRECTION OF THE MOON'S SEMIDIAMETER, OR HORIZONTAL PARALLAX, FOR ANY GIVEN TIME BETWEEN NOON AND MIDNIGHT, OR OF THE SUN OR A PLANET'S DECLINATION FOR A GIVEN TIME FROM THE PRECEDING NOON.

TIME AFTER NOON OR MIDNIGHT.	VARIATION OF THE ☽'S SEMIDIAMETER, OR HORIZONTAL PARALLAX, IN 12 HOURS.																												TIME PAST NOON.
	″ 1	″ 2	″ 3	″ 4	″ 5	″ 6	″ 7	″ 8	″ 9	″ 10	″ 11	″ 12	″ 13	″ 14	″ 15	″ 16	″ 17	″ 18	″ 19	″ 20	″ 21	″ 22	″ 23	″ 24	″ 25	″ 26	″ 27	″ 28	
H. M.																													H.
0 30	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
1 0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
1 30	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	·3	3	3	3	3	3	3	3	3
2 0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	4
2 30	0	0	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	5	5	6	5
3 0	0	0	1	1	1	1	2	2	2	2	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	6
3 30	0	1	1	1	1	2	2	2	3	3	3	3	4	4	4	5	5	5	6	6	6	6	7	7	7	8	8	8	7
4 0	0	1	1	1	2	2	2	3	3	3	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	8
4 30	0	1	1	1	2	2	3	3	3	4	4	4	5	5	6	6	6	7	7	7	8	8	9	9	9	10	10	10	9
5 0	0	1	1	2	2	2	3	3	4	4	5	5	5	6	6	7	7	7	8	8	9	9	10	10	10	11	11	12	10
5 30	0	1	1	2	2	3	3	4	4	5	5	5	6	6	7	7	8	8	9	9	10	10	11	11	11	12	12	13	11
6 0	0	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	9	10	10	11	11	12	12	13	13	14	12
6 30	1	1	2	2	3	3	4	4	5	5	6	6	7	8	8	9	9	10	10	11	11	12	12	13	14	14	15	15	13
7 0	1	1	2	2	3	3	4	5	5	6	6	7	8	8	9	9	10	10	11	12	12	13	13	14	15	15	16	16	14
7 30	1	1	2	2	3	4	4	5	6	6	7	7	8	9	9	10	11	11	12	12	13	14	14	15	16	16	17	17	15
8 0	1	1	2	3	3	4	5	5	6	7	7	8	9	9	10	11	11	12	13	13	14	15	15	16	17	17	18	19	16
8 30	1	1	2	3	4	4	5	6	6	7	8	8	9	10	11	11	12	13	13	14	15	16	16	17	18	18	19	20	17
9 0	1	1	2	3	4	4	5	6	7	7	8	9	10	10	11	12	13	13	14	15	16	16	17	18	19	19	20	21	18
9 30	1	2	2	3	4	5	6	6	7	8	9	9	10	11	12	13	13	14	15	16	17	17	18	19	20	21	21	22	19
10 0	1	2	2	3	4	5	6	7	7	8	9	10	11	12	12	13	14	15	16	17	17	18	19	20	21	22	22	23	20
10 30	1	2	3	3	4	5	6	7	8	9	10	10	11	12	13	14	15	16	17	17	18	19	20	21	22	23	24	24	21
11 0	1	2	3	4	5	5	6	7	8	9	10	11	12	13	14	15	16	16	17	18	19	20	21	22	23	24	25	26	22
11 30	1	2	3	4	5	6	7	8	9	10	11	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	23
12 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	24
TIME AFTER NOON OR MIDNIGHT.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	TIME PAST NOON.
	VARIATION OF THE ☉ OR PLANETS' DECLINATION IN 24 HOURS.																												

NOTE.—Enter this Table with the Time from Greenwich Noon or Midnight in the left side column, and the difference or change in the Semidiameter and Horizontal Parallax in 12 hours at the top, and at the angle of meeting, will be the correction; or, enter the right side of the Table with the Time from Greenwich Noon, and the difference or change of the Sun or Planet's Declination, at the bottom and at the angle of meeting, will be the correction, to be applied according as they are increasing or decreasing.

TABLE XXV.

CONTAINING THE CORRECTION FOR THE MOON'S PARALLAX IN ALTITUDE, GIVEN IN MINUTES AND TENTHS, WHICH IS ALWAYS ADDITIVE TO THE APPARENT ALTITUDE.

☽'s Ap. Alt.	HORIZONTAL PARALLAX.								☽'s Ap. Alt.	HORIZONTAL PARALLAX.							
	54′	55′	56′	57′	58′	59′	60′	61		54′	55′	56′	57′	58′	59′	60′	61′
°	′	′	′	′	′	′	′	′	°	′	′	′	′	′	′	′	′
5	43·9	44·9	45·9	46·9	47·9	48·9	49·9	50·9	48	35·3	35·9	36·6	37·3	38·0	38·6	39·3	40·0
6	45·2	46·2	47·2	48·2	49·2	50·2	51·2	52·2	49	34·6	35·3	35·9	36·6	37·2	37·9	38·5	39·2
7	46·2	47·2	48·2	49·2	50·2	51·2	52.2	53·2	50	33·9	34·6	35·2	35·8	36·5	37·1	36·8	38·4
8	46·9	47·9	48·9	49·9	50·9	51·9	52·9	53·9	51	33·2	33·8	34·5	35·1	35·7	36·4	37·0	37·6
9	47·6	48·6	49·6	50·6	51·6	52·6	53·6	54·6	52	32·5	33·1	33·7	34·4	35·0	35·6	36·2	36·8
10	47·9	48·9	49·8	50·8	51·8	52·8	53·8	54.8	53	31·8	32·4	33·0	33·6	34·2	34·8	35·4	36·0
11	48·2	49·2	50·1	51·1	52·1	53·1	54·1	55·0	54	31·1	31·6	32·2	32·8	33·4	34·0	34·6	35·2
12	48·4	49·4	50·4	51·3	52·3	53·3	54·2	55·2	55	30·3	30·9	31·5	32·0	32·6	33·2	33·8	34·3
13	48·5	49·5	50·5	51·4	52·4	53·4	54·4	55·3	56	29·6	30·1	30·7	31·2	31·8	32·4	32·9	33·5
14	48·6	49·6	50.5	51·5	52·5	53·4	54·4	55·4	57	28·8	29·3	29·9	30·4	31·0	31·5	32·1	32·6
15	48·6	49·6	50·5	51·5	52·5	53·4	54·4	55·4	58	28·0	28·6	29·1	29·6	30·1	30·7	31·2	31·7
16	48·6	49·5	50·5	51·5	52·4	53·4	54·4	55·3	59	27·2	27·8	28·3	28·6	29·3	29·6	30·3	30·9
17	48·5	49·5	50·4	51·4	52·3	53·3	54·3	55·2	60	26·5	27·0	27·5	28·0	28·5	29·0	29·5	30·0
18	48·4	49·4	50·3	51·3	52·2	53·2	54·1	55·1	61	25·7	26·1	26·6	27·1	27·6	28·1	28·6	29·1
19	48·3	49·2	50·2	51·1	52·1	53·0	53·9	54·9	62	24·9	25·3	25·6	26·3	26·7	27·2	27·7	28·1
20	48·1	49·1	50·0	50·9	51·9	52·8	53·8	54·7	63	24·0	24·5	24·9	25·4	25·9	26·3	26·8	27·2
21	47·9	48·9	49·8	50·7	51·7	52·6	53·5	54·6	64	23·2	23·7	24·1	24·5	25·0	25·4	25·8	26·3
22	47·7	48·6	49·5	50·5	51·4	52·3	53·3	54·2	65	22·4	22·8	23·2	23·7	24·1	24·5	24·9	25·3
23	47·4	48·4	49·3	50·2	51·1	52·1	53·0	53·9	66	21·5	22·0	22·4	22·8	23·2	23·6	24·0	24·4
24	47·2	48·1	49·0	49·9	50·9	51·8	52·7	53·6	67	20·7	21·1	21·5	21·9	22·3	22·7	23·0	23·4
25	46·9	47·8	48·7	49·6	50·5	51·4	52·3	52·2	68	19·9	20·2	20·6	21·0	21·4	21·7	22·1	22·5
26	46·6	47·5	48·4	49·3	50·2	51·1	52·0	52·9	69	19·0	19·4	19·7	20·1	20·4	20·8	21·1	20·5
27	46·2	47·1	48·0	48·9	49·8	50·7	51·6	52·5	70	18·1	18·5	18·8	19·2	19·5	19·8	20·2	20·5
28	45·9	46·8	47·6	48·5	49·4	50·3	51·2	52·1	71	17·3	17·6	17·9	18·2	18·6	18·9	19·2	19·5
29	45·5	46·4	47·3	48·1	49·0	49·9	50·8	51·6	72	16·4	16·7	17·0	17·3	17·6	17·9	18·2	18·5
30	45·1	46·0	46·8	47·7	48·6	49·4	50·3	51·2	73	15·5	15·8	16·1	16·4	16·7	17·0	17·3	17·6
31	44·7	45·6	46·4	47·3	48·1	49·0	49·9	50·7	74	14·6	14·9	15·2	15·4	15·7	16·0	16·3	16·5
32	44·3	45·1	45·9	46·8	47·7	48·5	49·4	50·2	75	13·7	14·0	14·2	14·5	14·8	15·0	15·3	15·5
33	43·8	44·7	45·5	46·3	47·2	48·0	48·9	49·7	76	12·8	13·1	13·3	13·5	13·8	14·0	14·3	14·5
34	43·4	44·2	45·0	45·8	46·7	47·5	48·3	49·2	77	11·9	12·2	12·4	12·6	12·8	13·1	13·3	13·5
35	43·0	43·7	44·5	45·3	46·1	46·9	47·8	48·6	78	11·0	11·2	11·4	11·7	11·9	12·1	12·3	12·5
36	42·3	43·2	43·9	44·8	45·6	46·4	47·2	48·0	79	10·1	10·3	10·5	10·7	10·9	11·1	11·3	11·5
37	41·9	42·7	43·5	44·3	45·1	45·9	46·8	47·5	80	9·2	9·4	9·6	9·7	9·9	10·1	10·3	10·4
38	41·3	42·1	42·9	43·7	44·5	45·3	46·1	46·9	81	8·3	8·5	8·6	8·8	8·9	9·1	9·2	9·4
39	40·8	41·6	42·3	43·1	43·9	44·7	45·4	46·2	82	7·4	7·5	7·7	7·8	7·9	8·1	8·2	8·4
40	40·2	41·0	41·8	42·5	43·3	44·1	44·8	45·6	83	6·5	6·6	6·7	6·8	6·9	7·1	7·2	7·3
41	39·7	40·4	41·2	41·9	42·7	43·4	44·2	44·9	84	5·6	5·7	5·8	5·9	6·0	6·1	6·2	6·3
42	39·1	39·8	40·6	41·3	42·0	42·8	43·5	44·3	85	4·6	4·7	4·8	4·9	5·0	5·1	5·2	5·3
43	38·5	39·2	39·9	40·7	41·4	42·1	42·9	43·6	86	3·7	3·8	3·8	3·9	4·0	4·0	4·1	4·2
44	37·9	38·6	39·3	40·1	40·7	41·5	42·2	42·9	87	2·8	2·8	2·9	2·9	3·0	3·0	3·1	3·1
45	37·2	37·9	38·6	39·4	40·1	40·8	41·5	42·2	88	1·9	1·9	1·9	2·0	2·0	2·0	2·1	2·1
46	36·6	37·3	38·0	38·7	39·4	40·1	40·8	41·5	89	0·9	0·9	1·0	1·0	1·0	1·0	1·0	1·0
47	35·9	36·6	37·3	38·0	38·7	39·4	40·0	40·7	90	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0

Enter this Table with the Apparent Altitude at the side, and the Horizontal Parallax at the top, and at the angle of meeting will be the required correction; and if Seconds be required, multiply the Tenths by 6 will give Seconds.

TABLE XXVI.

TO TURN DEGREES INTO TIME, OR, TIME INTO DEGREES.

Degrees.	Time. H. M.	Degrees.	Time. H. M.	Degrees.	Time. H. M.	Minutes of Degrees.	Time. M. S.	Seconds of Degrees.	Time. S. T.
1	0. 4	61	4. 4	121	8. 4	1	0. 4	1	0. 4
2	0. 8	62	4. 8	122	8. 8	2	0. 8	2	0. 8
3	0.12	63	4.12	123	8.12	3	0.12	3	0.12
4	0.16	64	4.16	124	8.16	4	0.16	4	0.16
5	0.20	65	4.20	125	8.20	5	0.20	5	0.20
6	0.24	66	4.24	126	8.24	6	0.24	6	0.24
7	0.28	67	4.28	127	8.28	7	0.28	7	0.28
8	0.32	68	4.32	128	8.32	8	0.32	8	0.32
9	0.36	69	4.36	129	8.36	9	0.36	9	0.36
10	0.40	70	4.40	130	8.40	10	0.40	10	0.40
11	0.44	71	4.44	131	8.44	11	0.44	11	0.44
12	0.48	72	4.48	132	8.48	12	0.48	12	0.48
13	0.52	73	4.52	133	8.52	13	0.52	13	0.52
14	0.56	74	4.56	134	8.56	14	0.56	14	0.56
15	1. 0	75	5. 0	135	9. 0	15	1. 0	15	1. 0
16	1. 4	76	5. 4	136	9. 4	16	1. 4	16	1. 4
17	1. 8	77	5. 8	137	9. 8	17	1. 8	17	1. 8
18	1.12	78	5.12	138	9.12	18	1.12	18	1.12
19	1.16	79	5.16	139	9.16	19	1.16	19	1.16
20	1.20	80	5.20	140	9.20	20	1.20	20	1.20
21	1.24	81	5.24	141	9.24	21	1.24	21	1.24
22	1.28	82	5.28	142	9.28	22	1.28	22	1.28
23	1.32	83	5.32	143	9.32	23	1.32	23	1.32
24	1.36	84	5.36	144	9.36	24	1.36	24	1.36
25	1.40	85	5.40	145	9.40	25	1.40	25	1.40
26	1.44	86	5.44	146	9.44	26	1.44	26	1.44
27	1.48	87	5.48	147	9.48	27	1.48	27	1.48
28	1.52	88	5.52	148	9.52	28	1.52	28	1.52
29	1.56	89	5.56	149	9.56	29	1.56	29	1.56
30	2. 0	90	6. 0	150	10. 0	30	2. 0	30	2. 0
31	2. 4	91	6. 4	151	10. 4	31	2. 4	31	2. 4
32	2. 8	92	6. 8	152	10. 8	32	2. 8	32	2. 8
33	2.12	93	6.12	153	10.12	33	2.12	33	2.12
34	2.16	94	6.16	154	10.16	34	2.16	34	2.16
35	2.20	95	6.20	155	10.20	35	2.20	35	2.20
36	2.24	96	6.24	156	10.24	36	2.24	36	2.24
37	2.28	97	6.28	157	10.28	37	2.28	37	2.28
38	2.32	98	6.32	158	10.32	38	2.32	38	2.32
39	2.36	99	6.36	159	10.36	39	2.36	39	2.36
40	2.40	100	6.40	160	10.40	40	2.40	40	2.40
41	2.44	101	6.44	161	10.44	41	2.44	41	2.44
42	2.48	102	6.48	162	10.48	42	2.48	42	2.48
43	2.52	103	6.52	163	10.52	43	2.52	43	2.52
44	2.56	104	6.56	164	10.56	44	2.56	44	2.56
45	3. 0	105	7. 0	165	11. 0	45	3. 0	45	3. 0
46	3. 4	106	7. 4	166	11. 4	46	3. 4	46	3. 4
47	3. 8	107	7. 8	167	11. 8	47	3. 8	47	3. 8
48	3.12	108	7.12	168	11.12	48	3.12	48	3.12
49	3.16	109	7.16	169	11.16	49	3.16	49	3.16
50	3.20	110	7.20	170	11.20	50	3.20	50	3.20
51	3.24	111	7.24	171	11.24	51	3.24	51	3.24
52	3.28	112	7.28	172	11.28	52	3.28	52	3.28
53	3.32	113	7.32	173	11.32	53	3.32	53	3.32
54	3.36	114	7.36	174	11.36	54	3.36	54	3.36
55	3.40	115	7.40	175	11.40	55	3.40	55	3.40
56	3.44	116	7.44	176	11.44	56	3.44	56	3.44
57	3.48	117	7.48	177	11.48	57	3.48	57	3.48
58	3.52	118	7.52	178	11.52	58	3.52	58	3.52
59	3.56	119	7.56	179	11.56	59	3.56	59	3.56
60	4. 0	120	8. 0	180	12. 0	60	4. 0	60	4. 0

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, OR POLAR DISTANCE. SECANT.

M.	0° or 90°	1° . 91°	2° . 92°	3° . 93°	4° . 94°	5° . 95°	6° . 96°	7° . 97°	8° . 98°	9° . 99°	
0	0 00000	00007	00026	00060	00106	00166	00239	00325	00425	00538	60
1	00000	00007	00027	00060	00107	00167	00240	00326	00426	00540	59
2	00000	00007	00027	00061	00108	00168	00241	00328	00428	00542	58
3	00000	00007	00028	00062	00108	00169	00243	00330	00430	00544	57
4	00000	00008	00028	00062	00109	00170	00244	00331	00432	00546	56
5	0.00000	00008	00029	00063	00110	00171	00245	00333	00434	00548	55
6	00000	00008	00029	00064	00111	00172	00247	00334	00435	00550	54
7	00000	00008	00030	00064	00112	00173	00248	00336	00437	00552	53
8	00000	00008	00030	00065	00113	00175	00249	00337	00439	00554	52
9	00000	00009	00031	00066	00114	00176	00251	00339	00441	00556	51
10	0.00000	00009	00031	00066	00115	00177	00252	00341	00443	00558	50
11	00000	00009	00032	00067	00116	00178	00253	00342	00444	00560	49
12	00000	00010	00032	00068	00117	00179	00255	00344	00446	00562	48
13	00000	00010	00033	00068	00118	00180	00256	00345	00448	00564	47
14	00000	00010	00033	00069	00119	00181	00258	00347	00450	00566	46
15	0.00000	00010	00033	00070	00120	00183	00259	00349	00452	00568	45
16	00000	00011	00034	00071	00121	00184	00260	00350	00454	00571	44
17	00001	00011	00034	00071	00121	00185	00262	00352	00455	00573	43
18	00001	00011	00035	00072	00122	00186	00263	00353	00457	00575	42
19	00001	00011	00036	00073	00123	00187	00264	00355	00459	00577	41
20	0.00001	00012	00036	00074	00124	00188	00266	00357	00461	00579	40
21	00001	00012	00037	00074	00125	00190	00267	00358	00463	00581	39
22	00001	00012	00037	00075	00126	00191	00269	00360	00465	00583	38
23	00001	00013	00038	00076	00127	00192	00270	00362	00467	00585	37
24	00001	00013	00038	00077	00128	00193	00272	00363	00468	00587	36
25	0.00001	00013	00039	00077	00129	00194	00273	00365	00470	00589	35
26	00001	00014	00039	00078	00130	00196	00274	00367	00472	00591	34
27	00001	00014	00040	00079	00131	00197	00276	00368	00474	00593	33
28	00001	00014	00040	00080	00132	00198	00277	00370	00476	00596	32
29	00002	00015	00041	00080	00133	00199	00279	00371	00478	00598	31
30	0.00002	00015	00041	00081	00134	00200	00280	00373	00480	00600	30
31	00002	00015	00042	00082	00135	00202	00282	00375	00482	00602	29
32	00002	00016	00042	00083	00136	00203	00283	00376	00483	00604	28
33	00002	00016	00043	00083	00137	00204	00284	00378	00485	00606	27
34	00002	00016	00044	00084	00138	00205	00286	00380	00487	00608	26
35	0.00002	00017	00044	00085	00139	00207	00287	00382	00489	00610	25
36	00002	00017	00045	00086	00140	00208	00289	00383	00491	00612	24
37	00003	00017	00045	00087	00141	00209	00290	00385	00493	00615	23
38	00003	00018	00046	00087	00142	00210	00292	00387	00495	00617	22
39	00003	00018	00046	00088	00143	00212	00293	00388	00497	00619	21
40	0.00003	00018	00047	00089	00144	00213	00295	00390	00499	00621	20
41	00003	00019	00048	00090	00145	00214	00296	00392	00501	00623	19
42	00003	00019	00048	00091	00146	00215	00298	00393	00503	00625	18
43	00003	00019	00049	00091	00147	00217	00299	00395	00505	00628	17
44	00004	00020	00049	00092	00148	00218	00301	00397	00506	00630	16
45	0.00004	00020	00050	00093	00149	00219	00302	00399	00508	00632	15
46	00004	00021	00051	00094	00150	00220	00304	00400	00510	00634	14
47	00004	00021	00051	00095	00152	00222	00305	00402	00512	00636	13
48	00004	00021	00052	00096	00153	00223	00307	00404	00514	00638	12
49	00004	00022	00052	00096	00154	00224	00308	00405	00516	00641	11
50	0.00005	00022	00053	00097	00155	00225	00310	00407	00518	00643	10
51	00005	00023	00054	00098	00156	00227	00311	00409	00520	00645	9
52	00005	00023	00054	00099	00157	00228	00313	00411	00522	00647	8
53	00005	00023	00055	00100	00158	00229	00314	00412	00524	00649	7
54	00005	00024	00056	00101	00159	00231	00316	00414	00526	00652	6
55	0 00006	00024	00056	00102	00160	00232	00317	00416	00528	00654	5
56	00006	00025	00057	00102	00161	00233	00319	00418	00530	00656	4
57	00006	00025	00058	00103	00162	00235	00320	00419	00532	00658	3
58	00006	00026	00058	00104	00163	00236	00322	00421	00534	00660	2
59	00006	00026	00059	00105	00164	00237	00323	00423	00536	00663	1
60	00006	00026	00060	00106	00165	00239	00325	00425	00538	0066[illegible]	0
	89°	88°	87°	86°	85°	84°	83°	82°	81°	80°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, OR POLAR DISTANCE. SECANT.

M.	10° or 100°	11°.101°	12°.102°	13°.103°	14°.104°	15°.105°	16°.106°	17°.107°	18°.108°	19°.109°	
0	0.00665	00805	00960	01128	01310	01506	01716	01940	02179	02433	60
1	00667	00808	00962	01131	01313	01509	01719	01944	02183	02437	59
2	00669	00810	00965	01133	01316	01512	01723	01948	02188	02442	58
3	00672	00813	00968	01136	01319	01516	01727	01952	02192	02446	57
4	00674	00815	00970	01139	01322	01519	01730	01956	02196	02450	56
5	0.00676	00818	00973	01142	01325	01523	01734	01960	02200	02455	55
6	00678	00820	00976	01145	01329	01526	01738	01964	02204	02459	54
7	00681	00823	00978	01148	01332	01529	01741	01968	02208	02464	53
8	00683	00825	00981	01151	01335	01533	01745	01971	02212	02468	52
9	00685	00828	00984	01154	01338	01536	01748	01975	02216	02472	51
10	0.00687	00830	00987	01157	01341	01540	01752	01979	02221	02477	50
11	00690	00833	00989	01160	01344	01543	01756	01983	02225	02481	49
12	00692	00835	00992	01163	01348	01547	01760	01987	02229	02485	48
13	00694	00838	00995	01166	01351	01550	01763	01991	02233	02490	47
14	00696	00840	00998	01169	01354	01553	01767	01995	02237	02494	46
15	0.00699	00843	01000	01172	01357	01557	01771	01999	02241	02499	45
16	00701	00845	01003	01175	01360	01560	01774	02003	02246	02503	44
17	00703	00848	01006	01178	01364	01564	01778	02007	02250	02508	43
18	00706	00850	01009	01181	01367	01567	01782	02011	02254	02512	42
19	00708	00853	01011	01184	01370	01571	01785	02014	02258	02516	41
20	0.00710	00855	01014	01187	01373	01574	01789	02018	02262	02521	40
21	00712	00858	01017	01190	01377	01578	01793	02022	02266	02525	39
22	00715	00860	01020	01193	01380	01581	01796	02026	02271	02530	38
23	00717	00863	01022	01196	01383	01585	01800	02030	02275	02534	37
24	00719	00865	01025	01199	01386	01588	01804	02034	02279	02539	36
25	0.00722	00868	01028	01202	01390	01591	01808	02038	02283	02543	35
26	00724	00870	01031	01205	01393	01595	01811	02042	02287	02547	34
27	00726	00873	01033	01208	01396	01598	01815	02046	02292	02552	33
28	00729	00876	01036	01211	01399	01602	01819	02050	02296	02556	32
29	00731	00878	01039	01214	01403	01605	01823	02054	02300	02561	31
30	0 00733	00881	01042	01217	.01406	01609	01826	02058	02304	02565	30
31	00736	00883	01045	01220	01409	01612	01830	02062	02309	02570	29
32	00738	00886	01047	01223	01412	01616	01834	02066	02313	02574	28
33	00740	00888	01050	01226	01416	01619	01838	02070	02317	02579	27
34	00743	00891	01053	01229	01419	01623	01841	02074	02321	02583	26
35	0.00745	00894	01056	01232	01422	01627	01845	02078	02326	02588	25
36	00748	00896	01059	01235	01426	01630	01849	02082	02330	02592	24
37	00750	00899	01062	01238	01429	01634	01853	02086	02334	02597	23
38	00752	00901	01064	01241	01432	01637	01856	02090	02338	02601	22
39	00755	00904	01067	01244	01435	01641	01860	02094	02343	02606	21
40	0.00757	00907	01070	01247	01439	01644	01864	02098	02347	02610	20
41	00759	00909	01073	01250	01442	01648	01868	02102	02351	02615	19
42	00762	00912	01076	01254	01445	01651	01871	02106	02355	02619	18
43	00764	00914	01079	01257	01449	01655	01875	02110	02360	02624	17
44	00767	00917	01081	01260	01452	01658	01879	02114	02364	02628	16
45	0.00769	00920	01084	01263	01455	01662	01883	02118	02368	02633	15
46	00771	00922	01087	01266	01459	01666	01887	02122	02372	02637	14
47	00774	00925	01090	01269	01462	01669	01890	02126	02377	02642	13
48	00776	00928	01093	01272	01465	01673	01894	02130	02381	02647	12
49	00779	00930	01096	01275	01469	01676	01898	02134	02385	02651	11
50	0.00781	00933	01099	01278	01472	01680	01902	02139	02390	02656	10
51	00783	00936	01102	01281	01475	01683	01906	02143	02394	02660	9
52	00786	00938	01104	01285	01479	01687	01910	02147	02398	02665	8
53	00788	00941	01107	01288	01482	01691	01913	02151	02403	02669	7
54	00791	00944	01110	01291	01485	01694	01917	02155	02407	02674	6
55	0 00793	00946	01113	01294	01489	01698	01921	02159	02411	02678	5
56	00796	00949	01116	01297	01492	01701	01925	02163	02416	02683	4
57	00798	00952	01119	01300	01495	01705	01929	02167	02420	02688	3
58	00800	00954	01122	01303	01499	01709	01933	02171	02424	02692	2
59	00803	00957	01125	01306	01502	01712	01937	02175	02429	02697	1
60	00805	00960	01128	01310	01506	01716	01940	02179	02433	02701	0
	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, OR POLAR DISTANCE. SECANT.

M.	20° or 110°	21°.111°	22°.112°	23°.113°	24°.114°	25°.115°	26°.116°	27° 117°	28°.118°	29°.119°	
0	0.02701	02985	03283	03597	03927	04272	04634	05012	05407	05818	60
1	02706	02990	03289	03603	03933	04278	04640	05018	05413	05825	59
2	02711	02995	03294	03608	03938	04284	04646	05025	05420	05832	58
3	02715	02999	03299	03613	03944	04290	04652	05031	05427	05839	57
4	02720	03004	03304	03619	03950	04296	04659	05038	05433	05846	56
5	0.02724	03009	03309	03624	03955	04302	04665	05044	05440	05853	55
6	02729	03014	03314	03630	03961	04308	04671	05051	05447	05860	54
7	02734	03019	03319	03635	03966	04314	04677	05057	05454	05867	53
8	02738	03024	03324	03640	03972	04320	04683	05064	05460	05874	52
9	02743	03029	03330	03646	03978	04326	04690	05070	05467	05881	51
10	0.02748	03034	03335	03651	03983	04332	04696	05077	05474	05888	50
11	02752	03038	03340	03657	03989	04337	04702	05083	05481	05895	49
12	02757	03043	03345	03662	03995	04343	04708	05089	05487	05902	48
13	02762	03048	03350	03667	04000	04349	04714	05096	05494	05910	47
14	02766	03053	03355	03673	04006	04355	04721	05102	05501	05917	46
15	0.02771	03058	03360	03678	04012	04361	04727	05109	05508	05924	45
16	02776	03063	03366	03684	04018	04367	04733	05115	05515	05931	44
17	02780	03068	03371	03689	04023	04373	04739	05122	05521	05938	43
18	02785	03073	03376	03695	04029	04379	04746	05129	05528	05945	42
19	02790	03078	03381	03700	04035	04385	04752	05135	05535	05952	41
20	0.02794	03083	03386	03706	04040	04391	04758	05142	05542	05959	40
21	02799	03088	03392	03711	04046	04397	04764	05148	05549	05966	39
22	02804	03093	03397	03716	04052	04403	04771	05155	05555	05973	38
23	02808	03097	03402	03722	04058	04409	04777	05161	05562	05980	37
24	02813	03102	03407	03727	04063	04415	04783	05168	05569	05988	36
25	0.02818	03107	03412	03733	04069	04421	04789	05174	05576	05995	35
26	02822	03112	03418	03738	04075	04427	04796	05181	05583	06002	34
27	02827	03117	03423	03744	04080	04439	04802	05187	05590	06009	33
28	02832	03122	03428	03749	04086	04439	04808	05194	05596	06016	32
29	02837	03127	03433	03755	04092	04445	04815	05201	05603	06023	31
30	0.02841	03132	03438	03760	04098	04451	04821	05207	05610	06030	30
31	02846	03137	03444	03766	04103	04457	04827	05214	05617	06037	29
32	02851	03142	03449	03771	04109	04463	04833	05220	05624	06045	28
33	02855	03147	03454	03777	04115	04469	04840	05227	05631	06052	27
34	02860	03152	03459	03782	04121	04475	04846	05233	05638	06059	26
35	0.02865	03157	03465	03788	04127	04481	04852	05240	05645	06066	25
36	02870	03162	03470	03793	04132	04487	04859	05247	05651	06073	24
37	02874	03167	03475	03799	04138	04493	04865	05253	05658	06080	23
38	02879	03172	03480	03804	04144	04500	04871	05260	05665	06088	22
39	02884	03177	03486	03810	04150	04506	04878	05266	05672	06095	21
40	0.02889	03182	03491	03815	04156	04512	04884	05273	05679	06102	20
41	02893	03187	03496	03821	04161	04518	04890	05280	05686	06109	19
42	02898	03192	03502	03826	04167	04524	04897	05286	05693	06116	18
43	02903	03197	03507	03832	04173	04530	04903	05293	05700	06124	17
44	02908	03202	03512	03838	04179	04536	04910	05300	05707	06131	16
45	0.02913	03207	03517	03843	04185	04542	04916	05306	05714	06138	15
46	02917	03212	03523	03849	04190	04548	04922	05315	05721	06145	14
47	02922	03217	03528	03854	04196	04554	04929	05320	05727	06153	13
48	02927	03222	03533	03860	04202	04560	04935	05326	05734	06160	12
49	02932	03228	03539	03865	04208	04566	04941	05333	05741	06167	11
50	0.02937	03233	03544	03871	04214	04573	04948	05340	05748	06174	10
51	02941	03238	03549	03877	04220	04579	04954	05346	05755	06181	9
52	02946	03243	03555	03882	04225	04585	04961	05353	05762	06189	8
53	02951	03248	03560	03888	04231	04591	04967	05360	05769	06196	7
54	02956	03253	03565	03893	04237	04597	04973	05366	05776	06203	6
55	0.02961	03258	03571	03899	04243	04603	04980	05373	05783	06211	5
56	02965	03263	03576	03905	04249	04609	04986	05380	05796	06218	4
57	02970	03268	03581	03910	04255	04616	04993	05386	05797	06225	3
58	02975	03273	03587	03916	04261	04622	04999	05393	05804	06232	2
59	02980	03278	03592	03921	04267	04628	05005	05400	05811	06240	1
60	02985	03283	03597	03927	04272	04634	05012	05407	05818	06247	0
	69°	68°	67°	66°	65°	64°	63°	62°	61°	60°	M.

POLAR DISTANCE. CO-SECANT.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, OR POLAR DISTANCE. SECANT

M.	30° or 120°	31°.121°	32°.122°	33°.123°	34°.124°	35°.125°	36°.126°	37°.127°	38°.128°	39°.129°	
0	0.06247	06693	07158	07641	08143	08664	09204	09765	10347	10950	60
1	06254	06701	07166	07649	08151	08672	09213	09775	10357	10960	59
2	06262	06709	07174	07657	08160	08681	09223	09784	10367	10970	58
3	06269	06716	07182	07665	08168	08690	09232	09794	10376	10980	57
4	06276	06724	07190	07674	08177	08699	09241	09803	10386	10991	56
5	0.06283	06731	07197	07682	08185	08708	09250	09813	10396	11001	55
6	06291	06739	07205	07690	08194	08717	09259	09822	10406	11011	54
7	06298	06747	07213	07698	08202	08726	09269	09832	10416	11022	53
8	06305	06754	07221	07707	08211	08734	09278	09841	10426	11032	52
9	06313	06762	07229	07715	08219	08743	09287	09851	10436	11042	51
10	0.06320	06770	07237	07723	08228	08752	09296	09861	10446	11052	50
11	06327	06777	07245	07734	08237	08761	09306	09870	10456	11063	49
12	06335	06785	07253	07740	08245	08770	09315	09880	10466	11073	48
13	06342	06793	07261	07748	08254	08779	09324	09889	10476	11083	47
14	06350	06800	07269	07756	08262	08788	09333	09899	10486	11094	46
15	0.06357	06808	07277	07765	08271	08797	09343	09909	10496	11104	45
16	06364	06816	07285	07773	08280	08806	09352	09918	10505	11114	44
17	06372	06823	07293	07781	08288	08815	09361	09928	10515	11125	43
18	06379	06831	07301	07789	08297	08824	09370	09937	10525	11135	42
19	06386	06839	07309	07798	08305	08833	09380	09947	10535	11145	41
20	0.06394	06846	07317	07806	08314	08842	09389	09957	10545	11156	40
21	06401	06854	07325	07814	08323	08851	09398	09966	10555	11166	39
22	06409	06862	07333	07823	08331	08859	09408	09976	10565	11176	38
23	06416	06869	07341	07831	08340	08868	09417	09986	10575	11187	37
24	06423	06877	07349	07839	08349	08877	09426	09995	10585	11197	36
25	0.06431	06885	07357	07848	08357	08886	09435	10005	10595	11207	35
26	06438	06892	07365	07856	08366	08895	09445	10015	10605	11218	34
27	06446	06900	07373	07864	08375	08904	09454	10024	10615	11228	33
28	06453	06908	07381	07873	08383	08913	09463	10034	10625	11239	32
29	06461	06916	07389	07881	08392	08922	09473	10044	10636	11249	31
30	0.06468	06923	07397	07889	08401	08931	09482	10053	10646	11259	30
31	06475	06931	07405	07898	08409	08940	09491	10063	10656	11270	29
32	06483	06939	07413	07906	08418	08949	09501	10073	10666	11280	28
33	06490	06947	07421	07914	08427	08958	09510	10084	10676	11291	27
34	06498	06954	07429	07923	08435	08967	09520	10092	10686	11301	26
35	0.06505	06962	07437	07931	08444	08977	09529	10102	10696	11312	25
36	06513	06970	07445	07940	08453	08986	09538	10112	10706	11322	24
37	06520	06978	07454	07948	08462	08995	09548	10121	10716	11332	23
38	06528	06986	07462	07956	08470	09004	09557	10131	10726	11343	22
39	06535	06993	07470	07965	08479	09013	09566	10141	10736	11353	21
40	0.06543	07001	07478	07973	08488	09022	09576	10151	10746	11364	20
41	06550	07009	07486	07982	08496	09031	09585	10160	10756	11374	19
42	06558	07017	07494	07990	08505	09040	09595	10170	10767	11385	18
43	06565	07024	07502	07998	08514	09049	09604	10180	10777	11395	17
44	06573	07032	07510	08007	08523	09058	09614	10190	10787	11406	16
45	0.06580	07040	07518	08015	08531	09067	09623	10199	10797	11416	15
46	06588	07048	07527	08024	08540	09076	09632	10209	10807	11427	14
47	06595	07056	07535	08032	08549	09085	09642	10219	10817	11437	13
48	06603	07064	07543	08041	08558	09094	09651	10229	10827	11448	12
49	06610	07071	07551	08049	08567	09104	09661	10239	10838	11458	11
50	0.06618	07079	07559	08058	08575	09113	09670	10248	10848	11469	10
51	06625	07087	07567	08066	08584	09122	09680	10258	10858	11479	9
52	06633	07095	07575	08075	08593	09131	09689	10268	10868	11490	8
53	06640	07103	07584	08084	08602	09140	09699	10278	10878	11501	7
54	06648	07111	07592	08092	08611	09149	09708	10288	10888	11511	6
55	0.06656	07119	07600	08100	08619	09158	09718	10298	10899	11522	5
56	06663	07126	07608	08109	08628	09168	09727	10307	10909	11532	4
57	06671	07134	07616	08117	08637	09177	09737	10317	10919	11543	3
58	06678	07142	07624	08126	08646	09186	09746	10327	10929	11553	2
59	06686	07150	07633	08134	08655	09195	09756	10337	10940	11564	1
60	06693	07158	07641	08143	08664	09204	09765	10347	10950	11575	0
	59°	58°	57°	56°	55°	54°	53°	52°	51°	50°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, OR POLAR DISTANCE. SECANT.

M.	40° or 130°	41°.131°	42°.132°	43°.133°	44°.134°	45°.135°	46°.136°	47°.137°	48°.138°	49°.139°	
0	0.11575	12222	12893	13587	14307	15051	15823	16622	17449	18306	60
1	11585	12233	12904	13599	14319	15064	15836	16635	17463	18320	59
2	11596	12244	12915	13611	14331	15077	15849	16649	17477	18335	58
3	11606	12255	12927	13623	14343	15089	15862	16662	17491	18349	57
4	11617	12266	12938	13634	14355	15102	15875	16676	17505	18364	56
5	0.11628	12277	12950	13646	14368	15115	15888	16689	17519	18378	55
6	11638	12288	12961	13658	14380	15127	15901	16703	17533	18393	54
7	11649	12299	12972	13670	14392	15140	15915	16717	17547	18408	53
8	11660	12310	12984	13682	14404	15153	15928	16730	17561	18422	52
9	11670	12321	12995	13694	14417	15165	15941	16744	17576	18437	51
10	0.11681	12332	13007	13705	14429	15178	15954	16758	17590	18451	50
11	11692	12343	13018	13717	14441	15191	15967	16771	17604	18466	49
12	11702	12354	13030	13729	14453	15204	15980	16785	17618	18481	48
13	11713	12365	13041	13741	14466	15216	15994	16798	17632	18495	47
14	11724	12376	13053	13753	14478	15229	16007	16812	17646	18510	46
15	0.11734	12387	13064	13765	14490	15242	16020	16826	17660	18525	45
16	11745	12399	13076	13777	14503	15255	16033	16839	17674	18539	44
17	11756	12410	13087	13789	14515	15267	16046	16853	17689	18554	43
18	11766	12421	13098	13800	14527	15280	16060	16867	17703	18569	42
19	11777	12432	13110	13812	14540	15293	16073	16880	17717	18583	41
20	0.11788	12443	13121	13824	14552	15306	16086	16894	17731	18598	40
21	11799	12454	13133	13836	14564	15318	16099	16908	17745	18613	39
22	11809	12465	13145	13848	14577	15331	16113	16922	17760	18628	38
23	11820	12476	13156	13860	14589	15344	16126	16935	17774	18642	37
24	11831	12487	13168	13872	14601	15357	16139	16949	17788	18657	36
25	0.11842	12499	13179	13884	14614	15370	16152	16963	17802	18672	35
26	11852	12510	13191	13896	14626	15382	16166	16977	17816	18686	34
27	11863	12521	13202	13908	14639	15395	16179	16990	17831	18701	33
28	11874	12532	13214	13920	14651	15408	16192	17004	17845	18716	32
29	11885	12543	13225	13932	14663	15421	16205	17018	17859	18731	31
30	0.11895	12554	13237	13944	14676	15434	16219	17032	17874	18746	30
31	11906	12566	13248	13956	14688	15447	16232	17045	17888	18760	29
32	11917	12577	13260	13968	14701	15460	16245	17059	17902	18775	28
33	11928	12588	13272	13980	14713	15472	16259	17073	17916	18790	27
34	11939	12599	13283	13992	14726	15485	16272	17087	17931	18805	26
35	0.11949	12610	13295	14004	14738	15498	16285	17101	17945	18820	25
36	11960	12622	13306	14016	14750	15511	16299	17115	17959	18834	24
37	11971	12633	13318	14028	14763	15524	16312	17128	17974	18849	23
38	11982	12644	13330	14040	14775	15537	16326	17142	17988	18864	22
39	11993	12655	13341	14052	14788	15550	16339	17156	18002	18879	21
40	0.12004	12666	13353	14064	14800	15563	16352	17170	18017	18894	20
41	12015	12678	13365	14076	14813	15576	16366	17184	18031	18909	19
42	12025	12689	13376	14088	14825	15589	16379	17198	18045	18924	18
43	12036	12700	13388	14100	14838	15602	16392	17212	18060	18939	17
44	12047	12712	13400	14112	14850	15615	16406	17225	18074	18954	16
45	0.12058	12723	13411	14124	14863	15627	16419	17239	18089	18968	15
46	12069	12734	13423	14136	14875	15640	16433	17253	18103	18983	14
47	12080	12745	13435	14149	14888	15653	16446	17267	18118	18998	13
48	12091	12757	13446	14161	14900	15666	16460	17281	18132	19013	12
49	12102	12768	13458	14173	14913	15679	16473	17295	18146	19028	11
50	0.12113	12779	13470	14185	14926	15692	16487	17309	18161	19043	10
51	12123	12791	13482	14197	14938	15705	16500	17323	18175	19058	9
52	12134	12802	13493	14209	14951	15718	16514	17337	18190	19073	8
53	12145	12813	13505	14221	14963	15731	16527	17351	18204	19088	7
54	12156	12825	13517	14234	14976	15745	16541	17365	18219	19103	6
55	0.12167	12836	13528	14246	14988	15758	16554	17379	18233	19118	5
56	12178	12847	13540	14258	15001	15771	16568	17393	18248	19133	4
57	12189	12859	13552	14270	15014	15784	16581	17407	18262	19148	3
58	12200	12870	13564	14282	15026	15797	16595	17421	18277	19163	2
59	12211	12881	13575	14294	15039	15810	16608	17435	18291	19178	1
60	12222	12893	13587	14307	15051	15823	16622	17449	18306	19193	0
	49°	48°	47°	46°	45°	44°	43°	42°	41°	40°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE. SECANT.

M.	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	
0	0.19193	20113	21066	22054	23078	24141	25244	26389	27579	28816	60
1	19208	20128	21082	22070	23096	24159	25263	26409	27599	28837	59
2	19223	20144	21098	22087	23113	24177	25281	26428	27619	28858	58
3	19238	20160	21114	22104	23130	24195	25300	26448	27640	28879	57
4	19254	20175	21131	22121	23148	24213	25319	26467	27660	28900	56
5	0.19269	20191	21147	22138	23165	24231	25338	26487	27680	28921	55
6	19284	20207	21163	22154	23183	24249	25356	26506	27701	28942	54
7	19299	20222	21179	22171	23200	24267	25375	26526	27721	28964	53
8	19314	20238	21195	22188	23218	24286	25394	26545	27741	28985	52
9	19329	20254	21212	22205	23235	24304	25413	26565	27762	29006	51
10	0.19344	20269	21228	22222	23253	24322	25432	26584	27782	29027	50
11	19359	20285	21244	22239	23270	24346	25451	26604	27802	29048	49
12	19374	20301	21261	22256	23288	24358	25469	26623	27823	29069	48
13	19390	20316	21277	22273	23305	24376	25488	26643	27843	29091	47
14	19405	20332	21293	22289	23323	24395	25507	26663	27863	29112	46
15	0.19420	20348	21309	22306	23340	24413	25526	26682	27884	29133	45
16	19435	20364	21326	22323	23358	24431	25545	26702	27904	29154	44
17	19450	20379	21342	22340	23375	24449	25564	26722	27925	29176	43
18	19466	20395	21358	22357	23393	24467	25583	26741	27945	29197	42
19	19481	20411	21375	22374	23410	24486	25602	26761	27966	29218	41
20	0.19496	20427	21391	22391	23428	24504	25621	26781	27986	29239	40
21	19511	20442	21408	22408	23446	24522	25640	26800	28006	29261	39
22	19527	20458	21424	22425	23463	24541	25659	26820	28027	29282	38
23	19542	20474	21440	22442	23481	24559	25678	26840	28048	29303	37
24	19557	20490	21457	22459	23499	24577	25697	26860	28068	29325	36
25	0.19572	20506	21473	22476	23516	24595	25716	26879	28089	29346	35
26	19588	20522	21490	22493	23534	24614	25735	26899	28109	29367	34
27	19603	20537	21506	22510	23552	24632	25754	26919	28130	29389	33
28	19618	20553	21522	22257	23569	24650	25773	26939	28150	29410	32
29	19634	20569	21539	22544	23587	24669	25792	26959	28171	29432	31
30	0.19649	20585	21555	22561	23605	24687	25811	26978	28191	29453	30
31	19664	20601	21572	22578	23622	24706	25830	26998	28212	29475	29
32	19680	20617	21588	22595	23640	24724	25849	27018	28233	29496	28
33	19695	20633	21605	22613	23658	24742	25868	27038	28253	29518	27
34	19710	20649	21621	22630	23676	24761	25887	27058	28274	29539	26
35	0.19726	20665	21638	22647	23693	24779	25907	27078	28295	29561	25
36	19741	20681	21654	22664	23711	24798	25926	27098	28315	29582	24
37	19756	20696	21671	22681	23729	24816	25945	27117	28336	29604	23
38	19772	20712	21687	22698	23747	24835	25964	27137	28357	29625	22
39	19787	20728	21704	22715	23764	24853	25983	27157	28378	29647	21
40	0.19803	20744	21720	22732	23782	24872	26003	27177	28398	29668	20
41	19818	20760	21737	22750	23800	24890	26022	27197	28419	29690	19
42	19834	20776	21754	22767	23818	24909	26041	27217	28440	29712	18
43	19849	20792	21770	22784	23836	24927	26060	27237	28461	29733	17
44	19864	20808	21787	22801	23854	24946	26079	27257	28481	29755	16
45	0.19880	20824	21803	22819	23871	24964	26099	27277	28502	29776	15
46	19895	20840	21820	22836	23889	24983	26118	27297	28523	29798	14
47	19911	20856	21837	22853	23907	25001	26137	27317	28544	29820	13
48	19926	20872	21853	22870	23925	25020	26157	27337	28565	29841	12
49	19942	20889	21870	22888	23943	25039	26176	27350	28586	29863	11
50	0.19957	20905	21887	22905	23961	25057	26195	27378	28607	29885	10
51	19973	20921	21903	22922	23979	25076	26215	27398	28627	29907	9
52	19988	20937	21920	22939	23997	25094	26234	27418	28648	29928	8
53	20004	20953	21937	22957	24015	25113	26253	27438	28669	29950	7
54	20019	20969	21953	22974	24033	25132	26273	27458	28690	29972	6
55	0.20035	20985	21970	22991	24051	25150	26292	27478	28711	29994	5
56	20050	21001	21987	23009	24069	25169	26311	27498	28732	30016	4
57	20066	21017	22003	23026	24087	25188	26331	27518	28753	30037	3
58	20082	21033	22020	23043	24105	25206	26350	27539	28774	30059	2
59	20097	21050	22037	23061	24123	25225	26370	27559	28795	30081	1
60	20113	21066	22054	23078	24141	25244	26389	27579	28816	30103	0
	39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE. SECANT.

M.	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	
0	0.30103	31443	32839	34295	35816	37405	39069	40812	42642	44567	60
1	30125	31466	32863	34320	35842	37432	39097	40842	42674	44600	59
2	30147	31488	32887	34345	35868	37459	39125	40872	42705	44633	58
3	30169	31511	32910	34370	35894	37487	39154	40902	42736	44666	57
4	30191	31534	32934	34395	35920	37514	39182	40931	42768	44699	56
5	0.30213	31557	32958	34420	35946	37541	39211	40961	42799	44732	55
6	30235	31580	32982	34444	35972	37568	39239	40991	42831	44765	54
7	30257	31603	33006	34469	35998	37595	39268	41021	42862	44798	53
8	30279	31626	33030	34494	36024	37623	39296	41051	42893	44831	52
9	30301	31649	33054	34519	36050	37650	39325	41081	42925	44864	51
10	0.30323	31672	33078	34544	36076	37677	39354	41111	42956	44898	50
11	30345	31695	33101	34569	36102	37704	39382	41141	42988	44931	49
12	30367	31718	33125	34594	36128	37732	39411	41171	43020	44964	48
13	30389	31740	33149	34619	36154	37759	39439	41201	43051	44997	47
14	30411	31763	33173	34644	36180	37786	39468	41231	43083	45031	46
15	0.30433	31787	33197	34669	36206	37814	39497	41261	43114	45064	45
16	30455	31810	33221	34694	36233	37841	39526	41291	43146	45097	44
17	30477	31833	33245	34719	36259	37869	39554	41322	43178	45131	43
18	30499	31856	33269	34745	36285	37896	39583	41352	43210	45164	42
19	30521	31879	33294	34770	36311	37924	39612	41382	43241	45198	41
20	0.30544	31902	33318	34795	36338	37951	39641	41412	43273	45231	40
21	30566	31925	33342	34820	36364	37979	39669	41443	43305	45265	39
22	30588	31948	33366	34845	36390	38006	39698	41473	43337	45298	38
23	30610	31971	33390	34870	36417	38034	39727	41503	43369	45332	37
24	30632	31994	33414	34896	36443	38061	39756	41533	43401	45365	36
25	0.30655	32018	33438	34921	36469	38089	39785	41564	43432	45399	35
26	30677	32041	33463	34946	36496	38117	39814	41594	43464	45433	34
27	30699	32064	33487	34971	36522	38144	39843	41625	43496	45466	33
28	30721	32087	33511	34997	36549	38172	39872	41655	43528	45500	32
29	30744	32110	33535	35022	36575	38200	39901	41686	43560	45534	31
30	0.30766	32134	33559	35047	36602	38227	39930	41716	43592	45567	30
31	30788	32157	33584	35073	36628	38255	39959	41747	43625	45601	29
32	30811	32180	33608	35098	36655	38283	39988	41777	43657	45635	28
33	30833	32204	33632	35123	36681	38311	40017	41808	43689	45669	27
34	30856	32227	33657	35149	36708	38338	40046	41838	43721	45703	26
35	0.30878	32250	33681	35174	36734	38366	40076	41869	43753	45737	25
36	30900	32274	33705	35200	36761	38394	40105	41899	43785	45771	24
37	30923	32297	33730	35225	36787	38422	40134	41930	43818	45805	23
38	30945	32320	33754	35251	36814	38450	40163	41961	43850	45839	22
39	30968	32344	33779	35276	36841	38478	40192	41992	43882	45873	21
40	0.30990	32367	33803	35302	36867	38506	40222	42022	43915	45907	20
41	31013	32391	33827	35327	36894	38534	40251	42053	43947	45941	19
42	31035	32414	33852	35353	36921	38562	40280	42084	43979	45975	18
43	31058	32438	33876	35378	36948	38590	40310	42115	44012	46009	17
44	31080	32461	33901	35404	36974	38618	40339	42145	44044	46043	16
45	0.31103	32485	33925	35429	37001	38646	40368	42176	44077	46078	15
46	31125	32508	33950	35455	37028	38674	40398	42207	44109	46112	14
47	31148	32532	33975	35481	37055	38702	40427	42238	44142	46146	13
48	31171	32555	33999	35506	37082	38730	40457	42269	44174	46181	12
49	31193	32579	34024	35532	37108	38758	40486	42300	44207	46215	11
50	0.31216	32602	34048	35558	37135	38786	40516	42331	44239	46249	10
51	31238	32626	34073	35583	37162	38814	40545	42362	44272	46284	9
52	31261	32650	34098	35609	37189	38842	40575	42393	44305	46318	8
53	31284	32673	34122	35635	37216	38871	40604	42424	44337	46353	7
54	31306	32697	34147	35661	37243	38899	40634	42455	44370	46387	6
55	0.31329	32720	34172	35687	37270	38927	40664	42486	44403	46422	5
56	31352	32744	34196	35712	37297	38955	40693	42518	44436	46456	4
57	31375	32768	34221	35738	37324	38984	40723	42549	44468	46491	3
58	31397	32792	34246	35764	37351	39012	40753	42580	44501	46525	2
59	31420	32815	34271	35790	37378	39040	40782	42611	44534	46560	1
60	31443	32839	34295	35816	37405	39069	40812	42642	44567	46595	0
	29	28°	27°	26°	25°	24	23°	22°	21°	20°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE, SECANT.

M.	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	
0	0.46595	48736	51002	53406	55966	58700	61632	64791	68212	71940	60
1	46630	48773	51041	53448	56010	58748	61683	64846	68272	72005	59
2	46664	48809	51080	53489	56054	58795	61734	64901	68331	72070	58
3	46699	48846	51119	53531	56099	58842	61785	64956	68391	72136	57
4	46734	48883	51158	53572	56143	58890	61836	65011	68451	72201	56
5	0.46769	48920	51197	53614	56187	58937	61887	65066	68510	72266	55
6	46804	48957	51236	53655	56231	58984	61938	65121	68570	72332	54
7	46839	48993	51275	53697	56276	59032	61989	65176	68630	72398	53
8	46874	49030	51314	53738	56320	59079	62040	65231	68690	72463	52
9	46908	49067	51353	53780	56365	59127	62091	65287	68750	72529	51
10	0.46944	49104	51393	53822	56409	59175	62142	65342	68811	72595	50
11	46979	49142	51432	53864	56454	59222	62194	65398	68871	72661	49
12	47014	49179	51471	53905	56498	59270	62245	65453	68932	72727	48
13	47049	49216	51510	53947	56543	59318	62297	65509	68992	72794	47
14	47084	49253	51550	53989	56588	59366	62348	65564	69053	72860	46
15	0.47119	49290	51589	54031	56633	59414	62400	65620	69113	72927	45
16	47154	49327	51629	54073	56677	59462	62451	65676	69174	72993	44
17	47189	49365	51668	54115	56722	59510	62503	65732	69235	73060	43
18	47225	49402	51708	54157	56767	59558	62555	65788	69296	73127	42
19	47260	49439	51748	54199	56812	59606	62607	65844	69357	73194	41
20	0.47295	49477	51787	54242	56857	59654	62659	65900	69418	73261	40
21	47331	49514	51827	54284	56902	59703	62711	65957	69479	73328	39
22	47366	49551	51867	54326	56947	59751	62763	66013	69541	73395	38
23	47402	49589	51906	54368	56992	59800	62815	66069	69602	73462	37
24	47437	49626	51946	54411	57038	59848	62867	66126	69664	73530	36
25	0.47473	49664	51986	54453	57083	59897	62919	66182	69725	73597	35
26	47508	49702	52026	54496	57128	59945	62972	66239	69787	73665	34
27	47544	49739	52066	54538	57174	59994	63024	66296	69849	73733	33
28	47579	49777	52106	54581	57219	60042	63076	66353	69910	73801	32
29	47615	49815	52146	54623	57265	60091	63129	66409	69972	73869	31
30	0.47650	49852	52186	54666	57310	60140	63181	66466	70034	73937	30
31	47686	49890	52226	54708	57356	60189	63234	66523	70097	74005	29
32	47722	49928	52266	54751	57401	60238	63287	66580	70159	74073	28
33	47758	49966	52306	54794	57447	60287	63340	66638	70221	74142	27
34	47793	50004	52346	54837	57493	60336	63392	66695	70284	74210	26
35	0.47829	50042	52387	54880	57539	60385	63445	66752	70346	74279	25
36	47865	50080	52427	54923	57584	60434	63498	66810	70409	74348	24
37	47901	50118	52467	54965	57630	60483	63551	66867	70471	74417	23
38	47937	50156	52508	55008	57676	60533	63605	66925	70534	74486	22
39	47973	50194	52548	55052	57722	60582	63658	66982	70597	74555	21
40	0.48009	50232	52589	55095	57768	60631	63711	67040	70660	74624	20
41	48045	50270	52629	55138	57814	60681	63764	67098	70723	74693	19
42	48081	50308	52670	55181	57860	60730	63818	67156	70786	74763	18
43	48117	50346	52710	55224	57907	60780	63871	67214	70850	74832	17
44	48153	50385	52751	55267	57953	60830	63925	67272	70913	74902	16
45	0.48189	50423	52791	55311	57999	60879	63978	67330	70976	74972	15
46	48226	50461	52832	55354	58046	60929	64032	67388	71040	75042	14
47	48262	50500	52873	55398	68092	60979	64086	67447	71104	75112	13
48	48298	50538	52914	55441	58139	61029	64140	67505	71167	75182	12
49	48334	50576	52955	55484	58185	61079	64194	67563	71231	75252	11
50	0.48371	50615	52995	55528	58232	61129	64248	67622	71295	75323	10
51	48407	50653	53036	55572	58278	61179	64302	67681	71359	75393	9
52	48443	50692	53077	55615	58325	61229	64356	67739	71423	75464	8
53	48480	50731	53118	55659	58372	61279	64410	67798	71488	75534	7
54	48516	50769	53159	55703	58418	61330	64464	67857	71552	75605	6
55	0.48553	50808	53200	55747	48465	61380	64519	67916	71616	75676	5
56	48589	50847	53242	55790	58512	61430	64573	67975	71681	75747	4
57	48626	50885	53283	55834	58559	61481	64627	68034	71746	75819	3
58	48662	50924	53324	55878	58606	61531	64682	68093	71810	75890	2
59	48699	50963	53365	55922	58653	61582	64737	68153	71875	75961	1
60	48736	51002	53406	55966	58700	61632	64791	68212	71940	76033	0
	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVII.

LOGARITHMS OF THE LATITUDE AND POLAR DISTANCE.

LATITUDE. SECANT.

M.	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°	
0	0.76033	80567	85644	91411	0.98077	1.05970	1.15642	1.28120	1.45718	1.75814	60
1	76105	80647	85734	91514	98197	06115	15823	28362	46081	76544	59
2	76177	80727	85825	91617	98318	06260	16004	28605	46448	77287	58
3	76248	80807	85915	91720	98439	06406	16187	28849	46817	78042	57
4	76321	80887	86006	91824	98560	06552	16370	29095	47190	78811	56
5	0.76393	80967	86096	91928	0.98682	1.06699	1.16554	1.29342	1.47566	1.79593	55
6	76465	81048	86187	92032	98804	06846	16739	29591	47945	80390	54
7	76538	81129	86278	92137	98926	06993	16925	29841	48327	81202	53
8	76610	81210	86370	92242	99049	07141	17112	30093	48713	82029	52
9	76683	81291	86461	92347	99172	07290	17299	30346	49103	82872	51
10	0.76756	81372	86553	92452	0.99296	1.07439	1.17487	1.30600	1.49495	1.83732	50
11	76829	81453	86645	92558	99419	07589	17676	30856	49892	84609	49
12	76902	81535	86737	92663	99544	07739	17866	31114	50292	85505	48
13	76975	81617	86829	92769	99668	07890	18056	31373	50696	86419	47
14	77048	81698	86922	92876	99793	08041	18248	31633	51104	87353	46
15	0.77122	81780	87015	92982	0.99918	1 08193	1.18440	1.31896	1.51515	1.88307	45
16	77195	81863	87108	93089	1.00044	08345	18633	32159	51931	89283	44
17	77269	81945	87201	93196	00170	08498	18827	32425	52350	90282	43
18	77343	82027	87294	93304	00296	08651	19022	32692	52774	91304	42
19	77417	82110	87388	93411	00423	08805	19218	32901	53201	92350	41
20	0.77491	82193	87481	93519	1.00550	1.08960	1.19415	1.33231	1.53633	1.93422	40
21	77565	82276	87575	93628	00678	09115	19612	33503	54070	94522	39
22	77639	82359	87669	93736	00806	09270	19811	33777	54511	95650	38
23	77714	82442	87764	93845	00934	09426	20010	34053	54956	96808	37
24	77789	82526	87858	93954	01063	09583	20211	34330	55406	97998	36
25	0.77863	82609	87953	94063	1.01192	1.09740	1.20412	1.34609	1.55861	1.99222	35
26	77938	82693	88048	94173	01321	09898	20614	34890	56320	2.00480	34
27	78013	82777	88143	94283	01451	10057	20817	35173	56784	01777	33
28	78088	82861	88239	94393	01581	10216	21021	35457	57254	03113	32
29	78164	82945	88334	94503	01712	10375	21226	35744	57728	04492	31
30	0.78239	83030	88430	94614	1.01843	1.10536	1.21432	1.36032	1.58208	2.05916	30
31	78315	83114	88526	94725	01974	10696	21639	36322	58693	07388	29
32	78390	83199	88623	94836	02106	10858	21848	36615	59184	08912	28
33	78466	83284	88719	94948	02238	11020	22057	36909	59680	10491	27
34	78542	83369	88816	95060	02371	11183	22267	37205	60182	12130	26
35	0.78618	83455	88913	95172	1.02504	1.11346	1.22478	1.37503	1.60690	2.13834	25
36	78694	83540	89010	95285	02637	11510	22690	37804	61204	15607	24
37	78771	83626	89107	95397	02771	11674	22903	38106	61724	17455	23
38	78847	83711	89205	95510	02905	11839	23117	38411	62250	19385	22
39	78924	83797	89303	95624	03040	12005	23332	38718	62783	21406	21
40	0.79001	83884	89401	95738	1.03175	1.12171	1.23549	1.39027	1.63322	2.23525	20
41	79078	83970	89499	95851	03311	12339	23766	39338	63868	25752	19
42	79155	84056	89598	95966	03447	12506	23985	39651	64422	28100	18
43	79232	84143	89696	96080	03583	12675	24204	39967	64982	30583	17
44	79309	84230	89795	96195	03720	12844	24425	40285	65550	33216	16
45	0.79387	84317	89894	96310	1.03857	1.13013	1.24647	1.40605	1.66125	2.36018	15
46	79465	84404	89994	96426	03995	13184	24870	40928	66708	39015	14
47	79542	84492	90093	96542	04133	13355	25094	41253	67298	42233	13
48	79620	84579	90193	96658	04272	13526	25320	41581	67897	45709	12
49	79698	84667	90293	96774	04411	13699	25546	41911	68505	49488	11
50	0.79777	84755	90394	96891	1.04550	1.13872	1.25774	1.42243	1.69121	2.53627	10
51	79855	84843	90494	97008	04690	14045	26003	42579	69745	58203	9
52	79933	84931	90595	97126	04830	14220	26233	42916	70379	63318	8
53	80012	85020	90696	97243	04971	14395	26465	43257	71023	69118	7
54	80091	85109	90798	97361	05113	14571	26697	43600	71676	75812	6
55	0.80170	85197	90899	97480	1.05254	1.14748	1.26931	1.43946	1.72339	2.83730	5
56	80249	85286	91001	97598	05397	14925	27166	44295	73012	93121	4
57	80328	85376	91103	97717	05539	15103	27403	44646	73696	3.05915	3
58	80408	85465	91205	97837	05683	15282	27640	45001	74391	23524	2
59	80487	85555	91308	97957	05826	15461	27880	45358	75097	53627	1
60	80567	85644	91411	98077	05970	15642	28120	45718	75814		0
	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	M.

POLAR DISTANCE. CO-SECANT.

TABLE XXVIII.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	89°	88°	87°	86°	85°	84°	83°	82°	81°	80°	
0	3.24186	3.54282	3.71880	3.84358	3.94030	4.01923	4.08589	14356	19433	23967	60
1	23456	53919	71638	84177	93885	01803	08486	14266	19353	23895	59
2	22713	53552	71395	83996	93740	01682	08383	14175	19273	23823	58
3	21958	53183	71151	83813	93594	01561	08280	14085	19193	23752	57
4	21189	52810	70905	83630	93448	01440	08176	13994	19113	23679	56
5	3.20407	3.52434	3.70658	3.83446	3.93301	4.01318	4.08072	13904	19033	23607	55
6	19610	52055	70409	83261	93154	01196	07968	13813	18952	23535	54
7	18799	51673	70159	83075	93007	01074	07863	13722	18871	23462	53
8	17971	51287	69907	82888	92859	00951	07758	13630	18790	23390	52
9	17128	50897	69654	82701	92710	00828	07653	13539	18709	23317	51
10	3.16268	3.50505	3.69400	3.82513	3.92561	4.00704	4.07548	13447	18628	23244	50
11	15391	50108	69144	82324	92411	00581	07442	13355	18547	23171	49
12	14495	49708	68886	82134	92261	00456	07337	13263	18465	23098	48
13	13581	49304	68627	81944	92110	00332	07231	13171	18383	23025	47
14	12647	48896	68367	81752	91959	00207	07124	13078	18302	22952	46
15	3.11693	3.48485	3.68104	3.81560	3.91807	4.00082	4.07018	12985	18220	22878	45
16	10717	48069	67841	81367	91655	3.99956	06911	12892	18137	22805	44
17	09718	47650	67575	81173	91502	99830	06804	12799	18055	22731	43
18	08696	47226	67308	80978	91349	99704	06696	12706	17973	22657	42
19	07650	46799	67039	80782	91195	99577	06589	12612	17890	22583	41
20	3.06578	3.46367	3.66769	3.80585	3.91040	3.99450	4.06481	12519	17807	22509	40
21	05478	45930	66497	80388	90885	99322	06372	12425	17724	22435	39
22	04350	45489	66223	80189	90730	99194	06264	12331	17641	22361	38
23	03192	45044	65947	79990	90574	99066	06155	12236	17558	22286	37
24	02002	44594	65670	79789	90417	98937	06046	12142	17474	22211	36
25	3.00779	3.44139	3.65391	3.79588	3.90260	3.98808	4.05937	12047	17391	22137	35
26	2.99520	43680	65110	79386	90102	98679	05827	11952	17307	22062	34
27	98223	43216	64827	79183	89943	98549	05717	11857	17223	21987	33
28	96887	42746	64543	78979	89784	98419	05607	11761	17139	21912	32
29	95508	42272	64256	78774	89625	98288	05497	11666	17055	21836	31
30	2.94084	3.41792	3.63968	3.78568	3.89464	3.98157	4.05386	11570	16970	21761	30
31	92612	41307	63678	78361	89304	98026	05275	11474	16886	21685	29
32	91088	40816	63385	78152	89142	97894	05164	11377	16801	21610	28
33	89509	40320	63091	77943	88980	97762	05052	11281	16716	21534	27
34	87870	39818	62795	77733	88817	97629	04940	11184	16631	21458	26
35	2.86166	3.39310	3.62497	3.77522	3.88654	3.97496	4.04828	11087	16545	21382	25
36	84393	38796	62196	77310	88490	97363	04715	10990	16460	21306	24
37	82545	38276	61894	77097	88326	97229	04603	10893	16374	21229	23
38	80615	37750	61589	76883	88161	97095	04490	10795	16289	21153	22
39	78594	37217	61282	76667	87995	96960	04376	10697	16203	21076	21
40	2.76475	3.36678	3.60973	3.76451	3.87829	3.96825	4.04262	10599	16116	20999	20
41	74248	36132	60662	76234	87661	96689	04149	10501	16030	20922	19
42	71900	35578	60349	76015	87494	96553	04034	10402	15944	20845	18
43	69417	35018	60033	75796	87325	96417	03920	10304	15857	20768	17
44	66784	34450	59715	75575	87156	96280	03805	10205	15770	20691	16
45	2.63982	3.33875	3.59395	3.75353	3.86987	3.96143	4.03690	10106	15683	20613	15
46	60985	33292	59072	75130	86816	96005	03574	10006	15596	20535	14
47	57767	32702	58747	74906	86645	95867	03458	09907	15508	20458	13
48	54291	32103	58419	74680	86474	95728	03342	09807	15421	20380	12
49	50512	31495	58089	74454	86301	95589	03226	09707	15333	20302	11
50	2.46373	3.30879	3.57757	3.74226	3.86128	3.95450	4.03109	09606	15245	20223	10
51	41797	30255	57421	73997	85955	95310	02992	09506	15157	20145	9
52	36682	29621	57084	73767	85780	95170	02874	09405	15069	20067	8
53	30882	28927	56743	73535	85605	95029	02757	09304	14980	19988	7
54	24188	28324	56400	73302	85429	94887	02639	09202	14891	19909	6
55	2.16270	3.27661	3.56054	3.73069	3.85252	3.94746	4.02520	09101	14803	19830	5
56	06579	26988	55705	72834	85075	94603	02402	08999	14714	19751	4
57	1.94085	26304	55354	72597	84897	94461	02283	08897	14624	19672	3
58	76476	25609	54999	72360	84718	94317	02163	08795	14535	19592	2
59	46373	24903	54642	72120	84539	94174	02043	08692	14445	19513	1
60	00000	24186	54282	71880	84358	94030	01923	08589	14356	19433	0
	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	M.

DIFFERENCE. SINE.

TABLE XXVIII.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	79°	78°	77°	76°	75°	74°	73°	72°	71°	70°	
0	4.28060	31788	35209	38368	41300	44034	46594	48998	51264	53405	60
1	27995	31728	35154	38317	41252	43990	46552	48959	51227	53370	59
2	27930	31669	35099	38266	41205	43946	46511	48920	51191	53336	58
3	27864	31609	35044	38215	41158	43901	46469	48881	51154	53301	57
4	27799	31549	34989	38164	41110	43857	46428	48842	51117	53266	56
5	4.27734	31490	34934	38113	41063	43813	46386	48803	51080	53231	55
6	27668	31430	34879	38062	41016	43769	46345	48764	51043	53196	54
7	27602	31370	34824	38011	40968	43724	46303	48725	51007	53161	53
8	27537	31310	34769	37960	40921	43680	46262	48686	50970	53126	52
9	27471	31250	34713	37909	40873	43635	46220	48647	50933	53092	51
10	4.27405	31189	34658	37858	40825	43591	46178	48607	50896	53056	50
11	27339	31129	34602	37806	40778	43546	46136	48568	50858	53021	49
12	27273	31068	34547	37755	40730	43502	46095	48529	50821	52986	48
13	27206	31008	34491	37703	40682	43457	46053	48490	50784	52951	47
14	27140	30947	34436	37652	40634	43412	46011	48450	50747	52916	46
15	4.27073	30887	34380	37600	40586	43367	45969	48411	50710	52881	45
16	27007	30826	34324	37549	40538	43323	45927	48371	50673	52846	44
17	26940	30765	34268	37497	40490	43278	45885	48332	50635	52811	43
18	26873	30704	34212	37445	40442	43233	45843	48292	50598	52775	42
19	26806	30643	34156	37393	40394	43188	45801	48252	50561	52740	41
20	4.26739	30582	34100	37341	40346	43143	45758	48213	50523	52705	40
21	26672	30521	34043	37289	40297	43098	45716	48173	50486	52669	39
22	26605	30459	33987	37237	40249	43053	45674	48133	50449	52634	38
23	26538	30398	33931	37185	40200	43008	45632	48094	50411	52598	37
24	26470	30336	33874	37133	40152	42962	45589	48054	50374	52563	36
25	4.26403	30275	33818	37081	40103	42917	45547	48014	50336	52527	35
26	26335	30213	33761	37028	40055	42872	45504	47974	50298	52492	34
27	26267	30151	33704	36976	40006	42826	45462	47934	50261	52456	33
28	26199	30090	33647	36924	39958	42781	45419	47894	50223	52421	32
29	26131	30028	33591	36871	39909	42735	45377	47854	50185	52385	31
30	4.26063	29966	33534	36819	39860	42690	45334	47814	50148	52350	30
31	25995	29903	33477	36766	39811	42644	45292	47774	50110	52314	29
32	25927	29841	33420	36713	39762	42599	45249	47734	50072	52278	28
33	25858	29779	33362	36660	39713	42553	45206	47694	50034	52242	27
34	25790	29716	33305	36608	39664	42507	45163	47654	49996	52207	26
35	4.25721	29654	33248	36555	39615	42461	45120	47613	49958	52171	25
36	25652	29591	33190	36502	39566	42416	45077	47573	49920	52135	24
37	25583	29529	33133	36449	39517	42370	45035	47533	49882	52099	23
38	25514	29466	33075	36395	39467	42324	44992	47492	49844	52063	22
39	25445	29403	33018	36342	39418	42278	44948	47452	49806	52027	21
40	4.25376	29340	32960	36289	39369	42232	44905	47411	49768	51991	20
41	25307	29277	32902	36236	39319	42186	44862	47371	49730	51955	19
42	25237	29214	32844	36182	39270	42140	44819	47330	49692	51919	18
43	25168	29150	32786	36129	39220	42093	44776	47290	49654	51883	17
44	25098	29087	32728	36075	39170	42047	44733	47249	49615	51847	16
45	4.25028	29024	32670	36022	39121	42001	44689	47209	49577	51811	15
46	24958	28960	32612	35968	39071	41954	44646	47168	49539	51774	14
47	24888	28896	32553	35914	39021	41908	44602	47127	49500	51738	13
48	24818	28833	32495	35860	38971	41861	44559	47086	49462	51702	12
49	24748	28769	32437	35806	38921	41815	44516	47045	49424	51666	11
50	4.24677	28705	32378	35752	38871	41768	44472	47005	49385	51629	10
51	24607	28641	32319	35698	38821	41722	44428	46964	49347	51593	9
52	24536	28577	32261	35644	38771	41675	44385	46923	49308	51557	8
53	24466	28511	32202	35590	38721	41628	44341	46882	49269	51520	7
54	24395	28448	32143	35536	38670	41582	44297	46841	49231	51484	6
55	4.24324	28384	32084	35481	38620	41535	44253	46800	49192	51447	5
56	24253	28319	32025	35427	38570	41488	44210	46758	49153	51411	4
57	24181	28254	31966	35373	38519	41441	44166	46717	49115	51374	3
58	24110	28190	31907	35318	38469	41394	44122	46676	49076	51338	2
59	24039	28125	31847	35263	38418	41347	44078	46635	49037	51301	1
60	23967	28060	31788	35209	38368	41300	44034	46594	48998	51264	0
	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	M.

DIFFERENCE. SINE.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	69°	68°	67°	66°	65°	64°	63°	62°	61°	60°	
0	4 55433	57358	59188	60931	62595	64184	65705	67161	68557	69897	60
1	55400	57326	59158	60903	62568	64158	65680	67137	68534	69875	59
2	55367	57295	59128	60875	62541	64132	65655	67113	68512	69853	58
3	55334	57264	59098	60846	62513	64106	65630	67090	68489	69831	57
4	55301	57232	59069	60818	62486	64080	65605	67066	68466	69809	56
5	4.55268	57201	59039	60789	62459	64054	65580	67042	68443	69787	55
6	55235	57169	59009	60761	62432	64028	65556	67018	68420	69765	54
7	55202	57138	58979	60732	62405	64002	65531	66994	68397	69743	53
8	55169	57107	58949	60704	62377	63976	65506	66970	68374	69721	52
9	55136	57075	58919	60675	62350	63950	65481	66946	68351	69699	51
10	4.55102	57044	58889	60646	62323	63924	65456	66922	68328	69677	50
11	55069	57012	58859	60618	62296	63898	65431	66899	68305	69655	49
12	55036	56980	58829	60589	62268	63872	65406	66875	68282	69633	48
13	55003	56949	58799	60561	62241	63846	65381	66851	68260	69611	47
14	54969	56917	58769	60532	62214	63820	65356	66827	68237	69589	46
15	4.54936	56886	58739	60503	62186	63794	65331	66803	68213	69567	45
16	54903	56854	58709	60474	62159	63767	65306	66779	68190	69545	44
17	54869	56822	58678	60446	62131	63741	65281	66755	68167	69523	43
18	54836	56790	58648	60417	62104	63715	65255	66731	68144	69501	42
19	54802	56759	58618	60388	62076	63689	65230	66706	68121	69479	41
20	4.54769	56727	58588	60359	62049	63662	65205	66682	68098	69456	40
21	54735	56695	58557	60331	62021	63636	65180	66658	68075	69434	39
22	54702	56663	58527	60302	61994	63610	65155	66634	68052	69412	38
23	54668	56631	58497	60273	61966	63583	65130	66610	68029	69390	37
24	54635	56599	58467	60244	61939	63557	65104	66586	68006	69368	36
25	4.54601	56568	58436	60215	61911	63531	65079	66562	67982	69345	35
26	54567	56536	58406	60186	61883	63504	65054	66537	67959	69323	34
27	54534	56504	58375	60157	61856	63478	65029	66513	67936	69301	33
28	54500	56472	58345	60128	61828	63451	65003	66489	67913	69279	32
29	54466	56440	58314	60099	61800	63425	64978	66465	67890	69256	31
30	4.54433	56408	58284	60070	61773	63398	64953	66441	67866	69234	30
31	54399	56375	58253	60041	61745	63372	64927	66416	67843	69212	29
32	54365	56343	58223	60012	61717	63345	64902	66392	67820	69189	28
33	54331	56311	58192	59983	61689	63319	64877	66368	67796	69167	27
34	54297	56279	58162	59954	61662	63292	64851	66343	67773	69144	26
35	4.54263	56247	58131	59924	61634	63266	64826	66319	67750	69122	25
36	54229	56215	58101	59895	61606	63239	64800	66295	67726	69100	24
37	54195	56182	58070	59866	61578	63213	64775	66270	67703	69077	23
38	54161	56150	58039	59837	61550	63186	64749	66246	67680	69055	22
39	54127	56118	58008	59808	61522	63159	64724	66221	67656	69032	21
40	4.54093	56085	57978	59778	61494	63133	64698	66197	67633	69010	20
41	54059	56053	57947	59749	61466	63106	64673	66173	67609	68987	19
42	54025	56021	57916	59720	61438	63079	64647	66148	67586	68965	18
43	53991	55988	57885	59690	61410	63052	64622	66124	67562	68942	17
44	53957	55956	57855	59661	61382	63026	64596	66099	67539	68920	16
45	4.53922	55923	57824	59632	61354	62999	64571	66075	67515	68897	15
46	53888	55891	57793	59602	61326	62972	64545	66050	67492	68875	14
47	53854	55858	57762	59573	61298	62945	64519	66025	67468	68852	13
48	53819	55826	57731	59543	61270	62918	64494	66001	67445	68829	12
49	53785	55793	57700	59514	61242	62892	64468	65976	67421	68807	11
50	4.53751	55761	57669	59484	61214	62865	64442	65952	67398	68784	10
51	53716	55728	57638	59455	61186	62838	64417	65927	67374	68762	9
52	53682	55695	57607	59425	61158	62811	64391	65902	67350	68739	8
53	53647	55663	57576	59396	61129	62784	64365	65878	67327	68716	7
54	53613	55630	57545	59366	61101	62757	64339	65853	67303	68694	6
55	4.53578	55597	57514	59336	61073	62730	64313	65828	67280	68671	5
56	53544	55564	57482	59307	61045	62703	64288	65804	67256	68648	4
57	53509	55532	57451	59277	61016	62676	64262	65779	67232	68625	3
58	53475	55499	57420	59247	60988	62649	64236	65754	67208	68603	2
59	53440	55466	57389	59218	60960	62622	64210	65729	67185	68580	1
60	53405	55433	57358	59188	60931	62595	64184	65705	67161	68557	0
	20°	2.°	22°	23°	24°	25°	26°	27°	28°	29°	M.

DIFFERENCE. SINE.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	59°	58°	57°	56°	55°	54°	53°	52°	51°	50°	
0	4.71184	72421	73611	74756	75859	76922	77946	78934	79887	80807	60
1	71163	72401	73591	74737	75841	76904	77930	78918	79872	80792	59
2	71142	72381	73572	74719	75823	76887	77913	78902	79856	80777	58
3	71121	72360	73552	74700	75805	76870	77896	78886	79840	80762	57
4	71100	72340	73533	74681	75787	76852	77879	78869	79825	80746	56
5	4.71079	72320	73513	74662	75769	76835	77862	78853	79809	80731	55
6	71058	72299	73494	74644	75751	76817	77846	78837	79793	80716	54
7	71036	72279	73474	74625	75733	76800	77829	78821	79778	80701	53
8	71015	72259	73455	74606	75714	76782	77812	78805	79762	80686	52
9	70994	72238	73435	74587	75696	76765	77795	78788	79746	80671	51
10	4.70973	72218	73416	74568	75678	76747	77778	78772	79731	80656	50
11	70952	72198	73396	74549	75660	76730	77761	78756	79715	80641	49
12	70931	72177	73377	74531	75642	76712	77744	78739	79699	80625	48
13	70909	72157	73357	74512	75624	76695	77727	78723	79684	80610	47
14	70888	72137	73337	74493	75605	76677	77711	78707	79668	80595	46
15	4.70867	72116	73318	74474	75587	76660	77694	78691	79652	80580	45
16	70846	72096	73298	74455	75569	76642	77677	78674	79636	80565	44
17	70824	72075	73278	74436	75551	76625	77660	78658	79621	80550	43
18	70803	72055	73259	74417	75533	76607	77643	78642	79605	80534	42
19	70782	72034	73239	74398	75514	76590	77626	78625	79589	80519	41
20	4.70761	72014	73219	74379	75496	76572	77609	78609	79573	80504	40
21	70739	71994	73200	74360	75478	76554	77592	78592	79558	80489	39
22	70718	71973	73180	74341	75459	76537	77575	78576	79542	80473	38
23	70697	71952	73160	74322	75441	76519	77558	78560	79526	80458	37
24	70675	71932	73140	74303	75423	76501	77541	78543	79510	80443	36
25	4.70654	71911	73121	74284	75405	76484	77524	78527	79494	80428	35
26	70633	71891	73101	74265	75386	76466	77507	78510	79478	80412	34
27	70611	71870	73081	74246	75368	76448	77490	78494	79463	80397	33
28	70590	71850	73061	74227	75350	76431	77473	78478	79447	80382	32
29	70568	71829	73041	74208	75331	76413	77456	78461	79431	80366	31
30	4.70547	71809	73022	74189	75313	76395	77439	78445	79415	80351	30
31	70525	71788	73002	74170	75294	76378	77422	78428	79399	80336	29
32	70504	71767	72982	74151	75276	76360	77405	78412	79383	80320	28
33	70482	71747	72962	74132	75258	76342	77387	78395	79367	80305	27
34	70461	71726	72942	74113	75239	76324	77370	78379	79351	80290	26
35	4.70439	71705	72922	74093	75221	76307	77353	78362	79335	80274	25
36	70418	71685	72902	74074	75202	76289	77336	78346	79319	80259	24
37	70396	71664	72883	74055	75184	76271	77319	78329	79304	80244	23
38	70375	71643	72863	74036	75165	76253	77302	78313	79288	80228	22
39	70353	71622	72843	74017	75147	76236	77285	78296	79272	80213	21
40	4.70332	71602	72823	73997	75128	76218	77268	78280	79256	80197	20
41	70210	71581	72803	73978	75110	76200	77250	78263	79240	80182	19
42	70288	71560	72783	73959	75091	76182	77233	78246	79224	80166	18
43	70267	71539	72763	73940	75073	76164	77216	78230	79208	80151	17
44	70245	71519	72743	73921	75054	76146	77199	78213	79192	80136	16
45	4.70224	71498	72723	73901	75036	76129	77181	78197	79176	80120	15
46	70202	71477	72703	73882	75017	76111	77164	78180	79160	80105	14
47	70180	71456	72683	73863	74999	76093	77147	78163	79144	80089	13
48	70159	71435	72663	73843	74980	76075	77130	78147	79128	80074	12
49	70137	71414	72643	73824	74961	76057	77112	78130	79111	80058	11
50	4.70115	71393	72622	73805	74943	76039	77095	78113	79095	80043	10
51	70093	71373	72602	73785	74924	76021	77078	78097	79079	80027	9
52	70072	71352	72582	73766	74906	76003	77061	78080	79063	80012	8
53	70050	71331	72562	73747	74887	75985	77043	78063	79047	79996	7
54	70028	71310	72542	73727	74868	75967	77026	78047	79031	79981	6
55	4.70006	71289	72522	73708	74850	75949	77009	78030	79015	79965	5
56	69984	71268	72502	73689	74831	75931	76991	78013	78999	79950	4
57	69963	71247	72482	73669	74812	75913	76974	77997	78983	79934	3
58	69941	71226	72461	73650	74794	75895	76957	77980	78967	79918	2
59	69919	71205	72441	73630	74775	75877	76939	77963	78950	79903	1
60	69897	71184	72421	73611	74756	75859	76922	77946	78934	79887	0
	30°	31°	32°	33°	34°	35°	36°	37°	38°	39°	M.

DIFFERENCE. SINE.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M	49°	48°	47°	46°	45°	44°	43°	42°	41°	40°	
0	4 81694	82551	83378	84177	84949	85693	86413	87107	87778	88425	60
1	81680	82537	83365	84164	84936	85681	86401	87096	87767	88415	59
2	81665	82523	83351	84151	84923	85669	86389	87085	87756	88404	58
3	81651	82509	83338	84138	84911	85657	86377	87073	87745	88394	57
4	81636	82495	83324	84125	84898	85645	86366	87062	87734	88383	56
5	4.81622	82481	83311	84112	84885	85632	86354	87050	87723	88372	55
6	81607	82467	83297	84099	84873	85620	86342	87039	87712	88362	54
7	81592	82453	83283	84085	84860	85608	86330	87028	87701	88351	53
8	81578	82439	83270	84072	84847	85596	86318	87016	87690	88340	52
9	81563	82424	83256	84059	84835	85583	86306	87005	87679	88330	51
10	4.81549	82410	83242	84046	84822	85571	86295	86993	87668	88319	50
11	81534	82396	83229	84033	84809	85559	86283	86982	87657	88308	49
12	81519	82382	83215	84020	84796	85547	86271	86970	87646	88298	48
13	81505	82368	83202	84006	84784	85534	86259	86959	87635	88287	47
14	81490	82354	83188	83993	84771	85522	86247	86947	87624	88276	46
15	4.81475	82340	83174	83980	84758	85510	86235	86936	87613	88266	45
16	81461	82326	83161	83967	84745	85497	86223	86924	87601	88255	44
17	81446	82311	83147	83954	84733	85485	86211	86913	87590	88244	43
18	81431	82297	83133	83940	84720	85473	86200	86902	87579	88234	42
19	81417	82283	83120	83927	84707	85460	86188	86890	87568	88223	41
20	4.81402	82269	83106	83914	84694	85448	86176	86879	87557	88212	40
21	81387	82255	83092	83901	84682	85436	86164	86867	87546	88201	39
22	81372	82240	83078	83887	84669	85423	86152	86855	87535	88191	38
23	81358	82226	83065	83874	84656	85411	86140	86844	87524	88180	37
24	81343	82212	83051	83861	84643	85399	86128	86832	87513	88169	36
25	4.81328	82198	83037	83848	84630	85386	86116	86821	87501	88158	35
26	81314	82184	83023	83834	84618	85374	86104	86809	87490	88148	34
27	81299	82169	83010	83821	84605	85361	86092	86798	87479	88137	33
28	81284	82155	82996	83808	84592	85349	86080	86786	87468	88126	32
29	81269	82141	82982	83795	84579	85337	86068	86775	87457	88115	31
30	4 81254	82126	82968	83781	84566	85324	86056	86763	87446	88105	30
31	81240	82112	82955	83768	84553	85312	86044	86752	87434	88094	29
32	81225	82098	82941	83755	84540	85299	86032	86740	87423	88083	28
33	81210	82084	82927	83741	84528	85287	86020	86728	87412	88072	27
34	81195	82069	82913	83728	84515	85274	86008	86717	87401	88061	26
35	4.81180	82055	82899	83715	84502	85262	85996	86705	87390	88051	25
36	81166	82041	82885	83701	84489	85250	85984	86694	87378	88040	24
37	81151	82026	82872	83688	84476	85237	85972	86682	87367	88029	23
38	81136	82012	82858	83674	84463	85225	85960	86670	87356	88018	22
39	81121	81998	82844	83661	84450	85212	85948	86659	87345	88007	21
40	4.81106	81983	82830	83648	84437	85200	85936	86647	87334	87996	20
41	81091	81969	82816	83634	84424	85187	85924	86635	87322	87985	19
42	81076	81955	82802	83621	84411	85175	85912	86624	87311	87975	18
43	81061	81940	82788	83608	84398	85162	85900	86612	87300	87964	17
44	81047	81926	82775	83594	84385	85150	85888	86600	87288	87953	16
45	4.81032	81911	82761	83581	84373	85137	85876	86589	87277	87942	15
46	81017	81897	82747	83567	84360	85125	85864	86577	87266	87931	14
47	81002	81882	82733	83554	84347	85112	85851	86565	87255	87920	13
48	80987	81868	82719	83540	84334	85100	85839	86554	87243	87909	12
49	80972	81854	82705	83527	84321	85087	85827	86542	87232	87898	11
50	4.80957	81839	82691	83513	84308	85074	85815	86530	87221	87887	10
51	80942	81825	82677	83500	84295	85062	85803	86518	87209	87877	9
52	80927	81810	82663	83486	84282	85049	85791	86507	87198	87866	8
53	80912	81796	82649	83473	84269	85037	85779	86495	87187	87855	7
54	80897	81781	82635	83459	84255	85024	85766	86483	87175	87844	6
55	4.80882	81767	82621	83446	84242	85012	85754	86472	87164	87833	5
56	80867	81752	82607	83432	84229	84999	85742	86460	87153	87822	4
57	80852	81738	82593	83419	84216	84986	85730	86448	87141	87811	3
58	80837	81723	82579	83405	84203	84974	85718	86436	87130	87800	2
59	80822	81709	82565	83392	84190	84961	85706	86425	87119	87789	1
60	80807	81694	82551	83378	84177	84949	85693	86413	87107	87778	0
	40°	41°	42°	43°	44°	45°	46°	47°	48°	49°	M.

DIFFERENCE. SINE.

TABLE XXVIII.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	39°	38°	37°	36°	35°	34°	33°	32°	31°	30°	
0	4.89050	89653	90235	90796	91336	91857	92359	92842	93307	93753	60
1	89040	89643	90225	90787	91328	91849	92351	92834	93299	93746	59
2	89030	89633	90216	90777	91319	91840	92343	92826	93291	93738	58
3	89020	89624	90206	90768	91310	91832	92334	92818	93284	93731	57
4	89009	89614	90197	90759	91301	91823	92326	92810	93276	93724	56
5	4.88999	89604	90187	90750	91292	91815	92318	92803	93269	93717	55
6	88989	89594	90178	90741	91283	91806	92310	92795	93261	93709	54
7	88978	89584	90168	90731	91274	91798	92302	92787	93253	93702	53
8	88968	89574	90159	90722	91266	91789	92293	92779	93246	93695	52
9	88958	89564	90149	90713	91257	91781	92285	92771	93238	93687	51
10	4.88948	89554	90139	90704	91248	91772	92277	92763	93230	93680	50
11	88937	89544	90130	90694	91239	91763	92269	92755	93223	93673	49
12	88927	89534	90120	90685	91230	91755	92260	92747	93215	93665	48
13	88917	89524	90111	90676	91221	91746	92252	92739	93207	93658	47
14	88906	89514	90101	90667	91212	91738	92244	92731	93200	93650	46
15	4.88896	89504	90091	90657	91203	91729	92235	92723	93192	93643	45
16	88886	89495	90082	90648	91194	91720	92227	92715	93184	93636	44
17	88875	89485	90072	90639	91185	91712	92219	92707	93177	93628	43
18	88865	89475	90063	90630	91176	91703	92211	92699	93169	93621	42
19	88855	89465	90053	90620	91167	91695	92202	92691	93161	93614	41
20	4.88844	89455	90043	90611	91158	91686	92194	92683	93154	93606	40
21	88834	89445	90034	90602	91149	91677	92186	92675	93146	93599	39
22	88824	89435	90024	90592	91141	91669	92177	92667	93138	93591	38
23	88813	89425	90014	90583	91132	91660	92169	92659	93131	93584	37
24	88803	89415	90005	90574	91123	91651	92161	92651	93123	93577	36
25	4.88793	89405	89995	90565	91114	91643	92152	92643	93115	93560	35
26	88782	89395	89985	90555	91105	91634	92144	92635	93108	93562	34
27	88772	89385	89976	90546	91096	91625	92136	92627	93100	93554	33
28	88761	89375	89966	90537	91087	91617	92127	92619	93092	93547	32
29	88751	89364	89956	90527	91078	91608	92119	92611	93084	93539	31
30	4.88741	89354	89947	90518	91069	91599	92111	92603	93077	93532	30
31	88730	89344	89937	90509	91060	91591	92102	92595	93069	93525	29
32	88720	89334	89927	90499	91051	91582	92094	92587	93061	93517	28
33	88709	89324	89918	90490	91042	91573	92086	92579	93053	93510	27
34	88699	89314	89908	90480	91033	91565	92077	92571	93046	93502	26
35	4.88688	89304	89898	90471	91023	91556	92069	92563	93038	93495	25
36	88678	89294	89888	90462	91014	91547	92060	92555	93030	93487	24
37	88668	89284	89879	90452	91005	91538	92052	92546	93022	93480	23
38	88657	89274	89869	90443	90996	91530	92044	92538	93014	93472	22
39	88647	89264	89859	90434	90987	91521	92035	92530	93007	93465	21
40	4.88636	89254	89849	90424	90978	91512	92027	92522	92999	93457	20
41	88626	89244	89840	90415	90969	91504	92018	92514	92991	93450	19
42	88615	89233	89830	90405	90960	91495	92010	92506	92983	93442	18
43	88605	89223	89820	90396	90951	91486	92002	92498	92976	93435	17
44	88594	89213	89810	90386	90942	91477	91993	92490	92968	93427	16
45	4.88584	89203	89801	90377	90933	91469	91985	92482	92960	93420	15
46	88573	89193	89791	90368	90924	91460	91976	92473	92952	93412	14
47	88563	89183	89781	90358	90915	91451	91968	92465	92944	93405	13
48	88552	89173	89771	90349	90906	91442	91959	92457	92936	93397	12
49	88542	89162	89761	90339	90896	91433	91951	92449	92929	93390	11
50	4.88531	89152	89752	90330	90887	91425	91942	92441	92921	93382	10
51	88521	89142	89742	90320	90878	91416	91934	92433	92913	93375	9
52	88510	89132	89732	90311	90869	91407	91925	92425	92905	93367	8
53	88499	89122	89722	90301	90860	91398	91917	92416	92897	93360	7
54	88489	89112	89712	90292	90851	91389	91908	92408	92889	93352	6
55	4.88478	89101	89702	90282	90842	91381	91900	92400	92881	93344	5
56	88468	89091	89693	90273	90832	91372	91891	92392	92874	93337	4
57	88457	89081	89683	90263	90823	91363	91883	92384	92866	93329	3
58	88447	89071	89673	90254	90814	91354	91874	92376	92858	93322	2
59	88436	89060	89663	90244	90805	91345	91866	92367	92850	93314	1
60	88425	89050	89653	90235	90796	91336	91857	92359	92842	93307	0
	50°	51°	52°	53°	54°	55°	56°	57°	58°	59°	M.

DIFFERENCE. SINE.

TABLE XXVIII.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	29°	28°	27°	26°	25°	24°	23°	22°	21°	20°	
0	4.94182	94593	94988	95366	95728	96073	96403	96717	97015	97299	60
1	94175	94587	94982	95360	95722	96067	96397	96711	97010	97294	59
2	94168	94580	94975	95354	95716	96062	96392	96706	97005	97289	58
3	94161	94573	94969	95348	95710	96056	96387	96701	97001	97285	57
4	94154	94567	94962	95341	95704	96050	96381	96696	96996	97280	56
5	4.94147	94560	94956	95335	95698	96045	96376	96691	96991	97276	55
6	94140	94553	94949	95329	95692	96039	96370	96686	96986	97271	54
7	94133	94546	94943	95323	95686	96034	96365	96681	96981	97266	53
8	94126	94540	94936	95317	95680	96028	96360	96676	96976	97262	52
9	94119	94533	94930	95310	95674	96022	96354	96670	96971	97257	51
10	4.94112	94526	94923	95304	95668	96017	96349	96665	96966	97252	50
11	94105	94519	94917	95298	95663	96011	96343	96660	96962	97248	49
12	94098	94513	94911	95292	95657	96005	96338	96655	96957	97243	48
13	94090	94506	94904	95286	95651	96000	96333	96650	96952	97238	47
14	94083	94499	94898	95279	95645	95994	96327	96645	96947	97234	46
15	4.94076	94492	94891	95273	95639	95988	96322	96640	96942	97229	45
16	94069	94485	94884	95267	95633	95982	96316	96634	96937	97224	44
17	94062	94479	94878	95261	95627	95977	96311	96629	96932	97220	43
18	94055	94472	94871	95254	95621	95971	96305	96624	96927	97215	42
19	94048	94465	94865	95248	95615	95965	96300	96619	96922	97210	41
20	4.94041	94458	94858	95242	95609	95960	96294	96614	96917	97206	40
21	94034	94451	94852	95236	95603	95954	96289	96608	96912	97201	39
22	94027	94445	94845	95229	95597	95948	96284	96603	96907	97196	38
23	94020	94438	94839	95223	95591	95942	96278	96598	96903	97192	37
24	94012	94431	94832	95217	95585	95937	96273	96593	96898	97187	36
25	4.94005	94424	94826	95211	95579	95931	96267	96588	96893	97182	35
26	93998	94417	94819	95204	95573	95925	96262	96582	96888	97178	34
27	93991	94410	94813	95198	95567	95920	96256	96577	96883	97173	33
28	93984	94404	94806	95192	95561	95914	96251	96572	96878	97168	32
29	93977	94397	94799	95185	95555	95908	96245	96567	96873	97163	31
30	4.93970	94390	94793	95179	95549	95902	96240	96562	96868	97159	30
31	93963	94383	94786	95173	95543	95897	96234	96556	96863	97154	29
32	93955	94376	94780	95167	95537	95891	96229	96551	96858	97149	28
33	93948	94369	94773	95160	95531	95885	96223	96546	96853	97145	27
34	93941	94362	94767	95154	95525	95879	96218	96541	96848	97140	26
35	4.93934	94355	94760	95148	95519	95873	96212	96535	96843	97135	25
36	93927	94349	94753	95141	95513	95868	96207	96530	96838	97130	24
37	93920	94342	94747	95135	95507	95862	96201	96525	96833	97126	23
38	93912	94335	94740	95129	95500	95856	96196	96520	96828	97121	22
39	93905	94328	94734	95122	95494	95850	96190	96514	96823	97116	21
40	4.93898	94321	94727	95116	95488	95844	96185	96509	96818	97111	20
41	93891	94314	94720	95110	95482	95839	96179	96504	96813	97107	19
42	93884	94307	94714	95103	95476	95833	96174	96498	96808	97102	18
43	93876	94300	94707	95097	95470	95827	96168	96493	96803	97097	17
44	93869	94293	94700	95090	95464	95821	96162	96488	96798	97092	16
45	4.93862	94286	94694	95084	95458	95815	96157	96483	96793	97087	15
46	93855	94279	94687	95078	95452	95810	96151	96477	96788	97083	14
47	93847	94273	94680	95071	95446	95804	96146	96472	96783	97078	13
48	93840	94266	94674	95065	95440	95798	96140	96467	96778	97073	12
49	93833	94259	94667	95059	95434	95792	96135	96461	96772	97068	11
50	4.93826	94252	94660	95052	95427	95786	96129	96456	96767	97063	10
51	93819	94245	94654	95046	95421	95780	96123	96451	96762	97059	9
52	93811	94238	94647	95039	95415	95775	96118	96445	96757	97054	8
53	93804	94231	94640	95033	95409	95769	96112	96440	96752	97049	7
54	93797	94224	94634	95027	95403	95763	96107	96435	96747	97044	6
55	4.93789	94217	94627	95020	95397	95757	96101	96429	96742	97039	5
56	93782	94210	94620	95014	95391	95751	96095	96424	96737	97035	4
57	93775	94203	94614	95007	95384	95745	96090	96419	96732	97030	3
58	93768	94196	94607	95001	95378	95739	96084	96413	96727	97025	2
59	93760	94189	94600	94995	95372	95733	96079	96408	96722	97020	1
60	93753	94182	94593	94988	95366	95728	96073	96403	96717	97015	0
	60°	61°	62°	63°	64°	65°	66°	67°	68°	69°	M.

DIFFERENCE. SINE.

TABLE XXVIII.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	19°	18°	17°	16°	15°	14°	13°	12°	11°	10°	
0	4.97567	97821	98060	98284	98494	98690	98872	99040	99195	99335	60
1	97563	97817	98056	98281	98491	98687	98869	99038	99192	99333	59
2	97558	97812	98052	98277	98488	98684	98867	99035	99190	99331	58
3	97554	97808	98048	98273	98484	98681	98864	99032	99187	99328	57
4	97550	97804	98044	98270	98481	98678	98861	99030	99185	99326	56
5	4.97545	97800	98040	98266	98477	98675	98858	99027	99182	99324	55
6	97541	97796	98036	98262	98474	98671	98855	99024	99180	99322	54
7	97536	97792	98032	98259	98471	98668	98852	99022	99177	99319	53
8	97532	97788	98029	98255	98467	98665	98849	99019	99175	99317	52
9	97528	97784	98025	98251	98464	98662	98846	99016	99172	99315	51
10	4.97523	97779	98021	98248	98460	98659	98843	99013	99170	99313	50
11	97519	97775	98017	98244	98457	98656	98840	99011	99167	99310	49
12	97515	97771	98013	98240	98453	98652	98837	99008	99165	99308	48
13	97510	97767	98009	98237	98450	98649	98834	99005	99162	99306	47
14	97506	97763	98005	98233	98447	98646	98831	99002	99160	99304	46
15	4.97501	97759	98001	98229	98443	98643	98828	99000	99157	99301	45
16	97497	97754	97997	98226	98440	98640	98825	98997	99155	99299	44
17	97492	97750	97993	98222	98436	98636	98822	98994	99152	99297	43
18	97488	97746	97989	98218	98433	98633	98819	98991	99150	99294	42
19	97484	97742	97986	98215	98429	98630	98816	98989	99147	99292	41
20	4.97479	97738	97982	98211	98426	98627	98813	98986	99145	99290	40
21	97475	97734	97978	98207	98422	98623	98810	98983	99142	99288	39
22	97470	97729	97974	98204	98419	98620	98807	98980	99140	99285	38
23	97466	97725	97970	98200	98415	98617	98804	98978	99137	99283	37
24	97461	97721	97966	98196	98412	98614	98801	98975	99135	99281	36
25	4.97457	97717	97962	98192	98409	98610	98798	98972	99132	99278	35
26	97453	97713	97958	98189	98405	98607	98795	98969	99130	99276	34
27	97448	97708	97954	98185	98402	98604	98792	98967	99127	99274	33
28	97444	97704	97950	98181	98398	98601	98789	98964	99124	99271	32
29	97439	97700	97946	98177	98395	98597	98786	98961	99122	99269	31
30	4.97435	97696	97942	98174	98391	98594	98783	98958	99119	99267	30
31	97430	97691	97938	98170	98388	98591	98780	98955	99117	99264	29
32	97426	97687	97934	98166	98384	98588	98777	98953	99114	99262	28
33	97421	97683	97930	98162	98381	98584	98774	98950	99112	99260	27
34	97417	97679	97926	98159	98377	98581	98771	98947	99109	99257	26
35	4.97412	97674	97922	98155	98373	98578	98768	98944	99106	99255	25
36	97408	97670	97918	98151	98370	98574	98765	98941	99104	99252	24
37	97403	97666	97914	98147	98366	98571	98762	98938	99101	99250	23
38	97399	97662	97910	98144	98363	98568	98759	98936	99099	99248	22
39	97394	97657	97906	98140	98359	98565	98756	98933	99096	99245	21
40	4.97390	97653	97902	98136	98356	98561	98753	98930	99093	99243	20
41	97385	97649	97898	98132	98352	98558	98750	98927	99091	99241	19
42	97381	97645	97894	98129	98349	98555	98746	98924	99088	99238	18
43	97376	97640	97890	98125	98345	98551	98743	98921	99086	99236	17
44	97372	97636	97886	98121	98342	98548	98740	98919	99083	99233	16
45	4.97367	97632	97882	98117	98338	98545	98737	98916	99080	99231	15
46	97363	97627	97878	98113	98334	98541	98734	98913	99078	99229	14
47	97358	97623	97874	98110	98331	98538	98731	98910	99075	99226	13
48	97353	97619	97870	98106	98327	98535	98728	98907	99072	99224	12
49	97349	97615	97866	98102	98324	98531	98725	98904	99070	99221	11
50	4.97344	97610	97861	98098	98320	98528	98722	98901	99067	99219	10
51	97340	97606	97857	98094	98317	98525	98719	98898	99064	99217	9
52	97335	97602	97853	98090	98313	98521	98715	98896	99062	99214	8
53	97331	97597	97849	98087	98309	98518	98712	98893	99059	99212	7
54	97326	97593	97845	98083	98306	98515	98709	98890	99056	99209	6
55	4.97322	97589	97841	98079	98302	98511	98706	98887	99054	99207	5
56	97317	97584	97837	98075	98299	98508	98703	98884	99051	99204	4
57	97312	97580	97833	98071	98295	98505	98700	98881	99048	99202	3
58	97308	97576	97829	98067	98291	98501	98697	98878	99046	99200	2
59	97303	97571	97825	98063	98288	98498	98694	98875	99043	99197	1
60	97299	97567	97821	98060	98284	98494	98690	98872	99040	99195	0
	70°	71°	72°	73°	74°	75°	76°	77°	78°	79°	M.

DIFFERENCE. SINE.

LOGARITHMS OF THE HALF SUM AND DIFFERENCE.

HALF SUM. CO-SINE.

M.	9°	8°	7°	6°	5°	4°	3°	2°	1°	0°	
0	4.99462	99575	99675	99761	99834	99894	99940	99974	99993	00000	60
1	99460	99573	99674	99760	99833	99893	99940	99973	99993	00000	59
2	99458	99572	99672	99759	99832	99892	99939	99973	99993	00000	58
3	99456	99570	99670	99757	99831	99891	99938	99972	99993	00000	57
4	99454	99568	99669	99756	99830	99891	99938	99972	99992	00000	56
5	4.99452	99566	99667	99755	99829	99890	99937	99971	99992	00000	55
6	99450	99565	99666	99753	99828	99889	99936	99971	99992	00000	54
7	99448	99563	99664	99752	99827	99888	99936	99970	99992	00000	53
8	99446	99561	99663	99751	99825	99887	99935	99970	99992	00000	52
9	99444	99559	99661	99749	99824	99886	99934	99969	99991	00000	51
10	4.99442	99557	99659	99748	99823	99885	99934	99969	99991	00000	50
11	99440	99556	99658	99747	99822	99884	99933	99968	99991	00000	49
12	99438	99554	99656	99745	99821	99883	99932	99968	99990	00000	48
13	99436	99552	99655	99744	99820	99882	99932	99967	99990	00000	47
14	99434	99550	99653	99742	99819	99881	99931	99967	99990	00000	46
15	4.99432	99548	99651	99741	99817	99880	99930	99967	99990	00000	45
16	99429	99546	99650	99740	99816	99879	99929	99966	99989	00000	44
17	99427	99545	99648	99738	99815	99879	99929	99966	99989	99999	43
18	99425	99543	99647	99737	99814	99878	99928	99965	99989	99999	42
19	99423	99541	99645	99736	99813	99877	99927	99964	99989	99999	41
20	4.99421	99539	99643	99734	99812	99876	99926	99964	99988	99999	40
21	99419	99537	99642	99733	99810	99875	99926	99963	99988	99999	39
22	99417	99535	99640	99731	99809	99874	99925	99963	99988	99999	38
23	99415	99533	99638	99730	99808	99873	99924	99962	99987	99999	37
24	99413	99532	99637	99728	99807	99872	99923	99962	99987	99999	36
25	4.99411	99530	99635	99727	99806	99871	99923	99961	99987	99999	35
26	99409	99528	99633	99726	99804	99870	99922	99961	99986	99999	34
27	99407	99526	99632	99724	99803	99869	99921	99960	99986	99999	33
28	99404	99524	99630	99723	99802	99868	99920	99960	99986	99999	32
29	99402	99522	99629	99721	99801	99867	99920	99959	99985	99998	31
30	4.99400	99520	99627	99720	99800	99866	99919	99959	99985	99998	30
31	99398	99518	99625	99718	99798	99865	99918	99958	99985	99998	29
32	99396	99517	99624	99717	99797	99864	99917	99958	99984	99998	28
33	99394	99515	99622	99716	99796	99863	99917	99957	99984	99998	27
34	99392	99513	99620	99714	99795	99862	99916	99956	99984	99998	26
35	4.99390	99511	99618	99713	99793	99861	99915	99956	99983	99998	25
36	99388	99509	99617	99711	99792	99860	99914	99955	99983	99998	24
37	99385	99507	99615	99710	99791	99859	99913	99955	99983	99997	23
38	99383	99505	99613	99708	99790	99858	99913	99954	99982	99997	22
39	99381	99503	99612	99707	99788	99857	99912	99954	99982	99997	21
40	4.99379	99501	99610	99705	99787	99856	99911	99953	99982	99997	20
41	99377	99499	99608	99704	99786	99855	99910	99952	99981	99997	19
42	99375	99497	99607	99702	99785	99854	99909	99952	99981	99997	18
43	99372	99495	99605	99701	99783	99853	99909	99951	99981	99997	17
44	99370	99494	99603	99699	99782	99852	99908	99951	99980	99996	16
45	4.99368	99492	99601	99698	99781	99851	99907	99950	99980	99996	15
46	99366	99490	99600	99696	99780	99850	99906	99949	99979	99996	14
47	99364	99488	99598	99695	99778	99848	99905	99949	99979	99996	13
48	99362	99486	99596	99693	99777	99847	99904	99948	99979	99996	12
49	99359	99484	99595	99692	99776	99846	99904	99948	99978	99996	11
50	4.99357	99482	99593	99690	99775	99845	99903	99947	99978	99995	10
51	99355	99480	99591	99689	99773	99844	99902	99946	99977	99995	9
52	99353	99478	99589	99687	99772	99843	99901	99946	99977	99995	8
53	99351	99476	99588	99686	99771	99842	99900	99945	99977	99995	7
54	99348	99474	99586	99684	99769	99841	99899	99944	99976	99995	6
55	4.99346	99472	99584	99683	99768	99840	99898	99944	99976	99994	5
56	99344	99470	99582	99681	99767	99839	99898	99943	99975	99994	4
57	99342	99468	99581	99680	99765	99838	99897	99942	99975	99994	3
58	99340	99466	99579	99678	99764	99837	99896	99942	99974	99994	2
59	99337	99464	99577	99677	99763	99836	99895	99941	99974	99994	1
60	99335	99462	99575	99675	99761	99834	99894	99940	99974	99993	0
	80°	81°	82°	83°	84°	85°	86°	87°	88°	89°	M.

DIFFERENCE. SINE.

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 0 HOURS, OR APP. TIME P. M. | PROPORTIONAL PARTS FOR SECONDS.

M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	3/4.	12127	72333	07551	32539	51921	67757	59									
1	4/5.67757	81147	92745	02976	12127	20406	27963	58									
2	5.27963	34916	41352	46345	52951	58216	63181	57									
3	63181	67877	72332	76570	80611	84472	88168	56									
4	5/6 88168	91714	95121	98399	01557	04605	07550	55									
5	6.07550	10398	13155	15828	18421	20938	23385	54									
6	23385	25765	28081	30337	32536	34681	36774	53									
7	36774	38817	40814	42766	44675	46543	48372	52									
8	48372	50162	51916	53636	55323	56977	58600	51									
9	58600	60194	61759	63296	64806	66291	67751	50									
10	6.67751	69186	70598	71988	73355	74702	76028	49									
11	76028	77334	78620	79888	81137	82369	83584	48									
12	83584	84782	85963	87129	88279	89414	90535	47									
13	90535	91641	92733	93812	94877	95930	96970	46									
14	6/7.96970	97997	99013	00017	01009	01990	02960	45									
15	7 02960	03920	04869	05807	06736	07655	08564	44	93	187	280	373	467	560	653	746	840
16	08564	09464	10354	11236	12108	12972	13827	43	87	175	263	350	438	526	614	702	789
17	13827	14674	15513	16344	17167	17982	18790	42	82	165	248	331	413	496	579	662	744
18	18790	19590	20383	21168	21947	22719	23483	41	78	156	234	313	391	469	547	625	704
19	23483	24241	24993	25738	26477	27210	27936	40	74	148	222	296	370	444	518	592	666
20	7.27936	28656	29371	30079	30782	31479	32171	39	70	140	211	281	352	422	492	563	633
21	32171	32857	33538	34213	34884	35549	36209	38	67	134	201	268	335	403	470	537	604
22	36209	36864	37514	38159	38800	39435	40067	37	64	128	192	256	320	385	449	513	577
23	40067	40693	41315	41933	42546	43155	43760	36	61	123	184	245	306	368	430	491	552
24	43760	44361	44957	45549	46138	46722	47302	35	59	118	171	235	295	353	412	471	531
25	7.47302	47879	48452	49021	49586	50148	50706	34	56	113	169	226	282	339	396	452	509
26	50706	51260	51811	52358	52902	53443	53980	33	54	109	163	218	272	327	381	436	490
27	53980	54514	55045	55572	56096	56017	57135	32	52	105	157	209	262	314	367	420	472
28	57135	57650	58162	58670	59176	59679	60179	31	51	101	152	202	253	303	354	405	455
29	60179	60676	61170	61662	62151	62636	63120	30	49	98	147	195	244	293	342	392	441
30	7.63120	63600	64078	64553	65026	65496	65964	29	47	95	142	189	236	284	331	378	426
31	65964	66429	66891	67351	67809	68264	68717	28	46	92	137	183	229	275	321	366	412
32	68717	69167	69616	70061	70505	70946	71385	27	44	89	133	178	222	267	311	355	400
33	71385	71822	72257	72689	73119	73548	73974	26	43	86	129	172	215	258	301	344	388
34	73974	74398	74819	75239	75657	76073	76487	25	42	83	125	167	209	251	293	334	377
35	7.76487	76898	77308	77716	78122	78526	78929	24	41	81	122	162	203	243	284	325	366
36	78929	79329	79728	80124	80519	80912	81303	23	40	79	118	158	197	237	277	316	356
37	81303	81693	82081	82467	82851	83234	83615	22	39	77	115	154	192	231	270	308	347
38	83615	83994	84372	84747	85122	85494	85866	21	38	75	112	150	187	225	263	300	338
39	85866	86235	86603	86969	87334	87697	88059	20	37	73	109	146	182	219	256	292	329
40	7.88059	88419	88778	89135	89491	89846	90198	19	36	71	106	142	178	213	249	284	321
41	90198	90550	90900	91248	91596	91941	92286	18	35	70	104	139	174	208	243	278	313
42	92286	92629	92970	93311	93650	93987	94324	17	34	68	102	136	170	204	238	272	306
43	94324	94659	94992	95325	95656	95986	96315	16	33	66	100	133	166	199	232	265	299
44	.96315	96642	96968	97293	97617	97939	98260	15	32	65	97	130	162	194	227	259	292
45	7/8.98260	98580	98899	99217	99534	99849	00163	14	32	63	95	127	158	190	222	253	286
46	8.00163	00476	00788	01099	01409	01717	02025	13	31	62	93	124	155	186	218	248	279
47	02025	02331	02636	02941	03244	03546	03847	12	30	61	91	121	152	182	212	243	273
48	03847	04147	04446	04744	05041	05336	05631	11	30	60	89	119	148	178	208	238	268
49	05631	05925	06218	06510	06800	07090	07379	10	29	58	87	116	145	175	204	233	262
50	8.07379	07667	07954	08240	08525	08809	09092	9	28	57	85	114	142	171	200	228	257
51	09092	09374	09656	09936	10216	10494	10772	8	28	56	84	112	140	168	196	224	252
52	10772	11048	11324	11599	11873	12147	12419	7	27	55	82	110	138	165	193	220	248
53	12419	12691	12961	13231	13500	13768	14035	6	27	54	81	108	135	162	189	216	243
54	14035	14302	14567	14832	15096	15359	05621	5	26	53	79	106	133	159	185	212	239
55	8.15621	15883	16144	16404	16663	16921	17179	4	26	52	78	104	130	156	182	208	234
56	17179	17436	17692	17947	18202	18455	18708	3	25	51	77	102	127	153	179	204	229
57	18708	18961	19212	19463	19713	19963	20211	2	25	50	75	100	125	150	175	200	224
58	20211	20459	20706	20953	21198	21444	21688	1	24	49	73	98	123	147	172	196	220
59	21688	21932	22175	22417	22658	22899	23140	0	24	48	72	96	120	145	169	193	217
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.

11 OR 23 HOURS, OR APP. TIME A. M. | PROPORTIONAL PARTS FOR SECONDS.

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 1 HOUR, OR APP. TIME P. M.									PROPORTIONAL PARTS FOR SECONDS.								
M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	8.23140	23379	23618	23856	24094	24331	24567	59	24	47	71	95	118	142	166	190	213
1	24567	24802	25037	25272	25505	25738	25971	58	23	47	70	93	116	140	163	187	210
2	25971	26203	26434	26664	26894	27123	27352	57	23	46	69	92	115	138	161	184	207
3	27352	27580	27807	28034	28260	28486	28711	56	23	45	68	91	113	136	159	181	204
4	28711	28935	29159	29383	29605	29827	30049	55	22	44	67	89	111	133	156	178	201
5	8.30049	30270	30490	30710	30929	31148	31366	54	22	44	66	87	109	131	153	175	198
6	31366	31583	31800	32016	32233	32448	32663	53	22	43	65	86	108	130	151	173	195
7	32663	32877	33091	33304	33517	33729	33940	52	21	43	64	85	106	128	149	170	192
8	33940	34151	34362	34572	34782	34991	35199	51	21	42	63	84	105	126	147	168	189
9	35199	35407	35614	35821	36028	36234	36439	50	21	41	62	83	103	124	145	165	186
10	8.36439	36644	36849	37053	37256	37459	37662	49	20	41	61	82	102	122	143	163	184
11	37662	37864	38065	38266	38467	38667	38866	48	20	40	60	81	100	120	141	161	181
12	38866	39066	39264	39463	39660	39858	40055	47	20	40	60	80	99	119	139	159	179
13	40055	40251	40447	40642	40837	41032	41226	46	20	39	59	78	98	118	137	157	177
14	41226	41420	41613	41806	41998	42191	42382	45	19	39	58	77	96	116	135	154	174
15	8.42382	42573	42764	42954	43144	43333	43522	44	19	38	57	76	95	114	133	152	171
16	43522	43710	43898	44086	44273	44460	44647	43	19	37	56	75	93	112	131	150	169
17	44647	44833	45018	45204	45388	45573	45757	42	19	37	55	74	92	111	130	148	167
18	45757	45940	46124	46306	46489	46671	46852	41	18	37	55	73	91	110	128	146	165
19	46852	47034	47215	47395	47575	47755	47934	40	18	36	54	72	90	108	126	144	162
20	8.47934	48113	48292	48470	48647	48825	49002	39	18	35	53	71	89	107	125	142	160
21	49002	49179	49355	49531	49706	49882	50056	38	18	35	53	70	88	106	123	141	158
22	50056	50231	50405	50579	50752	50925	51098	37	17	35	52	70	87	104	122	139	157
23	51098	51270	51442	51614	51785	51956	52127	36	17	34	52	69	86	103	120	138	155
24	52127	52297	52467	52636	52805	52974	53143	35	17	34	51	68	85	102	119	136	153
25	8.53143	53311	53479	53646	53814	53980	54147	34	17	33	50	67	83	100	117	134	151
26	54147	54313	54479	54645	54810	54975	55139	33	17	33	50	66	82	99	116	132	149
27	55139	55303	55467	55631	55794	55957	56120	32	16	33	49	65	81	98	114	130	147
28	56120	56282	56444	56606	56767	56928	57089	31	16	32	48	64	80	97	113	129	145
29	57089	57249	57410	57569	57729	57888	58047	30	16	32	48	63	80	96	111	127	143
30	8.58047	58206	58364	58522	58680	58837	58994	29	16	32	47	63	79	95	110	126	142
31	58994	59151	59308	59464	59620	59776	59931	28	16	31	47	62	78	94	109	125	141
32	59931	60086	60241	60395	60550	60704	60857	27	15	31	46	62	77	93	108	123	139
33	60857	61011	61164	61317	61469	61621	61773	26	15	30	46	61	77	92	107	122	138
34	61773	61925	62076	62228	62379	62529	62679	25	15	30	45	60	76	91	106	121	136
35	8.62679	62830	62979	63129	63278	63427	63576	24	15	30	45	60	75	90	105	119	134
36	63576	63724	63872	64020	64168	64315	64463	23	15	30	45	59	74	89	104	118	133
37	64463	64609	64756	64902	65048	65194	65340	22	15	29	44	58	73	88	102	117	132
38	65340	65485	65630	65775	65920	66664	66208	21	15	29	43	58	72	87	101	116	130
39	66208	66352	66496	66639	66782	66926	67067	20	14	29	43	57	72	86	100	115	129
40	8.67067	67209	67352	67494	67635	67777	67918	19	14	28	43	57	71	85	99	113	128
41	67918	68059	68199	68340	68480	68620	68759	18	14	28	42	56	70	84	98	112	126
42	68759	68899	69038	69177	69316	69454	69593	17	14	28	42	55	69	83	97	111	125
43	69593	69731	69869	70006	70144	70281	70418	16	14	27	41	55	69	82	96	110	124
44	70418	70554	70691	70827	70963	71099	71234	15	14	27	41	54	68	82	95	109	123
45	8.71234	71370	71505	71640	71774	71909	72043	14	14	27	40	54	67	81	95	108	122
46	72043	72177	72311	72444	72578	72711	72844	13	13	27	40	53	67	80	94	107	121
47	72844	72977	73109	73241	73374	73505	73637	12	13	26	40	53	66	79	93	106	119
48	73637	73768	73900	74031	74162	74292	74423	11	13	26	39	52	65	78	92	105	118
49	74423	74553	74683	74813	74942	75072	75201	10	13	26	39	52	65	78	91	104	117
50	8.75201	75330	75458	75587	75715	75843	75971	9	13	26	38	51	64	77	90	103	116
51	75971	76099	76227	76354	76481	76608	76735	8	13	25	38	51	63	76	89	102	115
52	76735	76862	76988	77114	77240	77366	77492	7	13	25	38	50	63	76	88	101	114
53	77492	77617	77742	77867	77992	78117	78241	6	13	25	37	50	62	75	87	100	113
54	78241	78365	78489	78613	78737	78861	78984	5	12	25	37	50	62	75	87	99	112
55	8.78984	79107	79230	79353	79475	79598	79720	4	12	25	37	49	61	74	86	98	111
56	79720	79842	79964	80085	80207	80328	80449	3	12	25	37	49	61	73	85	98	110
57	80449	80570	80691	80812	80932	81052	81172	2	12	24	36	48	60	73	85	97	109
58	81172	81292	81412	81531	81651	81770	81889	1	12	24	36	48	60	72	84	96	108
59	81889	82008	82126	82245	82363	82481	82599	0	12	24	36	48	60	72	83	95	107
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.
10 OR 22 HOURS, OR APP. TIME A. M.									PROPORTIONAL PARTS FOR SECONDS.								

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 3 HOURS, OR APP. TIME P. M. | PROPORTIONAL PARTS FOR SECONDS.

M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	8.82599	82717	82835	82952	83069	83187	83303	59	12	23	35	47	59	70	82	93	105
1	83303	83420	83537	83653	83769	83885	84001	58	12	23	35	46	58	70	81	93	105
2	84001	84117	84233	84348	84464	84579	84694	57	11	23	35	46	57	69	80	92	104
3	84694	84808	84923	85037	85152	85266	85380	56	11	23	34	45	57	68	80	91	103
4	85380	85494	85607	85721	85834	85947	86060	55	11	23	34	45	57	68	79	90	102
5	8.86060	86173	86286	86398	86511	86623	86735	54	11	22	34	45	56	67	78	90	101
6	86735	86847	86959	87070	87182	87293	87404	53	11	22	33	45	56	67	78	89	100
7	87404	87515	87626	87736	87847	87957	88068	52	11	22	33	44	55	66	78	89	100
8	88068	88178	88288	88397	88507	88616	88726	51	11	22	33	44	55	66	77	88	99
9	88726	88835	88944	89053	89162	89270	89379	50	11	22	33	44	55	65	76	87	98
10	8.89379	89487	89595	89703	89811	89918	90026	49	11	22	32	43	54	65	76	86	97
11	90026	90133	90241	90348	90455	90562	90668	48	11	21	32	43	54	64	75	86	96
12	90668	90775	90881	90988	91094	91200	91306	47	11	21	32	42	53	64	74	85	95
13	91306	91411	91517	91622	91728	91833	91938	46	11	21	32	42	53	63	73	84	95
14	91938	92043	92147	92252	92356	92461	92565	45	10	21	32	42	53	63	73	84	94
15	8.92565	92669	92773	92877	92980	93084	93187	44	10	21	31	42	52	62	73	83	93
16	93187	93290	93393	93496	93599	93702	93804	43	10	20	31	41	52	62	72	82	93
17	93804	93907	94009	94111	94213	94315	94417	42	10	20	31	41	51	61	71	82	92
18	94417	94519	94620	94722	94823	94924	95025	41	10	20	30	40	51	61	71	81	91
19	95025	95126	95227	95327	95428	95528	95628	40	10	20	30	40	50	60	70	80	90
20	8.95628	95728	95828	95928	96028	96128	96227	39	10	20	30	40	50	60	70	80	90
21	96227	96326	96426	96525	96624	96723	96821	38	10	20	30	40	50	60	69	79	89
22	96821	96920	97018	97117	97215	97313	97411	37	10	20	30	39	49	59	69	79	88
23	97411	97509	97607	97704	97802	97899	97996	36	10	19	29	39	49	59	68	78	87
24	97996	98094	98191	98288	98384	98481	98578	35	10	19	29	39	49	58	68	77	87
25	8.98578	98674	98770	98866	98963	99058	99154	34	10	19	29	38	48	58	67	77	86
26	99154	99250	99346	99441	99536	99632	99727	33	10	19	29	38	48	57	67	76	86
27	8/9.99727	99822	99917	00012	00106	00201	00295	32	9	19	28	38	47	57	66	76	85
28	9.00295	00390	00484	00578	00672	00766	00860	31	9	19	28	38	47	56	66	75	85
29	00860	00953	01047	01140	01234	01327	01420	30	9	19	28	37	47	56	65	75	84
30	9.01420	01513	01606	01698	01791	01884	01976	29	9	18	28	37	46	55	65	74	83
31	01976	02068	02161	02253	02345	02437	02528	28	9	18	28	37	46	55	64	74	83
32	02528	02620	02712	02803	02894	02986	03077	27	9	18	27	37	46	55	64	73	82
33	03077	03168	03259	03350	03440	03531	03621	26	9	18	27	36	45	54	64	73	82
34	03621	03712	03802	03892	03982	04072	04162	25	9	18	27	36	45	54	63	72	81
35	9.04162	04252	04341	04431	04520	04610	04699	24	9	18	27	36	45	54	63	72	81
36	04699	04788	04877	04966	05055	05144	05232	23	9	18	27	36	45	53	62	71	80
37	05232	05321	05409	05498	05586	05674	05762	22	9	18	26	35	44	53	62	71	79
38	05762	05850	05938	06025	06113	06200	06288	21	9	17	26	35	44	53	61	70	79
39	06288	06375	06462	06550	06637	06724	06810	20	9	17	26	35	43	52	61	70	78
40	9.06810	06897	06984	07070	07157	07243	07329	19	9	17	26	35	43	52	61	69	78
41	07329	07415	07501	07587	07673	07759	07845	18	9	17	26	34	43	52	60	69	77
42	07845	07930	08016	08101	08186	08271	08357	17	9	17	26	34	43	51	60	68	77
43	08357	08442	08526	08611	08696	08781	08865	16	8	17	25	34	42	51	59	67	76
44	08865	08949	09034	09118	09202	09286	09370	15	8	17	25	34	42	51	59	67	76
45	9.09370	09454	09538	09622	09705	09789	09872	14	8	17	25	34	42	50	59	67	76
46	09872	09955	10039	10122	10205	10288	10371	13	8	17	25	33	42	50	58	66	75
47	10371	10453	10536	10619	10701	10784	10866	12	8	16	25	33	41	50	58	66	74
48	10866	10948	11030	11112	11194	11276	11358	11	8	16	25	33	41	49	57	66	74
49	11358	11440	11521	11603	11684	11765	11847	10	8	16	24	33	41	49	57	65	73
50	9.11847	11928	12009	12090	12171	12252	12332	9	8	16	24	32	40	49	57	65	73
51	12332	12413	12494	12574	12655	12735	12815	8	8	16	24	32	40	48	56	64	73
52	12815	12895	12975	13055	13135	13215	13295	7	8	16	24	32	40	48	56	64	72
53	13295	13374	13454	13533	13613	13692	13771	6	8	16	24	32	40	48	56	64	72
54	13771	13850	13929	14008	14087	14166	14245	5	8	16	24	32	40	47	55	63	71
55	9.14245	14323	14402	14480	14559	14637	14715	4	8	16	24	31	39	47	55	63	71
56	14715	14793	14871	14949	15027	15105	15183	3	8	16	23	31	39	47	55	62	70
57	15183	15260	15338	15415	15493	15570	15647	2	8	15	23	31	39	47	54	62	70
58	15647	15724	15802	15879	15955	16032	16109	1	8	15	23	31	38	46	54	62	69
59	16109	16186	16262	16339	16415	16492	16568	0	8	15	23	31	38	46	54	61	69
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s

9 OR 21 HOURS, OR APP. TIME A. M. | PROPORTIONAL PARTS FOR SECONDS.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 3 HOURS, OR APP. TIME P. M. | PROPORTIONAL PARTS FOR SECONDS.

M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.16568	16644	16720	16796	16872	16948	17024	59	8	15	23	30	38	46	53	61	68
1	17024	17100	17175	17251	17326	17402	17477	58	8	15	23	30	38	45	53	60	68
2	17477	17553	17628	17703	17778	17853	17928	57	7	15	22	30	37	45	52	60	67
3	17928	18003	18077	18152	18227	18301	18376	56	7	14	22	30	37	45	52	60	67
4	18376	18450	18524	18598	18673	18747	18821	55	7	14	22	30	37	44	52	59	67
5	9.18821	18895	18968	19042	19116	19190	19263	54	7	14	22	30	37	44	52	59	67
6	19263	19337	19410	19483	19557	19630	19703	53	7	14	22	29	37	44	51	59	66
7	19703	19776	19849	19922	19995	20067	20140	52	7	14	22	29	37	44	51	58	66
8	20140	20213	20285	20358	20430	20502	20574	51	7	14	22	29	36	44	51	58	65
9	20574	20647	20719	20791	20863	20935	21006	50	7	14	22	29	36	43	50	58	65
10	9.21006	21078	21150	21221	21293	21364	21436	49	7	14	21	29	36	43	50	57	64
11	21436	21507	21578	21650	21721	21792	21863	48	7	14	21	28	36	43	50	57	64
12	21863	21934	22004	22075	22146	22216	22287	47	7	14	21	28	35	42	49	56	63
13	22287	22358	22428	22498	22569	22639	22709	46	7	14	21	28	35	42	49	56	63
14	22709	22779	22849	22919	22989	23059	23128	45	7	14	21	28	35	42	49	56	63
15	9.23128	23198	23268	23337	23407	23476	23545	44	7	14	21	28	35	42	49	56	63
16	23545	23615	23684	23753	23822	23891	23960	43	7	14	21	28	35	41	48	55	62
17	23960	24029	24098	24166	24235	24304	24372	42	7	14	21	28	35	41	48	55	62
18	24372	24441	24509	24577	24646	24714	24782	41	7	14	21	27	34	41	48	55	62
19	24782	24850	24918	24986	25054	25122	25190	40	7	14	20	27	34	41	48	54	61
20	9.25190	25257	25325	25393	25460	25527	25595	39	7	14	20	27	34	41	47	54	61
21	25595	25662	25729	25796	25864	25931	25998	38	7	13	20	27	34	40	47	54	60
22	25998	26065	26132	26198	26265	26332	26398	37	7	13	20	27	34	40	47	54	60
23	26398	26465	26532	26598	26664	26731	26797	36	7	13	20	27	33	40	47	53	60
24	26797	26863	26929	26995	27061	27127	27193	35	7	13	20	26	33	40	46	53	59
25	9.27193	27259	27325	27390	27456	27521	27587	34	7	13	20	26	33	40	46	53	59
26	27587	27652	27718	27783	27848	27914	27979	33	7	13	20	26	33	39	46	52	59
27	27979	28044	28109	28174	28239	28304	28368	32	6	13	20	26	32	39	46	52	59
28	28368	28433	28498	28562	28627	28691	28756	31	6	13	20	26	32	39	46	52	59
29	28756	28820	28885	28949	29013	29077	29141	30	6	13	19	26	32	39	45	52	58
30	9.29141	29205	29269	29333	29397	29461	29524	29	6	13	19	26	32	38	45	51	58
31	29524	29588	29652	29715	29779	29842	29905	28	6	13	19	25	32	38	45	51	57
32	29905	29969	30032	30095	30158	30221	30285	27	6	13	19	25	32	38	44	51	57
33	30285	30347	30410	30473	30536	30599	30661	26	6	13	19	25	32	38	44	50	57
34	30661	30724	30787	30849	30912	30974	31036	25	6	12	19	25	31	38	44	50	56
35	9.31036	31099	31161	31223	31285	31347	31409	24	6	12	19	25	31	37	43	50	56
36	31409	31471	31533	31595	31657	31719	31780	23	6	12	19	25	31	37	43	50	56
37	31780	31842	31903	31965	32026	32088	32149	22	6	12	18	25	31	37	43	49	55
38	32149	32210	32272	32333	32394	32455	32516	21	6	12	18	24	31	37	43	49	55
39	32516	32577	32638	32699	32760	32820	32881	20	6	12	18	24	31	37	43	49	55
40	9.32881	32942	33002	33063	33123	33184	33244	19	6	12	18	24	30	36	42	48	55
41	33244	33304	33365	33425	33485	33545	33605	18	6	12	18	24	30	36	42	48	54
42	33605	33665	33725	33785	33845	33905	33965	17	6	12	18	24	30	36	42	48	54
43	33965	34024	34084	34143	34203	34262	34322	16	6	12	18	24	30	36	42	48	54
44	34322	34381	34441	34500	34559	34618	34677	15	6	12	18	24	30	36	41	47	53
45	9.34677	34736	34795	34854	34913	34972	35031	14	6	12	18	24	30	35	41	47	53
46	35031	35090	35148	35207	35266	35324	35383	13	6	12	18	24	30	35	41	47	53
47	35383	35441	35499	35558	35616	35674	35733	12	6	12	18	23	29	35	41	47	53
48	35733	35791	35849	35907	35965	36023	36081	11	6	12	17	23	29	35	41	46	52
49	36081	36139	36196	36254	36312	36369	36427	10	6	12	17	23	29	35	41	46	52
50	9.36427	36485	36542	36599	36657	36714	36771	9	6	11	17	23	29	35	40	46	52
51	36771	36829	36886	36943	37000	37057	37114	8	6	11	17	23	29	34	40	46	51
52	37114	37171	37228	37285	37342	37399	37455	7	6	11	17	23	29	34	40	46	51
53	37455	37512	37568	37625	37682	37738	37794	6	6	11	17	23	28	34	40	45	51
54	37794	37851	37907	37963	38020	38076	38132	5	6	11	17	22	28	34	39	45	51
55	9.38132	38188	38244	38300	38356	38412	38468	4	6	11	17	22	28	34	39	45	50
56	38468	38524	38579	38635	38691	38746	38802	3	6	11	17	22	28	33	39	44	50
57	38802	38857	38913	38968	39024	39079	39134	2	6	11	17	22	28	33	39	44	50
58	39134	39189	39245	39300	39355	39410	39465	1	6	11	16	22	28	33	39	44	50
59	39465	39520	39575	39630	39684	39739	39794	0	6	11	16	22	28	33	39	44	50
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.

8 OR 20 HOURS, OR APP. TIME A. M. | PROPORTIONAL PARTS FOR SECONDS.

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 4 HOURS, OR APP. TIME P. M.									PROPORTIONAL PARTS FOR SECONDS.								
M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.39794	39849	39903	39958	40012	40067	40121	59	5	11	16	22	28	33	39	44	50
1	40121	40176	40230	40284	40339	40393	40447	58	5	11	16	22	27	33	38	44	49
2	40447	40501	40555	40609	40663	40717	40771	57	5	11	16	22	27	32	38	43	49
3	40771	40825	40879	40933	40986	41040	41094	56	5	11	16	22	27	32	38	43	49
4	41094	41147	41201	41254	41308	41361	41415	55	5	11	16	21	27	32	37	43	48
5	9.41415	41468	41521	41575	41628	41681	41734	54	5	11	16	21	27	32	37	43	48
6	41734	41787	41840	41893	41946	41999	42052	53	5	11	16	21	27	32	37	43	48
7	42052	42105	42157	42210	42263	42315	42368	52	5	10	16	21	26	31	37	42	47
8	42368	42420	42473	42525	42578	42630	42682	51	5	10	16	21	26	31	37	42	47
9	42682	42735	42787	42839	42891	42943	42996	50	5	10	16	21	26	31	36	42	47
10	9.42996	43048	43100	43151	43203	43255	43307	49	5	10	16	21	26	31	36	42	47
11	43307	43359	43411	43462	43514	43565	43617	48	5	10	15	21	26	31	36	41	46
12	43617	43669	43720	43771	43823	43874	43925	47	5	10	15	20	25	31	36	41	46
13	43925	43977	44028	44079	44130	44181	44232	46	5	10	15	20	25	31	36	41	46
14	44232	44283	44334	44385	44436	44487	44538	45	5	10	15	20	25	31	36	41	46
15	9.44538	44589	44639	44690	44741	44791	44842	44	5	10	15	20	25	30	35	40	45
16	44842	44892	44943	44993	45044	45094	45144	43	5	10	15	20	25	30	35	40	45
17	45144	45195	45245	45295	45345	45395	45446	42	5	10	15	20	25	30	35	40	45
18	45446	45496	45546	45595	45645	45695	45745	41	5	10	15	20	25	30	35	40	45
19	45745	45795	45845	45894	45944	45994	46043	40	5	10	15	20	25	30	35	40	45
20	9.46043	46093	46142	46192	46241	46291	46340	39	5	10	15	20	25	30	35	40	45
21	46340	46389	46439	46488	46537	46586	46635	38	5	10	15	20	25	29	34	39	44
22	46635	46684	46733	46782	46831	46880	46929	37	5	10	15	20	24	29	34	39	44
23	46929	46978	47027	47076	47124	47173	47222	36	5	10	15	20	24	29	34	39	44
24	47222	47270	47319	47367	47416	47464	47513	35	5	10	15	19	24	29	34	39	44
25	9.47513	47561	47610	47658	47706	47754	47803	34	5	10	14	19	24	29	34	38	43
26	47803	47851	47899	47947	47995	48043	48091	33	5	10	14	19	24	29	34	38	43
27	48091	48139	48187	48235	48282	48330	48378	32	5	10	14	19	24	29	34	38	43
28	48378	48425	48473	48521	48568	48616	48664	31	5	9	14	19	24	29	33	38	43
29	48664	48711	48758	48806	48853	48900	48948	30	5	9	14	19	24	28	33	38	42
30	9.48948	48995	49042	49089	49137	49184	49231	29	5	9	14	19	23	28	33	38	42
31	49231	49278	49325	49372	49419	49465	49512	28	5	9	14	19	23	28	33	38	42
32	49512	49559	49606	49653	49699	49746	49793	27	5	9	14	19	23	28	33	37	42
33	49793	49839	49886	49932	49979	50025	50071	26	5	9	14	19	23	28	33	37	42
34	50071	50118	50164	50211	50257	50303	50349	25	5	9	14	19	23	28	33	37	42
35	9.50349	50395	50441	50488	50534	50580	50626	24	5	9	14	18	23	28	32	37	41
36	50626	50672	50717	50763	50809	50855	50901	23	5	9	14	18	23	28	32	37	41
37	50901	50946	50992	51038	51083	51129	51174	22	5	9	14	18	23	27	32	36	41
38	51174	51220	51265	51311	51356	51402	51447	21	5	9	14	18	23	27	32	36	41
39	51447	51492	51538	51583	51628	51673	51718	20	4	9	13	18	22	27	31	36	40
40	9.51718	51763	51808	51853	51898	51943	51988	19	4	9	13	18	22	27	31	36	40
41	51988	52033	52078	52123	52168	52212	52257	18	4	9	13	18	22	27	31	36	40
42	52257	52302	52346	52391	52435	52480	52525	17	4	9	13	18	22	27	31	36	40
43	52525	52569	52613	52658	52702	52747	52791	16	4	9	13	18	22	27	31	36	40
44	52791	52835	52879	52923	52968	53012	53056	15	4	9	13	18	22	27	31	35	40
45	9.53056	53100	53144	53188	53232	53276	53320	14	4	9	13	18	22	26	31	35	40
46	53320	53364	53407	53451	53495	53539	53582	13	4	9	13	18	22	26	31	35	40
47	53582	53626	53670	53713	53757	53800	53844	12	4	9	13	17	22	26	30	35	39
48	53844	53887	53931	53974	54017	54061	54104	11	4	9	13	17	22	26	30	35	39
49	54104	54147	54190	54234	54277	54320	54363	10	4	9	13	17	22	26	30	35	39
50	9 54363	54406	54449	54492	54535	54578	54621	9	4	9	13	17	22	26	30	34	39
51	54621	54664	54707	54749	54792	54835	54878	8	4	9	13	17	22	26	30	34	39
52	54878	54920	54963	55005	55048	55091	55133	7	4	8	13	17	21	26	30	34	38
53	55133	55175	55218	55260	55303	55345	55387	6	4	8	13	17	21	26	30	34	38
54	55387	55430	55472	55514	55556	55598	55641	5	4	8	13	17	21	25	29	34	38
55	9.55641	55683	55725	55767	55809	55851	55893	4	4	8	13	17	21	25	29	34	38
56	55893	55934	55976	56018	56060	56102	56144	3	4	8	13	17	21	25	29	34	38
57	56144	56185	56227	56269	56310	56352	56393	2	4	8	12	17	21	25	29	33	37
58	56393	56435	56476	56518	56559	56601	56642	1	4	8	12	17	21	25	29	33	37
59	56642	56683	56725	56766	56807	56848	56889	0	4	8	12	16	20	25	29	33	37
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.
7 OR 19 HOURS, OR APP. TIME A. M.									PROPORTIONAL PARTS FOR SECONDS.								

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 5 HOURS, OR APP. TIME P. M.									PROPORTIONAL PARTS FOR SECONDS.								
M.	s. 0	10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.56889	56931	56972	57013	57054	57095	57136	59	4	8	12	16	20	25	29	33	37
1	57136	57177	57218	57259	57299	57340	57381	58	4	8	12	16	20	25	29	33	37
2	57381	57422	57463	57503	57544	57585	57625	57	4	8	12	16	20	25	29	33	37
3	57625	57666	57706	57747	57787	57828	57868	56	4	8	12	16	20	24	28	32	36
4	57868	57909	57949	57990	58030	58070	58110	55	4	8	12	16	20	24	28	32	36
5	9.58110	58151	58191	58231	58271	58311	58351	54	4	8	12	16	20	24	28	32	36
6	58351	58391	58431	58471	58511	58551	58591	53	4	8	12	16	20	24	28	32	36
7	58591	58631	58671	58711	58750	58790	58830	52	4	8	12	16	20	24	28	32	36
8	58830	58870	58909	58949	58988	59028	59068	51	4	8	12	16	20	24	28	32	36
9	59068	59107	59147	59186	59225	59265	59304	50	4	8	12	16	20	24	28	32	36
10	9.59304	59344	59383	59422	59461	59501	59540	49	4	8	12	16	20	24	28	32	36
11	59540	59579	59618	59657	59696	59735	59774	48	4	8	12	16	20	23	27	31	35
12	59774	59813	59852	59891	59930	59969	60008	47	4	8	12	16	20	23	27	31	35
13	60008	60047	60085	60124	60163	60202	60240	46	4	8	12	16	20	23	27	31	35
14	60240	60279	60318	60356	60395	60433	60472	45	4	8	12	16	20	23	27	31	35
15	9.60472	60510	60549	60587	60625	60664	60702	44	4	8	12	15	19	23	27	31	35
16	60702	60740	60779	60817	60855	60893	60931	43	4	8	12	15	19	23	27	31	35
17	60931	60970	61008	61046	61084	61122	61160	42	4	8	11	15	19	23	27	30	34
18	61160	61198	61236	61274	61311	61349	61387	41	4	8	11	15	19	23	27	30	34
19	61387	61425	61463	61500	61538	61576	61613	40	4	8	11	15	19	23	27	30	34
20	9.61613	61651	61689	61726	61764	61801	61839	39	4	8	11	15	19	23	27	30	34
21	61839	61876	61914	61951	61988	62026	62063	38	4	7	11	15	19	22	26	30	34
22	62063	62100	62138	62175	62212	62249	62287	37	4	7	11	15	19	22	26	30	34
23	62287	62324	62361	62398	62435	62472	62509	36	4	7	11	15	18	22	26	30	33
24	62509	62546	62583	62620	62657	62693	62730	35	4	7	11	15	18	22	26	30	33
25	9.62730	62767	62804	62841	62877	62914	62951	34	4	7	11	15	18	22	26	30	33
26	62951	62987	63024	63061	63097	63134	63170	33	4	7	11	15	18	22	26	29	33
27	63170	63207	63243	63279	63316	63352	63389	32	4	7	11	15	18	22	26	29	33
28	63389	63425	63461	63497	63534	63570	63606	31	4	7	11	14	18	22	25	29	32
29	63606	63642	63678	63715	63751	63787	63823	30	4	7	11	14	18	22	25	29	32
30	9.63823	63859	63895	63931	63966	64002	64038	29	4	7	11	14	18	22	25	29	32
31	64038	64074	64110	64146	64181	64217	64253	28	4	7	11	14	18	22	25	29	32
32	64253	64289	64324	64360	64395	64431	64467	27	4	7	11	14	18	21	25	28	32
33	64467	64502	64538	64573	64609	64644	64679	26	4	7	11	14	18	21	25	28	32
34	64679	64715	64750	64785	64821	64856	64891	25	4	7	11	14	18	21	25	28	32
35	9.64891	64926	64962	64997	65032	65067	65102	24	4	7	10	14	18	21	25	28	31
36	65102	65137	65172	65207	65242	65277	65312	23	3	7	10	14	18	21	25	28	31
37	65312	65347	65382	65417	65452	65486	65521	22	3	7	10	14	18	21	25	28	31
38	65521	65556	65591	65625	65660	65695	65729	21	3	7	10	14	18	21	25	28	31
39	65729	65764	65799	65834	65868	65902	65937	20	3	7	10	14	17	21	24	28	31
40	9.65937	65971	66006	66040	66074	66109	66143	19	3	7	10	14	17	21	24	28	31
41	66143	66177	66212	66246	66280	66314	66348	18	3	7	10	14	17	21	24	28	31
42	66348	66383	66417	66451	66485	66519	66553	17	3	7	10	14	17	20	24	27	31
43	66553	66587	66621	66655	66689	66723	66757	16	3	7	10	14	17	20	24	27	30
44	66757	66791	66824	66858	66892	66926	66959	15	3	7	10	14	17	20	24	27	30
45	9.66959	66993	67027	67060	67094	67128	67161	14	3	7	10	14	17	20	24	27	30
46	67161	67195	67228	67262	67295	67329	67362	13	3	7	10	13	17	20	23	27	30
47	67362	67396	67429	67462	67496	67529	67562	12	3	7	10	13	17	20	23	27	30
48	67562	67596	67629	67662	67695	67729	67762	11	3	7	10	13	17	20	23	27	30
49	67762	67795	67828	67861	67894	67927	67960	10	3	7	10	13	16	20	23	26	30
50	9.67960	67993	68026	68059	68092	68125	68158	9	3	7	10	13	16	20	23	26	30
51	68158	68190	68223	68256	68289	68322	68354	8	3	7	10	13	16	20	23	26	30
52	68354	68387	68420	68452	68485	68517	68550	7	3	7	10	13	16	19	23	26	29
53	68550	68583	68615	68648	68680	68713	68745	6	3	7	10	13	16	19	23	26	29
54	68745	68777	68810	68842	68874	68907	68939	5	3	7	10	13	16	19	23	26	29
55	9.68939	68971	69004	69036	69068	69100	69132	4	3	6	10	13	16	19	22	26	29
56	69132	69164	69197	69229	69261	69293	69325	3	3	6	10	13	16	19	22	26	29
57	69325	69355	69389	69421	69453	69484	69516	2	3	6	10	13	16	19	22	26	29
58	69516	69548	69580	69612	69644	69675	69707	1	3	6	10	13	16	19	22	26	29
59	69707	69739	69770	69802	69834	69866	69897	0	3	6	10	13	16	19	22	26	29
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.
6 OR 18 HOURS, OR APP. TIME A. M.									PROPORTIONAL PARTS FOR SECONDS.								

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 6 HOURS, OR APP. TIME P. M.									PROPORTIONAL PARTS FOR SECONDS.								
M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.69897	69929	69960	69992	70023	70055	70086	59	3	6	9	13	16	19	22	25	28
1	70086	70118	70149	70180	70211	70243	70274	58	3	6	9	13	16	19	22	25	28
2	70274	70306	70337	70368	70399	70431	70462	57	3	6	9	13	16	19	22	25	28
3	70462	70493	70524	70555	70586	70617	70648	56	3	6	9	12	15	19	22	25	28
4	70648	70680	70710	70741	70772	70803	70834	55	3	6	9	12	15	19	22	25	28
5	9.70834	70865	70896	70927	70958	70988	71019	54	3	6	9	12	15	19	22	25	28
6	71019	71050	71081	71111	71142	71173	71203	53	3	6	9	12	15	19	22	25	28
7	71203	71234	71265	71295	71326	71356	71387	52	3	6	9	12	15	18	21	24	27
8	71387	71417	71448	71478	71509	71539	71569	51	3	6	9	12	15	18	21	24	27
9	71569	71600	71630	71660	71691	71721	71751	50	3	6	9	12	15	18	21	24	27
10	9.71751	71781	71812	71842	71872	71902	71932	49	3	6	9	12	15	18	21	24	27
11	71932	71962	71992	72022	72052	72082	72112	48	3	6	9	12	15	18	21	24	27
12	72112	72142	72172	72202	72232	72262	72292	47	3	6	9	12	15	18	21	24	27
13	72292	72322	72352	72381	72411	72441	72471	46	3	6	9	12	15	18	21	24	27
14	72471	72500	72530	72560	72589	72619	72648	45	3	6	9	12	15	18	21	24	27
15	9.72648	72678	72708	72737	72767	72796	72825	44	3	6	9	12	15	18	21	24	27
16	72825	72855	72884	72914	72943	72972	73002	43	3	6	9	12	15	18	21	24	27
17	73002	73031	73060	73090	73119	73148	73177	42	3	6	9	12	14	17	20	23	26
18	73177	73207	73236	73265	73294	73323	73352	41	3	6	9	12	14	17	20	23	26
19	73352	73381	73410	73439	73468	73497	73526	40	3	6	9	12	14	17	20	23	26
20	9.73526	73555	73584	73613	73642	73671	73699	39	3	6	9	12	14	17	20	23	26
21	73699	73728	73757	73786	73815	73843	73872	38	3	6	9	11	14	17	20	23	26
22	73872	73901	73929	73958	73987	74015	74044	37	3	6	9	11	14	17	20	23	26
23	74044	74072	74101	74129	74158	74186	74215	36	3	6	9	11	14	17	20	23	26
24	74215	74243	74272	74300	74328	74357	74385	35	3	6	9	11	14	17	20	23	26
25	9.74385	74413	74442	74470	74498	74526	74554	34	3	6	8	11	14	17	20	22	25
26	74554	74583	74611	74639	74667	74695	74723	33	3	6	8	11	14	17	20	22	25
27	74723	74751	74779	74807	74835	74863	74891	32	3	6	8	11	14	17	20	22	25
28	74891	74919	74947	74975	75003	75031	75059	31	3	6	8	11	14	17	20	22	25
29	75059	75086	75114	75142	75170	75197	75225	30	3	6	8	11	14	17	20	22	25
30	9.75225	75253	75280	75308	75336	75363	75391	29	3	5	8	11	14	16	19	22	25
31	75391	75418	75446	75474	75501	75528	75556	28	3	5	8	11	14	16	19	22	25
32	75556	75583	75611	75638	75666	75693	75720	27	3	5	8	11	14	16	19	22	25
33	75720	75748	75775	75802	75830	75857	75884	26	3	5	8	11	14	16	19	22	25
34	75884	75911	75938	75966	75993	76020	76047	25	3	5	8	11	14	16	19	22	24
35	9.76047	76074	76101	76128	76155	76182	76209	24	3	5	8	11	14	16	19	22	24
36	76209	76236	76263	76290	76317	76344	76371	23	3	5	8	11	14	16	19	22	24
37	76371	76397	76424	76451	76478	76505	76531	22	3	5	8	11	14	16	19	21	24
38	76531	76558	76585	76611	76638	76665	76691	21	3	5	8	11	14	16	19	21	24
39	76691	76718	76745	76771	76798	76824	76851	20	3	5	8	11	13	16	19	21	24
40	9.76851	76877	76904	76930	76957	76983	77009	19	3	5	8	11	13	16	18	21	24
41	77009	77036	77062	77089	77115	77141	77167	18	3	5	8	11	13	16	18	21	24
42	77167	77194	77220	77246	77272	77298	77325	17	3	5	8	10	13	16	18	21	24
43	77325	77351	77377	77403	77429	77455	77481	16	3	5	8	10	13	16	18	21	24
44	77481	77507	77533	77559	77585	77611	77637	15	3	5	8	10	13	16	18	21	23
45	9.77637	77663	77689	77715	77741	77766	77792	14	3	5	8	10	13	15	18	21	23
46	77792	77818	77844	77870	77895	77921	77947	13	3	5	8	10	13	15	18	21	23
47	77947	77972	77998	78024	78049	78075	78101	12	3	5	8	10	13	15	18	21	23
48	78101	78126	78152	78177	78203	78228	78254	11	3	5	8	10	13	15	18	20	23
49	78254	78279	78305	78330	78355	78381	78406	10	3	5	8	10	13	15	18	20	23
50	9.78406	78431	78457	78482	78507	78533	78558	9	3	5	8	10	13	15	17	20	23
51	78558	78583	78608	78633	78659	78684	78709	8	3	5	7	10	13	15	17	20	23
52	78709	78734	78759	78784	78809	78834	78859	7	3	5	7	10	13	15	17	20	23
53	78859	78884	78909	78934	78959	78984	79009	6	3	5	7	10	13	15	17	20	23
54	79009	79034	79059	79084	79108	79133	79158	5	2	5	7	10	13	15	17	20	23
55	9.79158	79183	79208	79232	79257	79282	79306	4	2	5	7	10	13	15	17	20	23
56	79306	79331	79356	79380	79405	79430	79454	3	2	5	7	10	13	15	17	20	22
57	79454	79479	79503	79528	79552	79577	79601	2	2	5	7	10	12	15	17	20	22
58	79601	79626	79650	79674	79699	79723	79747	1	2	5	7	10	12	15	17	20	22
59	79747	79772	79796	79821	79845	79869	79893	0	2	5	7	10	12	15	17	20	22
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.
5 OR 17 HOURS, OR APP. TIME A. M.									PROPORTIONAL PARTS FOR SECONDS								

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 7 HOURS, OR APP. TIME P. M.									PROPORTIONAL PARTS FOR SECONDS.								
M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.79893	79918	79942	79966	79990	80014	80038	59	2	5	7	10	12	14	17	19	22
1	80038	80063	80087	80111	80135	80159	80183	58	2	5	7	10	12	14	17	19	22
2	80183	80207	80231	80255	80279	80303	80327	57	2	5	7	10	12	14	17	19	22
3	80327	80350	80374	80398	80422	80446	80470	56	2	5	7	10	12	14	17	19	22
4	80470	80494	80517	80541	80565	80588	80612	55	2	5	7	9	12	14	16	19	21
5	9.80612	80636	80660	80683	80707	80730	80754	54	2	5	7	9	12	14	16	19	21
6	80754	80778	80801	80825	80848	80872	80895	53	2	5	7	9	12	14	16	19	21
7	80895	80919	80942	80966	80989	81012	81036	52	2	5	7	9	12	14	16	19	21
8	81036	81059	81082	81106	81129	81152	81176	51	2	5	7	9	11	14	16	18	21
9	81176	81199	81222	81245	81269	81292	81315	50	2	5	7	9	11	14	16	18	21
10	9.81315	81338	81361	81384	81407	81430	81454	49	2	5	7	9	11	14	16	18	21
11	81454	81477	81500	81523	81546	81569	81592	48	2	5	7	9	11	14	16	18	21
12	81592	81614	81637	81660	81683	81706	81729	47	2	5	7	9	11	14	16	18	21
13	81729	81752	81775	81797	81820	81843	81866	46	2	5	7	9	11	14	16	18	21
14	81866	81888	81911	81934	81956	81979	82002	45	2	5	7	9	11	14	16	18	20
15	9.82002	82024	82047	82070	82092	82115	82137	44	2	5	7	9	11	14	16	18	20
16	82137	82160	82182	82205	82227	82250	82272	43	2	5	7	9	11	14	16	18	20
17	82272	82294	82317	82339	82362	82384	82406	42	2	5	7	9	11	14	16	18	20
18	82406	82429	82451	82473	82495	82518	82540	41	2	5	7	9	11	14	16	18	20
19	82540	82562	82584	82606	82629	82651	82673	40	2	4	7	9	11	13	15	18	20
20	9.82673	82695	82717	82739	82761	82783	82805	39	2	4	7	9	11	13	15	18	20
21	82805	82827	82849	82871	82893	82915	82937	38	2	4	7	9	11	13	15	18	20
22	82937	82959	82981	83003	83025	83046	83068	37	2	4	7	9	11	13	15	18	20
23	83068	83090	83112	83134	83155	83177	83199	36	2	4	7	9	11	13	15	18	20
24	83199	83220	83242	83264	83285	83307	83329	35	2	4	6	9	11	13	15	17	19
25	9.83329	83350	83372	83393	83415	83436	83458	34	2	4	6	9	11	13	15	17	19
26	83458	83479	83501	83522	83544	83565	83587	33	2	4	6	9	11	13	15	17	19
27	83587	83608	83629	83651	83672	83694	83715	32	2	4	6	9	11	13	15	17	19
28	83715	83736	83757	83779	83800	83821	83842	31	2	4	6	9	11	13	15	17	19
29	83842	83864	83885	83906	83927	83948	83969	30	2	4	6	8	11	13	15	17	19
30	9.83969	83990	84011	84033	84054	84075	84096	29	2	4	6	8	11	13	15	17	19
31	84096	84117	84138	84159	84179	84200	84221	28	2	4	6	8	11	13	15	17	19
32	84221	84242	84263	84284	84305	84326	84346	27	2	4	6	8	11	13	15	17	19
33	84346	84367	84388	84409	84430	84450	84471	26	2	4	6	8	11	13	15	17	19
34	84471	84492	84512	84533	84554	84574	84595	25	2	4	6	8	10	12	14	16	18
35	9.84595	84616	84636	84657	84677	84698	84718	24	2	4	6	8	10	12	14	16	18
36	84718	84739	84759	84780	84800	84821	84841	23	2	4	6	8	10	12	14	16	18
37	84841	84861	84882	84902	84923	84943	84963	22	2	4	6	8	10	12	14	16	18
38	84963	84984	85004	85024	85044	85065	85085	21	2	4	6	8	10	12	14	16	18
39	85085	85105	85125	85145	85166	85186	85206	20	2	4	6	8	10	12	14	16	18
40	9.85206	85226	85246	85266	85286	85306	85326	19	2	4	6	8	10	12	14	16	18
41	85326	85346	85366	85386	85406	85426	85446	18	2	4	6	8	10	12	14	16	18
42	85446	85466	85486	85506	85526	85546	85565	17	2	4	6	8	10	12	14	16	18
43	85565	85585	85605	85625	85645	85664	85684	16	2	4	6	8	10	12	14	16	18
44	85684	85704	85724	85743	85763	85783	85802	15	2	4	6	8	10	12	14	16	18
45	9.85802	85822	85841	85861	85881	85900	85920	14	2	4	6	8	10	12	14	16	18
46	85920	85939	85959	85978	85998	86017	86037	13	2	4	6	8	10	12	14	16	18
47	86037	86056	86076	86095	86114	86134	86153	12	2	4	6	8	10	12	14	16	18
48	86153	86172	86192	86211	86230	86250	86269	11	2	4	6	8	10	12	14	16	18
49	86269	86288	86307	86327	86346	86365	86384	10	2	4	6	8	10	12	14	16	18
50	9.86384	86403	86423	86442	86461	86480	86499	9	2	4	6	8	9	11	13	15	17
51	86499	86518	86537	86556	86575	86594	86613	8	2	4	6	8	9	11	13	15	17
52	86613	86632	86651	86670	86689	86708	86727	7	2	4	6	8	9	11	13	15	17
53	86727	86746	86764	86783	86802	86821	86840	6	2	4	6	8	9	11	13	15	17
54	86840	86858	86877	86896	86915	86933	86952	5	2	4	6	8	9	11	13	15	17
55	9.86952	86971	86990	87008	87027	87045	87064	4	2	4	6	8	9	11	13	15	17
56	87064	87083	87101	87120	87138	87157	87175	3	2	4	6	7	9	11	13	15	17
57	87175	87194	87212	87231	87249	87268	87286	2	2	4	6	7	9	11	13	15	17
58	87286	87305	87323	87341	87360	87378	87396	1	2	4	6	7	9	11	13	15	17
59	87396	87415	87433	87451	87470	87488	87506	0	2	4	6	7	9	11	13	15	17
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.
4 OR 16 HOURS, OR APP. TIME A. M.									PROPORTIONAL PARTS FOR SECONDS.								

TABLE XXIX.

LOGARITHMS OF THE APPARENT TIME, OR HOUR ANGLE.

HOUR ANGLE, 8 HOURS, OR APP. TIME P. M. | PROPORTIONAL PARTS FOR SECONDS.

M.	s. 0	s. 10	s. 20	s. 30	s. 40	s. 50	s. 60		s. 1	s. 2	s. 3	s. 4	s. 5	s. 6	s. 7	s. 8	s. 9
0	9.87506	87524	87543	87561	87579	87597	87615	59	2	4	5	7	9	11	13	14	16
1	87615	87633	87652	87670	87688	87706	87724	58	2	4	5	7	9	11	13	14	16
2	87724	87742	87760	87778	87796	87814	87832	57	2	4	5	7	9	11	13	14	16
3	87832	87850	87868	87886	87904	87921	87939	56	2	4	5	7	9	11	13	14	16
4	87939	87957	87975	87993	88011	88028	88046	55	2	4	5	7	9	11	13	14	16
5	9.88046	88064	88082	88100	88117	88135	88153	54	2	4	5	7	9	11	13	14	16
6	88153	88170	88188	88206	88223	88241	88259	53	2	3	5	7	9	11	12	14	16
7	88259	88276	88294	88311	88329	88346	88364	52	2	3	5	7	9	11	12	14	16
8	88364	88381	88399	88416	88434	88451	88469	51	2	3	5	7	9	11	12	14	16
9	88469	88486	88503	88521	88538	88556	88573	50	2	3	5	7	9	11	12	14	16
10	9.88573	88590	88607	88625	88642	88659	88677	49	2	3	5	7	8	10	12	14	15
11	88677	88694	88711	88728	88745	88763	88780	48	2	3	5	7	8	10	12	14	15
12	88780	88797	88814	88831	88848	88865	88882	47	2	3	5	7	8	10	12	14	15
13	88882	88899	88916	88933	88950	88967	88984	46	2	3	5	7	8	10	12	14	15
14	88984	89001	89018	89035	89052	89069	89086	45	2	3	5	7	8	10	12	14	15
15	9.89086	89103	89120	89137	89153	89170	89187	44	2	3	5	7	8	10	12	14	15
16	89187	89204	89221	89237	89254	89271	89287	43	2	3	5	7	8	10	12	14	15
17	89287	89304	89321	89338	89354	89371	89387	42	2	3	5	7	8	10	12	14	15
18	89387	89404	89421	89438	89454	89470	89487	41	2	3	5	7	8	10	12	13	15
19	89487	89503	89520	89536	89553	89569	89586	40	2	3	5	7	8	10	12	13	15
20	9.89586	89602	89619	89635	89651	89668	89684	39	2	3	5	7	8	16	12	13	15
21	89684	89701	89717	89733	89749	89766	89782	38	2	3	5	7	8	10	12	13	15
22	89782	89798	89815	89831	89847	89863	89879	37	2	3	5	7	8	10	12	13	15
23	89879	89896	89912	89928	89944	89960	89976	36	2	3	5	6	8	10	11	13	14
24	89976	89992	90008	90024	90040	90056	90072	35	2	3	5	6	8	10	11	13	14
25	9.90072	90088	90104	90120	90136	90152	90168	34	2	3	5	6	8	10	11	13	14
26	90168	90184	90200	90216	90232	90248	90263	33	2	3	5	6	8	10	11	13	14
27	90263	90279	90295	90311	90327	90342	90358	32	2	3	5	6	8	10	11	13	14
28	90358	90374	90390	90405	90421	90437	90452	31	2	3	5	6	8	10	11	13	14
29	90452	90468	90484	90499	90515	90531	90546	30	2	3	5	6	8	10	11	13	14
30	9.90546	90562	90577	90593	90608	90624	90639	29	2	3	5	6	8	9	11	12	14
31	90639	90655	90670	90686	90701	90717	90732	28	2	3	5	6	8	9	11	12	14
32	90732	90747	90763	90778	90794	90809	90824	27	2	3	5	6	8	9	11	12	14
33	90824	90840	90855	90870	90885	90901	90916	26	2	3	5	6	8	9	11	12	14
34	90916	90931	90946	90961	90977	90992	91007	25	2	3	5	6	8	9	11	12	14
35	9.91007	91022	91037	91052	91067	91083	91098	24	2	3	4	6	7	9	10	12	14
36	91098	91113	91128	91143	91158	91173	91188	23	2	3	4	6	7	9	10	12	14
37	91188	91203	91218	91233	91248	91262	91277	22	2	3	4	6	7	9	10	12	14
38	91277	91292	91307	91322	91337	91352	91367	21	2	3	4	6	7	9	10	12	14
39	91367	91381	91396	91411	91426	91440	91455	20	2	3	4	6	7	9	10	12	14
40	9.91455	91470	91485	91499	91514	91529	91543	19	1	3	4	6	7	9	10	12	13
41	91543	91558	91573	91587	91602	91616	91631	18	1	3	4	6	7	9	10	12	13
42	91631	91645	91660	91674	91689	91703	91718	17	1	3	4	6	7	9	10	12	13
43	91718	91732	91747	91761	91776	91790	91805	16	1	3	4	6	7	9	10	12	13
44	91805	91819	91833	91848	91862	91876	91891	15	1	3	4	6	7	9	10	12	13
45	9.91891	91905	91919	91934	91948	91962	91976	14	1	3	4	6	7	8	10	11	13
46	91976	91991	92005	92019	92033	92047	92061	13	1	3	4	6	7	8	10	11	13
47	92061	92076	92090	92104	92118	92132	92146	12	1	3	4	6	7	8	10	11	13
48	92146	92160	92174	92188	92202	92216	92230	11	1	3	4	6	7	8	10	11	13
49	92230	92244	92258	92272	92286	92300	92314	10	1	3	4	6	7	8	10	11	13
50	9.92314	92328	92342	92355	92369	92383	92397	9	1	3	4	6	7	8	10	11	13
51	92397	92411	92425	92438	92452	92466	92480	8	1	3	4	6	7	8	10	11	13
52	92480	92493	92507	92521	92534	92548	92562	7	1	3	4	5	7	8	9	11	12
53	92562	92575	92589	92603	92616	92630	92643	6	1	3	4	5	7	8	9	11	12
54	92643	92657	92670	92684	92698	92711	92725	5	1	3	4	5	7	8	9	11	12
55	9.92725	92738	92751	92765	92778	92792	92805	4	1	3	4	5	7	8	9	11	12
56	92805	92819	92832	92845	92859	92872	92885	3	1	3	4	5	7	8	9	11	12
57	92885	92899	92912	92925	92939	92952	92965	2	1	3	4	5	7	8	9	11	12
58	92965	92978	92992	93005	93018	93031	93044	1	1	3	4	5	7	8	9	10	12
59	93044	93057	93071	93084	93097	93110	93123	0	1	3	4	5	7	8	9	10	12
	60s.	50s.	40s.	30s.	20s.	10s.	0s.	M.	1s.	2s.	3s.	4s.	5s.	6s.	7s.	8s.	9s.

3 OR 15 HOURS, OR APP. TIME A. M. | PROPORTIONAL PARTS FOR SECONDS.

TABLE XXX.

FOR CORRECTING THE LONGITUDE BY CHRONOMETER FROM THE EFFECT OF AN ERROR IN THE LATITUDE USED IN FINDING THE TIME.

TABLE A.

Enter this Table with the Latitude worked with at the Side, and the Hour Angle at the Top.

(See explanation of this Table at page 144.)

Lat. D.R.	HOUR ANGLE.						HOUR ANGLE.					HOUR ANGLE.				HOUR. AN.		H. A.
	H. M. 1 0	H. M. 1 10	H. M. 1 20	H. M. 1 30	H. M. 1 40	H. M. 1 50	H. M. 2 0	H. M. 2 10	H. M. 2 20	H. M. 2 30	H. M. 2 45	H. M. 3 0	H. M. 3 15	H. M. 3 30	H. M. 3 45	H. M. 4 0	H. M. 4 30	H. M. 5 0
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
2	0. 8	0. 7	0. 6	0. 5	0. 4	0. 4	0. 4	0. 3	0. 3	0. 2	0. 2	0. 2	0. 2	0. 1	0. 1	0. 1	0. 0	0. 0
4	0.15	0.13	0.12	0.10	0. 9	0. 8	0. 7	0. 7	0. 6	0. 5	0. 5	0. 4	0. 4	0. 3	0. 2	0. 2	0. 2	0. 1
6	0.23	0.20	0.17	0.15	0.13	0.12	0.10	0.10	0. 9	0. 8	0. 7	0. 7	0. 6	0. 5	0. 4	0. 3	0. 2	0. 2
8	0.31	0.27	0.23	0.20	0.18	0.16	0.14	0.13	0.12	0.11	0.10	0. 9	0. 8	0. 7	0. 6	0. 5	0. 4	0. 3
10	0.40	0.34	0.29	0.25	0.22	0.20	0.18	0.16	0.15	0.14	0.12	0.11	0. 9	0. 8	0. 7	0. 6	0. 5	0. 3
12	0.47	0.40	0.35	0.31	0.28	0.25	0.22	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0. 8	0. 7	0. 5	0. 4
14	0.56	0.47	0.41	0.36	0.32	0.29	0.26	0.23	0.21	0.19	0.17	0.15	0.13	0.11	0.10	0. 8	0. 6	0. 4
16	1. 4	0.54	0.47	0.41	0.37	0.33	0.29	0.27	0.25	0.22	0.19	0.16	0.15	0.13	0.11	0.10	0. 7	0. 5
18	1.12	1. 2	0.53	0.47	0.41	0.37	0.34	0.31	0.28	0.25	0.22	0.19	0.17	0.15	0.13	0.11	0. 8	0. 6
20	1.22	1. 9	1. 0	0.53	0.47	0.43	0.38	0.34	0.31	0.28	0.25	0.22	0.19	0.17	0.15	0.13	0. 9	0. 6
22	1.31	1.17	1. 7	0.58	0.52	0.47	0.42	0.38	0.35	0.32	0.28	0.24	0.21	0.19	0.16	0.14	0.10	0. 7
24	1.40	1.25	1.13	1. 4	0.57	0.52	0.46	0.42	0.38	0.35	0.31	0.26	0.23	0.20	0.18	0.15	0.11	0. 7
26	1.49	1.33	1.20	1.11	1. 3	0.56	0.50	0.46	0.42	0.38	0.34	0.29	0.26	0.22	0.20	0.17	0.12	0. 8
28	1.59	1.41	1.28	1.17	1. 8	1. 1	0.55	0.50	0.46	0.41	0.37	0.32	0.28	0.25	0.22	0.19	0.13	0. 8
30	2. 9	1.50	1.35	1.23	1.14	1. 7	1. 0	0.54	0.49	0.45	0.39	0.34	0.31	0.26	0.23	0.20	0.14	0. 9
32	2.19	1.59	1.43	1.31	1.20	1.12	1. 5	0.59	0.53	0.49	0.43	0.37	0.33	0.27	0.25	0.22	0.16	0.10
34	2.31	2. 8	1.51	1.30	1.27	1.18	1.10	1. 4	0.58	0.53	0.46	0.40	0.35	0.31	0.27	0.23	0.17	0.11
36	2.43	2.18	2. 0	1.45	1.34	1.24	1.16	1. 8	1. 2	0.57	0.59	0.43	0.38	0.34	0.29	0.25	0.18	0.11
38	2.55	2.29	2. 9	1.53	1.41	1.30	1.21	1.14	1. 7	1. 1	0.53	0.47	0.41	0.36	0.31	0.27	0.19	0.13
40	3. 8	2 40	2.19	2. 2	1.48	1.37	1.27	1.19	1.12	1. 5	0.57	0.50	0.44	0.39	0.34	0.29	0.21	0.13
42	3.22	2.52	2.28	2.10	1.56	1.44	1.34	1.25	1.17	1.10	1. 1	0.54	0.47	0.41	0.36	0.31	0.22	0.14
44	3.36	3. 4	2.39	2.20	2 .4	1.52	1.40	1.31	1.23	1.16	1. 6	0.58	0.51	0.44	0.39	0.34	0.24	0.16
46	3.51	3.16	2.50	2.30	2.13	1.59	1.47	1.38	1.29	1.21	1.11	1. 2	0.55	0.47	0.41	0.36	0.25	0.17
48		3.31	3. 3	2.41	2.23	2. 8	1.55	1.44	1.35	1.27	1.16	1. 7	0.58	0.51	0.44	0.38	0.28	0.18
50			3.16	2.53	2.34	2.17	2. 4	1.52	1.43	1.34	1.21	1.11	1. 3	0.55	0.47	0.41	0.29	0.19
52				3. 5	2.44	2.28	2.13	2. 0	1.50	1.40	1.28	1.17	1. 7	0.59	0.51	0.44	0.32	0.20
54				3.19	2.57	2.38	2.23	2.10	2.58	1.48	1.34	1.23	1.13	1. 3	0.55	0.47	0.34	0.22
56				3.35	3.11	2.50	2.34	2.20	2. 7	1.56	1.41	1.29	1.18	1. 8	0.59	0.51	0.37	0.24
58				3.52	3.26	3. 4	2.44	2.31	2.17	2. 5	1.49	1.36	1.24	1.14	1. 4	0.55	0.40	0.26
60				4.10	3.43	3.20	3. 0	2.43	2.29	2.16	1.58	1.44	1.31	1.20	1.10	1. 0	0.43	0.28
62					4. 2	3.37	3.14	2.57	2.39	2.27	2. 8	1.53	1.39	1.26	1.16	1. 5	0.47	0.30
64						3.56	3.33	3.13	2.56	2.40	2.20	2. 3	1.58	1.34	1.22	1.11	0.51	0.33
66							3.53	3.32	3.13	2.56	2.34	2.15	1.58	1.43	1.30	1.18	0.56	0.36
68								3.53	3.32	3.14	2.49	2.28	2.10	1.54	1.39	1.26	1. 1	0.40

TABLE B.

Enter this Table with the Declination at the Side, and the Hour Angle at the Top.

Dec.	HOUR ANGLE.						HOUR ANGLE.					HOUR ANGLE.				HOUR AN.		H. A.
	H. M. 1 0	H. M. 1 10	H. M. 1 20	H. M. 1 30	H. M. 1 40	H. M. 1 50	H. M. 2 0	H. M. 2 10	H. M. 2 20	H. M. 2 30	H. M. 2 45	H. M. 3 0	H. M. 3 15	H. M. 3 30	H. M. 3 45	H. M. 4 0	H. M. 4 30	H. M. 5 0
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″
2	0. 8	0. 7	0. 6	0. 5	0. 5	0. 5	0. 4	0. 4	0. 4	0.04	0. 3	0. 3	0. 3	0. 2	0. 2	0. 2	0. 2	0. 2
4	0.16	0.14	0.12	0.11	0.10	0. 9	0. 8	0. 8	0. 7	0.07	0. 7	0. 6	0. 5	0. 5	0. 5	0. 5	0. 5	0. 4
6	0.25	0.21	0.19	0.16	0.15	0.14	0.13	0.12	0.11	0.10	0.10	0. 9	0. 8	0. 8	0. 8	0. 7	0. 7	0. 7
8	0.32	0.28	0.25	0.22	0.20	0.18	0.17	0.16	0.14	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0. 9	0. 9
10	0.41	0.35	0.31	0.28	0.25	0.23	0.21	0.20	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.11
12	0.49	0.43	0.37	0.33	0.30	0.28	0.25	0.24	0.22	0.21	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.13
14	0.58	0.50	0.44	0.39	0.35	0.32	0.30	0.28	0.26	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16	0.15
16	1. 7	0.57	0.50	0.45	0.41	0.37	0.34	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.21	0.20	0.19	0.18
18	1.16	1. 5	0.57	0.51	0.46	0.42	0.39	0.36	0.34	0.32	0.29	0.28	0.26	0.25	0.23	0.22	0.21	0.20
20	1.25	1.13	1. 4	0.57	0.52	0.47	0.44	0.41	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.25	0.23	0.22
22	1.34	1.20	1.11	1. 4	0.58	0.52	0.49	0.45	0.42	0.40	0.37	0.34	0.32	0.31	0.29	0.28	0.26	0.25
24	1.43	1.27	1.18	1.11	1. 4	0.57	0.54	0.49	0.46	0.44	0.41	0.37	0.35	0.34	0.32	0.31	0.29	0.28

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE

APPARENT DISTANCE.

M.	18°		19°		20°		21°		22°		23°		M.
	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	
0	0.4900	0.5118	0.5126	0.5370	0.5341	0.5611	0.5543	0.5842	0.5736	0.6064	0.5919	0.6279	0
1	4904	5122	5130	5374	5344	5615	5547	5846	5739	6068	5922	6282	1
2	4908	5126	5134	5378	5347	5619	5550	5849	5742	6071	5925	6286	2
3	4911	5131	5137	5382	5351	5622	5553	5853	5745	6075	5928	6289	3
4	4915	5135	5141	5386	5354	5626	5556	5857	5748	6079	5931	6293	4
5	0.4919	0.5139	0.5145	0.5390	0.5358	0.5630	0.5560	0.5861	0.5751	0.6082	0.5934	0.6296	5
6	4923	5143	5148	5394	5361	5634	5563	5864	5754	6086	5937	6300	6
7	4927	5148	5152	5398	5365	5638	5566	5868	5758	6090	5940	6303	7
8	4931	5152	5156	5402	5368	5642	5570	5872	5761	6093	5943	6307	8
9	4935	5156	5159	5407	5372	5646	5573	5876	5764	6097	5945	6310	9
10	0.4939	0.5161	0.5163	0.5411	0.5375	0.5650	0.5576	0.5879	0.5767	0.6100	0.5948	0.6314	10
11	4942	5165	5167	5415	5379	5654	5579	5883	5770	6104	5951	6317	11
12	4946	5169	5170	5419	5382	5658	5583	5887	5773	6108	5954	6321	12
13	4950	5173	5174	5423	5385	5662	5586	5891	5776	6111	5957	6324	13
14	4954	5178	5177	5427	5389	5665	5589	5894	5779	6115	5960	6328	14
15	0.4958	0.5182	0.5181	0.5431	0.5392	0.5669	0.5592	0.5898	0.5782	0.6118	0.5963	0.6331	15
16	4962	5186	5185	5435	5396	5673	5596	5902	5785	6122	5966	6334	16
17	4965	5190	5188	5439	5399	5677	5599	5906	5789	6126	5969	6338	17
18	4969	5195	5192	5443	5402	5681	5602	5909	5792	6129	5972	6341	18
19	4973	5199	5196	5447	5406	5685	5605	5913	5795	6133	5975	6345	19
20	0.4977	0.5203	0.5199	0.5451	0.5409	0.5689	0.5609	0.5917	0.5798	0.6136	0.5978	0.6348	20
21	4981	5207	5203	5455	5413	5693	5612	5921	5801	6140	5981	6352	21
22	4984	5212	5206	5459	5416	5696	5615	5924	5804	6144	5984	6355	22
23	4988	5216	5210	5463	5420	5700	5618	5928	5807	6147	5987	6359	23
24	4992	5220	5213	5467	5423	5704	5621	5932	5810	6151	5990	6362	24
25	0.4996	0.5224	0.5217	0.5471	0.5426	0.5708	0.5625	0.5935	0.5813	0.6154	0.5992	0.6366	25
26	5000	5228	5221	5475	5430	5712	5628	5939	5816	6158	5995	6369	26
27	5003	5233	5224	5479	5433	5716	5631	5943	5819	6162	5998	6373	27
28	5007	5237	5228	5483	5436	5720	5634	5947	5822	6165	6001	6376	28
29	5011	5241	5231	5487	5440	5724	5638	5950	5825	6169	6004	6380	29
30	0.5015	0.5245	0.5235	0.5491	0.5443	0.5727	0.5641	0.5954	0.5828	0.6172	0.6007	0.6383	30
31	5019	5249	5239	5496	5447	5731	5644	5958	5831	6176	6010	6386	31
32	5022	5254	5242	5500	5450	5735	5647	5961	5834	6179	6013	6190	32
33	5026	5258	5246	5504	5453	5739	5650	5965	5838	6183	6016	6393	33
34	5030	5262	5249	5508	5457	5743	5654	5969	5841	6187	6019	6397	34
35	0.5034	0.5266	0.5253	0.5512	0.5460	0.5747	0.5657	0.5972	0.5844	0.6190	0.6022	0.6400	35
36	5037	5270	5256	5516	5463	5750	5660	5976	5847	6194	6024	6404	36
37	5041	5275	5260	5520	5467	5754	5663	5980	5850	6197	6027	6407	37
38	5045	5279	5263	5524	5470	5758	5666	5984	5853	6201	6030	6411	38
39	5049	5283	5267	5528	5474	5762	5670	5987	5856	6204	6033	6414	39
40	0.5052	0 5287	0.5270	0.5531	0.5477	0.5766	0.5673	0.5991	0.5859	0.6208	0.6036	0.6417	40
41	5056	5292	5274	5535	5480	5770	5676	5995	5862	6211	6039	6421	41
42	5060	5295	5278	5539	5484	5773	5679	5998	5865	6215	6042	6424	42
43	5064	5299	5281	5543	5487	5777	5682	6002	5868	6219	6045	6428	43
44	5067	5304	5285	5547	5490	5781	5685	6006	5871	6222	6047	6431	44
45	0.5071	0.5308	0.5288	0.5551	0.5494	0.5785	0.5689	0.6009	0.5874	0.6226	0.6050	0.6435	45
46	5075	5312	5292	5555	5497	5789	5692	6013	5877	6229	6053	6438	46
47	5078	5316	5295	5559	5500	5792	5695	6017	5880	6233	6056	6441	47
48	5082	5320	5299	5563	5504	5796	5698	6020	5883	6236	6059	6445	48
49	5086	5324	5302	5567	5507	5800	5701	6024	5886	6240	6062	6448	49
50	0.5090	0.5329	0.5306	0.5571	0.5510	0.5804	0.5704	0.6028	0.5889	0.6243	0.6065	0.6452	50
51	5093	5333	5309	5575	5514	5808	5708	6031	5892	6247	6068	6455	51
52	5097	5337	5313	5579	5517	5811	5711	6035	5895	6250	6070	6459	52
53	5101	5341	5316	5583	5520	5815	5714	6039	5898	6254	6073	6462	53
54	5104	5345	5320	5587	5523	5819	5717	6042	5901	6257	6076	6465	54
55	0.5108	0.5349	0.5323	0.5591	0.5527	0.5823	0.5720	0.6046	0.5904	0.6261	0.6079	0.6469	55
56	5112	5353	5327	5595	5530	5827	5723	6050	5907	6264	6082	6472	56
57	5115	5357	5330	5599	5533	5830	5726	6053	5910	6268	6085	6476	57
58	5119	5362	5334	5603	5537	5834	5730	6057	5913	6271	6087	6479	58
59	5123	5366	5337	5607	5540	5838	5733	6060	5916	6275	6090	6482	59
60	5126	5370	5341	5611	5543	5842	5736	6064	5919	6279	6093	6486	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	18°		19°		20°		21°		22°		23°		

APPARENT DISTANCE.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	24°		25°		26°		27°		28°		29°		M.
	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T	
0	0.6093	0.6486	0.6259	0.6687	0.6418	0.6882	0.6570	0.7072	0.6716	0.7257	0.6856	0.7438	0
1	6096	6489	6262	6690	6421	6885	6573	7075	6718	7260	6858	7441	1
2	6099	6493	6265	6693	6424	6888	6575	7078	6721	7263	6860	7443	2
3	6102	6496	6268	6697	6426	6891	6578	7081	6723	7266	6863	7446	3
4	6104	6499	6270	6700	6429	6895	6580	7084	6726	7269	6865	7449	4
5	0.6107	0.6503	0.6273	0.6703	0.6431	0.6898	0.6583	0.7087	0.6728	0.7272	0.6867	0.7452	5
6	6110	6506	6276	6706	6434	6901	6585	7090	6730	7275	6869	7455	6
7	6113	6510	6278	6710	6437	6904	6588	7093	6733	7278	6872	7458	7
8	6116	6513	6281	6713	6439	6907	6590	7097	6735	7281	6874	7461	8
9	6119	6516	6284	6716	6442	6911	6593	7100	6737	7284	6876	7464	9
10	0.6121	0.6520	0.6286	0.6720	0.6444	0.6914	0.6595	0.7103	0.6740	0.7287	0.6878	0.7467	10
11	6124	6523	6289	6723	6447	6917	6598	7106	6742	7290	6881	7470	11
12	6127	6527	6292	6726	6449	6920	6600	7109	6744	7293	6883	7473	12
13	6130	6530	6295	6729	6452	6923	6603	7112	6747	7296	6885	7476	13
14	6133	6533	6297	6733	6455	6927	6605	7115	6749	7299	6887	7479	14
15	0.6135	0.6537	0.6300	0.6736	0.6457	0.6930	0.6607	0.7118	0.6752	0.7302	0.6890	0.7482	15
16	6138	6540	6303	6739	6460	6933	6610	7121	6754	7305	6892	7485	16
17	6141	6543	6305	6743	6462	6936	6612	7125	6756	7308	6894	7488	17
18	6144	6547	6308	6746	6465	6939	6615	7128	6759	7311	6896	7491	18
19	6147	6550	6311	6749	6467	6942	6617	7131	6761	7314	6899	7494	19
20	0.6149	0.6553	0.6313	0.6752	0.6470	0.6946	0.6620	0.7134	0.6763	0.7317	0.6901	0.7497	20
21	6152	6557	6316	6756	6472	6949	6622	7137	6766	7320	6903	7500	21
22	6155	6560	6319	6759	6475	6952	6625	7140	6768	7324	6905	7503	22
23	6158	6564	6321	6762	6477	6955	6627	7143	6770	7327	6908	7506	23
24	6161	6567	6324	6765	6480	6958	6629	7146	6773	7330	6910	7509	24
25	0.6163	0.6570	0.6327	0.6769	0.6483	0.6962	0.6632	0.7149	0.6775	0.7333	0.6912	0.7512	25
26	6166	6574	6329	6772	6485	6965	6634	7152	6777	7336	6914	7515	26
27	6169	6577	6332	6775	6488	6968	6637	7156	6780	7339	6917	7518	27
28	6172	6580	6335	6778	6490	6971	6639	7159	6782	7342	6919	7521	28
29	6175	6584	6337	6782	6493	6974	6642	7162	6784	7345	6921	7523	29
30	0.6177	0.6587	0.6340	0.6785	0.6495	0.6977	0.6644	0.7165	0.6787	0.7348	0.6923	0.7526	30
31	6180	6590	6342	6788	6498	6981	6646	7168	6789	7351	6926	7529	31
32	6183	6594	6345	6791	6500	6984	6649	7171	6791	7354	6928	7532	32
33	6186	6597	6348	6795	6503	6987	6651	7174	6794	7357	6930	7535	33
34	6188	6600	6350	6798	6505	6990	6654	7177	6796	7360	6932	7538	34
35	0.6191	0.6604	0.6353	0.6801	0.6508	0.6993	0.6656	0.7180	0.6798	0.7363	0.6935	0.7541	35
36	6194	6607	6356	6804	6510	6996	6659	7183	6801	7366	6937	7544	36
37	6197	6610	6358	6808	6513	6999	6661	7186	6803	7369	6939	7547	37
38	6199	6614	6361	6811	6515	7003	6663	7189	6805	7372	6941	7550	38
39	6202	6617	6364	6814	6518	7006	6666	7192	6808	7375	6943	7553	39
40	0.6205	0.6620	0.6366	0.6817	0 6521	0.7009	0.6668	0.7196	0.6810	0.7378	0.6946	9.7556	40
41	6208	6624	6369	6821	6523	7012	6671	7199	6812	7381	6948	7559	41
42	6210	6627	6371	6824	6526	7015	6673	7202	6814	7384	6950	7562	42
43	6213	6630	6374	6827	6528	7018	6675	7205	6817	7387	6952	7565	43
44	6216	6634	6377	6830	6531	7022	6678	7208	6819	7390	6954	7568	44
45	0.6219	0.6637	0.6379	0.6834	0.6533	0.7025	0.6680	0.7211	0.6821	0.7393	0.6957	0.7571	45
46	6221	6640	6382	6837	6536	7028	6683	7214	6824	7396	6959	7573	46
47	6224	6644	6385	6840	6538	7031	6685	7217	6826	7399	6961	7576	47
48	6227	6647	6387	6843	6541	7034	6687	7220	6828	7402	6963	7579	48
49	6230	6650	6390	6846	6543	7037	6690	7223	6831	7405	6966	7582	49
50	0.6232	0.6654	0.6392	0.6850	0.6546	0.7040	0.6692	0.7226	0.6833	0.7408	0.6968	0.7585	50
51	6235	6657	6395	6853	6548	7043	6695	7229	6835	7411	6970	7588	51
52	6238	6660	6398	6856	6551	7047	6697	7232	6837	7414	6972	7591	52
53	6240	6664	6400	6859	6553	7050	6699	7235	6840	7417	6974	7594	53
54	6243	6667	6403	6863	6556	7053	6702	7238	6842	7420	6977	7597	54
55	0.6246	0.6670	0.6405	0.6866	0.6558	0.7056	0.6704	0.7241	0.6844	0.7423	0.6979	0.7600	55
56	6249	6674	6408	6869	6561	7059	6707	7245	6847	7426	6981	7603	56
57	6251	6677	6411	6872	6563	7062	6709	7248	6849	7429	6983	7606	57
58	6254	6680	6413	6875	6566	7065	6711	7251	6851	7432	6985	7609	58
59	6257	6683	6416	6879	6568	7069	6714	7254	6853	7435	6988	7611	59
60	6259	6687	6418	6882	6570	7072	6716	7257	6856	7438	6990	7614	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	24°		25°		26°		27°		28°		29°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE

APPARENT DISTANCE.

	30°		31°		32°		33°		34°		35°		
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M
0	0.6990	0.7614	0.7118	0.7788	0.7242	0.7958	0.7361	0.8125	0.7476	0.8290	0.7586	0.8452	0
1	6992	7617	7121	7791	7244	7961	7363	8128	7477	8293	7588	8455	1
2	6994	7620	7123	7793	7246	7964	7365	8131	7479	8295	7590	8458	2
3	6996	7623	7125	7796	7248	7966	7367	8133	7481	8298	7591	8460	3
4	6998	7626	27	7799	7250	7969	7369	8136	7483	8301	7593	8463	4
5	0.7001	0.7629	0.7129	0.7802	0.7252	0.7972	0.7371	0.8139	0.7485	0.8303	0.7595	0.8466	5
6	7003	7632	7131	7805	7254	7975	7373	8142	7487	8306	7597	8468	6
7	7005	7635	7133	7808	7256	7978	7375	8145	7489	8309	7599	8471	7
8	7007	7638	7135	7811	7258	7980	7377	8147	7491	8312	7600	8474	8
9	7009	7641	7137	7813	7260	7983	7379	8150	7492	8314	7602	8476	9
10	0.7012	0.7644	0.7139	0.7816	0.7262	0.7986	0.7380	0.8153	0.7494	0.8317	0.7604	0.8479	10
11	7014	7646	7141	7819	7264	7989	7382	8156	7496	8320	7606	8482	11
12	7016	7649	7144	7822	7266	7992	7384	8158	7498	8323	7607	8484	12
13	7018	7652	7146	7825	7268	7994	7386	8161	7500	8325	7609	8487	13
14	7020	7655	7148	7828	7270	7997	7388	8164	7502	8328	7611	8490	14
15	0.7022	0.7658	0.7150	0.7831	0.7272	0.8000	0.7390	0.8167	0.7504	0.8331	0.7613	0.8493	15
16	7025	7661	7152	7833	7274	8003	7392	8169	7505	8333	7615	8495	16
17	7027	7664	7154	7836	7276	8006	7394	8172	7507	8336	7616	8498	17
18	7029	7667	7156	7839	7278	8008	7396	8175	7509	8339	7618	8501	18
19	7031	7670	7158	7842	7280	8011	7398	8178	7511	8342	7620	8503	19
20	0.7033	0.7673	0.7160	0.7845	0.7282	0.8014	0.7400	0.8180	0.7513	0.8345	0.7622	0.8506	20
21	7035	7675	7162	7848	7284	8017	7402	8183	7515	8347	7624	8509	21
22	7037	7678	7164	7850	7286	8020	7404	8186	7517	8350	7625	8511	22
23	7040	7681	7166	7853	7288	8022	7406	8189	7518	8352	7627	8514	23
24	7042	7684	7168	7856	7290	8025	7407	8191	7520	8355	7629	8517	24
25	0.7044	0.7687	0.7171	0.7859	0.7292	0.8028	0.7409	0.8194	0.7522	0.8358	0.7631	0.8519	25
26	7046	7690	7173	7862	7294	8031	7411	8197	7524	8361	7632	8522	26
27	7048	7693	7175	7865	7296	8034	7413	8200	7526	8363	7634	8525	27
28	7050	7696	7177	7868	7298	8036	7415	8202	7528	8366	7636	8527	28
29	7053	7699	7179	7870	7300	8039	7417	8205	7529	8369	7638	8530	29
30	0.7055	0.7701	0.7181	0.7873	0.7302	0.8042	0.7419	0.8208	0.7531	0.8371	0.7640	0.8532	30
31	7057	7704	7183	7876	7304	8045	7421	8211	7533	8374	7641	8535	31
32	7059	7707	7185	7879	7306	8047	7423	8213	7535	8377	7643	8538	32
33	7061	7710	7187	7882	7308	8050	7425	8216	7537	8379	7645	8541	33
34	7063	7713	7189	7885	7310	8053	7427	8219	7539	8382	7647	8543	34
35	0.7065	0.7716	0.7191	0.7887	0.7312	0.8056	0.7428	0.8222	0.7540	0.8385	0.7648	0.8546	35
36	7068	7719	7193	7890	7314	8059	7430	8224	7542	8388	7650	8549	36
37	7070	7722	7195	7893	7316	8061	7432	8227	7544	8390	7652	8551	37
38	7072	7725	7197	7896	7318	8064	7434	8230	7546	8393	7654	8554	38
39	7074	7727	7199	7899	7320	8067	7436	8233	7548	8396	7655	8557	39
40	0.7076	0.7730	0.7201	0.7902	0.7322	0.8070	0.7438	0.8235	0.7550	0.8398	0.7657	0.8559	40
41	7078	7733	7203	7904	7324	8072	7440	8238	7551	8401	7659	8562	41
42	7080	7736	7205	7907	7326	8075	7442	8241	7553	8404	7661	8565	42
43	7082	7739	7208	7910	7328	8078	7444	8243	7555	8406	7662	8567	43
44	7085	7742	7210	7913	7330	8081	7446	8246	7557	8409	7664	8570	44
45	0.7087	0.7745	0.7212	0.7916	0.7332	0.8084	0.7447	0.8249	0.7559	0.8412	0.7666	0.8573	45
46	7089	7748	7214	7918	7334	8086	7449	8252	7561	8415	7668	8575	46
47	7091	7750	7216	7921	7336	8089	7451	8254	7562	8417	7669	8578	47
48	7093	7753	7218	7924	7338	8092	7453	8257	7564	8420	7671	8581	48
49	7095	7756	7220	7927	7340	8095	7455	8260	7566	8423	7673	8583	49
50	0.7097	0.7759	0.7222	0.7930	0.7342	0.8097	0.7457	0.8263	0.7568	0.8425	0.7675	0.8586	50
51	7099	7762	7224	7933	7344	8100	7459	8265	7570	8428	7676	8589	51
52	7102	7765	7226	7935	7345	8103	7461	8268	7571	8431	7678	8591	52
53	7104	7768	7228	7938	7347	8106	7462	8271	7573	8433	7680	8594	53
54	7106	7771	7230	7941	7349	8109	7464	8274	7575	8436	7682	8597	54
55	0.7108	0.7773	0.7232	0.7944	0.7351	0.8111	0.7466	0.8276	0.7577	0.8439	0.7683	0.8599	55
56	7110	7776	7234	7947	7353	8114	7468	8279	7579	8442	7685	8602	56
57	7112	7779	7236	7949	7355	8117	7470	8282	7581	8444	7687	8605	57
58	7114	7782	7238	7952	7357	8120	7472	8284	7582	8447	7689	8607	58
59	7116	7785	7240	7955	7359	8122	7474	8287	7584	8450	7690	8610	59
60	7118	7788	7242	7958	7361	8125	7476	8290	7586	8452	7692	8613	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M
	30°		31°		32°		33°		34°		35°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	36° Log. S.	36° Log. T.	37° Log. S.	37° Log. T.	38° Log. S.	38° Log. T.	39° Log. S.	39° Log. T.	40° Log. S.	40° Log. T.	41° Log. S.	41° Log. T.	M.
0	0.7692	0.8613	0.7795	0.8771	0.7893	0.8928	0.7989	0.9084	0.8081	0.9238	0.8169	0.9392	0
1	7694	8615	7796	8774	7895	8931	7990	9086	8082	9241	8171	9394	1
2	7696	8618	7798	8776	7897	8933	7992	9089	8084	9243	8172	9397	2
3	7697	8621	7800	8779	7898	8936	7993	9091	8085	9246	8174	9399	3
4	7699	8623	7801	8782	7900	8939	7995	9094	8087	9248	8175	9402	4
5	0.7701	0.8626	0.7803	0.8784	0.7901	0.8941	0.7997	0.9097	0.8088	0.9251	0.8177	0.9404	5
6	7703	8629	7805	8787	7903	8944	7998	9099	8090	9254	8178	9407	6
7	7704	8631	7806	8790	7905	8946	8000	9102	8091	9256	8180	9409	7
8	7706	8634	7808	8792	7906	8949	8001	9104	8093	9259	8181	9412	8
9	7708	8637	7810	8795	7908	8952	8003	9107	8094	9261	8182	9415	9
10	0.7710	0.8639	0.7811	0.8797	0.7910	0.8954	0.8004	0.9110	0.8096	0.9264	0.8184	0.9417	10
11	7711	8642	7813	8800	7911	8957	8006	9112	8097	9266	8185	9420	11
12	7713	8644	7815	8803	7913	8959	8007	9115	8099	9269	8187	9422	12
13	7715	8647	7816	8805	7914	8962	8009	9117	8100	9271	8188	9425	13
14	7716	8650	7818	8808	7916	8965	8010	9120	8102	9274	8190	9427	14
15	0.7718	0.8652	0.7820	0.8811	0.7918	0.8967	0.8012	0.9122	0.8103	0.9277	0.8191	0.9430	15
16	7720	8655	7821	8813	7919	8970	8014	9125	8105	9279	8193	9432	16
17	7722	8658	7823	8816	7921	8972	8015	9128	8106	9282	8194	9435	17
18	7223	8660	7825	8818	7922	8975	8017	9130	8108	9284	8195	9438	18
19	7725	8663	7826	8821	7924	8978	8018	9133	8109	9287	8197	9440	19
20	0.7727	0.8666	0.7828	0.8824	0.7926	0.8980	0.8020	0.9135	0.8111	0.9289	0.8198	0.9443	20
21	7728	8668	7830	8826	7927	8983	8021	9138	8112	9292	8200	9445	21
22	7730	8671	7831	8829	7929	8985	8023	9140	8114	9295	8201	9448	22
23	7732	8674	7833	8831	7930	8988	8024	9143	8115	9297	8203	9450	23
24	7734	8676	7835	8834	7932	8990	8026	9146	8117	9300	8204	9453	24
25	0.7735	0.8679	0.7836	0.8837	0.7934	0.8993	0.8027	0.9148	0.8118	0.9302	0.8206	0.9455	25
26	7737	8682	7838	8839	7935	8996	8029	9151	8120	9305	8207	9458	26
27	7739	8684	7840	8842	7937	8998	8031	9153	8121	9307	8208	9460	27
28	7740	8687	7841	8845	7938	9001	8032	9156	8122	9310	8210	9463	28
29	7742	8689	7843	8847	7940	9003	8034	9158	8124	9312	8211	9466	29
30	0.7744	0.8692	0.7844	0.8850	0.7942	0.9006	0.8035	0.9161	0.8125	0.9315	0.8213	0.9468	30
31	7746	8695	7846	8852	7943	9009	8037	9164	8127	9318	8214	9471	31
32	7747	8697	7848	8855	7945	9011	8038	9166	8128	9320	8216	9473	32
33	7749	8700	7849	8858	7946	9014	8040	9169	8130	9323	8217	9476	33
34	7751	8703	7851	8860	7948	9016	8041	9171	8131	9325	8218	9478	34
35	0.7752	0.8705	0.7853	0.8863	0.7949	0.9019	0.8043	0.9174	0.8133	0.9328	0.8220	0.9481	35
36	7754	8708	7854	8865	7951	9022	8044	9176	8134	9330	8221	9483	36
37	7756	8711	7856	8868	7953	9024	8046	9179	8136	9333	8223	9486	37
38	7758	8713	7858	8871	7954	9026	8047	9182	8137	9335	8224	9488	38
39	7759	8716	7859	8873	7956	9029	8049	9184	8139	9338	8225	9491	39
40	0.7761	0.8718	0.7861	0.8876	0.7957	0.9032	0.8050	0.9187	0.8140	0.9341	0.8227	0.9494	40
41	7763	8721	7863	8879	7959	9035	8052	9189	8142	9343	8228	9496	41
42	7764	8724	7864	8881	7960	9037	8053	9192	8143	9346	8230	9499	42
43	7766	8726	7866	8884	7962	9040	8055	9194	8145	9348	8231	9501	43
44	7768	8729	7867	8886	7964	9042	8056	9197	8146	9351	8233	9504	44
45	0.7769	0.8732	0.7869	0.8889	0.7965	0.9045	0.8058	0.9200	0.8148	0.9353	0.8234	0.9506	45
46	7771	8734	7871	8892	7967	9048	8060	9202	8149	9356	8235	9509	46
47	7773	8737	7872	8894	7968	9050	8061	9205	8150	9358	8237	9511	47
48	7774	8740	7874	8897	7970	9053	8063	9207	8152	9361	8238	9514	48
49	7776	8742	7876	8899	7972	9055	8064	9210	8153	9364	8240	9516	49
50	0.7778	0.8745	0.7877	0.8902	0.7973	0.9057	0.8066	0.9212	0.8155	0.9366	0.8241	0.9519	50
51	7780	8747	7879	8905	7975	9060	8067	9215	8156	9369	8242	9522	51
52	7781	8750	7880	8907	7976	9063	8069	9218	8158	9371	8244	9524	52
53	7783	8753	7882	8910	7978	9066	8070	9220	8159	9374	8245	9527	53
54	7785	8755	7884	8912	7979	9068	8072	9223	8161	9376	8247	9529	54
55	0.7786	0.8758	0.7885	0.8915	0.7981	0.9071	0.8073	0.9225	0.8162	0.9379	0.8248	0.9532	55
56	7788	8761	7887	8918	7982	9073	8075	9228	8164	9381	8249	9534	56
57	7790	8763	7889	8920	7984	9076	8076	9230	8165	9384	8251	9537	57
58	7791	8766	7890	8923	7986	9079	8078	9233	8167	9387	8252	9539	58
59	7793	8769	7892	8925	7987	9081	8079	9236	8168	9389	8254	9542	59
60	7795	8771	7893	8928	7989	9084	8081	9238	8169	9392	8255	9544	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M
	36°		37°		38°		39°		40°		41°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	42°		43°		44°		45°		46°		47°		M.
	Log. S.	Log. T.	Log. S	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	
0	0.8255	0.9544	0.8338	0.9697	0.8418	0.9848	0.8495	1.0000	0.8569	1.0152	0.8641	1.0303	0
1	8257	9547	8339	9699	8419	9851	8496	0003	8571	0154	8642	0306	1
2	8258	9549	8341	9702	8420	9853	8497	0005	8572	0157	8644	0309	2
3	8259	9552	8342	9704	8422	9856	8499	0008	8573	0159	8645	0311	3
4	8261	9555	8343	9707	8423	9858	8500	0010	8574	0162	8646	0314	4
5	0.8262	0.9557	0.8345	0.9709	0.8424	0.9861	0.8501	1.0013	0.8575	1.0164	0.8647	1.0316	5
6	8264	9560	8346	9712	8426	9864	8502	0015	8577	0167	8648	0319	6
7	8265	9562	8347	9714	8427	9866	8504	0018	8578	0169	8650	0321	7
8	8266	9565	8349	9717	8428	9869	8505	0020	8579	0172	8651	0324	8
9	8268	9567	8350	9719	8429	9871	8506	0023	8580	0174	8652	0326	9
10	0.8269	0.9570	0.8351	0.9722	0.8431	0.9874	0.8507	1.0025	0.8582	1.0177	0.8653	1.0329	10
11	8270	9572	8353	9724	8432	9876	8509	0028	8583	0179	8654	0331	11
12	8272	9575	8354	9727	8433	9879	8510	0030	8584	0182	8655	0334	12
13	8273	9577	8355	9729	8435	9881	8511	0033	8585	0185	8657	0336	13
14	8275	9580	8357	9732	8436	9884	8512	0035	8586	0187	8658	0339	14
15	0.8276	0.9582	0.8358	0.9735	0.8437	0.9886	0.8514	1.0038	0.8588	1.0190	0.8659	1.0341	15
16	8277	9585	8359	9737	8439	9889	8515	0040	8589	0192	8660	0344	16
17	8279	9588	8361	9740	8440	9891	8516	0043	8590	0195	8661	0347	17
18	8280	9590	8362	9742	8441	9894	8517	0045	8591	0197	8662	0349	18
19	8282	9593	8363	9745	8442	9896	8519	0048	8592	0200	8663	0352	19
20	0.8283	0.9595	0.8365	0.9747	0.8444	0.9899	0.8520	1.0051	0.8594	1.0202	0.8665	1.0354	20
21	8284	9598	8366	9750	8445	9901	8521	0053	8595	0205	8666	0357	21
22	8286	9600	8367	9752	8446	9904	8522	0056	8596	0207	8667	0359	22
23	8287	9603	8369	9755	8448	9907	8524	0058	8597	0210	8668	0362	23
24	8289	9605	8370	9757	8449	9909	8525	0061	8598	0212	8669	0364	24
25	0.8290	0.9608	0.8371	0.9760	0.8450	0.9912	0.8526	1.0063	0.8600	1.0215	0.8671	1.0367	25
26	8291	9610	8373	9762	8451	9914	8527	0066	8601	0217	8672	0369	26
27	8293	9613	8374	9765	8453	9917	8529	0068	8602	0220	8673	0372	27
28	8294	9615	8375	9767	8454	9919	8530	0071	8603	0222	8674	0374	28
29	8295	9618	8377	9770	8455	9922	8531	0073	8604	0225	8675	0377	29
30	0.8297	0.9621	0.8378	0.9773	0.8457	0.9924	0.8532	1.0076	0.8606	1.0228	0.8676	1.0379	30
31	8298	9623	8379	9775	8458	9927	8534	0078	8607	0230	8677	0382	31
32	8300	9626	8381	9778	8459	9929	8535	0081	8608	0233	8679	0385	32
33	8301	9628	8382	9780	8460	9932	8536	0083	8609	0235	8680	0387	33
34	8302	9631	8383	9783	8462	9934	8537	0086	8610	0238	8681	0390	34
35	0.8304	0.9633	0.8385	0.9785	0.8463	0.9937	0.8539	1.0088	0.8612	1.0240	0.8682	1.0392	35
36	8305	9636	8386	9788	8464	9939	8540	0091	8613	0243	8683	0395	36
37	8306	9638	8387	9790	8466	9942	8541	0093	8614	0245	8684	0397	37
38	8308	9641	8389	9793	8467	9944	8542	0096	8615	0248	8686	0400	38
39	8309	9643	8390	9795	8468	9947	8544	0099	8616	0250	8687	0402	39
40	0.8311	0.9646	0.8391	0.9798	0.8469	0.9949	0.8545	1.0101	0.8618	1.0253	0.8688	1.0405	40
41	8312	9648	8393	9800	8471	9952	8546	0104	8619	0255	8689	0407	41
42	8313	9651	8394	9803	8472	9955	8547	0106	8620	0258	8690	0410	42
43	8315	9653	8395	9805	8473	9957	8549	0109	8621	0260	8691	0412	43
44	8316	9656	8397	9808	8475	9960	8550	0111	8622	0263	8692	0415	44
45	0.8317	0.9659	0.8398	0.9810	0.8476	0.9962	0.8551	1.0114	0.8624	1.0265	0.8694	1.0418	45
46	8319	9661	8399	9813	8477	9965	8552	0116	8625	0268	8695	0420	46
47	8320	9664	8401	9816	8478	9967	8553	0119	8626	0271	8696	0423	47
48	8322	9666	8402	9818	8480	9970	8555	0121	8627	0273	8697	0425	48
49	8323	9669	8403	9821	8481	9972	8556	0124	8628	0276	8698	0428	49
50	0.8324	0.9671	0.8405	0.9823	0.8482	0.9975	0.8557	1.0126	0.8629	1.0278	0.8699	1.0430	50
51	8326	9674	8406	9826	8483	9977	8558	0129	8631	0281	8700	0433	51
52	8327	9676	8407	9828	8485	9980	8560	0131	8632	0283	8702	0435	52
53	8328	9679	8409	9831	8486	9982	8561	0134	8633	0286	8703	0438	53
54	8330	9681	8410	9833	8487	9985	8562	0136	8634	0288	8704	0440	54
55	0.8331	0.9684	0.8411	0.9836	0.8489	0.9987	0.8563	1.0139	0.8635	1.0291	0.8705	1.0443	55
56	8332	9686	8412	9838	8490	9990	8564	0142	8637	0293	8706	0445	56
57	8334	9689	8414	9841	8491	9992	8566	0144	8638	0296	8707	0448	57
58	8335	9691	8415	9843	8492	9995	8567	0147	8639	0298	8708	0451	58
59	8336	9694	8416	9846	8494	9997	8568	0149	8640	0301	8710	0453	59
60	8338	9697	8418	9848	8495	1.0000	8569	0152	8641	0303	8711	0456	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	42°		43°		44°		45°		46°		47°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	48°		49°		50°		51°		52°		53°		M.
	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	
0	0.8711	1.0456	0.8778	1.0608	0.8843	1.0762	0.8905	1.0916	0.8965	1.1072	0.9023	1.1229	0
1	8712	0458	8779	0611	8844	0764	8906	0919	8966	1075	9024	1231	1
2	8713	0461	8780	0613	8845	0767	8907	0921	8967	1077	9025	1234	2
3	8714	0463	8781	0616	8846	0770	8908	0924	8968	1080	9026	1237	3
4	8715	0466	8782	0619	8847	0772	8909	0927	8969	1082	9027	1239	4
5	0.8716	1.0468	0.8783	1.0621	0.8848	1.0775	0.8910	1.0929	0.8970	1.1085	0.9028	1.1242	5
6	8718	0471	8784	0624	8849	0777	8911	0932	8971	1088	9029	1245	6
7	8719	0473	8785	0626	8850	0780	8912	0934	8972	1090	9030	1247	7
8	8720	0476	8787	0629	8851	0782	8913	0937	8973	1093	9031	1250	8
9	8721	0479	8788	0631	8852	0785	8914	0940	8974	1095	9032	1253	9
10	0.8722	1.0481	0.8789	1.0634	0.8853	1.0788	0.8915	1.0942	0.8975	1.1098	0.9033	1.1255	10
11	8723	0484	8790	0636	8854	0790	8916	0945	8976	1101	9034	1258	11
12	8724	0486	8791	0639	8855	0793	8917	0947	8977	1103	9035	1260	12
13	8725	0489	8792	0642	8856	0795	8918	0950	8978	1106	9036	1263	13
14	8727	0491	8793	0644	8857	0798	8619	0953	8979	1108	9037	1266	14
15	0.8728	1.0494	0.8794	1.0647	0.8858	1.0800	0.8920	1.0955	0.8980	1.1111	0.9038	1.1268	15
16	8729	0496	8795	0649	8859	0803	8921	0958	8981	1114	9039	1271	16
17	8730	0499	8796	0652	8860	0806	8922	0960	8982	1116	9040	1274	17
18	8731	0501	8797	0654	8862	0808	8923	0963	8983	1119	9041	1276	18
19	8732	0504	8799	0657	8863	0811	8924	0965	8984	1121	9041	1279	19
20	0.8733	1.0506	0.8800	1.0659	0.8864	1.0813	0.8925	1.0968	0.8985	1.1124	0.9042	1.1282	20
21	8734	0509	8801	0662	8865	0816	8926	0971	8986	1127	9043	1284	21
22	8736	0512	8802	0665	8866	0818	8927	0973	8987	1129	9044	1287	22
23	8737	0514	8803	0667	8867	0821	8928	0976	8988	1132	9045	1289	23
24	8738	0517	8804	0670	8868	0824	8929	0978	8989	1135	9046	1292	24
25	0.8739	1.0519	0.8805	1.0672	0.8869	1.0826	0.8930	1.0981	0.8990	1.1137	0.9047	1.1295	25
26	8740	0522	8806	0675	8870	0829	8931	0984	8991	1140	9048	1297	26
27	8741	0524	8807	0677	8871	0831	8932	0986	8992	1142	9049	1300	27
28	8742	0527	8808	0680	8872	0834	8933	0989	8993	1145	9050	1303	28
29	8743	0529	8809	0682	8873	0836	8934	0991	8994	1148	9051	1305	29
30	0.8745	1.0532	0.8810	1.0685	0.8874	1.0839	0.8935	1.0994	0.8995	1.1150	0.9052	1.1308	30
31	8746	0534	8812	0688	8875	0842	8936	0997	8996	1153	9053	1311	31
32	8747	0537	8813	0690	8876	0844	8937	0999	8997	1155	9054	1313	32
33	8748	0540	8814	0693	8877	0847	8938	1002	8998	1158	9055	1316	33
34	8749	0542	8815	0695	8878	0849	8939	1004	8999	1161	9056	1318	34
35	0.8750	1.0545	0.8816	1.0698	0.8879	1.0852	0.8940	1.1007	0.9000	1.1163	0.9056	1.1321	35
36	8751	0547	8817	0700	8880	0854	8941	1010	9000	1166	9057	1324	36
37	8752	0550	8818	0703	8881	0857	8942	1012	9001	1169	9058	1326	37
38	8753	0552	8819	0705	8882	0860	8943	1015	9002	1171	9059	1329	38
39	8755	0555	8820	0708	8883	0862	8944	1017	9003	1174	9060	1332	39
40	0.8756	1.0557	0.8821	1.0711	0.8884	1.0865	0.8945	1.1020	0.9004	1.1176	0.9061	1.1334	40
41	8757	0560	8822	0713	8885	0867	8946	1022	9005	1179	9062	1337	41
42	8758	0562	8823	0716	8887	0870	8947	1025	9006	1182	9063	1340	42
43	8759	0565	8824	0718	8888	0872	8948	1028	9007	1184	9064	1342	43
44	8760	0568	8825	0721	8889	0875	8949	1030	9008	1187	9065	1345	44
45	0.8761	1.0570	0.8827	1.0723	0.8890	0.0878	0.8950	1.1033	0.9009	1.1189	0.9066	1.1348	45
46	8762	0573	8828	0726	8891	0880	8951	1035	9010	1192	9067	1350	46
47	8763	0575	8829	0729	8892	0883	8952	1038	9011	1195	9068	1353	47
48	8765	0578	8830	0731	8893	0885	8953	1041	9012	1197	9069	1356	48
49	8766	0580	8831	0734	8894	0888	8954	1043	9013	1200	9069	1358	49
50	0.8767	1.0583	0.8832	1.0736	0.8895	1.0890	0.8955	1.1046	0.9014	1.1203	0.9070	1.1361	50
51	8768	0585	8833	0739	8896	0893	8956	1048	9015	1205	9071	1364	51
52	8769	0588	8834	0741	8897	0896	8957	1051	9016	1208	9072	1366	52
53	8770	0591	8835	0744	8898	0898	8958	1054	9017	1210	9073	1369	53
54	8771	0593	8836	0746	8899	0901	8959	1056	9018	1213	9074	1371	54
55	0.8772	1.0596	0.8837	1.0749	0.8900	1.0903	0.8960	1.1059	0.9019	1.1216	0.9075	1.1374	55
56	8773	0598	8838	0752	8901	0906	8961	1061	9020	1218	9076	1377	56
57	8775	0601	8839	0754	8902	0909	8962	1064	9021	1221	9077	1379	57
58	8776	0603	8840	0757	8903	0911	8963	1067	9022	1224	9078	1382	58
59	8777	0606	8841	0759	8904	0914	8964	1069	9023	1226	9079	1385	59
60	8778	0608	8843	0762	8905	0916	8965	1072	9023	1229	9080	1387	60
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	48°		49°		50°		51°		52°		53°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	54° Log. S.	54° Log. T.	55° Log. S.	55° Log. T.	56° Log. S.	56° Log. T.	57° Log. S.	57° Log. T.	58° Log. S.	58° Log. T.	59° Log. S.	59° Log. T.	M.
0	0.9080	1.1387	0.9134	1.1548	0.9186	1.1710	0.9236	1.1875	0.9284	1.2042	0.9331	1.2212	60
1	9080	1390	9135	1550	9187	1713	9237	1878	9285	2045	9331	2215	59
2	9081	1393	9135	1553	9187	1716	9238	1880	9286	2048	9332	2218	58
3	9082	1395	9136	1556	9188	1718	9238	1883	9287	2051	9333	2221	57
4	9083	1398	9137	1558	9189	1721	9239	1886	9287	2053	9334	2224	56
5	0.9084	1.1401	0.9138	1.1561	0.9190	1.1724	0.9240	1.1889	0.9288	1.2056	0.9334	1 2227	55
6	9085	1403	9139	1564	9191	1726	9241	1891	9289	2059	9335	2229	54
7	9086	1406	9140	1567	9192	1729	9242	1894	9290	2062	9336	2232	53
8	9087	1409	9141	1569	9193	1732	9242	1897	9291	2065	9337	2235	52
9	9088	1411	9142	1572	9193	1735	9243	1900	9291	2067	9337	2238	51
10	0.9089	1.1414	0.9142	1.1575	0.9194	1.1737	0.9244	1.1903	0.9292	1.2070	0.9338	1.2241	50
11	9090	1417	9143	1577	9195	1740	9245	1905	9293	2073	9339	2244	49
12	9091	1419	9144	1580	9196	1743	9246	1908	9294	2076	9340	2247	48
13	9091	1422	9145	1583	9197	1746	9247	1911	9294	2079	9340	2250	47
14	9092	1425	9146	1585	9198	1748	9247	1914	9295	2082	9341	2252	46
15	0.9093	1.1427	0.9147	1.1588	0.9198	1.1751	0.9248	1.1916	0.9296	1.2084	0.9342	1.2255	45
16	9094	1430	9148	1591	9199	1754	9249	1919	9297	2087	9343	2258	44
17	9095	1433	9149	1594	9200	1757	9250	1922	9298	2090	9343	2261	43
18	9096	1435	9149	1596	9201	1759	9251	1925	9298	2093	9344	2264	42
19	9097	1438	9150	1599	9202	1762	9251	1928	9299	2096	9345	2267	41
20	0.9098	1.1441	0.9151	1.1602	0.9203	1.1765	0.9252	1.1930	0.9300	1.2098	0.9346	1.2270	40
21	9099	1443	9152	1604	9204	1767	9253	1933	9301	2101	9346	2273	39
22	9100	1446	9153	1607	9204	1770	9254	1936	9301	2104	9347	2275	38
23	9101	1449	9154	1610	9205	1773	9255	1939	9302	2107	9348	2278	37
24	9101	1451	9155	1612	9206	1776	9255	1941	9303	2110	9349	2281	36
25	0.9102	1.1454	0.9156	1.1615	0.9207	1.1778	0.9256	1.1944	0.9304	1.2113	0.9349	1.2284	35
26	9103	1457	9156	1618	9208	1781	9257	1947	9305	2115	9350	2287	34
27	9104	1459	9157	1621	9209	1784	9258	1950	9305	2118	9351	2290	33
28	9105	1462	9158	1623	9209	1787	9259	1953	9306	2121	9352	2293	32
29	9106	1465	9159	1626	9210	1789	9259	1955	9307	2124	9352	2296	31
30	0.9107	1.1467	0.9160	1.1629	0.9211	1.1792	0.9260	1.1958	0.9308	1.2127	0.9353	1.2299	30
31	9108	1470	9161	1631	9212	1795	9261	1961	9308	2130	9354	2301	29
32	9109	1473	9162	1634	9213	1798	9262	1964	9309	2132	9355	2304	28
33	9110	1475	9163	1637	9214	1800	9263	1966	9310	2135	9355	2307	27
34	9110	1478	9163	1639	9214	1803	9264	1969	9311	2138	9356	2310	26
35	0.9111	1.1481	0.9164	1.1642	0.9215	1.1806	0.9264	1.1972	0.9312	1.2141	0.9357	1.2313	25
36	9112	1483	9165	1645	9216	1809	9265	1975	9312	2144	9358	2316	24
37	9113	1486	9166	1648	9217	1811	9266	1978	9313	2147	9358	2319	23
38	9114	1489	9167	1650	9218	1814	9267	1980	9314	2150	9359	2322	22
39	9115	1491	9168	1653	9219	1817	9268	1983	9315	2152	9360	2325	21
40	0.9116	1.1494	0.9169	1.1656	0.9219	1.1820	0.9268	1.1986	0.9315	1.2155	0.9361	1.2327	20
41	9117	1497	9169	1658	9220	1822	9269	1989	9316	2158	9361	2330	19
42	9118	1499	9170	1661	9221	1825	9270	1992	9317	2161	9362	2333	18
43	9119	1502	9171	1664	9222	1828	9271	1994	9318	2164	9363	2336	17
44	9119	1505	9172	1667	9223	1831	9272	1997	9318	2167	9364	2339	16
45	0.9120	1.1507	0.9173	1.1669	0.9224	1.1833	0.9272	1.2000	0.9319	1.2169	0.9364	1.2342	15
46	9121	1510	9174	1672	9224	1836	9273	2003	9320	2172	9365	2345	14
47	9122	1513	9175	1675	9225	1839	9274	2006	9321	2175	9366	2348	13
48	9123	1516	9175	1677	9226	1842	9275	2008	9322	2178	9367	2351	12
49	9124	1518	9176	1680	9227	1844	9275	2011	9322	2181	9367	2354	11
50	0.9125	1.1521	0.9177	1.1683	0.9228	1.1847	0.9276	1.2014	0.9323	1.2184	0.9368	1.2356	10
51	9126	1524	9178	1686	9229	1850	9277	2017	9324	2187	9369	2359	9
52	9127	1526	9179	1688	9229	1853	9278	2020	9325	2189	9369	2362	8
53	9127	1529	9180	1691	9230	1855	9279	2022	9325	2192	9370	2365	7
54	9128	1532	9181	1694	9231	1858	9279	2025	9326	2195	9371	2368	6
55	0.9129	1.1534	0.9181	1.1697	0.9232	1.1861	0.9280	1.2028	0.9327	1.2198	0.9372	1.2371	5
56	9130	1537	9182	1699	9233	1864	9281	2031	9328	2201	9372	2374	4
57	9131	1540	9183	1702	9233	1867	9282	2034	9328	2204	9373	2377	3
58	9132	1542	9184	1705	9234	1869	9283	2036	9329	2207	9374	2380	2
59	9133	1545	9185	1707	9235	1872	9283	2039	9330	2209	9375	2383	1
60	9134	1548	9186	1710	9236	1875	9284	2042	9331	2212	9375	2386	0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	125°		124°		123°		122°		121°		120°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE

APPARENT DISTANCE.

M.	60° Log. S.	60° Log. T.	61° Log. S.	61° Log. T.	62° Log. S.	62° Log. T.	63° Log. S.	63° Log. T.	64° Log. S.	64° Log. T.	65° Log. S.	65° Log. T.	M.
0	0.9375	1.2386	0.9418	1.2562	0.9459	1.2743	0.9499	1.2928	0.9537	1.3118	0.9573	1.3313	60
1	9376	2389	9419	2565	9460	2746	9499	2931	9537	3121	9573	3317	59
2	9377	2391	9420	2568	9461	2749	9500	3935	9538	3125	9574	3320	58
3	9377	2394	9420	2571	9461	2752	9501	2938	9538	3128	9575	3323	57
4	9378	2397	9421	2574	9462	2755	9501	2941	9539	3131	9575	3326	56
5	0.9379	1.2400	0.9422	1.2577	0.9463	1.2759	0.9502	1.2944	0.9540	1.3134	0.9576	1.3330	55
6	9380	2403	9422	2580	9463	2762	9503	2947	9540	3137	9576	3333	54
7	9380	2406	9423	2583	9464	2765	9503	2950	9541	3141	9577	3336	53
8	9381	2409	9424	2586	9465	2768	9504	2953	9542	3144	9577	3340	52
9	9382	2412	9424	2589	9465	2771	9505	2957	9542	3147	9578	3343	51
10	0.9383	1.2415	0.9425	1.2592	0.9466	1.2774	0.9505	1.2960	0.9543	1.3150	0.9579	1.3346	50
11	9383	2418	9426	2595	9467	2777	9506	2963	9543	3154	9579	3350	49
12	9384	2421	9427	2598	9467	2780	9506	2966	9544	3157	9580	3353	48
13	9385	2424	9427	2601	9468	2783	9507	2969	9545	3160	9580	3356	47
14	9385	2427	9428	2604	9469	2786	9508	2972	9545	3163	9581	3360	46
15	0.9386	1.2429	0.9429	1.2607	0.9469	1.2789	0.9508	1.2975	0.9546	1.3166	0.9582	1.3363	45
16	9387	2432	9429	2610	9470	2792	9509	2978	9546	3170	9582	3366	44
17	9388	2435	9430	2613	9471	2795	9510	2982	9547	3173	9583	3370	43
18	9388	2438	9431	2616	9471	2798	9510	2985	9548	3176	9583	3373	42
19	9389	2441	9431	2619	9472	2801	9511	2988	9548	3179	9584	3376	41
20	0.9390	1.2444	0.9432	1.2622	0.9473	1.2804	0.9512	1.2991	0.9549	1.3183	0.9584	1.3380	40
21	9391	2447	9433	2625	9473	2808	9512	2994	9549	3186	9585	3383	39
22	9391	2450	9433	2628	9474	2811	9513	2997	9550	3189	9586	3386	38
23	9392	2453	9434	2631	9475	2814	9513	3001	9551	3192	9586	3390	37
24	9393	2456	9435	2634	9475	2817	9514	3004	9551	3196	9587	3393	36
25	0.9393	1.2459	0.9436	1.2637	0.9476	1.2820	0.9515	1.3007	0.9552	1.3199	0.9587	1.3396	35
26	9394	2462	9436	2640	9477	2823	9515	3010	9552	3202	9588	3400	34
27	9395	2465	9437	2643	9477	2826	9516	3013	9553	3205	9588	3403	33
28	9396	2468	9438	2646	9478	2829	9517	3016	9554	3209	9589	3406	32
29	9396	2471	9438	2649	9479	2832	9517	3019	9554	3212	9590	3410	31
30	0.9397	1.2474	0.9439	1.2652	0.9479	1.2835	0.9518	1.3023	0.9555	1.3215	0.9590	1.3413	30
31	9398	2477	9440	2655	9480	2838	9519	3026	9555	3218	9591	3416	29
32	9398	2479	9440	2658	9481	2841	9519	3029	9556	3222	9591	3420	28
33	9399	2482	9441	2661	9481	2844	9520	3032	9557	3225	9592	3423	27
34	9400	2485	9442	2664	9482	2848	9520	3035	9557	3228	9593	3426	26
35	0.9401	1.2488	0.9442	1.2667	0.9483	1.2851	0.9521	1.3038	0.9558	1.3231	0.9593	1.3430	25
36	9401	2491	9443	2670	9483	2854	9522	3042	9558	3235	9594	3433	24
37	9402	2494	9444	2673	9484	2857	9522	3045	9559	3238	9594	3436	23
38	9403	2497	9444	2676	9485	2860	9523	3048	9560	3241	9595	3440	22
39	9403	2500	9445	2680	9485	2863	9524	3051	9560	3244	9595	3443	21
40	0.9404	1 2503	0.9446	1.2683	0.9486	1.2866	0.9524	1.3054	0.9561	1.3248	0.9596	1.3447	20
41	9405	2506	9447	2686	9486	2869	9525	3058	9561	3251	9597	3450	19
42	9406	2509	9447	2689	9487	2872	9525	3061	9562	3254	9597	3453	18
43	9406	2512	9448	2692	9488	2875	9526	3064	9563	3257	9598	3457	17
44	9407	2515	9448	2695	9488	2879	9527	3067	9563	3261	9598	3460	16
45	0.9408	1.2518	0.9449	1.2698	0.9489	1.2882	0.9527	1.3070	0.9564	3.3264	0.9599	1.3463	15
46	9408	2521	9450	2701	9490	2885	9528	3073	9564	3267	9599	3467	14
47	9409	2524	9451	2704	9490	2888	9529	3077	9565	3271	9600	3470	13
48	9410	2527	9451	2707	9491	2891	9529	3080	9566	3274	9601	3473	12
49	9410	2530	9452	2710	9492	2894	9530	3083	9566	3277	9601	3477	11
50	0.9411	1.2533	0.9453	1.2713	0.9492	1.2897	0.9530	1.3086	0.9567	1.3280	0.9602	1.3480	10
51	9412	2536	9453	2716	9493	2900	9531	3089	9567	3284	9602	3484	9
52	9413	2539	9454	2719	9494	2903	9532	3093	9568	3287	9603	3487	8
53	9413	2542	9455	2722	9494	2907	9532	3096	9569	3290	9603	3490	7
54	9414	2545	9455	2725	9495	2910	9533	3099	9569	3294	9604	3494	6
55	0.9415	1.2548	0.9456	1.2728	0.9496	1.2913	0.9534	1.3102	0.9570	1.3297	0.9604	1.3497	5
56	9415	2551	9457	2731	9496	2916	9534	3105	9570	3300	9605	3501	4
57	9416	2554	9457	2734	9497	2919	9535	3109	9571	3303	9606	3504	3
58	9417	2557	9458	2737	9498	2922	9535	3112	9572	3307	9606	3507	2
59	9417	2560	9459	2740	9498	2925	9536	3115	9572	3310	9607	3511	1
60	9418	2562	9459	2743	9499	2928	9537	3118	9573	3313	9607	3514	0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	119°		118°		117°		116°		115°		114°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	66°		67°		68°		69°		70°		71°		M.
	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	
0	0.9607	1.3514	0.9640	1.3721	0.9672	1.3936	0.9702	1.4158	0.9730	1.4389	0 9757	1 4630	60
1	9608	3518	9641	3725	9672	3940	9702	4162	9730	4393	9757	4634	59
2	9608	3521	9641	3729	9673	3943	9702	4166	9731	4397	9758	4638	58
3	9609	3524	9642	3732	9673	3947	9703	4170	9731	4401	9758	4643	57
4	9610	3528	9642	3736	9674	3950	9703	4173	9732	4405	9758	4647	56
5	0.9610	1.3531	0.9643	1.3739	0.9674	1.3954	0.9704	1.4177	0.9732	1.4409	0.9759	1.4651	55
6	9611	3535	9643	3743	9675	3958	9704	4181	9733	4413	9759	4655	54
7	9611	3538	9644	3746	9675	3961	9705	4185	9733	4417	9760	4659	53
8	9612	3541	9645	3750	9676	3965	9705	4189	9734	4421	9760	4663	52
9	9612	3545	9645	3753	9676	3969	9706	4192	9734	4425	9761	4667	51
10	0.9613	1.3548	0.9646	1.3757	0.9677	1.3972	0.9706	1.4196	0.9734	1.4429	0.9761	1.4671	50
11	9613	3552	9646	3760	9677	3976	9707	4200	9735	4433	9761	4676	49
12	9614	3555	9647	3764	9678	3980	9707	4204	9735	4437	9762	4680	48
13	9615	3559	9647	3767	9678	3983	9708	4208	9736	4441	9762	4684	47
14	9615	3562	9648	3771	9679	3987	9708	4211	9736	4445	9763	4688	46
15	0.9616	1.3565	0.9648	1.3774	0.9679	1.3991	0.9709	1.4215	0.9737	1.4449	0.9763	1.4692	45
16	9616	3569	9649	3778	9680	3994	9709	4219	9737	4453	9764	4696	44
17	9617	3572	9649	3781	9680	3998	9710	4223	9738	4457	9764	4700	43
18	9617	3576	9650	3785	9681	4002	9710	4227	9738	4461	9764	4705	42
19	9618	3579	9650	3789	9681	4005	9711	4230	9739	4465	9765	4709	41
20	0.9618	1.3583	0.9651	1.3792	0.9682	1.4009	0.9711	1.4234	0.9739	1.4469	0.9765	1.4713	40
21	9619	3586	9651	3796	9682	4013	9712	4238	9739	4473	9766	4717	39
22	9620	3589	9652	3799	9683	4016	9712	4242	9740	4476	9766	4721	38
23	9620	3593	9652	3803	9683	4020	9713	4246	9740	4480	9767	4725	37
24	9621	3596	9653	3806	9684	4024	9713	4250	9741	4484	9767	4730	36
25	0.9621	1.3600	0.9654	1.3810	0.9684	1.4028	0.9714	1.4253	0.9741	1.4488	0.9767	1.4734	35
26	9622	3603	9654	3813	9685	4031	9714	4257	9742	4492	9768	4738	34
27	9622	3607	9655	3817	9685	4035	9714	4261	9742	4496	9768	4742	33
28	9623	3610	9655	3821	9686	4039	9715	4265	9743	4500	9769	4746	32
29	9623	3614	9656	3824	9686	4042	9715	4269	9743	4504	9769	4751	31
30	0.9624	1.3617	0.9656	1.3828	0.9687	1.4046	0.9716	1.4273	0.9743	1.4509	0.9770	1.4755	30
31	9625	3620	9657	3831	9687	4050	9716	4276	9744	4513	9770	4759	29
32	9625	3624	9657	3835	9688	4053	9717	4280	9744	4517	9770	4763	28
33	9626	3627	9658	3838	9688	4057	9717	4284	9745	4521	9771	4767	27
34	9626	3631	9658	3842	9689	4061	9718	4288	9745	4525	9771	4772	26
35	0.9627	1.3634	0.9659	1.3846	0.9689	1.4065	0.9718	1.4292	0.9746	1.4529	0.9772	1.4776	25
36	9627	3638	9659	3849	9690	4068	9719	4296	9746	4533	9772	4780	24
37	9628	3641	9660	3853	9690	4072	9719	4300	9747	4537	9773	4784	23
38	9628	3645	9660	3856	9691	4076	9720	4304	9747	1541	9773	4788	22
39	9629	3648	9661	3860	9691	4079	9720	4307	9747	4545	9773	4793	21
40	0.9629	1.3652	0.9661	1.3864	0.9692	1.4083	0.9721	1.4311	0.9748	1.4549	0.9774	1.4797	20
41	9630	3655	9662	3867	9692	4087	9721	4315	9748	4553	9774	4801	19
42	9631	3659	9662	3871	9693	4091	9722	4319	9749	4557	9775	4805	18
43	9631	3662	9663	3874	9693	4094	9722	4323	9749	4561	9775	4810	17
44	9632	3666	9663	3878	9694	4098	9722	4327	9750	4565	9775	4814	16
45	0.9632	1.3669	0.9664	1.3882	0.9694	1.4102	0.9723	1.4331	0.9750	1.4569	0.9776	1.4818	15
46	9633	3673	9664	3885	9695	4106	9723	4335	9751	4573	9776	4822	14
47	9633	3676	9665	3889	9695	4109	9724	4338	9751	4577	9777	4827	13
48	9634	3679	9665	3892	9696	4113	9724	4342	9751	4581	9777	4831	12
49	9634	3683	9666	3896	9696	4117	9725	4346	9752	4585	9778	4835	11
50	0.9635	1.3686	0.9667	1.3900	0.9697	1.4121	0.9725	1.4350	0.9752	1.4589	0.9778	1.4839	10
51	9635	3690	9667	3903	9697	4124	9726	4354	9753	4593	9778	4844	9
52	9636	3693	9668	3907	9698	4128	9726	4358	9753	4598	9779	4848	8
53	9636	3697	9668	3910	9698	4132	9727	4362	9754	4602	9779	4852	7
54	9637	3700	9669	3914	9699	4136	9727	4366	9754	4606	9780	4857	6
55	0.9638	1.3704	..9669	1.3918	0.9699	1.4139	0.9728	1.4370	0.9755	1.4610	0.9780	1.4861	5
56	9638	3707	9670	3921	9700	4143	9728	4374	9755	4614	9780	4865	4
57	9639	3711	9670	3925	9700	4147	9728	4378	9755	4618	9781	4869	3
58	9639	3714	9671	3929	9701	4151	9729	4381	9756	4622	9781	4874	2
59	9640	3718	9671	3932	9701	4154	9729	4385	9756	4626	9782	4878	1
60	9640	3721	9672	3936	9702	4158	9730	4389	9757	4630	9782	4882	0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	113°		112°		111°		110°		109°		108°		

APPARENT DISTANCE.

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	72°		73°		74°		75°		76°		77°		M.
	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	
0	0.9782	1.4882	0.9806	1.5147	0.9828	1.5425	0.9849	1.5719	0.9869	1.6032	0.9887	1.6366	60
1	9782	4887	9806	5151	9829	5430	9850	5725	9869	6038	9888	6372	59
2	9783	4891	9807	5156	9829	5435	9850	5730	9870	6043	9888	6378	58
3	9783	4895	9807	5160	9829	5439	9850	5735	9870	6048	9888	6384	57
4	9784	4899	9807	5165	9830	5444	9851	5740	9870	6054	9888	6389	56
5	0.9784	1.4904	0.9808	1.5169	0.9830	1.5449	0.9851	1.5745	0.9871	1.6059	0.9889	1.6395	55
6	9785	4908	9808	5174	9831	5454	9851	5750	9871	6065	9889	6401	54
7	9785	4912	9809	5178	9831	5459	9852	5755	9871	6070	9889	6407	53
8	9785	4917	9809	5183	9831	5463	9852	5760	9872	6076	9890	6413	52
9	9786	4921	9809	5187	9832	5468	9852	5765	9872	6081	9890	6419	51
10	0.9786	1.4925	0.9810	1.5192	0.9832	1.5473	0.9853	1.5770	0.9872	1.6086	0.9890	1.6424	50
11	9787	4930	9810	5197	9832	5478	9853	5775	9872	6092	9890	6430	49
12	9787	4934	9811	5201	9833	5483	9853	5780	9873	6097	9891	6436	48
13	9787	4938	9811	5206	9833	5487	9854	5786	9873	6103	9891	6442	47
14	9788	4943	9811	5210	9833	5492	9854	5791	9873	6108	9891	6448	46
15	0.9788	1.4947	0.9812	1.5215	0.9834	1.5497	0.9854	1.5796	0.9874	1.6114	0.9892	1.6454	45
16	9789	4951	9812	5219	9834	5502	9855	5801	9874	6119	9892	6459	44
17	9789	4956	9812	5224	9835	5507	9855	5806	9874	6125	9892	6465	43
18	9789	4960	9813	5229	9835	5512	9855	5811	9875	6130	9892	6471	42
19	9790	4965	9813	5233	9835	5516	9856	5816	9875	6136	9893	6477	41
20	0.9790	1.4969	0.9814	1.5238	0.9836	1.5521	0.9856	1.5822	0.9875	1.6141	0.9893	1.6483	40
21	9791	4973	9814	5242	9836	5526	9856	5827	9876	6147	9893	6489	39
22	9791	4978	9814	5247	9836	5531	9857	5832	9876	6152	9894	6495	38
23	9791	4982	9815	5252	9837	5536	9857	5837	9876	6158	9894	6501	37
24	9792	4986	9815	5256	9837	5541	9857	5842	9876	6163	9894	6507	36
25	0.9792	1.4991	0.9815	1.5261	0.9837	1.5546	0.9858	1.5847	0.9877	1.6169	0.9894	1.6513	35
26	9793	4995	9816	5265	9838	5551	9858	5853	9877	6174	9895	6519	34
27	9793	5000	9816	5270	9838	5555	9858	5858	9877	6180	9895	6525	33
28	9793	5004	9817	5275	9838	5560	9859	5863	9878	6185	9895	6531	32
29	9794	5008	9817	5279	9839	5565	9859	5868	9878	6191	9896	6536	31
30	0.9794	1.5013	0.9817	1.5284	0.9839	1.5570	0.9859	1.5873	0.9878	1.6196	0.9896	1.6542	30
31	9795	5017	9818	5289	9839	5575	9860	5879	9879	6202	9896	6548	29
32	9795	5022	9818	5293	9840	5580	9860	5884	9879	6208	9896	6554	28
33	9795	5026	9818	5298	9840	5585	9860	5889	9879	6213	9897	6560	27
34	9796	5030	9819	5303	9840	5590	9861	5894	9880	6219	9897	6566	26
35	0.9796	1.5035	0.9819	1.5307	0.9841	1.5595	0.9861	1.5900	0.9880	1.6224	0.9897	1.6572	25
36	9797	5039	9820	5312	9841	5600	9861	5905	9880	6230	9897	6578	24
37	9797	5044	9820	5317	9842	5605	9862	5910	9880	6236	9898	6584	23
38	9797	5048	9820	5321	9842	5610	9862	5915	9881	6241	9898	6591	22
39	9798	5053	9821	5326	9842	5614	9862	5921	9881	6247	9898	6597	21
40	0.9798	1.5057	0.9821	1.5331	0.9843	1.5619	0.9863	1.5926	0.9881	1.6252	0.9899	1.6603	20
41	9799	5061	9821	5335	9843	5624	9863	5931	9882	6258	9899	6609	19
42	9799	5066	9822	5340	9843	5629	9863	5936	9882	6264	9899	6615	18
43	9799	5070	9822	5345	9844	5634	9864	5942	9882	6269	9899	6621	17
44	9800	5075	9823	5350	9844	5639	9864	5947	9883	6275	9900	6627	16
45	0.9800	1.5079	0.9823	1.5354	0.9844	1.5644	0.9864	1.5952	0.9883	1.6281	0.9900	1.6633	15
46	9801	5084	9823	5359	9845	5649	9865	5958	9883	6286	9900	6639	14
47	9801	5088	9824	5363	9845	5654	9865	5963	9883	6292	9901	6645	13
48	9801	5092	9824	5368	9845	5659	9865	5968	9884	6298	9901	6651	12
49	9802	5097	9824	5373	9846	5664	9866	5973	9884	6303	9901	6657	11
50	0.9802	1.5102	0.9825	1.5378	0.9846	1.5669	0.9866	1.5979	0.9884	1.6309	0.9901	1.6664	10
51	9802	5106	9825	5382	9846	5674	9866	5984	9885	6315	9902	6670	9
52	9803	5111	9826	5387	9847	5679	9867	5989	9885	6320	9902	6676	8
53	9803	5115	9826	5392	9847	5684	9867	5995	9885	6326	9902	6682	7
54	9804	5120	9826	5397	9847	5689	9867	6000	9885	6332	9902	6688	6
55	0.9804	1.5124	0.9827	1.5401	0.9848	1.5694	0.9868	1.6005	0.9886	1.6338	0.9903	1.6694	5
56	9804	5129	9827	5406	9848	5699	9868	6011	9886	6343	9903	6700	4
57	9805	5133	9827	5411	9848	5704	9868	6016	9886	6349	9903	6707	3
58	9805	5138	9828	5416	9849	5709	9868	6022	9887	6355	9904	6713	2
59	9806	5142	9828	5420	9849	5714	9869	6027	9887	6361	9904	6719	1
60	9806	5147	9828	5425	9849	5719	9869	6032	9887	6366	9904	6725	0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	107°		106°		105°		104°		103°		102°		

APPARENT DISTANCE

TABLE XXXI.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	78° Log. S.	78° Log. T.	79° Log. S.	79° Log. T.	80° Log. S.	80° Log. T.	81° Log. S.	81° Log. T.	82° Log. S.	82° Log. T.	83° Log. S.	83° Log. T.	M.
0	0.9904	1.6725	0.9919	1.7113	0.9934	1.7537	0.9946	1.8003	0.9958	1.8522	0.9968	1.9109	60
1	9904	6731	9920	7120	9934	7544	9946	8011	9958	8531	9968	9119	59
2	9905	6738	9920	7127	9934	7552	9947	8019	9958	8540	9968	9129	58
3	9905	6744	9920	7134	9934	7559	9947	8027	9958	8550	9968	9140	57
4	9905	6750	9920	7141	9934	7566	9947	8036	9958	8559	9968	9151	56
5	0.9905	1.6756	0.9921	1.7147	0.9935	1.7574	0.9947	1.8044	0.9958	1.8568	0.9968	1.9161	55
6	9906	6763	9921	7154	9935	7581	9947	8052	9959	8577	9968	9172	54
7	9906	6769	9921	7161	9935	7589	9948	8060	9959	8587	9969	9182	53
8	9906	6775	9921	7168	9935	7596	9948	8069	9959	8596	9969	9193	52
9	9906	6781	9922	7175	9936	7604	9948	8077	9959	8605	1.9969	9204	51
10	0.9907	1.6788	0.9922	1.7181	0.9936	1.7611	0.9948	1.8085	0.9959	1.8615	1.9969	1.9214	50
11	9907	6794	9922	7188	9936	7619	9948	8094	9959	8624	9969	9225	49
12	9907	6800	9922	7195	9936	7626	9949	8102	9960	8633	9969	9236	48
13	9907	6807	9923	7202	9936	7634	9949	8110	9960	8643	9969	9246	47
14	9908	6813	9923	7209	9937	7641	9949	8119	9960	8652	9970	9257	46
15	0.9908	1.6819	0.9923	1.7216	0.9937	1.7649	0.9949	1.8127	0.9960	1.8662	1.9970	1.9268	45
16	9908	6826	9923	7223	9937	7657	9949	8136	9960	8671	9970	9279	44
17	9908	6832	9924	7230	9937	7664	9950	8144	9960	8681	9970	9290	43
18	9909	6838	9924	7236	9937	7672	9950	8152	9961	8690	9970	9301	42
19	9909	6845	9924	7243	9938	7679	9950	8161	9961	8700	9970	9312	41
20	0.9909	1.6851	0.9924	1.7250	0.9938	1.7687	0.9950	1.8170	0.9961	1.8709	1.9971	1.9322	40
21	9910	6858	9925	7257	9938	7695	9950	8178	9961	8719	9971	9333	39
22	9910	6864	9925	7264	9938	7702	9951	8186	9961	8728	9971	9344	38
23	9910	6870	9925	7271	9939	7710	9951	8195	9962	8738	9971	9355	37
24	9910	6877	9925	7278	9939	7718	9951	8203	9962	8748	9971	9367	36
25	0.9911	1.6883	0.9925	1.7285	0.9939	1.7725	0.9951	1.8212	0.9962	1.8757	1.9971	1.9378	35
26	9911	6890	9926	7292	9939	7733	9951	8221	9962	8767	9971	9389	34
27	9911	6896	9926	7299	9939	7741	9951	8229	9962	8777	9972	9400	33
28	9911	6902	9926	7306	9940	7748	9952	8238	9962	8786	9972	9411	32
29	9912	6909	9926	7313	9940	7756	9952	8246	9963	8796	9972	9422	31
30	0.9912	1.6915	0.9927	1.7320	0.9940	1.7764	0.9952	1.8255	0.9963	1.8806	1.9972	1.9433	30
31	9912	6922	9927	7327	9940	7772	9952	8264	9963	8815	9972	9445	29
32	9912	6928	9927	7334	9940	7779	9952	8272	9963	8825	9972	9456	28
33	9913	6935	9927	7342	9941	7787	9953	8281	9963	8835	9972	9467	27
34	9913	6941	9928	7349	9941	7795	9953	8290	9963	8845	9973	9479	26
35	0.9913	1 6948	0.9928	1.7356	0.9941	1.7803	0.9953	1.8298	0.9964	1.8855	1.9973	1.9490	25
36	9913	6954	9928	7363	9941	7811	9953	8307	9964	8865	9973	9501	24
37	9914	6961	9928	7370	9942	7819	9953	8316	9964	8875	9973	9513	23
38	9914	6967	9929	7377	9942	7826	9954	8325	9964	8884	9973	9524	22
39	9914	6974	9929	7384	9942	7834	9954	8333	9964	8894	9973	9536	21
40	0.9914	1.6980	0.9929	1.7391	0.9942	1.7842	0.9954	1.8342	0.9964	1.8904	1.9973	1.9547	20
41	9915	6987	9929	7399	9942	7850	9954	8351	9964	8914	9974	9559	19
42	9915	6994	9929	7406	9943	7858	9954	8360	9965	8924	9974	9570	18
43	9915	7000	9930	7413	9943	7866	9954	8369	9965	8934	9974	9582	17
44	9915	7007	9930	7420	9943	7874	9955	8378	9965	8944	9974	9593	16
45	0.9916	1.7013	0.9930	1.7427	0.9943	1.7882	0.9955	1.8387	0.9965	1.8955	1.9974	1.9605	15
46	9916	7020	9930	7435	9943	7890	9955	8395	9965	8965	9974	9617	14
47	9916	7027	9931	7442	9944	7898	9955	8404	9965	8975	9974	9629	13
48	9916	7033	9931	7449	9944	7906	9955	8413	9966	8985	9975	9640	12
49	9917	7040	9931	7456	9944	7914	9956	8422	9966	8995	9975	9652	11
50	0.9917	1.7047	0.9931	1.7464	0.9944	1.7922	0.9956	1.8431	0.9966	1.9005	1.9975	1.9664	10
51	9917	7053	9931	7471	9944	7930	9956	8440	9966	9016	9975	9676	9
52	9917	7060	9932	7478	9945	7938	9956	8449	9966	9026	9975	9688	8
53	9918	7066	9932	7485	9945	7946	9956	8458	9966	9036	9975	9700	7
54	9918	7073	9932	7493	9945	7954	9956	8467	9967	9046	9975	9711	6
55	0.9918	1.7080	0.9932	1.7500	0.9945	1.7962	0.9957	1.8476	0.9967	1.9057	1.9975	1.9723	5
56	9918	7087	9933	7507	9945	7970	9957	8485	9967	9067	9976	9735	4
57	9919	7093	9933	7515	9946	7978	9957	8495	9967	9077	9976	9747	3
58	9919	7100	9933	7522	9946	7987	9957	8504	9967	9088	9976	9760	2
59	9919	7107	9933	7529	9946	7995	9957	8513	9967	9098	9976	9772	1
60	9919	7113	9934	7537	9946	8003	9958	8522	9968	9109	9976	9784	0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M.
	101°		100°		99°		98°		97°		96°		

APPARENT DISTANCE.

LOGARITHMS OF THE APPARENT DISTANCE.

APPARENT DISTANCE.

M.	84° Log. S.	Log. T.	85° Log. S.	Log. T.	86° Log. S.	Log. T.	87° Log. S.	Log. T.	88° Log. S.	Log. T.	89° Log. S.	Log. T.	M.
0	0.9976	1.9784	0.9983	2.0580	0.9989	2.1554	0.9994	2.2806	0.9997	2.4569	0.9999	2.7581	60
1	9976	9796	9984	0595	9989	1572	9994	2830	9997	4606	9999	7654	59
2	9976	9808	9984	0610	9990	1590	9994	2855	9997	4642	9999	7728	58
3	9977	9820	9984	0624	9990	1608	9994	2879	9997	4679	9999	7804	57
4	9977	9833	9984	0639	9990	1627	9994	2904	9998	4717	9999	7880	56
5	0.9977	1.9845	0.9984	2.0654	0.9990	2.1645	0.9994	2.2929	0.9998	2.4754	0.9999	2.7959	55
6	9977	9857	9984	0669	9990	1664	9994	2954	9998	4792	9999	8038	54
7	9977	9870	9984	0684	9990	1683	9995	2979	9998	4830	9999	8120	53
8	9977	9882	9984	0698	9990	1701	9995	3004	9998	4869	9999	8202	52
9	9977	9895	9984	0713	9990	1720	9995	3029	9998	4908	1.0000	8287	51
10	0.9977	1.9907	0.9985	2.0728	0.9990	2.1739	0.9995	2.3055	0.9998	2.4947	1.0000	2.8373	50
11	9978	9920	9985	0744	9990	1758	9995	3081	9998	4987	0000	8460	49
12	9978	9932	9985	0759	9990	1777	9995	3106	9998	5027	0000	8550	48
13	9978	9945	9985	0774	9991	1796	9995	3132	9998	5067	0000	8641	47
14	9978	9957	9985	0789	9991	1815	9995	3158	9998	5108	0000	8735	46
15	0.9978	1.9970	0.9985	2.0804	0.9991	2.1835	0.9995	2.3185	0.9998	2.5149	1.0000	2.8830	45
16	9978	9983	9985	0820	9991	1854	9995	3211	9998	5191	0000	8928	44
17	9978	9995	9985	0835	9991	1874	9995	3238	9998	5233	0000	9028	43
18	9978	2.0008	9985	0850	9991	1893	9995	3264	9998	5275	0000	9130	42
19	9979	0021	9985	0866	9991	1913	9995	3291	9998	5318	0000	9235	41
20	0.9979	2.0034	0.9986	2.0882	0.9991	2.1933	0.9995	2.3318	0.9998	2.5362	1.0000	2.9342	40
21	9979	0047	9986	0897	9991	1952	9995	3346	9998	5405	0000	9452	39
22	9979	0060	9986	0913	9991	1972	9995	3373	9998	5449	0000	9565	38
23	9979	0073	9986	0929	9991	1992	9995	3401	9998	5494	0000	9681	37
24	9979	0086	9986	0944	9991	2012	9996	3429	9998	5539	0000	9799	36
25	0.9979	2.0099	0.9986	2.0960	0.9991	2.2033	0.9996	2.3456	0.9998	2.5584	1.0000	2.9922	35
26	9979	0112	9986	0976	9992	2053	9996	3485	9998	5630	0000	3.0048	34
27	9980	0125	9986	0992	9992	2073	9996	3513	9998	5677	0000	0177	33
28	9980	0138	9986	1008	9992	2094	9996	3541	9998	5724	0000	0311	32
29	9980	0151	9986	024	9992	2114	9996	3570	9998	5771	0000	0449	31
30	0.9980	2.0164	0.9987	2.1040	0.9992	2.2135	0.9996	2.3599	0.9999	2.5819	1.0000	3.0591	30
31	9980	0178	9987	1056	9992	2156	9996	3628	9999	5868	0000	0739	29
32	9980	0191	9987	1073	9992	2177	9996	3657	9999	5917	0000	0891	28
33	9980	0204	9987	1089	9992	2198	9996	3687	9999	5967	0000	1049	27
34	9980	0218	9987	1105	9992	2219	9996	3717	9999	6017	0000	1213	26
35	0.9981	2.0231	0.9987	2.1122	0.9992	2.2240	0.9996	2.3746	0.9999	2.6068	1.0000	3.1383	25
36	9981	0244	9987	1138	9992	2261	9996	3777	9999	6119	0000	1561	24
37	9981	0258	9987	1155	9992	2283	9996	3807	9999	6171	0000	1745	23
38	9981	0271	9987	1171	9992	2304	9996	3837	9999	6224	0000	1938	22
39	9981	0285	9987	1188	9993	2326	9996	3868	9999	6277	0000	2140	21
40	0.9981	2.0299	0.9988	2.1205	0.9993	2.2348	0.9996	2.3899	0.9999	2.6331	1.0000	3.2352	20
41	9981	0312	9988	1222	9993	2369	9996	3930	9999	6386	0000	2575	19
42	9981	0326	9988	1238	9993	2391	9996	3962	9999	6441	0000	2810	18
43	9982	0340	9988	1255	9993	2413	9997	3993	9999	6497	0000	3058	17
44	9982	0354	9988	1272	9993	2435	9997	4025	9999	6554	0000	3322	16
45	0.9982	2.0367	0.9988	2.1289	0.9993	2.2458	0.9997	2.4057	0.9999	2.6611	1.0000	3.3602	15
46	9982	0381	9988	1306	9993	2480	9997	4089	9999	6670	0000	3901	14
47	9982	0395	9988	1324	9993	2502	9997	4122	9999	6729	0000	4223	13
48	9982	0409	9988	1341	9993	2525	9997	4155	9999	6789	0000	4571	12
49	9982	0423	9988	1358	9993	2548	9997	4188	9999	6850	0000	4949	11
50	0.9982	2.0437	0.9989	2.1376	0.9993	2.2571	0.9997	2.4221	0.9999	2.6911	1.0000	3.5363	10
51	9982	0451	9989	1393	9993	2594	9997	4255	9999	6974	0000	5820	9
52	9983	0466	9989	1411	9993	2617	9997	4289	9999	7037	0000	6332	8
53	9983	0480	9989	1428	9994	2640	9997	4323	9999	7101	0000	6912	7
54	9983	0494	9989	1446	9994	2663	9997	4357	9999	7167	0000	7581	6
55	0.9983	2.0508	0.9989	2.1464	0.9994	2.2687	0.9997	2.4392	0.9999	2.7233	1.0000	3.8373	5
56	9983	0523	9989	1482	9994	2710	9997	4427	9999	7300	0000	9342	4
57	9983	0537	9989	1499	9994	2734	9997	4462	9999	7369	0000	4.0592	3
58	9983	0552	9989	1517	9994	2758	9997	4497	9999	7438	0000	2352	2
59	9983	0566	9989	1535	9994	2782	9997	4533	9999	7509	0000	5363	1
60	9983	0580	9989	1554	9994	2806	9997	4569	9999	7581	0000		0
M.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	Log. S.	Log. T.	M
	95°		94°		93°		92°		91°		90°		

APPARENT DISTANCE.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

2 DEGREES.

S.	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	
0	1.0000	1.0024	1.0049	1.0073	1.0098	1.0122	1.0147	1.0172	1.0197	1.0223	1.0248	1.0274	60
1	0000	0025	0049	0073	0098	0123	0148	0173	0198	0223	0249	0274	59
2	0001	0025	0049	0074	0098	0123	0148	0173	0198	0224	0249	0275	58
3	0001	0025	0050	0074	0099	0124	0148	0174	0199	0224	0250	0275	57
4	0002	0026	0050	0075	0099	0124	0149	0174	0199	0224	0250	0276	56
5	1.0002	1.0026	1.0051	1.0075	1.0100	1.0124	1.0149	1.0174	1.0200	1.0225	1.0250	1.0276	55
6	0002	0027	0051	0075	0100	0125	0150	0175	0200	0225	0251	0276	54
7	0003	0027	0051	0076	0100	0125	0150	0175	0200	0226	0251	0277	53
8	0003	0027	0052	0076	0101	0126	0151	0176	0201	0226	0252	0277	52
9	0004	0028	0052	0077	0101	0126	0151	0176	0201	0227	0252	0278	51
10	1.0004	1.0028	1.0053	1.0077	1.0102	1.0126	1.0151	1.0176	1.0202	1.0227	1.0252	1.0278	50
11	0004	0029	0053	0077	0102	0127	0152	0177	0202	0227	0253	0279	49
12	0005	0029	0053	0078	0103	0127	0152	0177	0202	0228	0253	0279	48
13	0005	0029	0054	0078	0103	0128	0153	0178	0203	0228	0253	0279	47
14	0006	0030	0054	0079	0103	0128	0153	0178	0203	0229	0254	0280	46
15	1.0006	1.0030	1.0055	1.0079	1.0104	1.0129	1.0153	1.0179	1.0204	1.0229	1.0255	1.0280	45
16	0006	0031	0055	0080	0104	0129	0154	0179	0204	0230	0255	0281	44
17	0007	0031	0055	0080	0105	0129	0154	0179	0205	0230	0255	0281	43
18	0007	0031	0056	0080	0105	0130	0155	0180	0205	0230	0256	0282	42
19	0008	0032	0056	0081	0105	0130	0155	0180	0205	0231	0256	0282	41
20	1.0008	1.0032	1.0057	1.0081	1.0106	1.0131	1.0156	1.0181	1.0206	1.0231	1.0257	1.0282	40
21	0008	0033	0057	0082	0106	0131	0156	0181	0207	0232	0257	0283	39
22	0009	0033	0057	0082	0107	0131	0156	0181	0207	0232	0258	0283	38
23	0009	0034	0058	0082	0107	0132	0157	0182	0207	0233	0258	0284	37
24	0010	0034	0058	0083	0107	0132	0157	0182	0208	0233	0258	0284	36
25	1.0010	1.0034	1.0059	1.0083	1.0108	1.0133	1.0158	1.0183	1.0208	1.0233	1.0259	1.0285	35
26	0010	0035	0059	0084	0108	0133	0158	0183	0208	0234	0259	0285	34
27	0011	0035	0060	0084	0109	0134	0158	0184	0209	0234	0259	0285	33
28	0011	0036	0060	0084	0109	0134	0159	0184	0209	0235	0260	0286	32
29	0012	0036	0060	0085	0110	0134	0159	0184	0210	0235	0260	0286	31
30	1.0012	1.0036	1.0061	1.0085	1.0110	1.0135	1.0160	1.0185	1.0210	1.0235	1.0261	1.0287	30
31	0012	0037	0061	0086	0110	0135	0160	0185	0211	0236	0261	0287	29
32	0013	0037	0062	0086	0111	0136	0161	0186	0211	0236	0261	0288	28
33	0013	0038	0062	0087	0111	0136	0161	0186	0211	0237	0262	0288	27
34	0014	0038	0062	0087	0112	0136	0161	0187	0212	0237	0262	0288	26
35	1.0014	1.0038	1.0063	1.0087	1.0112	1.0137	1.0162	1.0187	1.0212	1.0238	1.0263	1.0289	25
36	0015	0039	0063	0088	0112	0137	0162	0187	0213	0238	0263	0289	24
37	0015	0039	0064	0088	0113	0138	0163	0188	0213	0238	0264	0290	23
38	0015	0040	0064	0089	0113	0138	0163	0188	0213	0239	0264	0290	22
39	0016	0040	0064	0089	0114	0139	0163	0189	0214	0239	0264	0291	21
40	1.0016	1.0040	1.0065	1.0089	1.0114	1.0139	1.0164	1.0189	1.0214	1.0240	1.0265	1.0291	20
41	0017	0041	0065	0090	0114	0139	0164	0189	0215	0240	0266	0291	19
42	0017	0041	0066	0090	0115	0140	0165	0190	0215	0241	0266	0292	18
43	0017	0042	0066	0091	0115	0140	0165	0190	0216	0241	0267	0292	17
44	0018	0042	0066	0091	0116	0141	0166	0191	0216	0241	0267	029	16
45	1.0018	1.0042	1.0067	1.0091	1.0116	1.0141	1.0166	1.0191	1.0216	1.0242	1.0267	1.0293	15
46	0019	0043	0067	0092	0117	0141	0166	0192	0217	0242	0268	0294	14
47	0019	0043	0068	0092	0117	0142	0167	0192	0217	0243	0268	0294	13
48	0019	0044	0068	0093	0117	0142	0167	0192	0218	0243	0269	0294	12
49	0020	0044	0068	0093	0118	0143	0168	0193	0218	0244	0269	0295	11
50	1.0020	1.0044	1.0069	1.0093	1.0118	1.0143	1.0168	1.0193	1.0219	1.0244	1.0270	1.0295	10
51	0021	0045	0069	0094	0119	0143	0169	0194	0219	0244	0270	0296	9
52	0021	0045	0070	0094	0119	0144	0169	0194	0219	0245	0270	0296	8
53	0021	0046	0070	0095	0119	0144	0169	0194	0220	0245	0271	0297	7
54	0022	0046	0071	0095	0120	0145	0170	0195	0220	0246	0271	0297	6
55	1.0022	1.0046	1.0071	1.0096	1.0120	1.0145	1.0170	1.0195	1.0221	1.0246	1.0272	1.0297	5
56	0023	0047	0071	0096	0121	0146	0171	0196	0221	0247	0272	0298	4
57	0023	0047	0072	0096	0121	0146	0171	0196	0221	0247	0273	0298	3
58	0023	0048	0072	0097	0122	0146	0171	0197	0222	0247	0273	0299	2
59	0024	0048	0073	0097	0122	0147	0172	0197	0222	0248	0273	0299	1
60	0024	0049	0073	0098	0122	0147	0172	0197	0223	0248	0274	0300	0
	59′	58′	57′	56′	55′	54′	53′	52′	51′	50′	49′	48′	S.

7 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°

2 DEGREES.

S.	12′	13′	14′	15′	16′	17′	18′	19′	20′	21′	22′	23′	
0	1.0300	1.0326	1.0352	1.0378	1.0405	1.0431	1.0458	1.0484	1.0512	1.0539	1.0566	1.0594	60
1	0300	0326	0352	0378	0405	0432	0458	0485	0512	0539	0567	0594	59
2	0300	0326	0353	0379	0406	0432	0459	0485	0512	0540	0567	0595	58
3	0301	0327	0353	0379	0406	0433	0459	0486	0513	0540	0568	0595	57
4	0301	0327	0353	0380	0406	0433	0460	0486	0513	0541	0568	0596	56
5	1.0302	1.0328	1.0354	1.0380	1.0407	1.0434	1.0460	1.0487	1.0514	1.0541	1.0568	1.0596	55
6	0302	0328	0354	0381	0407	0434	0461	0487	0514	0541	0569	0596	54
7	0303	0329	0355	0381	0408	0434	0461	0488	0515	0542	0569	0597	53
8	0303	0329	0355	0381	0408	0435	0462	0488	0515	0542	0570	0597	52
9	0304	0329	0356	0382	0409	0435	0462	0489	0516	0543	0570	0598	51
10	1.0304	1.0330	1.0356	1.0382	1.0409	1.0436	1.0462	1.0489	1.0516	1.0543	1.0571	1.0598	50
11	0304	0330	0356	0383	0409	0436	0463	0489	0517	0544	0571	0599	49
12	0305	0331	0357	0383	0410	0437	0463	0490	0517	0544	0572	0599	48
13	0305	0331	0358	0384	0410	0437	0464	0490	0517	0545	0572	0600	47
14	0306	0332	0358	0384	0410	0438	0464	0491	0518	0545	0573	0600	46
15	1.0306	1.0332	1.0359	1.0384	1.0411	1.0438	1.0465	1.0491	1.0518	1.0546	1.0573	1.0601	45
16	0307	0333	0359	0385	0411	0438	0465	0492	0519	0546	0573	0601	44
17	0307	0333	0360	0385	0412	0439	0466	0492	0519	0546	0574	0602	43
18	0307	0333	0360	0386	0412	0439	0466	0493	0520	0547	0574	0602	42
19	0308	0334	0361	0386	0413	0440	0466	0493	0520	0547	0575	0602	41
20	1.0308	1.0334	1.0361	1.0387	1.0413	1.0440	1.0467	1.0493	1.0521	1.0548	1.0575	1.0603	40
21	0309	0335	0361	0387	0414	0440	0467	0494	0521	0548	0576	0603	39
22	0309	0335	0362	0388	0414	0441	0468	0494	0521	0549	0576	0604	38
23	0310	0336	0362	0388	0414	0441	0468	0495	0522	0549	0577	0604	37
24	0310	0336	0362	0388	0415	0442	0469	0495	0522	0550	0577	0605	36
25	1.0310	1.0336	1.0363	1.0389	1.0415	1.0442	1.0469	1.0496	1.0523	1.0550	1.0578	1.0605	35
26	0311	0337	0363	0389	0416	0442	0470	0496	0523	0551	0578	0606	34
27	0311	0337	0363	0390	0416	0443	0470	0497	0524	0551	0579	0606	33
28	0312	0338	0364	0390	0417	0443	0470	0497	0524	0552	0579	0607	32
29	0312	0338	0364	0391	0417	0444	0471	0498	0525	0552	0579	0607	31
30	1.0313	1.0339	1.0365	1.0391	1.0418	1.0444	1.0471	1.0498	1.0525	1.0552	1.0580	1.0608	30
31	0313	0339	0365	0392	0418	0445	0471	0498	0526	0553	0580	0608	29
32	0313	0339	0366	0392	0418	0445	0472	0499	0526	0553	0581	0609	28
33	0314	0340	0366	0392	0419	0446	0472	0499	0526	0554	0581	0609	27
34	0314	0340	0366	0393	0419	0446	0472	0500	0527	0554	0582	0609	26
35	1.0315	1.0341	1.0367	1.0393	1.0420	1.0446	1.0473	1.0500	1.0527	1.0555	1.0582	1.0610	25
36	0315	0341	0367	0394	0420	0447	0474	0501	0528	0555	0583	0610	24
37	0316	0342	0368	0394	0421	0447	0474	0501	0528	0556	0583	0611	23
38	0316	0342	0368	0395	0421	0448	0475	0502	0529	0556	0584	0611	22
39	0317	0342	0369	0395	0422	0448	0475	0502	0529	0557	0584	0612	21
40	1.0317	1.0343	1.0369	1.0395	1.0422	1.0449	1.0475	1.0502	1.0530	1.0557	1.0585	1.0612	20
41	0318	0343	0370	0396	0422	0449	0476	0503	0531	0557	0585	0613	19
42	0318	0344	0370	0396	0423	0450	0476	0503	0531	0558	0585	0613	18
43	0318	0344	0370	0397	0423	0450	0477	0504	0531	0558	0586	0614	17
44	0319	0345	0371	0397	0424	0450	0477	0504	0532	0559	0586	0614	16
45	1.0319	1.0345	1.0371	1.0398	1.0424	1.0451	1.0478	1.0505	1.0532	1.0559	1.0587	1.0615	15
46	0319	0346	0372	0398	0425	0451	0478	0505	0532	0560	0587	0615	14
47	0320	0346	0372	0399	0425	0452	0479	0506	0533	0560	0588	0615	13
48	0320	0346	0373	0399	0426	0452	0479	0506	0533	0561	0588	0616	12
49	0321	0347	0373	0399	0426	0453	0480	0507	0534	0561	0589	0616	11
50	1.0321	1.0347	1.0374	1.0400	1.0426	1.0453	1.0480	1.0507	1.0534	1.0562	1.0589	1.0617	10
51	0322	0348	0374	0400	0427	0454	0480	0507	0535	0562	0590	0617	9
52	0322	0348	0374	0401	0427	0454	0481	0508	0535	0562	0590	0618	8
53	0323	0349	0375	0401	0428	0454	0481	0508	0536	0563	0591	0618	7
54	0323	0349	0375	0402	0428	0455	0482	0509	0536	0563	0591	0619	6
55	1.0323	1.0349	1.0376	1.0402	1.0429	1.0455	1.0482	1.0509	1.0536	1.0564	1.0591	1.0619	5
56	0324	0350	0376	0403	0429	0456	0483	0510	0537	0564	0592	0620	4
57	0324	0350	0377	0403	0430	0456	0483	0510	0537	0565	0592	0620	3
58	0325	0351	0377	0403	0430	0457	0484	0511	0538	0565	0593	0621	2
59	0325	0351	0377	0404	0430	0457	0484	0511	0538	0566	0593	0621	1
60	0326	0352	0378	0404	0431	0458	0484	0512	0539	0566	0594	0621	0
	47′	46′	45′	44′	43′	42′	41′	40′	39′	38	37′	36′	S.

7 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

2 DEGREES.

S.	24′	25′	26′	27′	28′	29′	30′	31′	32′	33′	34′	35′	
0	1.0621	1.0649	1.0678	1.0706	1.0734	1.0763	1.0792	1.0821	1.0850	1.0880	1.0909	1.0939	60
1	0622	0650	0678	0706	0735	0763	0792	0821	0851	0880	0910	0940	59
2	0622	0650	0678	0707	0735	0764	0793	0822	0851	0881	0910	0940	58
3	0623	0651	0679	0707	0736	0764	0793	0822	0852	0881	0911	0941	57
4	0623	0651	0679	0708	0736	0765	0794	0823	0852	0882	0911	0941	56
5	1.0624	1.0652	1.0680	1.0708	1.0737	1.0765	1.0794	1.0823	1.0853	1.0882	1.0912	1.0942	55
6	0624	0652	0680	0709	0737	0766	0795	0824	0853	0883	0912	0942	54
7	0625	0653	0681	0709	0738	0766	0795	0824	0854	0883	0913	0943	53
8	0625	0653	0681	0710	0738	0767	0796	0825	0854	0883	0913	0943	52
9	0626	0654	0682	0710	0739	0767	0796	0825	0855	0884	0914	0944	51
10	1.0626	1.0654	1.0682	1.0711	1.0739	1.0768	1.0797	1.0826	1.0855	1.0884	1.0914	1.0944	50
11	0627	0655	0683	0711	0740	0768	0797	0826	0855	0885	0915	0945	49
12	0627	0655	0683	0711	0740	0769	0798	0827	0856	0885	0915	0945	48
13	0628	0655	0684	0712	0740	0769	0798	0827	0856	0886	0916	0946	47
14	0628	0656	0684	0712	0741	0770	0799	0828	0857	0886	0916	0946	46
15	1.0628	1.0656	1.0685	1.0713	1.0741	1.0770	1.0799	1.0828	1.0857	1.0887	1.0917	1.0947	45
16	0629	0657	0685	0713	0742	0771	0800	0829	0858	0887	0917	0947	44
17	0629	0657	0686	0714	0742	0771	0800	0829	0858	0888	0918	0948	43
18	0630	0658	0686	0714	0743	0772	0801	0830	0859	0888	0918	0948	42
19	0630	0658	0686	0715	0743	0772	0801	0830	0859	0889	0919	0949	41
20	1.0631	1.0659	1.0687	1.0715	1.0744	1.0773	1.0801	1.0831	1.0860	1.0889	1.0919	1.0949	40
21	0631	0659	0687	0716	0744	0773	0802	0831	0860	0890	0920	0950	39
22	0632	0660	0688	0716	0745	0774	0802	0832	0861	0890	0920	0950	38
23	0632	0660	0688	0717	0745	0774	0803	0832	0861	0891	0921	0951	37
24	0633	0661	0689	0717	0746	0774	0803	0833	0862	0891	0921	0951	36
25	1.0633	1.0661	1.0689	1.0718	1.0746	1.0775	1.0804	1.0833	1.0862	1.0892	1.0922	1.0952	35
26	0634	0662	0690	0718	0747	0775	0804	0834	0863	0893	0922	0952	34
27	0634	0662	0690	0719	0747	0776	0805	0834	0863	0893	0923	0953	33
28	0634	0663	0691	0719	0748	0776	0805	0834	0864	0894	0923	0953	32
29	0635	0663	0691	0720	0748	0777	0806	0835	0864	0894	0924	0954	31
30	1.0635	1.0663	1.0692	1.0720	1.0749	1.0777	1.0806	1.0835	1.0865	1.0895	1.0924	1.0954	30
31	0636	0664	0692	0721	0749	0778	0807	0836	0865	0895	0925	0955	29
32	0636	0664	0693	0721	0750	0778	0807	0836	0866	0896	0925	0955	28
33	0637	0665	0693	0721	0750	0779	0808	0837	0866	0896	0926	0956	27
34	0637	0665	0694	0722	0751	0779	0808	0837	0867	0897	0926	0956	26
35	1.0738	1.0666	1.0694	1.0722	1.0751	1.0780	1.0809	1.0838	1.0867	1.0897	1.0927	1.0957	25
36	0638	0666	0694	0723	0751	0780	0809	0838	0868	0898	0927	0957	24
37	0639	0667	0695	0723	0752	0781	0810	0839	0868	0898	0928	0958	23
38	0639	0667	0695	0724	0752	0781	0810	0839	0869	0899	0928	0958	22
39	0640	0668	0696	0724	0753	0782	0811	0840	0869	0899	0929	0959	21
40	1.0640	1.0668	1.0696	1.0725	1.0753	1.0782	1.0811	1.0840	1.0870	1.0899	1.0929	1.0959	20
41	0641	0669	0697	0725	0754	0783	0812	0841	0870	0900	0930	0960	19
42	0641	0669	0697	0726	0754	0783	0812	0841	0871	0900	0930	0960	18
43	0641	0670	0698	0726	0755	0784	0813	0842	0871	0901	0931	0961	17
44	0642	0670	0698	0727	0755	0784	0813	0842	0872	0901	0931	0961	16
45	1.0642	1.0670	1.0699	1.0727	1.0756	1.0785	1.0814	1.0843	1.0872	1.0902	1.0932	1.0962	15
46	0643	0671	0699	0728	0756	0785	0814	0843	0873	0902	0932	0962	14
47	0643	0671	0700	0728	0757	0786	0815	0844	0873	0903	0933	0963	13
48	0644	0672	0700	0729	0757	0786	0815	0844	0874	0903	0933	0963	12
49	0644	0672	0701	0729	0758	0787	0816	0845	0874	0904	0934	0964	11
50	1.0645	1.0673	1.0701	1.0730	1.0758	1.0787	1.0816	1.0845	1.0875	1.0904	1.0934	1.0964	10
51	0645	0673	0702	0730	0759	0787	0816	0846	0875	0905	0935	0965	9
52	0646	0674	0702	0730	0759	0788	0817	0846	0876	0905	0935	0965	8
53	0646	0674	0703	0731	0760	0788	0817	0847	0876	0906	0936	0966	7
54	0647	0675	0703	0731	0760	0789	0818	0847	0877	0906	0936	0966	6
55	1.0647	1.0675	1.0703	1.0732	1.0761	1.0789	1.0818	1.0848	1.0877	1.0907	1.0937	1.0967	5
56	0648	0676	0704	0732	0761	0790	0819	0848	0878	0907	0937	0967	4
57	0648	0676	0704	0733	0762	0790	0819	0849	0878	0908	0938	0968	3
58	0648	0677	0705	0733	0762	0791	0820	0849	0879	0908	0938	0968	2
59	0649	0677	0705	0734	0762	0791	0820	0850	0879	0909	0939	0969	1
60	0649	0678	0706	0734	0763	0792	0821	0850	0880	0909	0939	0969	0
	35′	34′	33′	32′	31′	30′	29′	28′	27′	26′	25′	24′	S.

7 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

2 DEGREES.

S.	36′	37′	38′	39′	40′	41′	42′	43′	44′	45′	46′	47′	
0	1.0969	1.0999	1.1030	1.1061	1.1091	1.1123	1.1154	1.1186	1.1217	1.1249	1.1282	1.1314	60
1	0970	1000	1030	1061	1092	1123	1154	1186	1218	1250	1282	1315	59
2	0970	1000	1031	1062	1092	1124	1155	1187	1218	1250	1283	1315	58
3	0971	1001	1031	1062	1093	1124	1156	1187	1219	1251	1283	1316	57
4	0971	1001	1032	1063	1094	1125	1156	1188	1219	1252	1284	1316	56
5	1.0972	1.1002	1.1032	1.1063	1.1094	1.1125	1.1157	1.1188	1.1220	1.1252	1.1284	1.1317	55
6	0972	1002	1032	1064	1095	1126	1157	1189	1221	1253	1285	1317	54
7	0973	1003	1033	1064	1095	1126	1158	1189	1221	1253	1285	1318	53
8	0973	1003	1034	1065	1096	1127	1158	1190	1222	1254	1286	1319	52
9	0974	1004	1034	1065	1096	1127	1159	1190	1222	1254	1287	1319	51
10	1.0974	1.1004	1.1035	1.1066	1.1097	1.1128	1.1159	1.1191	1.1223	1.1255	1.1287	1.1320	50
11	0975	1005	1035	1066	1097	1128	1160	1191	1223	1255	1288	1320	49
12	0975	1005	1036	1067	1098	1129	1160	1192	1224	1256	1288	1321	48
13	0976	1006	1036	1067	1098	1129	1161	1192	1224	1256	1289	1321	47
14	0976	1006	1037	1068	1099	1130	1161	1193	1225	1257	1289	1322	46
15	1.0977	1.1007	1.1037	1.1068	1.1099	1.1130	1.1162	1.1193	1.1225	1.1257	1.1290	1.1322	45
16	0977	1007	1038	1069	1100	1131	1162	1194	1226	1258	1290	1323	44
17	0978	1008	1039	1069	1100	1131	1163	1195	1226	1259	1291	1323	43
18	0978	1008	1039	1070	1101	1132	1163	1195	1227	1259	1291	1324	42
19	0979	1009	1040	1070	1101	1132	1164	1196	1227	1260	1292	1325	41
20	1.0979	1.1009	1.1040	1.1071	1.1102	1.1133	1.1164	1.1196	1.1228	1.1260	1.1292	1.1325	40
21	0980	1010	1041	1071	1102	1134	1165	1197	1229	1261	1293	1326	39
22	0980	1011	1041	1072	1103	1134	1165	1197	1229	1261	1294	1326	38
23	0981	1011	1042	1072	1103	1135	1166	1198	1230	1262	1294	1327	37
24	0981	1012	1042	1073	1104	1135	1167	1198	1230	1262	1295	1327	36
25	1.0982	1.1012	1.1043	1.1073	1.1104	1.1136	1.1167	1.1199	1.1231	1.1263	1.1295	1.1328	35
26	0982	1013	1043	1074	1105	1136	1168	1199	1231	1264	1296	1328	34
27	0983	1013	1044	1074	1105	1137	1168	1200	1232	1264	1296	1329	33
28	0983	1014	1044	1075	1106	1137	1169	1200	1232	1265	1297	1329	32
29	0984	1014	1045	1075	1106	1138	1169	1201	1233	1265	1297	1330	31
30	1.0984	1.1015	1.1045	1.1076	1.1107	1.1138	1.1170	1.1201	1.1233	1.1266	1.1298	1.1331	30
31	0985	1016	1046	1076	1108	1139	1170	1202	1234	1266	1298	1331	29
32	0985	1016	1046	1077	1108	1139	1171	1202	1234	1267	1299	1332	28
33	0986	1017	1047	1078	1109	1140	1171	1203	1235	1267	1300	1332	27
34	0986	1017	1047	1078	1110	1140	1172	1204	1235	1268	1300	1333	26
35	1.0987	1.1018	1.1048	1.1079	1.1110	1.1141	1.1172	1.1204	1.1236	1.1268	1.1301	1.1333	25
36	0987	1018	1048	1079	1111	1141	1173	1205	1237	1269	1301	1334	24
37	0988	1019	1049	1080	1111	1142	1173	1205	1237	1269	1302	1334	23
38	0988	1019	1049	1080	1112	1142	1174	1206	1238	1270	1302	1335	22
39	0989	1020	1050	1081	1112	1143	1174	1206	1238	1270	1303	1335	21
40	1.0989	1.1020	1.1050	1.1081	1.1112	1.1143	1.1175	1.1207	1.1239	1.1271	1.1303	1.1336	20
41	0990	1021	1051	1082	1113	1144	1175	1207	1239	1271	1304	1337	19
42	0990	1021	1051	1082	1113	1145	1176	1208	1240	1272	1304	1337	18
43	0991	1022	1052	1083	1114	1145	1177	1208	1240	1273	1305	1338	17
44	0991	1022	1052	1083	1114	1146	1177	1209	1241	1273	1306	1338	16
45	1.0992	1.1023	1.1053	1.1084	1.1115	1.1146	1.1178	1.1209	1.1241	1.1274	1.1306	1.1339	15
46	0992	1023	1053	1084	1115	1147	1178	1210	1242	1274	1307	1339	14
47	0993	1024	1054	1085	1116	1147	1179	1210	1242	1275	1307	1340	13
48	0993	1024	1054	1085	1116	1148	1179	1211	1243	1275	1308	1340	12
49	0994	1025	1055	1086	1117	1148	1180	1211	1243	1276	1308	1341	11
50	1.0994	1.1025	1.1055	1.1086	1.1117	1.1149	1.1180	1.1212	1.1244	1.1276	1.1309	1.1342	10
51	0995	1026	1056	1087	1118	1149	1181	1213	1245	1277	1309	1342	9
52	0995	1026	1056	1087	1118	1150	1181	1213	1245	1277	1310	1343	8
53	0996	1027	1057	1088	1119	1150	1182	1214	1246	1278	1310	1343	7
54	0996	1027	1057	1088	1119	1151	1182	1214	1246	1278	1311	1344	6
55	1.0997	1.1028	1.1058	1.1089	1.1120	1.1151	1.1183	1.1215	1.1247	1.1279	1.1311	1.1344	5
56	0997	1028	1058	1089	1120	1152	1183	1215	1247	1280	1312	1345	4
57	0998	1028	1059	1090	1121	1152	1184	1216	1248	1280	1313	1345	3
58	0998	1029	1060	1090	1122	1153	1184	1216	1248	1281	1313	1346	2
59	0999	1029	1060	1091	1122	1153	1185	1217	1249	1281	1314	1346	1
60	0999	1030	1061	1091	1123	1154	1186	1217	1249	1282	1314	1347	0
	23′	22′	21′	20′	19′	18′	17′	16′	15′	14′	13′	12′	S.

7 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

2 DEGREES.

S.	48′	49′	50′	51′	52	53′	54′	55′	56′	57′	58′	59′	
0	1.1347	1.1380	1.1413	1.1447	1.1481	1.1515	1.1549	1.1584	1.1619	1.1654	1.1689	1.1725	60
1	1348	1381	1414	1447	1481	1515	1550	1584	1619	1654	1690	1725	59
2	1348	1381	1414	1448	1482	1516	1550	1585	1620	1655	1690	1726	58
3	1349	1382	1415	1449	1482	1516	1551	1585	1620	1655	1691	1727	57
4	1349	1382	1416	1449	1483	1517	1551	1586	1621	1656	1692	1727	56
5	1.1350	1.1383	1.1416	1.1450	1.1483	1.1518	1.1552	1.1587	1.1621	1.1657	1.1692	1.1728	55
6	1350	1383	1417	1450	1484	1518	1552	1587	1622	1657	1693	1728	54
7	1351	1384	1417	1451	1485	1519	1553	1588	1623	1658	1693	1729	53
8	1351	1384	1418	1451	1485	1519	1554	1588	1623	1658	1694	1730	52
9	1352	1385	1418	1452	1486	1520	1554	1589	1624	1659	1694	1730	51
10	1.1352	1.1386	1.1419	1.1452	1.1486	1.1520	1.1555	1.1589	1.1624	1.1660	1.1695	1.1731	50
11	1353	1386	1419	1453	1487	1521	1555	1590	1625	1660	1696	1731	49
12	1354	1387	1420	1454	1487	1522	1556	1591	1625	1661	1696	1732	48
13	1354	1387	1421	1454	1488	1522	1556	1591	1626	1661	1697	1733	47
14	1355	1388	1421	1455	1489	1523	1557	1592	1627	1662	1697	1733	46
15	1.1355	1.1388	1.1422	1.1455	1.1489	1.1523	1.1558	1.1592	1.1627	1.1663	1.1698	1.1734	45
16	1356	1389	1422	1456	1490	1524	1558	1593	1628	1663	1699	1734	44
17	1356	1389	1423	1456	1490	1524	1559	1593	1628	1664	1699	1735	43
18	1357	1390	1423	1457	1491	1525	1559	1594	1629	1664	1700	1736	42
19	1357	1391	1424	1458	1491	1526	1560	1595	1630	1665	1700	1736	41
20	1.1358	1.1391	1.1424	1.1458	1.1492	1.1526	1.1561	1.1595	1.1630	1.1665	1.1701	1.1737	40
21	1359	1392	1425	1459	1493	1527	1561	1596	1631	1666	1702	1737	39
22	1359	1392	1426	1459	1493	1527	1562	1596	1631	1667	1702	1738	38
23	1360	1393	1426	1460	1494	1528	1562	1597	1632	1667	1703	1739	37
24	1360	1393	1427	1460	1494	1528	1563	1598	1633	1668	1706	1739	36
25	1.1361	1.1394	1.1427	1.1461	1.1495	1.1529	1.1563	1.1598	1.1633	1.1668	1.1704	1.1740	35
26	1361	1394	1428	1461	1495	1530	1564	1599	1634	1669	1705	1740	34
27	1362	1395	1428	1462	1496	1530	1565	1599	1634	1670	1705	1741	33
28	1362	1396	1429	1463	1496	1531	1565	1600	1635	1670	1706	1742	32
29	1363	1396	1429	1463	1497	1531	1566	1600	1635	1671	1706	1742	31
30	1.1363	1.1397	1.1430	1.1464	1.1498	1.1532	1.1566	1.1601	1.1636	1.1671	1.1707	1.1743	30
31	1364	1397	1431	1464	1498	1532	1567	1602	1637	1672	1708	1743	29
32	1365	1398	1431	1465	1499	1533	1567	1602	1637	1673	1708	1744	28
33	1365	1398	1432	1465	1499	1534	1568	1603	1638	1673	1709	1745	27
34	1366	1399	1432	1466	1500	1534	1569	1603	1638	1674	1709	1745	26
35	1.1366	1.1399	1.1433	1.1467	1.1500	1.1535	1.1569	1.1604	1.1639	1.1675	1.1710	1.1746	25
36	1367	1400	1433	1467	1501	1535	1570	1605	1640	1675	1711	1746	24
37	1367	1401	1434	1468	1502	1536	1570	1605	1640	1676	1711	1747	23
38	1368	1401	1435	1468	1502	1536	1571	1606	1641	1676	1712	1748	22
39	1368	1402	1435	1469	1503	1537	1571	1606	1641	1677	1712	1748	21
40	1.1369	1.1402	1.1436	1.1469	1.1503	1.1538	1.1572	1.1607	1.1642	1.1677	1.1713	1.1749	20
41	1370	1403	1436	1470	1504	1538	1573	1607	1643	1678	1714	1749	19
42	1370	1403	1437	1470	1504	1539	1573	1608	1643	1678	1714	1750	18
43	1371	1404	1437	1471	1505	1539	1574	1609	1644	1679	1715	1751	17
44	1371	1404	1438	1472	1506	1540	1574	1609	1644	1680	1715	1751	16
45	1.1372	1.1405	1.1438	1.1472	1.1506	1.1540	1.1575	1.1610	1.1645	1.1680	1.1716	1.1752	15
46	1372	1405	1439	1473	1507	1541	1576	1610	1645	1681	1717	1752	14
47	1373	1406	1440	1473	1507	1542	1576	1611	1646	1681	1717	1753	13
48	1373	1406	1440	1474	1508	1542	1577	1612	1647	1682	1718	1754	12
49	1374	1407	1441	1474	1508	1543	1577	1612	1647	1683	1718	1754	11
50	1.1374	1.1407	1.1441	1.1475	1.1509	1.1543	1.1578	1.1613	1.1648	1.1683	1.1719	1.1755	10
51	1375	1408	1442	1476	1510	1544	1578	1613	1648	1684	1719	1755	9
52	1376	1408	1442	1476	1510	1544	1579	1614	1649	1684	1720	1756	8
53	1376	1409	1443	1477	1511	1545	1580	1614	1650	1685	1721	1757	7
54	1377	1409	1443	1477	1511	1546	1580	1615	1650	1686	1721	1757	6
55	1.1377	1.1410	1.1444	1.1478	1.1512	1.1546	1.1581	1.1616	1.1651	1.1686	.17221	1.1758	5
56	1378	1411	1445	1478	1512	1547	1581	1616	1651	1687	1722	1759	4
57	1378	1411	1445	1479	1513	1547	1582	1617	1652	1687	1723	1759	3
58	1379	1412	1446	1479	1514	1548	1582	1617	1652	1688	1724	1760	2
59	1379	1412	1446	1480	1514	1548	1583	1618	1653	1689	1724	1760	1
60	1380	1413	1447	1481	1515	1549	1584	1619	1654	1689	1725	1761	0
	11′	10′	9′	8′	7′	6′	5′	4′	3′	2′	1′	0′	S.

7 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°

3 DEGREES.

S.	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	
0	1.1761	1.1797	1.1834	1.1871	1.1908	1.1946	1.1984	1.2022	1.2061	1.2099	1.2139	1.2178	60
1	1762	1798	1835	1871	1909	1946	1984	2023	2061	2100	2139	2179	59
2	1762	1798	1835	1872	1909	1947	1985	2023	2062	2101	2140	2180	58
3	1763	1799	1836	1873	1910	1948	1986	2024	2062	2101	2141	2180	57
4	1763	1800	1836	1873	1911	1948	1986	2025	2063	2102	2141	2181	56
5	1.1764	1.1800	1.1837	1.1874	1.1911	1.1949	1.1987	1.2025	1.2064	1.2103	1.2142	1.2182	55
6	1765	1801	1838	1875	1912	1950	1987	2026	2064	2103	2143	2182	54
7	1765	1802	1838	1875	1913	1950	1988	2026	2065	2104	2143	2183	53
8	1766	1802	1839	1876	1913	1951	1989	2027	2066	2105	2144	2184	52
9	1766	1803	1839	1876	1914	1951	1989	2028	2066	2105	2145	2184	51
10	1.1767	1.1803	1.1840	1.1877	1.1914	1.1952	1.1990	1.2028	1.2067	1.2106	1.2145	1.2185	50
11	1768	1804	1841	1878	1915	1953	1991	2029	2068	2107	2146	2186	49
12	1768	1805	1841	1878	1916	1953	1991	2030	2068	2107	2147	2186	48
13	1769	1805	1842	1879	1916	1954	1992	2030	2069	2108	2147	2187	47
14	1769	1806	1843	1880	1917	1955	1993	2031	2070	2109	2148	2188	46
15	1.1770	1.1806	1.1843	1.1880	1.1918	1.1955	1.1994	1.2032	1.2070	1.2109	1.2149	1.2188	45
16	1771	1807	1844	1881	1918	1956	1994	2032	2071	2110	2149	2189	44
17	1771	1808	1844	1881	1919	1956	1995	2033	2072	2111	2150	2190	43
18	1772	1808	1845	1882	1919	1957	1996	2033	2072	2111	2151	2190	42
19	1772	1809	1846	1883	1920	1958	1996	2034	2073	2112	2151	2191	41
20	1.1773	1.1809	1.1846	1.1883	1.1921	1.1959	1.1997	1.2035	1.2073	1.2113	1.2152	1.2192	40
21	1774	1810	1847	1884	1921	1960	1997	2035	2074	2113	2153	2192	39
22	1774	1811	1847	1884	1922	1960	1998	2036	2075	2114	2153	2193	38
23	1775	1811	1848	1885	1923	1961	1998	2037	2075	2115	2154	2194	37
24	1775	1812	1849	1886	1923	1962	1999	2037	2076	2115	2155	2194	36
25	1.1776	1.1812	1.1849	1.1886	1.1924	1.1962	1.2000	1.2038	1.2077	1.2116	1.2155	1.2195	35
26	1777	1813	1850	1887	1924	1963	2000	2039	2078	2116	2156	2196	34
27	1777	1814	1850	1888	1925	1963	2001	2039	2079	2117	2157	2196	33
28	1778	1814	1851	1888	1926	1964	2001	2040	2079	2118	2157	2197	32
29	1778	1815	1852	1889	1926	1964	2002	2041	2080	2118	2158	2198	31
30	1.1779	1.1816	1.1852	1.1889	1.1927	1.1965	1.2003	1.2041	1.2080	1.2119	1.2159	1.2198	30
31	1780	1816	1853	1890	1928	1965	2003	2042	2081	2120	2159	2199	29
32	1780	1817	1854	1891	1928	1966	2004	2042	2081	2120	2160	2200	28
33	1781	1817	1854	1891	1929	1967	2005	2043	2082	2121	2161	2200	27
34	1781	1818	1855	1892	1929	1967	2005	2044	2083	2122	2161	2201	26
35	1.1782	1.1819	1.1856	1.1893	1.1930	1.1968	1.2006	1.2044	1.2083	1.2122	1.2162	1.2202	25
36	1783	1819	1857	1893	1931	1968	2007	2045	2084	2123	2163	2202	24
37	1783	1820	1857	1894	1931	1969	2007	2046	2085	2124	2163	2203	23
38	1784	1820	1858	1894	1932	1970	2008	2046	2085	2124	2164	2204	22
39	1785	1821	1858	1895	1933	1970	2009	2047	2086	2125	2165	2204	21
40	1.1785	1.1822	1.1859	1.1896	1.1933	1.1971	1.2009	1.2048	1.2086	1.2126	1.2165	1.2205	20
41	1786	1822	1859	1896	1934	1972	2010	2048	2087	2126	2166	2206	19
42	1786	1823	1860	1897	1934	1972	2010	2049	2088	2127	2167	2206	18
43	1787	1823	1860	1898	1935	1973	2011	2050	2088	2128	2167	2207	17
44	1788	1824	1861	1898	1936	1974	2012	2050	2089	2128	2168	2208	16
45	1.1788	1.1825	1.1862	1.1899	1.1936	1.1974	1.2012	1.2051	1.2090	1.2129	1.2169	1.2208	15
46	1789	1825	1862	1899	1937	1975	2013	2052	2090	2130	2169	2209	14
47	1789	1826	1863	1900	1938	1975	2014	2052	2091	2130	2170	2210	13
48	1790	1827	1863	1901	1938	1976	2014	2053	2092	2131	2170	2210	12
49	1791	1827	1864	1901	1939	1977	2015	2053	2092	2132	2171	2211	11
50	1.1791	1.1828	1.1865	1.1902	1.1939	1.1977	1.2016	1.2054	1.2093	1.2132	1.2172	1.2212	10
51	1792	1828	1865	1903	1940	1978	2016	2055	2094	2133	2172	2212	9
52	1792	1829	1866	1903	1941	1979	2017	2055	2094	2134	2173	2213	8
53	1793	1830	1867	1904	1941	1979	2017	2056	2095	2134	2174	2214	7
54	1794	1830	1867	1904	1942	1980	2018	2057	2096	2135	2174	2214	6
55	1.1794	1.1831	1.1868	1.1905	1.1942	1.1981	1.2019	1.2057	1.2096	1.2136	1.2175	1.2215	5
56	1795	1831	1868	1906	1943	1981	2019	2058	2097	2136	2176	2216	4
57	1795	1832	1869	1906	1944	1982	2020	2059	2098	2137	2176	2216	3
58	1796	1833	1870	1907	1944	1982	2021	2059	2098	2137	2177	2217	2
59	1797	1833	1870	1908	1945	1983	2021	2060	2099	2138	2178	2218	1
60	1797	1834	1871	1908	1946	1984	2022	2061	2099	2139	2178	2218	0
	59′	58′	57′	56′	55′	54′	53′	52′	51′	50′	49′	48′	S.

6 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

3 DEGREES.

S.	12′	13′	14′	15′	16′	17′	18′	19′	20′	21′	22′	23′	
0	1.2218	1.2259	1.2300	1.2341	1.2382	1.2424	1.2467	1.2510	1.2553	1.2596	1.2640	1.2685	60
1	2219	2260	2300	2342	2383	2425	2467	2510	2553	2597	2641	2686	59
2	2220	2260	2301	2342	2384	2426	2468	2511	2554	2598	2642	2687	58
3	2220	2261	2302	2343	2384	2426	2469	2512	2555	2599	2643	2688	57
4	2221	2262	2302	2344	2385	2427	2470	2512	2556	2599	2643	2688	56
5	1.2222	1.2262	1.2303	1.2344	1.2386	1.2428	1.2470	1.2513	1.2556	1.2600	1.2644	1.2689	55
6	2223	2263	2304	2345	2387	2429	2471	2514	2557	2601	2645	2689	54
7	2223	2264	2304	2346	2387	2429	2472	2515	2558	2601	2646	2690	53
8	2224	2264	2305	2346	2388	2430	2472	2515	2559	2602	2646	2691	52
9	2225	2265	2306	2347	2389	2431	2473	2516	2559	2603	2647	2692	51
10	1.2225	1.2266	1.2307	1.2348	1.2389	1.2431	1.2474	1.2517	1.2560	1.2604	1.2648	1.2692	50
11	2226	2266	2307	2348	2390	2432	2475	2517	2561	2604	2649	2693	49
12	2227	2267	2308	2349	2391	2433	2475	2518	2561	2605	2649	2694	48
13	2227	2268	2309	2350	2391	2433	2476	2519	2562	2606	2650	2695	47
14	2228	2268	2309	2350	2392	2434	2477	2520	2563	2607	2651	2695	46
15	1.2229	1.2269	1.2310	1.2351	1.2393	1.2435	1.2477	1.2520	1.2564	1.2607	1.2652	1.2696	45
16	2229	2270	2311	2352	2394	2436	2478	2521	2564	2608	2652	2697	44
17	2230	2270	2312	2353	2394	2436	2479	2522	2565	2609	2653	2698	43
18	2231	2271	2313	2353	2395	2437	2480	2522	2566	2610	2654	2698	42
19	2231	2272	2313	2354	2396	2438	2480	2523	2566	2610	2655	2699	41
20	1.2232	1.2272	1.2314	1.2355	1.2396	1.2438	1.2481	1.2524	1.2567	1.2611	1.2655	1.2700	40
21	2233	2273	2315	2355	2397	2439	2482	2525	2568	2612	2656	2701	39
22	2233	2274	2315	2356	2398	2440	2482	2525	2569	2612	2657	2701	38
23	2234	2274	2316	2357	2398	2441	2483	2526	2569	2613	2657	2702	37
24	2235	2275	2317	2357	2399	2441	2484	2527	2570	2614	2658	2703	36
25	1.2235	1.2276	1.2317	1.2358	1.2400	1.2442	1.2485	1.2527	1.2571	1.2615	1.2659	1.2704	35
26	2236	2277	2318	2359	2401	2443	2485	2528	2572	2615	2660	2704	34
27	2237	2277	2319	2359	2401	2443	2486	2529	2572	2616	2660	2705	33
28	2237	2278	2320	2360	2402	2444	2487	2530	2573	2617	2661	2706	32
29	2238	2279	2320	2361	2403	2445	2487	2530	2574	2618	2662	2707	31
30	1.2239	1.2279	1.2321	1.2362	1.2403	1.2445	1.2488	1.2531	1.2574	1.2618	1.2663	1.2707	30
31	2239	2280	2321	2362	2404	2446	2489	2532	2575	2619	2663	2708	29
32	2240	2281	2322	2363	2405	2447	2489	2533	2576	2620	2664	2709	28
33	2241	2281	2322	2364	2405	2448	2490	2533	2577	2621	2665	2710	27
34	2241	2282	2323	2364	2406	2448	2491	2534	2577	2621	2666	2710	26
35	1.2242	1.2283	1.2324	1.2365	1.2407	1.2449	1.2492	1.2535	1.2578	1.2622	1.2666	1.2711	25
36	2243	2283	2324	2366	2408	2450	2492	2535	2579	2623	2667	2712	24
37	2243	2284	2325	2366	2408	2450	2493	2536	2580	2624	2668	2713	23
38	2244	2285	2326	2367	2409	2451	2494	2537	2580	2624	2669	2713	22
39	2245	2285	2326	2368	2410	2452	2494	2538	2581	2625	2669	2714	21
40	1.2245	1.2286	1.2327	1.2368	1.2410	1.2453	1.2495	1.2538	1.2582	1.2626	1.2670	1.2715	20
41	2246	2287	2328	2369	2411	2453	2496	2539	2583	2626	2671	2716	19
42	2247	2287	2328	2370	2412	2454	2497	2540	2583	2627	2672	2716	18
43	2247	2288	2329	2371	2412	2455	2497	2540	2584	2628	2672	2717	17
44	2248	2289	2330	2371	2413	2455	2498	2541	2585	2629	2673	2718	16
45	1.2249	1.2289	1.2331	1.2372	1.2414	1.2456	1.2499	1.2542	1.2585	1.2629	1.2674	1.2719	15
46	2249	2290	2331	2373	2415	2457	2499	2543	2586	2630	2675	2719	14
47	2250	2291	2332	2373	2415	2458	2500	2543	2587	2631	2675	2720	13
48	2251	2291	2333	2374	2416	2458	2501	2544	2588	2632	2676	2721	12
49	2251	2292	2333	2375	2417	2459	2502	2545	2588	2632	2677	2722	11
50	1.2252	1.2293	1.2334	1.2375	1.2417	1.2460	1.2502	1.2545	1.2589	1.2633	1.2678	1.2722	10
51	2253	2294	2335	2376	2418	2460	2503	2546	2590	2634	2678	2723	9
52	2253	2294	2335	2377	2419	2461	2504	2547	2591	2635	2679	2724	8
53	2254	2295	2336	2378	2419	2462	2504	2548	2591	2635	2680	2725	7
54	2255	2296	2337	2378	2420	2462	2505	2548	2592	2636	2681	2725	6
55	1.2256	1.2296	1.2337	1.2379	1.2421	1.2463	1.2506	1.2549	1.2593	1.2637	1.2681	1.2726	5
56	2256	2297	2338	2380	2422	2464	2507	2550	2593	2638	2682	2727	4
57	2257	2298	2339	2380	2422	2465	2507	2551	2594	2638	2683	2728	3
58	2258	2298	2339	2381	2423	2465	2508	2551	2595	2639	2684	2729	2
59	2258	2299	2340	2382	2424	2466	2509	2552	2596	2640	2684	2729	1
60	2259	2300	2341	2382	2424	2467	2510	2553	2596	2640	2685	2730	0
	47′	46′	45′	44′	43′	42′	41′	40′	39′	38′	37′	36′	S.

6 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

3 DEGREES.

S.	24′	25′	26′	27′	28′	29′	30′	31′	32′	33′	34′	35′	
0	1.2730	1.2775	1.2821	1.2868	1.2915	1.2962	1.3010	1.3059	1.3108	1.3158	1.3208	1.3259	60
1	2731	2776	2822	2869	2916	2963	3011	3060	3109	3158	3209	3259	59
2	7232	2777	2823	2869	2916	2964	3012	3060	3110	3159	3209	3260	58
3	2732	2778	2824	2870	2917	2965	3013	3061	3110	3160	3210	3261	57
4	2733	2779	2825	2871	2918	2965	3014	3062	3111	3161	3211	3262	56
5	1.2734	1.2779	1.2825	1.2872	1.2919	1.2966	1.3014	1.3063	1.3112	1.3162	1.3212	1.3263	55
6	2735	2780	2826	2873	2920	2967	3015	3064	3113	3163	3213	3264	54
7	2735	2781	2827	2873	2920	2968	3016	3065	3114	3163	3214	3265	53
8	2736	2782	2828	2874	2921	2969	3017	3065	3114	3164	3214	3265	52
9	2737	2782	2828	2875	2922	2969	3018	3066	3115	3165	3215	3266	51
10	1.2738	1.2783	1.2829	1.2876	1.2923	1.2970	1.3018	1.3067	1.3116	1.3166	1.3216	1.3267	50
11	2738	2784	2830	2876	2924	2971	3019	3068	3117	3167	3217	3268	49
12	2739	2785	2831	2877	2924	2972	3020	3069	3118	3168	3218	3269	48
13	2740	2785	2831	2878	2925	2973	3021	3069	3119	3168	3219	3270	47
14	2741	2786	2832	2879	2926	2973	3022	3070	3119	3169	3220	3270	46
15	1.2741	1.2787	1.2833	1.2880	1.2927	1.2974	1.3022	1.3071	1.3120	1.3170	1.3220	1.3271	45
16	2742	2788	2834	2880	2927	2975	3023	3072	3121	3171	3221	3272	44
17	2743	2788	2835	2881	2928	2976	3024	3073	3122	3172	3222	3273	43
18	2744	2789	2835	2882	2929	2977	3025	3073	3123	3173	3223	3274	42
19	2744	2790	2836	2883	2930	2977	3026	3074	3124	3173	3224	3275	41
20	1.2745	1.2791	1.2837	1.2883	1.2931	1.2978	1.3026	1.3075	1.3124	2.3174	1.3225	1.3276	40
21	2746	2792	2838	2884	2931	2979	3027	3076	3125	3175	3225	3276	39
22	2747	2792	2838	2885	2932	2980	3028	3077	3126	3176	3226	3277	38
23	2747	2793	2839	2886	2933	2981	3029	3078	3127	3177	3227	3278	37
24	2748	2794	2840	2887	2934	2981	3030	3078	3128	3178	3228	3279	36
25	1.2749	1.2795	1.2841	1.2887	1.2935	1.2982	1.3030	1.3079	1.3129	1.3178	1.3229	1.3280	35
26	2750	2795	2841	2888	2935	2983	3031	3080	3129	3179	3230	3281	34
27	2750	2796	2842	2889	2936	2984	3032	3081	3130	3180	3231	3282	33
28	2751	2797	2843	2890	2937	2985	3033	3082	3131	3181	3231	3282	32
29	2752	2798	2844	2891	2938	2985	3034	3082	3132	3182	3232	3283	31
30	1.2753	1.2798	1.2845	1.2891	1.2939	1.2986	1.3034	1.3083	1.3132	1.3183	1.3233	1.3284	30
31	2753	2799	2845	2892	2939	2987	3035	3084	3133	3183	3234	3285	29
32	2754	2800	2846	2893	2940	2988	3036	3085	3134	3184	3235	3286	28
33	2755	2801	2847	2894	2941	2989	3037	3086	3135	3185	3236	3287	27
34	2756	2801	2848	2894	2942	2989	3038	3087	3136	3186	3236	3288	26
35	1.2756	1.2802	1.2848	1.2895	1.2942	1.2990	1.3039	1.3087	1.3137	1.3187	1.3237	1.3288	25
36	2757	2803	2849	2896	2943	2991	3039	3088	3138	3188	3238	3289	24
37	2758	2804	2850	2897	2944	2992	3040	3089	3138	3188	3239	3290	23
38	2759	2805	2851	2898	2945	2993	3041	3090	3139	3189	3240	3291	22
39	2760	2805	2852	2898	2946	2993	3042	3091	3140	3190	3241	3292	21
40	1.2760	1.2806	1.2852	1.2899	1.2946	1.2994	1.3043	1.3091	1.3141	1.3191	1.3242	1.3293	20
41	2761	2807	2853	2900	2947	2995	3043	3092	3142	3192	3242	3294	19
42	2762	2808	2854	2901	2948	2996	3044	3093	3143	3193	3243	3294	18
43	2763	2808	2855	2901	2949	2997	3045	3094	3143	3193	3244	3295	17
44	2763	2809	2855	2902	2950	2997	3046	3095	3144	3194	3245	3296	16
45	1.2764	1.2810	1.2856	1.2903	1.2950	1.2998	1.3047	1.3096	1.3145	1.3195	1.3246	1.3297	15
46	2765	2811	2857	2904	2951	2999	3047	3096	3146	3196	3247	3298	14
47	2766	2811	2858	2905	2952	3000	3048	3097	3147	3197	3247	3299	13
48	2766	2812	2859	2905	2953	3001	3049	3098	3148	3198	3248	3200	12
49	2767	2813	2859	2906	2954	3001	3050	3099	3148	3198	3249	3200	11
50	1.2768	1.2814	1.2860	1.2907	1.2954	1.3002	1.3051	1.3100	1.3149	1.3199	1.3250	1.3301	10
51	2769	2815	2861	2908	2955	3003	3052	3101	3150	3200	3251	3302	9
52	2769	2815	2862	2909	2956	3004	3052	3101	3151	3201	3252	3303	8
53	2770	2816	2862	2909	2957	3005	3053	3102	3152	3202	3253	3304	7
54	2771	2817	2863	2910	2958	3005	3054	3103	3153	3203	3253	3305	6
55	1.2772	1.2818	1.2864	1.2911	1.2958	1.3006	1.3055	1.3104	1.3153	1.3204	1.3254	1.3306	5
56	2772	2818	2865	2912	2959	3007	3056	3105	3154	3204	3255	3306	4
57	2773	2819	2866	2912	2960	3008	3056	3105	3155	3205	3256	3307	3
58	2774	2820	2866	2913	2961	3009	3057	3106	3156	3206	3257	3308	2
59	2775	2821	2867	2914	2962	3009	3058	3107	3157	3207	3258	3309	1
60	2775	2821	2868	2915	2962	3010	3059	3108	3158	3208	3259	3310	0
	35′	34′	33′	32′	31′	30′	29′	28′	27′	26′	25′	24′	S.

6 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°

3 DEGREES.

S.	36′	37′	38′	39′	40′	41′	42′	43′	44′	45′	46′	47′	
0	1 3310	1.3362	1.3415	1.3468	1.3522	1.3576	1.3632	1.3688	1.3745	1.3802	1.3860	1.3919	60
1	3311	3363	3415	3469	3523	3577	3633	3689	3746	3803	3861	3920	59
2	3312	3364	3416	3470	3524	3578	3634	3690	3746	3804	3862	3921	58
3	3313	3365	3417	3471	3525	3579	3635	3691	3747	3805	3863	3922	57
4	3313	3365	3418	3471	3525	3580	3635	3692	3748	3806	3864	3923	56
5	1.3314	1.3366	1.3419	1.3472	1.3526	1.3581	1.3636	1.3693	1.3749	1.3807	1.3865	1.3924	55
6	3315	3367	3420	3473	3527	3582	3637	3694	3750	3808	3866	3925	54
7	3316	3368	3421	3474	3528	3583	3638	3695	3751	3809	3867	3926	53
8	3317	3369	3422	3475	3529	3584	3639	3695	3752	3810	3868	3927	52
9	3318	3370	3423	3476	3530	3585	3640	3696	3753	3811	3869	3928	51
10	1.3319	1.3371	1.3423	1.3477	1.3531	1.3586	1.3641	1.3697	1.3754	1.3812	1.3870	1.3929	50
11	3319	3372	3424	3478	3532	3587	3642	3698	3755	3813	3871	3930	49
12	3320	3372	3425	3479	3533	3587	3643	3699	3756	3814	3872	3931	48
13	3321	3373	3426	3480	3534	3588	3644	3700	3757	3815	3873	3932	47
14	3322	3374	3427	3480	3535	3589	3645	3701	3758	3816	3874	3933	46
15	1.3323	1.3375	1.3428	1.3481	1.3535	1.3590	1.3646	1.3702	1.3759	1.3817	1.3875	1.3934	45
16	3324	3376	3429	3482	3536	3591	3647	3703	3760	3818	3876	3935	44
17	3325	3377	3430	3483	3537	3592	3648	3704	3761	3819	3877	3936	43
18	3325	3378	3431	3484	3538	3593	3649	3705	3762	3819	3878	3937	42
19	3326	3379	3431	3485	3539	3594	3649	3706	3763	3820	3879	3938	41
20	1.3327	1.3379	1.3432	1.3486	1.3540	1.3595	1.3650	1.3707	1.3764	2.3821	1.3880	1.3939	40
21	3328	3380	3433	3487	3541	3596	3651	3708	3765	3822	3881	3940	39
22	3329	3381	3434	3488	3542	3597	3652	3709	3766	3823	3882	3941	38
23	3330	3382	3435	3488	3543	3598	3653	3709	3767	3824	3883	3942	37
24	3331	3383	3436	3489	3544	3598	3654	3710	3768	3825	3884	3943	36
25	1.3332	1.3384	1.3437	1.3490	1.3545	1.3599	1.3655	1.3711	1.3768	1.3826	1.3885	1.3944	35
26	3332	3385	3438	3491	3545	3600	3656	3712	3769	3827	3886	3945	34
27	3333	3386	3438	3492	3546	3601	3657	3713	3770	3828	3887	3946	33
28	3334	3386	3439	3493	3547	3602	3658	3714	3771	3829	3888	3947	32
29	3335	3387	3440	3494	3548	3603	3659	3715	3772	3830	3889	3948	31
30	1.3336	1.3388	1.3441	1.3495	1.3549	1.3604	1.3660	1.3716	1.3773	1.3831	1.3890	1.3949	30
31	3337	3389	3442	3496	3550	3605	3661	3717	3774	3832	3891	3950	29
32	3338	3390	3443	3497	3551	3606	3662	3718	3775	3833	3892	3951	28
33	3338	3391	3444	3498	3552	3607	3663	3719	3776	3834	3893	3952	27
34	3339	3392	3445	3499	3553	3608	3663	3720	3777	3835	3894	3953	26
35	1.3340	1.3393	1.3446	1.3500	1.3554	1.3609	1.3664	1.3721	1.3778	1.3836	1.3895	1.3954	25
36	3341	3393	3446	3501	3555	3610	3665	3722	3779	3837	3896	3955	24
37	3342	3394	3447	3502	3555	3610	3666	3723	3780	3838	3897	3956	23
38	3343	3395	3448	3503	3556	3611	3667	3724	3781	3839	3898	3957	22
39	3344	3396	3449	3504	3557	3612	3668	3725	3782	3840	3899	3958	21
40	1.3345	1.3397	1.3450	1.3505	1.3558	1.3613	1.3669	1.3726	1.3783	1.3841	1.3900	1.3959	20
41	3345	3398	3451	3506	3559	3614	3670	3727	3784	3842	3901	3960	19
42	3346	3399	3452	3506	3560	3615	3671	3727	3785	3843	3902	3961	18
43	3347	3400	3453	3507	3561	3616	3672	3728	3786	3844	3903	3962	17
44	3348	3400	3454	3508	3562	3617	3673	3729	3787	3845	3904	3963	16
45	1.3349	1.3401	1.3454	1.3509	1.3563	1.3618	1.3674	1.3730	1.3788	1.3846	1.3905	1.3964	15
46	3350	3402	3455	3510	3564	3619	3675	3731	3789	3847	3906	3965	14
47	3351	3403	3456	3511	3565	3620	3676	3732	3790	3848	3907	3966	13
48	3351	3404	3457	3512	3565	3621	3677	3733	3791	3849	3908	3967	12
49	3352	3405	3458	3513	3566	3622	3677	3734	3792	3850	3909	3968	11
50	1.3353	1.3406	1.3459	1.3513	1.3567	1.3623	1.3678	1.3735	1.3793	1.3851	1.3910	1.3969	10
51	3354	3407	3460	3514	3568	3623	3679	3736	3793	3852	3911	3970	9
52	3355	3408	3461	3515	3569	3624	3680	3737	3794	3853	3912	3971	8
53	3356	3408	3462	3516	3570	3625	3681	3738	3795	3854	3913	3972	7
54	3357	3409	3463	3516	3571	3626	3682	3739	3796	3855	3914	3973	6
55	1.3358	1.3410	1.3463	1.3517	1.3572	1.3627	1.3683	1.3740	1.3797	1.3856	1.3915	1.3974	5
56	3358	3411	3464	3518	3573	3628	3684	3741	3798	3856	3916	3975	4
57	3359	3412	3465	3519	3574	3629	3685	3742	3799	3857	3917	3976	3
58	3360	3413	3466	3520	3575	3630	3686	3743	3800	3858	3918	3977	2
59	3361	3414	3467	3521	3576	3631	3687	3744	3801	3859	3919	3978	1
60	3362	3415	3468	3522	3576	3632	3688	3745	3802	3860	3919	3979	0
	23′	22′	21′	20′	19′	18′	17′	16′	15′	41′	13′	12′	S.

6 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

3 DEGREES.

S.	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	
0	1.3979	1.4040	1.4102	1.4164	1.4228	1.4292	1.4357	1.4424	1.4491	1.4559	1.4629	1.4699	60
1	3980	4041	4103	4165	4229	4293	4358	4425	4492	4560	4630	4701	59
2	3981	4042	4104	4166	4230	4294	4359	4426	4493	4562	4631	4702	58
3	3982	4043	4105	4167	4231	4295	4361	4427	4494	4563	4632	4703	57
4	3983	4044	4106	4168	4232	4296	4362	4428	4495	4564	4633	4704	56
5	1.3984	1.4045	1.4107	1 4169	1.4233	1.4297	1.4363	1.4429	1.4497	1.4565	1.4635	1.4705	55
6	3985	4046	4108	4171	4234	4298	4364	4430	4498	4566	4636	4707	54
7	3986	4047	4109	4172	4235	4300	4365	4431	4499	4567	4637	4708	53
8	3987	4048	4110	4173	4236	4301	4366	4433	4500	4569	4638	4709	52
9	3988	4049	4111	4174	4237	4302	4367	4434	4501	4570	4639	4710	51
10	1.3989	1.4050	1.4112	1.4175	1.4238	1.4303	1.4368	1.4435	1.4502	1.4571	1.4640	1.4711	50
11	3990	4051	4113	4176	4239	4304	4369	4436	4503	4572	4642	4712	49
12	3991	4052	4114	4177	4240	4305	4370	4437	4504	4573	4643	4714	48
13	3992	4053	4115	4178	4241	4306	4372	4438	4506	4574	4644	4715	47
14	3993	4054	4116	4179	4243	4307	4373	4439	4507	4575	4645	4716	46
15	1.3995	1.4055	1.4117	1.4180	1.4244	1.4308	1.4374	1.4440	1.4508	1.4577	1.4646	1.4717	45
16	3996	4056	4118	4181	4245	4309	4375	4441	4509	4578	4648	4718	44
17	3997	4058	4119	4182	4246	4310	4376	4443	4510	4579	4649	4720	43
18	3998	4059	4120	4183	4247	4311	4377	4444	4511	4580	4650	4721	42
19	3999	4060	4121	4184	4248	4313	4378	4445	4512	4581	4651	4722	41
20	1.4000	1.4061	1.4122	1.4185	1.4249	1.4314	1.4379	1.4446	1.4514	2.4582	1.4652	1.4723	40
21	4001	4062	4124	4186	4250	4315	4380	4447	4515	4584	4653	4724	39
22	4002	4063	4125	4187	4251	4316	4381	4448	4516	4585	4655	4726	38
23	4003	4064	4126	4188	4252	4317	4383	4449	4517	4586	4656	4727	37
24	4004	4065	4127	4189	4253	4318	4384	4450	4518	4587	4657	4728	36
25	1.4005	1.4066	1.4128	1.4191	1.4254	1.4319	1.4385	1.4452	1.4519	1.4588	1.4658	1.4729	35
26	4006	4067	4129	4192	4255	4320	4386	4453	4520	4589	4659	4730	34
27	4007	4068	4130	4193	4256	4321	4387	4454	4522	4590	4660	4732	33
28	4008	4069	4131	4194	4258	4322	4388	4455	4523	4592	4662	4733	32
29	4009	4070	4132	4195	4259	4323	4389	4456	4524	4593	4663	4734	31
30	1.4010	1.4071	1.4133	1.4196	1.4260	1.4325	1.4390	1.4457	1.4525	1.4594	1.4664	1.4735	30
31	4011	4072	4134	4197	4261	4326	4391	4458	4526	4595	4665	4736	29
32	4012	4073	4135	4198	4262	4327	4393	4459	4527	4596	4666	4737	28
33	4013	4074	4136	4199	4263	4328	4394	4460	4528	4597	4668	4739	27
34	4014	4075	4137	4200	4264	4329	4395	4462	4530	4599	4669	4740	26
35	1.4015	1.4076	1.4138	1.4201	1.4265	1.4330	1.4396	1.4463	1.4531	1.4600	1.4670	1.4741	25
36	4016	4077	4139	4202	4266	4331	4397	4464	4532	4601	4671	4742	24
37	4017	4078	4140	4203	4267	4332	4398	4465	4533	4602	4672	4744	23
38	4018	4079	4141	4204	4268	4333	4399	4466	4534	4603	4673	4745	22
39	4019	4080	4142	4205	4269	4334	4400	4467	4535	4604	4675	4746	21
40	1.4020	1.4081	1.4143	1.4206	1.4270	1.4335	1.4401	1.4468	1.4536	1.4606	1.4676	1.4747	20
41	4021	4082	4144	4207	4271	4336	4402	4469	4538	4607	4677	4748	19
42	4022	4083	4145	4209	4273	4338	4404	4471	4539	4608	4678	4750	18
43	4023	4084	4146	4210	4274	4339	4405	4472	4540	4609	4679	4751	17
44	4024	4085	4147	4211	4275	4340	4406	4473	4541	4610	4680	4752	16
45	1.4025	1.4086	1.4149	1.4212	1.4276	1.4341	1.4407	1.4474	1.4542	1.4611	1.4682	1.4753	15
46	4026	4087	4150	4213	4277	4342	4408	4475	4543	4612	4683	4754	14
47	4027	4088	4151	4214	4278	4343	4409	4476	4544	4614	4684	4756	13
48	4028	4089	4152	4215	4279	4344	4410	4477	4546	4615	4685	4757	12
49	4029	4090	4153	4216	4280	4345	4411	4479	4547	4616	4686	4758	11
50	1.4030	1.4091	1.4154	1.4217	1.4281	1.4346	1.4412	1.4480	1.4548	1.4617	1.4688	1.4759	10
51	4031	4092	4155	4218	4282	4347	4414	4481	4549	4618	4689	4760	9
52	4032	4093	4156	4219	4283	4349	4415	4482	4550	4619	4690	4762	8
53	4033	4095	4157	4220	4284	4350	4416	4483	4551	4621	4691	4763	7
54	4034	4096	4158	4221	4285	4351	4417	4484	4552	4622	4692	4764	6
55	1.4035	1.4097	1.4159	1.4222	1.4287	1.4352	1.4418	1.4485	1.4554	1.4623	1.4693	1.4765	5
56	4036	4098	4160	4223	4288	4353	4419	4486	4555	4624	4695	4766	4
57	4037	4099	4161	4224	4289	4354	4420	4488	4556	4625	4696	4768	3
58	4038	4100	4162	4226	4290	4355	4421	4489	4557	4626	4697	4769	2
59	4039	4101	4163	4227	4291	4356	4422	4490	4558	4628	4698	4770	1
60	4040	4102	4164	4228	4292	4357	4424	4491	4559	4629	4699	4771	0
	11′	10′	9′	8′	7′	6′	5′	4′	3′	2′	1′	0′	S.

6 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

4 DEGREES.

S.	0′	1′	2′	3′	4′	5′	6′	7′	8′	9′	10′	11′	
0	1.4771	1.4844	1.4918	1.4994	1.5071	1.5149	1.5229	1.5310	1.5393	1.5477	1.5563	1.5651	60
1	4772	4845	4920	4995	5072	5150	5230	5311	5394	5478	5564	5652	59
2	4774	4847	4921	4997	5073	5152	5231	5313	5395	5480	5566	5654	58
3	4775	4848	4922	4998	5075	5153	5233	5314	5397	5481	5567	5655	57
4	4776	4849	4923	4999	5076	5154	5234	5315	5398	5483	5569	5657	56
5	1.4777	1.4850	1.4925	1.5000	1.5077	1.5156	1.5235	1.5317	1.5400	1.5484	1.5570	1.5658	55
6	4778	4852	4926	5002	5079	5157	5237	5318	5401	5486	5572	5660	54
7	4780	4853	4927	5003	5080	5158	5238	5320	5402	5487	5573	5661	53
8	4781	4854	4928	5004	5081	5160	5240	5321	5404	5488	5575	5663	52
9	4782	4855	4930	5005	5082	5161	5241	5322	5405	5490	5576	5664	51
10	1.4783	1.4856	1.4931	1.5007	1.5084	1.5162	1.5242	1.5324	1.5407	1.5491	1.5578	1.5666	50
11	4785	4858	4932	5008	5085	5164	5244	5325	5408	5493	5579	5667	49
12	4786	4859	4933	5009	5086	5165	5245	5326	5409	5494	5580	5669	48
13	4787	4860	4935	5011	5088	5166	5246	5328	5411	5496	5582	5670	47
14	4788	4861	4936	5012	5089	5168	5248	5329	5412	5497	5583	5671	46
15	1.4789	1.4863	1.4937	1.5013	1.5090	1.5169	1.5249	1.5331	1.5414	1.5498	1.5585	1.5673	45
16	4791	4864	4938	5014	5092	5170	5250	5332	5415	5500	5586	5674	44
17	4792	4865	4940	5016	5093	5172	5252	5333	5416	5501	5588	5676	43
18	4793	4866	4941	5017	5094	5173	5253	5335	5418	5503	5589	5677	42
19	4794	4868	4942	5018	5095	5174	5254	5336	5419	5504	5591	5679	41
20	1.4795	1.4869	1.4943	1.5019	1.5097	1.5175	1.5256	1.5337	1.5421	1.5506	1.5592	1.5680	40
21	4797	4870	4945	5021	5098	5177	5257	5339	5422	5507	5594	5682	39
22	4798	4871	4946	5022	5099	5178	5258	5340	5423	5508	5595	5683	38
23	4799	4873	4947	5023	5101	5179	5260	5341	5425	5510	5596	5685	37
24	4800	4874	4949	5025	5102	5181	5261	5343	5426	5511	5598	5686	36
25	1.4801	1.4875	1.4950	1.5026	1.5103	1.5182	1.5262	1.5344	1.5428	1.5513	1.5599	1.5688	35
26	4803	4876	4951	5027	5105	5183	5264	5346	5429	5514	5601	5689	34
27	4804	4877	4952	5028	5106	5185	5265	5347	5430	5516	5602	5691	33
28	4805	4879	4954	5030	5107	5186	5266	5348	5432	5517	5604	5692	32
29	4806	4880	4955	5031	5108	5187	5268	5350	5433	5518	5605	5694	31
30	1.4808	1.4881	1.4956	1.5032	1.5110	1.5189	1.5269	1.5351	1.5435	1.5520	1.5607	1.5695	30
31	4809	4882	4957	5034	5111	5190	5271	5353	5436	5521	5608	5697	29
32	4810	4884	4959	5035	5112	5191	5272	5354	5437	5522	5610	5698	28
33	4811	4885	4960	5036	5114	5193	5273	5355	5439	5524	5611	5700	27
34	4812	4886	4961	5037	5115	5194	5275	5357	5440	5526	5613	5701	26
35	1.4814	1.4887	1.4962	1.5039	1.5116	1.5195	1.5276	1.5358	1.5442	1.5527	1.5614	1.5703	25
36	4815	4889	4964	5040	5118	5197	5277	5359	5443	5528	5615	5704	24
37	4816	4890	4965	5041	5119	5198	5279	5361	5445	5530	5617	5706	23
38	4817	4891	4966	5043	5120	5199	5280	5362	5446	5531	5618	5707	22
39	4819	4892	4967	5044	5122	5200	5281	5364	5447	5533	5620	5709	21
40	1.4820	1.4894	1.4969	1.5045	1.5123	1.5202	1.5283	1.5365	1.5449	1.5534	1.5621	1.5710	20
41	4821	4895	4970	5046	5124	5203	5284	5366	5450	5536	5623	5712	19
42	4822	4896	4971	5048	5125	5205	5285	5368	5452	5537	5624	5713	18
43	4823	4897	4972	5049	5127	5206	5287	5369	5453	5538	5626	5715	17
44	4825	4899	4974	5050	5128	5207	5288	5370	5454	5540	5627	5716	16
45	1.4826	1.4900	1.4975	1.5051	1.5129	1.5209	1.5290	1.5372	1.5456	1.5541	1.5629	1.5718	15
46	4827	4901	4976	5053	5131	5210	5291	5373	5457	5543	5630	5719	14
47	4828	4902	4977	5054	5132	5211	5292	5375	5459	5544	5632	5721	13
48	4830	4903	4979	5055	5133	5213	5294	5376	5460	5546	5633	5722	12
49	4831	4905	4980	5057	5135	5214	5295	5377	5461	5547	5635	5724	11
50	1.4832	1.4906	1.4981	1.5058	1.5136	1.5215	1.5296	1.5379	1.5463	1.5549	1.5636	1.5725	10
51	4833	4907	4983	5059	5137	5217	5298	5380	5464	5550	5637	5727	9
52	4834	4908	4984	5061	5139	5218	5299	5382	5466	5551	5639	5728	8
53	4836	4910	4985	5062	5140	5219	5300	5383	5467	5553	5640	5730	7
54	4837	4911	4986	5063	5141	5221	5302	5384	5469	5554	5642	5731	6
55	1.4838	1.4912	1.4988	1.5064	1.5143	1.5222	1.5303	1.5386	1.5470	1.5556	1.5643	1.5733	5
56	4839	4913	4989	5066	5144	5223	5305	5387	5471	5557	5645	5734	4
57	4841	4915	4990	5067	5145	5225	5306	5389	5473	5559	5646	5736	3
58	4842	4916	4991	5068	5146	5226	5307	5390	5474	5560	5648	5737	2
59	4843	4917	4992	5070	5148	5227	5309	5391	5476	5562	5649	5739	1
60	4844	4918	4994	5071	5149	5229	5310	5393	5477	5563	5651	5740	0
	59′	58′	57′	56′	55′	54′	53′	52′	51′	50′	49′	48′	S.

5 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°

4 DEGREES.

S.	12′	13′	14′	15′	16′	17′	18′	19′	20′	21′	22′	23′	
0	1.5740	1.5832	1.5925	1.6021	1.6118	1.6218	1.6320	1.6425	1.6532	1.6642	1.6755	1.6871	60
1	5742	5833	5927	6022	6120	6220	6322	6427	6534	6644	6757	6873	59
2	5743	5835	5928	6024	6121	6221	6324	6428	6536	6646	6759	6875	58
3	5745	5836	5930	6025	6123	6223	6325	6430	6538	6648	6761	6877	57
4	5746	5838	5931	6027	6125	6225	6327	6432	6539	6650	6763	6879	56
5	1.5748	1.5839	1.5933	1.6029	1.6126	1.6226	1.6329	1.6434	1.6541	1.6651	1.6764	1.6881	55
6	5749	5841	5935	6030	6128	6228	6331	6435	6543	6653	6766	6882	54
7	5751	5843	5936	6032	6130	6230	6332	6437	6545	6655	6768	6884	53
8	5752	5844	5938	6033	6131	6232	6334	6439	6547	6657	6770	6886	52
9	5754	5846	5939	6035	6133	6233	6336	6441	6548	6659	6772	6888	51
10	1.5755	1.5847	1.5941	1.6037	1.6135	1.6235	1.6338	1.6443	1.6550	1.6661	1.6774	1.6890	50
11	5757	5849	5942	6038	6136	6237	6339	6444	6552	6663	6776	6892	49
12	5758	5850	5944	6040	6138	6238	6341	6446	6554	6664	6778	6894	48
13	5760	5852	5946	6042	6140	6240	6343	6448	6556	6666	6780	6896	47
14	5761	5853	5947	6043	6141	6242	6344	6450	6558	6668	6782	6898	46
15	1.5763	1.5855	1.5949	1.6045	1.6143	1.6243	1.6346	1.6451	1.6559	1.6670	1.6784	1.6900	45
16	5765	5856	5950	6046	6145	6245	6348	6453	6561	6672	6785	6902	44
17	5766	5858	5952	6048	6146	6247	6350	6455	6563	6674	6787	6904	43
18	5768	5860	5954	6050	6148	6248	6351	6457	6565	6676	6789	6906	42
19	5769	5861	5955	6051	6150	6250	6353	6459	6567	6677	6791	6908	41
20	1.5771	1.5863	1.5957	1.6053	1.6151	1.6252	1.6355	1.6460	1.6568	1.6679	1.6793	1.6910	40
21	5772	5864	5958	6055	6153	6254	6357	6462	6570	6681	6795	6912	39
22	5774	5866	5960	6056	6155	6255	6358	6464	6572	6683	6797	6914	38
23	5775	5867	5961	6058	6156	6257	6360	6466	6574	6685	6799	6916	37
24	5777	5869	5963	6059	6158	6259	6362	6467	6576	6687	6801	6918	36
25	1.5778	1.5870	1.5965	1.6061	1.6160	1.6260	1.6364	1.6469	1.6578	1.6689	1.6803	1.6920	35
26	5780	5872	5966	6063	6161	6262	6365	6471	6579	6691	6805	6922	34
27	5781	5874	5968	6064	6163	6264	6367	6473	6581	6692	6807	6924	33
28	5783	5875	5969	6066	6165	6265	6369	6475	6583	6694	6809	6926	32
29	5784	5877	5971	6067	6166	6267	6371	6476	6585	6696	6810	6928	31
30	1.5786	1.5878	1.5973	1.6069	1.6168	1.6269	1.6372	1.6478	1.6587	1.6698	1.6812	1.6930	30
31	5787	5880	5974	6071	6169	6271	6374	6480	6589	6700	6814	6932	29
32	5789	5881	5976	6072	6171	6272	6376	6482	6590	6702	6816	6934	28
33	5790	5883	5977	6074	6173	6274	6377	6484	6592	6704	6818	6936	27
34	5792	5884	5979	6076	6174	6276	6379	6485	6594	6706	6820	6938	26
35	1.5793	1.5886	1.5981	1.6077	1.6176	1.6277	1.6381	1.6487	1.6596	1.6708	1.6822	1.6940	25
36	5795	5888	5982	6079	6178	6279	6383	6489	6598	6709	6824	6942	24
37	5796	5889	5984	6081	6179	6281	6384	6491	6600	6711	6826	6944	23
38	5798	5891	5985	6082	6181	6282	6386	6492	6601	6713	6828	6946	22
39	5800	5892	5987	6084	6183	6284	6388	6494	6603	6715	6830	6948	21
40	1.5801	1.5894	1.5989	1.6085	1.6185	1.6286	1.6390	1.6496	1.6605	1.6717	1.6832	1.6950	20
41	5803	5895	5990	6087	6186	6288	6391	6498	6607	6719	6834	6952	19
42	5804	5897	5992	6089	6188	6289	6393	6500	6609	6721	6836	6954	18
43	5806	5898	5993	6090	6190	6291	6395	6501	6611	6723	6838	6956	17
44	5807	5900	5995	6092	6191	6293	6397	6503	6612	6725	6840	6958	16
45	1.5809	1.5902	1.5997	1.6094	1.6193	1.6294	1.6398	1.6505	1.6614	1.6726	1.6841	1.6960	15
46	5810	5903	5998	6095	6195	6296	6400	6507	6616	6728	6843	6962	14
47	5812	5905	6000	6097	6196	6298	6402	6509	6618	6730	6845	6964	13
48	5813	5906	6001	6099	6198	6300	6404	6510	6620	6732	6847	6966	12
49	5815	5908	6003	6100	6200	6301	6406	6512	6622	6734	6849	6968	11
50	1.5816	1.5909	1.6005	1.6102	1.6201	1.6303	1.6407	1.6514	1.6624	1.6736	1.6851	1.6970	10
51	5818	5911	6006	6103	6203	6305	6409	6516	6625	6738	6853	6972	9
52	5819	5913	6008	6105	6205	6306	6411	6518	6627	6740	6855	6974	8
53	5821	5914	6009	6107	6206	6308	6413	6519	6629	6742	6857	6976	7
54	5823	5916	6011	6108	6208	6310	6414	6521	6631	6743	6859	6978	6
55	1.5824	1.5917	1.6013	1.6110	1.6210	1.6312	1.6416	1.6523	1.6633	1.6745	1.6861	1.6980	5
56	5826	5919	6014	6112	6211	6313	6418	6525	6635	6747	6863	6982	4
57	5827	5920	6016	6113	6213	6315	6420	6527	6637	6749	6865	6984	3
58	5829	5922	6017	6115	6215	6317	6421	6529	6638	6751	6867	6986	2
59	5830	5924	6019	6117	6216	6319	6423	6530	6640	6753	6869	6988	1
60	5832	5925	6021	6118	6218	6320	6425	6532	6642	6755	6871	6990	0
	47′	46′	45′	44′	43′	42′	41′	40′	39′	38′	37′	36′	S.

5 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

4 DEGREES.

S.	24′	25′	26′	27′	28′	29′	30′	31′	32′	33′	34′	35′	
0	1.6990	1.7112	1.7238	1.7368	1.7501	1.7639	1.7782	1.7929	1.8081	1.8239	1.8403	1.8573	60
1	6992	7114	7240	7370	7503	7641	7784	7931	8084	8242	8406	8576	59
2	6994	7116	7242	7372	7506	7644	7786	7934	8086	8244	8409	8579	58
3	6996	7118	7244	7374	7508	7646	7789	7936	8089	8247	8411	8582	57
4	6998	7120	7246	7376	7510	7648	7791	7939	8091	8250	8414	8583	56
5	1.7000	1.7122	1.7249	1.7379	1.7513	1.7651	1.7794	1.7941	1.8094	1.8253	1.8417	1.8588	55
6	7002	7124	7251	7381	7515	7653	7796	7944	8097	8255	8420	8591	54
7	7004	7127	2253	7383	7517	7655	7798	7946	8099	8258	8423	8594	53
8	7006	7129	7255	7385	7519	7658	7801	7949	8102	8261	8425	8597	52
9	7008	7131	7257	7387	7522	7660	7803	7951	8104	8263	8428	8599	51
10	1.7010	1.7133	1.7259	1.7390	1.7524	1.7663	1.7806	1.7954	1.8107	1.8266	1.8431	1.8602	50
11	7012	7135	7261	7392	7526	7665	7808	7956	8110	8269	8434	8605	49
12	7014	7137	7264	7394	7528	7667	7811	7959	8112	8271	8437	8608	48
13	7016	7139	7266	7396	7531	7670	7813	7961	8115	8274	8439	8611	47
14	7018	7141	7268	7398	7533	7672	7815	7964	8117	8277	8442	8614	46
15	1.7020	1.7143	1.7270	1.7401	1.7535	1.7674	1.7818	1.7966	1.8120	1.8279	1.8445	1.8617	45
16	7022	7145	7272	7403	7538	7677	7820	7969	8123	8282	8448	8620	44
17	7024	7147	7274	7405	7540	7679	7823	7971	8125	8285	8451	8623	43
18	7026	7149	7276	7407	7542	7681	7825	7974	8128	8288	8453	8626	42
19	7028	7152	7279	7409	7544	7684	7828	7976	8131	8290	8456	8629	41
20	1.7030	1.7154	1.7281	1.7412	1.7547	1.7686	1.7830	1.7979	1.8133	1.8293	1.8459	1.8632	40
21	7032	7156	7283	7414	7549	7688	7832	7981	8136	8296	8462	8635	39
22	7034	7158	7285	7416	7551	7691	7835	7984	8138	8298	8465	8637	38
23	7036	7160	7287	7418	7554	7693	7837	7987	8141	8301	8467	8640	37
24	7038	7162	7289	7421	7556	7696	7840	7989	8144	8304	8470	8643	36
25	1.7040	1.7164	1.7291	1.7423	1.7558	1.7698	1.7842	1.7992	1.8146	1.8307	1.8473	1.8646	35
26	7042	7166	7294	7425	7560	7700	7845	7994	8149	8309	8476	8649	34
27	7044	7168	7296	7427	7563	7703	7847	7997	8152	8312	8479	8652	33
28	7046	7170	7298	7429	7565	7705	7850	7999	8154	8315	8482	8655	32
29	7048	7172	7300	7432	7567	7707	7852	8002	8157	8318	8484	8658	31
30	1.7050	1.7175	1.7302	1.7434	1.7570	1.7710	1.7855	1.8004	1.8159	1.8320	1.8487	1.8661	30
31	7052	7177	7304	7436	7572	7712	7857	8007	8162	8323	8490	8664	29
32	7055	7179	7307	7438	7574	7714	7859	8009	8165	8326	8493	8667	28
33	7057	7181	7309	7441	7576	7717	7862	8012	8167	8328	8496	8670	27
34	7059	7183	7311	7443	7579	7719	7864	8014	8170	8331	8499	8673	26
35	1.7061	1.7185	1.7313	1.7445	1.7581	1.7722	1.7867	1.8017	1.8173	1.8334	1.8502	1.8676	25
36	7063	7187	7315	7447	7583	7724	7869	8020	8175	8337	8504	8679	24
37	7065	7189	7317	7450	7586	7726	7872	8022	8178	8339	8507	8682	23
38	7067	7191	7320	7452	7588	7729	7874	8025	8181	8342	8510	8685	22
39	7069	7193	7322	7454	7590	7731	7877	8027	8183	8345	8513	8688	21
40	1.7071	1.7196	1.7324	1.7456	1.7593	1.7734	1.7879	1.8030	1.8186	1.8348	1.8516	1.8691	20
41	7073	7198	7326	7458	7595	7736	7882	8032	8188	8350	8519	8694	19
42	7075	7200	7328	7461	7597	7738	7884	8035	8191	8353	8522	8697	18
43	7077	7202	7330	7463	7600	7741	7887	8037	8194	8356	8524	8700	17
44	7079	7204	7333	7465	7602	7743	7889	8040	8196	8359	8527	8703	16
45	1.7081	1.7206	1.7335	1.7467	1.7604	1.7745	1.7891	1.8043	1.8199	1.8361	1.8530	1.8706	15
46	7083	7208	7337	7470	7607	7748	7894	8045	8202	8364	8533	8709	14
47	7085	7210	7339	7472	7609	7750	7896	8048	8204	8367	8536	8712	13
48	7087	7212	7341	4774	7611	7753	7899	8050	8207	8370	8539	8715	12
49	7089	7215	7344	7476	7613	7755	7901	8053	8210	8372	8542	8718	11
50	1.7091	1.7217	1.7346	1.7479	1.7616	1.7758	1.7904	1.8055	1.8212	1.8375	1.8544	1.8721	10
51	7093	7219	7348	7481	7618	7760	7906	8058	8215	8378	8547	8724	9
52	7096	7221	7350	7483	7620	7762	7909	8061	8218	8381	8550	8727	8
53	7098	7223	7352	7485	7623	7765	7911	8063	8220	8384	8553	8730	7
54	7100	7225	7354	7488	7625	7767	7914	8066	8223	8386	8556	8733	6
55	1.7102	1.7227	1.7357	1.7490	1.7627	1.7769	1.7916	1.8068	1.8226	1.8389	1.8559	1.8736	5
56	7104	7229	7359	7492	7630	7772	7919	8071	8228	8392	8562	8739	4
57	7106	7232	7361	7494	7632	7774	7921	8073	8231	8395	8565	8742	3
58	7108	7234	6363	7497	7634	7777	7924	8076	8234	8397	8568	8745	2
59	7110	7236	7365	7499	7637	7779	7926	8079	8236	8400	8570	8748	1
60	7112	7238	7368	7501	7639	7782	7929	8081	8239	8403	8573	8751	0
	35′	34′	33′	32′	31′	30′	29′	28′	27′	26′	25′	24′	S.

5 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

4 DEGREES.

S.	36′	37′	38′	39′	40′	41′	42′	43′	44′	45′	46′	47′	
0	1.8751	1.8935	1.9128	1.9331	1.9542	1.9765	2.0000	2.0248	2.0512	2.0792	2.1091	2.1413	60
1	8754	8939	9132	9334	9546	9769	0004	0252	0516	0797	1097	1419	59
2	8757	8942	9135	9337	9550	9773	0008	0257	0521	0801	1102	1424	58
3	8760	8945	9138	9341	9553	9777	0012	0261	0525	0806	1107	1430	57
4	8763	8948	9142	9344	9557	9780	0016	0265	0530	0811	1112	1436	56
5	1.8766	1.8951	1.9145	1.9348	1.9561	1.9784	2.0020	2.0270	2.0534	2.0816	2.1117	2.1441	55
6	8769	8954	9148	9351	9564	9788	0024	0274	0539	0821	1123	1447	54
7	8772	8958	9152	9355	9568	9792	0028	0278	0543	0826	1128	1452	53
8	8775	8961	9155	9358	9571	9796	0032	0282	0548	0831	1133	1458	52
9	8778	8964	9158	9362	9575	9800	0036	0287	0552	0835	1138	1464	51
10	1.8781	1.8967	1.9162	1.9365	1.9579	1.9803	2.0040	2.0291	2.0557	2.0840	2.1143	2.1469	50
11	8784	8970	9165	9369	9582	9807	0044	0295	0562	0845	1149	1475	49
12	8787	8973	9168	9372	9586	9811	0049	0300	0566	0850	1154	1481	48
13	8790	8977	9172	9376	9590	9815	0053	0304	0571	0855	1159	1486	47
14	8793	8980	9175	9379	9593	9819	0057	0308	0575	0860	1164	1492	46
15	1.8796	1.8983	1.9178	1.9383	1.9597	1.9823	2.0061	2.0313	2.0580	2.0865	2.1170	2.1498	45
16	8799	8986	9181	9386	9601	9827	0065	0317	0585	0870	1175	1503	44
17	8802	8989	9185	9390	9604	9830	0069	0321	0589	0875	1180	1509	43
18	8805	8992	9188	9393	9608	9834	0073	0326	0594	0880	1186	1515	42
19	8808	8996	9191	9397	9612	9838	0077	0330	0598	0884	1191	1520	41
20	1.8811	1.8999	1.9195	1.9400	1.9615	1.9842	2.0081	2.0334	2.0603	2.0889	2.1196	2.1526	40
21	8814	9002	9198	9404	9619	9846	0085	0339	0608	0894	1201	1532	39
22	8817	9005	9201	9407	9623	9850	0089	0343	0612	0899	1207	1538	38
23	8821	9008	9205	9411	9626	9854	0093	0347	0617	0904	1212	1543	37
24	8824	9012	9208	9414	9630	9858	0098	0352	0621	0909	1217	1549	36
25	1.8827	1.9015	1.9212	1.9418	1.9634	1.9861	2.0102	2.0356	2.0626	2.0914	2.1223	2.1555	35
26	8830	9018	9215	9421	9638	9865	0106	0360	0631	0919	1228	1561	34
27	8833	9021	9218	9425	9641	9869	0110	0365	0635	0924	1233	1566	33
28	8836	9024	9222	9428	9645	9873	0114	0369	0640	0929	1239	1572	32
29	8839	9028	9225	9432	9649	9877	0118	0374	0645	0934	1244	1578	31
30	1.8842	1.9031	1.9228	1.9435	1.9652	1.9881	2.0122	2.0378	2.0649	2.0939	2.1249	2.1584	30
31	8845	9034	9232	9439	9656	9885	0126	0382	0654	0944	1255	1589	29
32	8848	9037	9235	9442	9660	9889	0131	0387	0659	0949	1260	1595	28
33	8851	9041	9238	9446	9664	9893	0135	0391	0663	0954	1266	1601	27
34	8854	9044	9242	9449	9667	9897	0139	0395	0668	0959	1271	1607	26
35	1.8857	1.9047	1.9245	1.9453	1.9671	1.9901	2.0143	2.0400	2.0673	2.0964	2.1276	2.1613	25
36	8861	9050	9249	9456	9675	9905	0147	0404	0678	0969	1282	1619	24
37	8864	9053	9252	9460	9678	9908	0151	0409	0682	0974	1287	1624	23
38	8867	9057	9255	9464	9682	9912	0156	0413	0687	0979	1292	1630	22
39	8870	9060	9259	9467	9686	9916	0160	0418	0692	0984	1298	1636	21
40	1.8873	1.9063	1.9262	1.9471	1.9690	1.9920	2.0164	2.0422	2.0696	2.0989	2.1303	2.1642	20
41	8876	9066	9266	9474	9693	9924	0168	0426	0701	0994	1309	1648	19
42	8879	9070	9269	9478	9697	9928	0172	0431	0706	0999	1314	1654	18
43	8882	9073	9272	9481	9701	9932	0176	0435	0711	1004	1320	1660	17
44	8885	9076	9276	9485	9705	9936	0181	0440	0715	1009	1325	1665	16
45	1.8888	1.9079	1.9279	1.9488	1.9708	1.9940	2.0185	2.0444	2.0720	2.1015	2.1331	2.1671	15
46	8892	9083	9283	9492	9712	9944	0189	0449	0725	1020	1336	1677	14
47	8895	9086	9286	9496	9716	9948	0193	0453	0730	1025	1342	1683	13
48	8898	9089	9289	9499	9720	9952	0197	0458	0734	1030	1347	1689	12
49	8901	9092	9293	9503	9723	9956	0202	0462	0739	1035	1352	1695	11
50	1.8904	1.9096	1.9296	1.9506	1.9727	1.9960	2.0206	2.0467	2.0744	2.1040	2.1358	2.1701	10
51	8907	9099	9300	9510	9731	9964	0210	0471	0749	1045	1363	1707	9
52	8910	9102	9303	9514	9735	9968	0214	0475	0753	1050	1369	1713	8
53	8913	9106	9306	9517	9739	9972	0219	0480	0758	1055	1374	1719	7
54	8917	9109	9310	9521	9742	9976	0223	0484	0763	1061	1380	1725	6
55	1.8920	1.9112	1.9313	1.9524	1.9746	1.9980	2.0227	2.0489	2.0768	2.1066	2.1386	2.1731	5
56	8923	9115	9317	9528	9750	9984	0231	0493	0773	1071	1391	1737	4
57	8926	9119	9320	9532	9754	9988	0235	0498	0777	1076	1397	1743	3
58	8929	9122	9324	9535	9758	9992	0240	0502	0782	1081	1402	1749	2
59	8932	9125	9327	9539	9761	9996	0244	0507	0787	1086	1408	1755	1
60	8935	9128	9331	9542	9765	2.0000	0248	0512	0792	1091	1413	1761	0
	23′	22′	21′	20′	19′	18′	17′	16′	15′	14′	13′	12′	S.

5 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

TABLE XXXII.

LOGARITHMS OF THE FIRST AND SECOND CORRECTIONS.

The First Correction is *always* to be taken from the Top, and also the Second, when the Apparent Distance is *greater* than 90°.

4 DEGREES.

S.	48′	49′	50′	51′	52′	53′	54′	55′	56′	57′	58′	59′	
0	2.1761	2.2139	2.2553	2.3010	2.3522	2.4102	2.4771	2.5563	2.6532	2.7782	2.9542	3.2553	60
1	1767	2145	2560	3018	3531	4112	4783	5578	6550	7806	9579	2626	59
2	1773	2152	2567	3026	3540	4122	4795	5592	6568	7830	9615	2700	58
3	1779	2159	2574	3034	3549	4133	4808	5607	6587	7855	9652	2775	57
4	1785	2165	2582	3043	3558	4143	4820	5621	6605	7879	9690	2852	56
5	2.1791	2.2172	2.2589	2.3051	2.3567	2.4154	2.4832	2.5636	2.6624	2.7904	2.9727	3.2931	55
6	1797	2178	2596	3059	3576	4164	4844	5651	6642	7929	9765	3010	54
7	1803	2185	2604	3067	3586	4175	4856	5666	6661	7954	9803	3091	53
8	1809	2192	2611	3075	3595	4185	4869	5680	6679	7979	9842	3174	52
9	1816	2198	2618	3083	3604	4196	4881	5695	6698	8004	9881	3259	51
10	2.1822	2.2205	2.2626	2.3091	2.3613	2.4206	2.4894	2.5710	2.6717	2.8030	2.9920	3.3345	50
11	1828	2212	2633	3100	3623	4217	4906	5725	6736	8055	9960	3432	49
12	1834	2218	2640	3108	3632	4228	4918	5740	6755	8081	3.0000	3522	48
13	1840	2225	2648	3116	3641	4238	4931	5755	6774	8107	0040	3613	47
14	1846	2232	2655	8124	3650	4249	4943	5771	6793	8133	0081	3707	46
15	2.1852	2.2239	2.2663	2.3133	2.3660	2.4260	2.4956	2.5786	2.6812	2.8159	3.0122	3.3802	45
16	1859	2245	2670	3141	3669	4270	4969	5801	6832	8186	0164	3900	44
17	1865	2252	2678	3149	3678	4281	4981	5816	6851	8212	0206	4000	43
18	1871	2259	2685	3158	3688	4292	4994	5832	6871	8239	0248	4102	42
19	1877	2266	2692	3166	3697	4303	5007	5847	6890	8266	0291	4206	41
20	2.1883	2.2272	2.2700	2.3174	2.3707	2.4314	2.5019	2.5863	2.6910	2.8293	3.0334	3.4314	40
21	1889	2279	2707	3183	3716	4325	5032	5878	6930	8320	0378	4424	39
22	1896	2286	2715	3191	3726	4335	5045	5894	6950	8348	0422	4536	38
23	1902	2293	2722	3199	3735	4346	5058	5909	6970	8375	0467	4652	37
24	1908	2300	2730	3208	3745	4357	5071	5925	6990	8403	0512	4771	36
25	2.1914	2.2307	2.2738	2.3216	2.3754	2.4368	2.5084	2.5941	2.7010	2.8431	3.0557	3.4894	35
26	1921	2313	2745	3225	3764	4379	5097	5957	7030	8459	0603	5019	34
27	1927	2320	2753	3233	3773	4390	5110	5973	7050	8487	0649	5149	33
28	1933	2327	2760	3242	3783	4401	5123	5989	7071	8516	0696	5283	32
29	1939	2334	2768	3250	3792	4412	5136	6005	7091	8544	0744	5421	31
30	2.1946	2.2341	2.2775	2.3259	2.3802	2.4424	2.5149	2.6021	2.7112	2.8573	3.0792	3.5563	30
31	1952	2348	2783	3267	3812	4435	5162	6037	7133	8602	0840	5710	29
32	1958	2355	2791	3276	3821	4446	5175	6053	7154	8632	0889	5863	28
33	1965	2362	2798	3284	3831	4457	5189	6069	7175	8661	0939	6021	27
34	1971	2368	2806	3293	3841	4468	5202	6085	7196	8691	0989	6185	26
35	2.1977	2.2375	2.2814	2.3301	2.3851	2.4480	2.5215	2.6102	2.7217	2.8721	3.1040	3.6355	25
36	1984	2382	2821	3310	3860	4491	5229	6118	7238	8751	1091	6532	24
37	1990	2389	2829	3319	3870	4502	5242	6135	7259	8781	1143	6717	23
38	1996	2396	2837	3327	3880	4514	5256	6151	7281	8811	1196	6910	22
39	2003	2403	2845	3336	3890	4525	5269	6168	7302	8842	1249	7112	21
40	2.2009	2.2410	2.2852	2.3345	2.3900	2.4536	2.5283	2.6185	2.7324	2.8873	3.1303	3.7324	20
41	2016	2417	2860	3353	3910	4548	5296	6201	7346	8904	1358	7547	19
42	2022	2424	2868	3362	3919	4559	5310	6218	7368	8935	1413	7782	18
43	2028	2431	2876	3371	3929	4571	5324	6235	7390	8967	1469	8030	17
44	2035	2438	2883	3379	3939	4582	5337	6252	7412	8999	1526	8293	16
45	2.2041	2.2445	2.2891	2.3388	2.3949	2.4594	2.5351	2.6269	2.7434	2.9031	3.1584	3.8573	15
46	2048	2453	2899	3397	3959	4606	5365	6286	7456	9063	1642	8873	14
47	2054	2460	2907	3406	3969	4617	5379	6303	7479	9096	1701	9195	13
48	2061	2467	2915	3415	3979	4629	5393	6320	7501	9128	1761	9542	12
49	2067	2474	2923	3423	3989	4640	5407	6338	7524	9162	1822	9920	11
50	2.2073	2.2481	2.2931	2.3432	2.4000	2.4652	2.5421	2.6355	2.7547	2.9195	3.1883	4.0334	10
51	2080	2488	2939	3441	4010	4664	5435	6372	7570	9228	1946	0792	9
52	2086	2495	2946	3450	4020	4676	5449	6390	7593	9262	2009	1303	8
53	2093	2502	2954	3459	4030	4688	5463	6407	7616	9296	2073	1883	7
54	2099	2510	2962	3468	4040	4699	5477	6425	7639	9331	2139	2553	6
55	2.2106	2.2517	2.2970	2.3477	2.4050	2.4711	2.5491	2.6443	2.7663	2.9365	3.2205	4.3345	5
56	2113	2524	2978	3486	4061	4723	5506	6460	7686	9400	2272	4314	4
57	2119	2531	2986	3495	4071	4735	5520	6478	7710	9435	2341	5563	3
58	2126	2538	2994	3504	4081	4747	5534	6496	7734	9471	2410	7324	2
59	2132	2545	3002	3513	4091	4759	5549	6514	7757	9506	2481	5.0334	1
60	2139	2553	3010	3522	4102	4771	5563	6532	7782	9542	2553		0
	11′	10′	9′	8′	7′	6′	5′	4′	3′	2′	1′	0′	S.

5 DEGREES.

When the Apparent Distance is *less* than 90°, the Second Correction is to be taken from the Bottom.

ANGLE OF AZIMUTH AND CORRESPONDING CHANGE OF ALTITUDE IN ONE MINUTE OF TIME.

Enter this Table with the Latitude in, at the side, and opposite to which, in the body of the Table, find the approximate Azimuth or Sun's Angle from the Meridian in Degrees at the time of the observation. Then at the Top will be found the Sun's change of altitude in 1 minute of time.

This Table is useful to verify a set of Altitudes for Chronometer, taken when the Sun is not on the Prime Vertical, and for other purposes when precision is required.

LAT.	CHANGE OF ALTITUDE IN 1 MINUTE.															
		′ 1	′ 2	′	′ 4	′ 5	′ 6	′ 7	′ 8	′ 9	′ 10	′ 11	′ 12	′ 13	′ 14	′ 15
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0	4	8	12	15	19	24	28	32	37	42	47	53	60	69	87
2	0	4	8	12	15	19	24	28	32	37	42	47	53	60	69	87
4	0	4	8	12	15	20	24	28	32	37	42	47	53	60	69	
6	0	4	8	12	16	20	24	28	32	37	42	48	54	61	70	
8	0	4	8	12	16	20	24	28	33	37	42	48	54	61	71	
10	0	4	8	12	16	20	24	28	33	38	43	48	54	62	71	
11	0	4	8	12	16	20	24	28	33	38	43	48	55	62	72	
12	0	4	8	12	16	20	24	28	33	38	43	49	55	62	73	
13	0	4	8	12	16	20	24	29	33	38	43	49	55	63	73	
14	0	4	8	12	16	20	24	29	33	38	43	49	56	63	74	
15	0	4	8	12	16	20	24	29	34	38	44	49	56	64	75	
16	0	4	8	12	16	20	25	29	34	39	44	50	56	64	76	
17	0	4	8	12	16	20	25	29	34	39	44	50	57	65	77	
18	0	4	8	12	16	21	25	29	34	39	44	50	57	66	79	
19	0	4	8	12	16	21	25	30	34	39	45	51	58	66	81	
20	0	4	8	12	16	21	25	30	35	40	45	51	58	67	83	
21	0	4	8	12	17	21	25	30	35	40	46	52	59	68	89	
22	0	4	8	12	17	21	26	30	35	40	46	52	60	69		
23	0	4	8	13	17	21	26	30	35	41	46	53	60	70		
24	0	4	8	13	17	21	26	31	36	41	47	53	61	72		
25	0	4	8	13	17	22	26	31	36	41	47	54	62	73		
26	0	4	9	13	17	22	26	31	36	42	48	55	63	75		
27	0	4	9	13	17	22	27	32	37	42	48	55	64	77		
28	0	4	9	13	18	22	27	32	37	43	49	56	65	79		
29	0	4	9	13	18	22	27	32	37	43	50	57	66	82		
30	0	4	9	13	18	23	27	33	38	44	50	58	67			
31	0	4	9	13	18	23	28	33	38	44	51	59	69			
32	0	5	9	14	18	23	28	33	39	45	52	60	71			
33	0	5	9	14	19	23	28	34	39	46	53	61	73			
34	0	5	9	14	19	24	29	34	40	46	54	62	75			
35	0	3	9	14	19	24	29	35	41	47	54	64	78			
36	0	5	9	14	19	24	30	35	41	48	55	65	81			
37	0	5	10	14	19	25	30	36	42	49	57	67				
38	0	5	10	15	20	25	30	36	43	49	58	69				
39	0	5	10	15	20	25	31	37	43	51	59	71				
40	0	5	10	15	20	26	31	38	44	52	60	73				
41	0	5	10	15	21	26	32	38	45	53	62	76				
42	0	5	10	16	21	27	33	39	46	54	64	81				
43	0	5	10	16	21	27	33	40	47	55	66					
44	0	5	11	16	22	28	34	40	48	57	68					
45	0	5	11	16	22	28	34	41	49	58	71					
46	0	5	11	17	23	29	35	42	50	60	74					
47	0	6	11	17	23	29	36	43	51	62	78					
48	0	6	11	17	23	30	37	44	53	64	85					
49	0	6	12	18	24	31	38	45	54	66						
50	0	6	12	18	25	31	38	47	56	69						
51	0	6	12	19	25	32	39	48	58	72						
52	0	6	12	19	26	33	41	49	60	77						
53	0	6	13	19	26	34	42	51	62	85						
54	0	7	13	20	27	35	43	53	65							
55	0	7	13	20	28	36	44	54	68							
56	0	7	14	21	28	37	46	57	73							
57	0	7	14	22	29	38	47	59	78							
58	0	7	15	22	30	40	49	62								
59	0	7	15	23	31	40	51	65								
60	0	8	15	24	32	42	53	69								
61	0	8	16	24	33	43	56	74								
62	0	8	16	25	35	45	58	84								
63	0	8	17	26	36	47	62									
64	0	9	18	27	37	49	66									
65	0	9	18	28	39	52	70									
66	0	9	19	29	41	55	80									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 20°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR. 6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 38	1 42	1 46	1 55	2 7	2 19	2 34	3 9	3 43	4 17	4 51	5 25	5 59	6 32			6
7	1 46	1 37	1 40	1 46	1 53	2 3	2 12	2 36	3 1	3 29	3 57	4 24	4 50	5 16			7
8	1 55	1 43	1 36	1 40	1 44	1 49	1 56	2 14	2 35	2 56	3 17	3 39	4 0	4 21	4 42		8
9	2 8	1 51	1 40	1 36	1 39	1 42	1 45	1 57	2 12	2 29	2 47	3 5	3 23	3 41	3 58		9
10	2 23	2 0	1 46	1 40	1 36	1 37	1 39	1 46	1 56	2 10	2 24	2 38	2 53	3 8	3 23	3 37	10
11	2 38	2 11	1 54	1 45	1 38	1 37	1 37	1 40	1 46	1 56	2 8	2 20	2 32	2 44	2 56	3 7	11
12	2 53	2 23	2 3	1 51	1 41	1 37	1 35	1 37	1 41	1 47	1 56	2 6	2 16	2 26	2 35	2 44	12
13	3 9	2 35	2 13	1 57	1 46	1 40	1 37	1 35	1 37	1 41	1 48	1 56	2 4	2 12	2 19	2 26	13
14	3 25	2 47	2 23	2 3	1 52	1 44	1 39	1 33	1 34	1 37	1 42	1 48	1 54	2 0	2 5	2 11	14
15	3 41	3 0	2 34	2 11	1 58	1 49	1 42	1 35	1 33	1 35	1 38	1 41	1 45	1 50	1 54	1 59	15
16	3 58	3 13	2 45	2 20	2 4	1 54	1 46	1 36	1 32	1 33	1 34	1 36	1 38	1 42	1 46	1 50	16
17	4 15	3 26	2 56	2 29	2 10	1 59	1 50	1 38	1 33	1 31	1 32	1 33	1 34	1 36	1 39	1 42	17
18	4 32	3 40	3 7	2 38	2 17	2 4	1 54	1 40	1 34	1 30	1 30	1 30	1 31	1 32	1 34	1 36	18
19	4 49	3 53	3 18	2 47	2 24	2 9	1 58	1 43	1 35	1 31	1 29	1 29	1 29	1 30	1 32	1 33	19
20	5 5	4 6	3 28	2 56	2 31	2 15	2 2	1 46	1 37	1 31	1 28	1 28	1 28	1 29	1 30	1 30	20
21	5 21	4 19	3 39	3 4	2 38	2 20	2 6	1 49	1 39	1 32	1 29	1 27	1 27	1 27	1 27	1 27	21
22	5 36	4 32	3 49	3 12	2 46	2 26	2 11	1 53	1 40	1 33	1 29	1 26	1 25	1 25	1 25	1 25	22
23	5 51	4 44	3 59	3 20	2 53	2 32	2 16	1 57	1 42	1 34	1 29	1 26	1 25	1 24	1 24	1 23	23
24	6 5	4 56	4 9	3 28	3 0	2 38	2 22	2 0	1 43	1 35	1 30	1 26	1 24	1 24	1 23	1 22	24
25	6 19	5 7	4 18	3 36	3 7	2 44	2 26	2 3	1 45	1 36	1 30	1 26	1 24	1 23	1 21	1 20	25
26	6 32	5 18	4 27	3 44	3 14	2 49	2 31	2 6	1 47	1 37	1 31	1 27	1 25	1 23	1 21	1 19	26
27	6 45	5 29	4 35	3 52	3 20	2 54	2 35	2 8	1 49	1 38	1 32	1 28	1 25	1 23	1 21	1 19	27
28		5 39	4 42	3 59	3 26	2 59	2 38	2 11	1 50	1 39	1 33	1 28	1 25	1 23	1 21	1 19	28
29			4 49	4 6	3 32	3 4	2 41	2 13	1 52	1 40	1 33	1 28	1 25	1 23	1 21	1 19	29
30				4 12	3 37	3 8	2 45	2 15	1 54	1 41	1 34	1 28	1 25	1 23	1 21	1 19	30
31					3 42	3 12	2 49	2 16	1 56	1 42	1 34	1 28	1 25	1 22	1 20	1 18	31
32						3 16	2 52	2 18	1 58	1 43	1 34	1 28	1 24	1 21	1 19	1 18	32
33							2 55	2 20	1 59	1 43	1 33	1 27	1 24	1 21	1 19	1 17	33
34								2 21	1 59	1 43	1 33	1 26	1 23	1 20	1 18	1 16	34
35								2 22	1 59	1 43	1 32	1 25	1 22	1 19	1 17	1 15	35
36									1 59	1 42	1 31	1 24	1 20	1 17	1 15	1 14	36
37									1 59	1 42	1 30	1 23	1 19	1 16	1 14	1 13	37
38										1 41	1 29	1 22	1 18	1 15	1 13	1 12	38
39										1 41	1 28	1 21	1 17	1 13	1 11	1 11	39
40											1 27	1 20	1 15	1 12	1 10	1 10	40
41											1 26	1 18	1 13	1 10	1 9	1 8	41
42												1 17	1 11	1 8	1 7	1 7	42
43												1 16	1 10	1 6	1 5	1 5	43
44													1 9	1 4	1 3	1 3	44
46													1 7	1 2	1 0	1 0	46
48														0 59	0 56	0 56	48
50															0 52	0 50	50
52																0 45	52
54																	54
56																	56
58																	58
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 20°.

☽'s App. Alt.	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6																	6
7																	7
8																	8
9																	9
10																	10
11	3 16																11
12	2 52																12
13	2 32	2 38															13
14	2 16	2 21															14
15	2 3	2 7	2 13														15
16	1 53	1 56	1 59														16
17	1 44	1 46	1 48	1 51													17
18	1 37	1 39	1 40	1 41													18
19	1 33	1 34	1 34	1 34													19
20	1 30	1 30	1 29	1 28	1 26												20
21	1 27	1 26	1 25	1 23	1 21												21
22	1 24	1 23	1 22	1 20	1 18												22
23	1 22	1 21	1 20	1 18	1 15												23
24	1 21	1 20	1 18	1 16	1 12	1 8											24
25	1 19	1 18	1 16	1 14	1 9	1 4											25
26	1 17	1 16	1 14	1 12	1 7	1 1											26
27	1 17	1 15	1 13	1 11	1 6	1 0											27
28	1 17	1 15	1 13	1 10	1 4	0 57	0 50										28
29	1 17	1 16	1 14	1 11	1 5	0 58	0 50										29
30	1 18	1 17	1 15	1 12	1 7	0 59	0 50										30
31	1 17	1 16	1 15	1 12	1 7	0 59	0 51										31
32	1 17	1 16	1 14	1 12	1 7	0 59	0 51	0 42									32
33	1 16	1 15	1 13	1 12	1 8	1 1	0 52	0 43									33
34	1 15	1 14	1 13	1 11	1 8	1 1	0 53	0 43									34
35	1 14	1 13	1 12	1 11	1 8	1 1	0 53	0 44									35
36	1 13	1 12	1 11	1 10	1 7	1 1	0 54	0 45	0 36								36
37	1 12	1 11	1 10	1 9	1 6	1 1	0 54	0 46	0 37								37
38	1 11	1 10	1 9	1 8	1 6	1 1	0 55	0 47	0 38								38
39	1 10	1 10	1 9	1 8	1 5	1 1	0 55	0 47	0 39								39
40	1 9	1 9	1 8	1 6	1 4	1 0	0 55	0 48	0 39	0 32							40
41	1 8	1 8	1 7	1 5	1 3	1 0	0 55	0 48	0 39	0 32							41
42	1 7	1 7	1 6	1 4	1 2	0 59	0 55	0 48	0 40	0 33							42
43	1 5	1 5	1 5	1 4	1 2	0 59	0 55	0 48	0 40	0 33							44
44	1 4	1 4	1 4	1 3	1 1	0 59	0 55	0 48	0 40	0 34	0 29						45
46	1 1	1 2	1 2	1 1	1 0	0 58	0 54	0 48	0 41	0 35	0 30						46
48	0 56	0 58	0 59	0 59	0 58	0 56	0 53	0 49	0 43	0 37	0 31	0 25					48
50	0 52	0 54	0 55	0 56	0 55	0 54	0 51	0 48	0 43	0 38	0 33	0 27					50
52	0 48	0 49	0 50	0 51	0 51	0 51	0 49	0 47	0 43	0 39	0 35	0 29	0 24				52
54	0 44	0 43	0 45	0 46	0 47	0 48	0 47	0 45	0 43	0 40	0 36	0 30	0 25				54
56		0 38	0 40	0 42	0 44	0 45	0 45	0 44	0 42	0 40	0 35	0 31	0 27	0 22			56
58			0 35	0 38	0 40	0 42	0 43	0 42	0 40	0 38	0 34	0 31	0 27	0 23			58
60				0 34	0 36	0 39	0 41	0 41	0 39	0 36	0 33	0 29	0 26	0 23	0 21		60
62					0 33	0 36	0 38	0 39	0 38	0 35	0 32	0 29	0 26	0 24	0 22		62
64					0 30	0 33	0 35	0 37	0 37	0 35	0 32	0 29	0 27	0 25	0 22		64
66						0 30	0 32	0 35	0 36	0 34	0 31	0 29	0 27	0 25	0 23	0 21	66
68						0 27	0 29	0 32	0 34	0 32	0 30	0 28	0 26	0 25	0 23	0 21	68
70							0 27	0 30	0 32	0 31	0 29	0 27	0 26	0 24	0 22	0 20	70
72							0 25	0 27	0 29	0 29	0 28	0 27	0 25	0 23	0 21	0 20	72
74								0 25	0 27	0 27	0 27	0 26	0 24	0 22	0 21	0 20	74
76								0 23	0 25	0 26	0 26	0 25	0 24	0 22	0 10	0 19	76
78									0 23	0 24	0 25	0 24	0 23	0 21	0 20		78
80									0 21	0 23	0 24	0 23	0 22	0 21	0 20		80
82										0 22	0 23	0 22	0 21	0 21			82
84										0 21	0 22	0 21	0 21				84
86											0 21	0 20	0 20				86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 24°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 28	1 31	1 35	1 42	1 52	2 3	2 16	2 46	3 16	3 47	4 19	4 50	5 20	5 50	6 20	6 50	6
7	1 35	1 27	1 30	1 34	1 39	1 46	1 54	2 15	2 38	3 3	3 29	3 55	4 20	4 46	5 10	5 34	7
8	1 45	1 32	1 26	1 28	1 30	1 35	1 41	1 58	2 17	2 37	2 58	3 18	3 39	4 1	4 20	4 39	8
9	1 56	1 39	1 30	1 25	1 26	1 29	1 34	1 44	1 59	2 15	2 31	2 48	3 6	3 24	3 40	3 56	9
10	2 8	1 48	1 36	1 29	1 25	1 26	1 28	1 35	1 45	1 57	2 13	2 27	2 43	2 58	3 12	3 26	10
11	2 21	1 58	1 43	1 34	1 28	1 24	1 26	1 30	1 36	1 46	1 58	2 11	2 24	2 37	2 49	3 0	11
12	2 36	2 9	1 52	1 41	1 33	1 27	1 24	1 26	1 30	1 37	1 47	1 58	2 9	2 20	2 29	2 38	12
13	2 51	2 20	2 1	1 48	1 38	1 31	1 27	1 24	1 27	1 32	1 40	1 48	1 57	2 6	2 14	2 22	13
14	3 6	2 31	2 10	1 55	1 43	1 35	1 30	1 23	1 25	1 28	1 33	1 40	1 48	1 55	2 2	2 10	14
15	3 21	2 42	2 20	2 2	1 50	1 39	1 33	1 24	1 23	1 25	1 24	1 34	1 40	1 46	1 52	1 59	15
16	3 36	2 54	2 30	2 9	1 56	1 44	1 36	1 26	1 22	1 23	1 25	1 29	1 33	1 38	1 44	1 50	16
17	3 51	3 6	2 40	2 17	2 2	1 49	1 39	1 28	1 23	1 21	1 23	1 26	1 29	1 34	1 39	1 43	17
18	4 6	3 18	2 49	2 25	2 8	1 54	1 43	1 31	1 24	1 20	1 21	1 23	1 26	1 30	1 34	1 37	18
19	4 21	3 30	2 59	2 33	2 14	1 59	1 47	1 33	1 25	1 21	1 20	1 22	1 24	1 27	1 30	1 32	19
20	4 35	3 42	3 9	2 41	2 21	2 5	1 52	1 36	1 27	1 22	1 19	1 20	1 22	1 24	1 26	1 28	20
21	4 50	3 54	3 19	2 50	2 28	2 11	1 56	1 39	1 29	1 23	1 20	1 19	1 20	1 21	1 23	1 25	21
22	5 4	4 6	3 28	2 58	2 35	2 17	2 1	1 42	1 31	1 24	1 20	1 18	1 19	1 19	1 20	1 22	22
23	5 19	4 18	3 38	3 6	2 43	2 23	2 6	1 46	1 33	1 25	1 21	1 18	1 18	1 18	1 18	1 19	23
24	5 33	4 29	3 48	3 14	2 51	2 29	2 12	1 50	1 36	1 27	1 22	1 19	1 17	1 17	1 17	1 17	24
25	5 47	4 41	3 57	3 22	2 58	2 35	2 17	1 53	1 38	1 28	1 23	1 20	1 18	1 16	1 16	1 16	25
26	6 1	4 52	4 6	3 30	3 4	2 41	2 22	1 57	1 41	1 30	1 24	1 20	1 18	1 16	1 15	1 15	26
27	6 14	5 4	4 15	3 38	3 10	2 47	2 27	2 0	1 43	1 32	1 25	1 21	1 18	1 15	1 14	1 13	27
28	6 27	5 15	4 23	3 45	3 16	2 53	2 32	2 4	1 46	1 34	1 27	1 21	1 18	1 15	1 13	1 12	28
29	6 38	5 26	4 32	3 53	3 22	2 58	2 38	2 8	1 49	1 36	1 28	1 22	1 18	1 15	1 13	1 11	29
30	6 50	5 36	4 41	4 0	3 28	3 3	2 44	2 12	1 52	1 38	1 29	1 23	1 19	1 15	1 13	1 11	30
31	7 0	5 45	4 50	4 7	3 34	3 8	2 49	2 16	1 55	1 40	1 30	1 24	1 19	1 15	1 13	1 11	31
32		5 53	4 58	4 14	3 40	3 13	2 54	2 19	1 57	1 41	1 31	1 24	1 19	1 15	1 13	1 11	32
33			5 5	4 20	3 46	3 18	2 58	2 22	1 59	1 42	1 31	1 24	1 19	1 15	1 13	1 11	33
34				4 25	3 51	3 22	3 1	2 24	2 1	1 43	1 32	1 25	1 20	1 15	1 13	1 11	34
35					3 56	3 26	3 3	2 26	2 2	1 45	1 33	1 25	1 20	1 15	1 13	1 11	35
36						3 30	3 5	2 28	2 4	1 46	1 34	1 25	1 20	1 15	1 12	1 10	36
37							3 7	2 30	2 6	1 47	1 35	1 25	1 20	1 15	1 12	1 10	37
38								2 32	2 7	1 48	1 35	1 25	1 20	1 15	1 12	1 10	38
39								2 34	2 8	1 49	1 35	1 25	1 19	1 15	1 12	1 10	39
40									2 9	1 50	1 35	1 25	1 19	1 15	1 11	1 9	40
41									2 10	1 50	1 35	1 25	1 19	1 15	1 11	1 8	41
42										1 51	1 36	1 25	1 19	1 14	1 10	1 7	42
43										1 52	1 36	1 25	1 18	1 13	1 9	1 6	43
44											1 36	1 25	1 18	1 13	1 8	1 5	44
46											1 36	1 25	1 17	1 12	1 7	1 3	46
48												1 25	1 17	1 10	1 5	1 1	48
50													1 17	1 8	1 4	0 59	50
52														1 7	1 3	0 58	52
54															1 2	0 57	54
56																0 56	56
58																	58
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 24°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6																	6
7																	7
8	4 58																8
9	4 12																9
10	3 39	3 51															10
11	3 11	3 21	3 30														11
12	2 48	2 56	3 5	3 12													12
13	2 30	2 37	2 44	2 49													13
14	2 16	2 22	2 27	2 32													14
15	2 4	2 9	2 14	2 18													15
16	1 54	1 59	2 3	2 6	2 11												16
17	1 46	1 50	1 53	1 56	2 0												17
18	1 40	1 43	1 45	1 47	1 51												18
19	1 35	1 37	1 39	1 41	1 43												19
20	1 30	1 32	1 33	1 34	1 36	1 38											20
21	1 26	1 27	1 28	1 29	1 30	1 31											21
22	1 22	1 23	1 24	1 24	1 25	1 25											22
23	1 20	1 20	1 21	1 21	1 21	1 21											23
24	1 18	1 18	1 19	1 19	1 18	1 17	1 15										24
25	1 16	1 16	1 17	1 17	1 16	1 14	1 11										25
26	1 14	1 14	1 14	1 14	1 13	1 11	1 8										26
27	1 13	1 13	1 12	1 12	1 1	1 9	1 6										27
28	1 12	1 12	1 11	1 10	1 9	1 7	1 4	1 1									28
29	1 11	1 11	1 10	1 9	1 8	1 5	1 2	0 59									29
30	1 11	1 10	1 9	1 8	1 7	1 4	1 0	0 57									30
31	1 10	1 9	1 8	1 8	1 6	1 2	0 58	0 55									31
32	1 9	1 9	1 8	1 7	1 5	1 1	0 57	0 54	0 51								32
33	1 9	1 8	1 7	1 6	1 4	1 1	0 57	0 53	0 50								33
34	1 9	1 7	1 6	1 5	1 3	1 0	0 57	0 53	0 49								34
35	1 9	1 7	1 6	1 5	1 2	1 0	0 56	0 52	0 48								35
36	1 8	1 7	1 6	1 4	1 2	1 0	0 56	0 51	0 47	0 44							36
37	1 8	1 6	1 5	1 3	1 1	0 58	0 55	0 51	0 46	0 43							37
38	1 8	1 6	1 5	1 3	1 0	0 57	0 54	0 50	0 46	0 43							38
39	1 8	1 6	1 4	1 2	0 59	0 56	0 52	0 48	0 45	0 42							39
40	1 7	1 5	1 4	1 2	0 59	0 55	0 51	0 47	0 44	0 41	0 39						40
41	1 6	1 4	1 3	1 1	0 58	0 54	0 50	0 47	0 44	0 41	0 38						41
42	1 5	1 4	1 3	1 1	0 57	0 54	0 50	0 47	0 44	0 41	0 38						42
43	1 4	1 3	1 2	1 0	0 56	0 53	0 50	0 47	0 43	0 40	0 37	0 34					43
44	1 3	1 2	1 1	0 59	0 56	0 53	0 50	0 47	0 43	0 40	0 37	0 34					44
46	1 1	1 0	0 59	0 58	0 55	0 52	0 49	0 46	0 43	0 40	0 37	0 34	0 32				46
48	0 59	0 59	0 58	0 57	0 54	0 51	0 49	0 46	0 43	0 40	0 37	0 34	0 32				48
50	0 57	0 57	0 56	0 55	0 53	0 50	0 48	0 45	0 43	0 40	0 37	0 34	0 32	0 30			50
52	0 55	0 54	0 53	0 52	0 51	0 49	0 47	0 45	0 43	0 40	0 37	0 34	0 32	0 30			52
54	0 54	0 52	0 51	0 50	0 49	0 47	0 46	0 44	0 42	0 39	0 37	0 34	0 32	0 29	0 27		54
56	0 53	0 51	0 49	0 48	0 47	0 45	0 44	0 43	0 41	0 38	0 36	0 34	0 31	0 29	0 27		56
58	0 52	0 49	0 47	0 46	0 45	0 44	0 43	0 42	0 40	0 37	0 35	0 33	0 31	0 29	0 27	0 26	58
60		0 47	0 45	0 44	0 43	0 42	0 41	0 40	0 38	0 36	0 34	0 32	0 30	0 28	0 27	0 26	60
62			0 43	0 43	0 41	0 40	0 39	0 38	0 37	0 35	0 33	0 31	0 29	0 28	0 27	0 26	62
64				0 42	0 39	0 38	0 38	0 37	0 36	0 34	0 32	0 30	0 29	0 28	0 27	0 26	64
66					0 38	0 37	0 37	0 36	0 35	0 33	0 31	0 29	0 28	0 27	0 26	0 25	66
68					0 37	0 35	0 35	0 34	0 34	0 33	0 31	0 29	0 28	0 27	0 26	0 25	68
70						0 34	0 34	0 33	0 33	0 32	0 30	0 28	0 27	0 26	0 25	0 25	70
72						0 33	0 33	0 32	0 32	0 31	0 29	0 28	0 26	0 25	0 24	0 25	72
74							0 32	0 31	0 31	0 30	0 29	0 28	0 26	0 25	0 24		74
76							0 31	0 30	0 30	0 29	0 28	0 27	0 25	0 24	0 24		76
78								0 29	0 29	0 29	0 28	0 27	0 25	0 24			78
80								0 28	0 28	0 28	0 27	0 26	0 25	0 24			80
82									0 27	0 27	0 26	0 25	0 24				82
84									0 26	0 26	0 25	0 25	0 24				84
86										0 26	0 25	0 25					86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 28°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 20	1 23	1 27	1 33	1 40	1 49	2 00	2 28	2 56	3 24	3 53	4 21	4 48	5 15	5 42	6 9	6
7	1 25	1 20	1 23	1 27	1 32	1 38	1 45	2 5	2 26	2 49	3 13	3 36	3 58	4 20	4 43	5 6	7
8	1 32	1 24	1 20	1 22	1 25	1 29	1 35	1 50	2 7	2 26	2 46	3 4	3 23	3 42	4 1	4 20	8
9	1 41	1 29	1 23	1 20	1 22	1 24	1 28	1 39	1 52	2 7	2 22	2 37	2 53	3 9	3 25	3 41	9
10	1 53	1 37	1 28	1 23	1 20	1 21	1 23	1 30	1 39	1 52	2 5	2 18	2 31	2 44	2 58	3 11	10
11	2 6	1 46	1 34	1 27	1 23	1 20	1 21	1 24	1 31	1 41	1 52	2 4	2 15	2 26	2 37	2 48	11
12	2 19	1 56	1 41	1 32	1 26	1 22	1 19	1 21	1 26	1 33	1 42	1 52	2 1	2 10	2 20	2 30	12
13	2 32	2 6	1 49	1 38	1 30	1 25	1 21	1 20	1 23	1 28	1 34	1 42	1 49	1 57	2 6	2 15	13
14	2 46	2 17	1 58	1 44	1 34	1 28	1 23	1 19	1 21	1 24	1 28	1 34	1 40	1 47	1 55	2 3	14
15	3 00	2 28	2 7	1 51	1 39	1 32	1 25	1 20	1 19	1 21	1 24	1 28	1 33	1 39	1 45	1 52	15
16	3 14	2 39	2 16	1 58	1 45	1 36	1 28	1 21	1 18	1 19	1 21	1 24	1 28	1 33	1 38	1 44	16
17	3 28	2 51	2 25	2 5	1 51	1 41	1 32	1 23	1 19	1 18	1 19	1 21	1 24	1 28	1 33	1 38	17
18	3 41	3 2	2 35	2 13	1 58	1 46	1 36	1 25	1 20	1 17	1 18	1 19	1 21	1 24	1 28	1 33	18
19	3 55	3 13	2 45	2 21	2 5	1 52	1 41	1 27	1 21	1 18	1 16	1 17	1 18	1 21	1 24	1 28	19
20	4 9	3 24	2 55	2 29	2 11	1 57	1 46	1 30	1 23	1 18	1 16	1 15	1 16	1 18	1 21	1 24	20
21	4 23	3 35	3 4	2 37	2 17	2 3	1 51	1 33	1 25	1 19	1 16	1 14	1 15	1 16	1 18	1 20	21
22	4 36	3 46	3 13	2 45	2 24	2 9	1 56	1 36	1 27	1 20	1 16	1 13	1 14	1 15	1 16	1 17	22
23	4 49	3 57	3 22	2 53	2 31	2 14	2 1	1 40	1 29	1 22	1 17	1 13	1 13	1 13	1 14	1 15	23
24	5 2	4 8	3 31	3 0	2 37	2 20	2 6	1 43	1 31	1 24	1 18	1 14	1 12	1 12	1 12	1 13	24
25	5 16	4 19	3 40	3 8	2 43	2 26	2 11	1 47	1 34	1 26	1 19	1 15	1 13	1 11	1 11	1 12	25
26	5 29	4 30	3 49	3 15	2 50	2 32	2 16	1 51	1 36	1 28	1 20	1 15	1 13	1 11	1 11	1 11	26
27	5 42	4 41	3 58	3 23	2 57	2 38	2 21	1 55	1 39	1 30	1 21	1 16	1 13	1 11	1 10	1 10	27
28	5 55	4 52	4 7	3 30	3 4	2 44	2 26	1 59	1 42	1 32	1 22	1 17	1 14	1 11	1 10	1 10	28
29	6 7	5 3	4 16	3 38	3 11	2 50	2 31	2 3	1 45	1 34	1 24	1 18	1 14	1 12	1 10	1 10	29
30	6 19	5 13	4 25	3 45	3 18	2 55	2 36	2 7	1 47	1 36	1 26	1 19	1 15	1 12	1 10	1 9	30
31	6 31	5 23	4 34	3 52	3 25	3 1	2 41	2 10	1 50	1 38	1 27	1 20	1 15	1 12	1 10	1 9	31
32	6 42	5 32	4 43	3 59	3 31	3 7	2 46	2 13	1 53	1 40	1 29	1 21	1 16	1 12	1 10	1 9	32
33	6 53	5 41	4 51	4 6	3 37	3 12	2 51	2 17	1 56	1 42	1 31	1 22	1 16	1 12	1 10	1 9	33
34	7 4	5 50	4 58	4 13	3 43	3 17	2 55	2 20	1 58	1 44	1 32	1 23	1 17	1 12	1 10	1 9	34
35	7 15	5 59	5 5	4 20	3 48	3 21	2 59	2 23	2 00	1 46	1 33	1 23	1 17	1 13	1 10	1 8	35
36		6 8	5 11	4 26	3 53	3 25	3 3	2 26	2 3	1 47	1 34	1 24	1 18	1 13	1 10	1 8	36
37			5 17	4 32	3 58	3 29	3 7	2 29	2 5	1 49	1 35	1 25	1 18	1 13	1 10	1 8	37
38				4 38	4 2	3 33	3 10	2 32	2 7	1 51	1 36	1 26	1 19	1 14	1 10	1 8	38
39					4 6	3 37	3 12	2 34	2 9	1 52	1 37	1 27	1 19	1 14	1 11	1 8	29
40						3 41	3 15	2 37	2 11	1 53	1 38	1 27	1 20	1 15	1 11	1 8	40
41							3 17	2 40	2 13	1 54	1 39	1 28	1 20	1 15	1 11	1 8	41
42								2 42	2 15	1 55	1 40	1 29	1 21	1 15	1 10	1 7	44
43								2 44	2 17	1 56	1 40	1 29	1 21	1 15	1 10	1 7	43
44									2 18	1 57	1 41	1 30	1 21	1 15	1 10	1 7	44
46									2 19	1 59	1 42	1 30	1 22	1 15	1 10	1 7	46
48										2 0	1 43	1 31	1 22	1 15	1 10	1 6	48
50											1 44	1 32	1 23	1 15	1 10	1 6	50
52												1 33	1 24	1 15	1 9	1 5	52
54													1 25	1 15	1 9	1 5	54
56														1 15	1 9	1 4	56
58															1 9	1 3	58
60																1 3	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 28°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	6 37	7 4															6
7	5 28	5 49	6 8														7
8	4 40	4 57	5 11														8
9	3 58	4 13	4 26	4 38													9
10	3 25	3 38	3 50	4 2													10
11	3 0	3 12	3 23	3 33													11
12	2 40	2 50	2 59	3 7	3 22												12
13	2 24	2 33	2 41	2 48	3 0												13
14	2 11	2 18	2 25	2 31	2 42												14
15	1 59	2 6	2 12	2 17	2 27												15
16	1 50	1 56	2 1	2 6	2 14	2 21											16
17	1 43	1 48	1 52	1 56	2 3	2 9											17
18	1 37	1 41	1 45	1 48	1 54	1 59											18
19	1 31	1 35	1 38	1 41	1 46	1 50											19
20	1 26	1 29	1 32	1 34	1 38	1 42	1 45										20
21	1 22	1 25	1 27	1 29	1 32	1 36	1 38										21
22	1 19	1 21	1 23	1 25	1 28	1 30	1 32										22
23	1 17	1 18	1 20	1 22	1 24	1 26	1 27										23
24	1 15	1 16	1 17	1 18	1 20	1 22	1 23	1 24									24
25	1 13	1 14	1 14	1 15	1 16	1 18	1 19	1 19									25
26	1 11	1 12	1 12	1 13	1 13	1 14	1 15	1 15									26
27	1 10	1 11	1 11	1 11	1 11	1 11	1 12	1 12									27
28	1 10	1 10	1 10	1 10	1 10	1 9	1 9	1 9	1 9								28
29	1 10	1 10	1 10	1 9	1 9	1 8	1 7	1 6	1 6								29
30	1 9	1 9	1 9	1 8	1 8	1 7	1 6	1 4	1 3								30
31	1 8	1 8	1 7	1 7	1 6	1 5	1 4	1 2	1 1								31
32	1 8	1 7	1 6	1 6	1 5	1 4	1 3	1 1	1 0	0 59							32
33	1 7	1 6	1 5	1 5	1 4	1 3	1 2	1 0	0 58	0 56							33
34	1 7	1 5	1 4	1 4	1 3	1 2	1 1	0 59	0 57	0 54							34
35	1 7	1 5	1 4	1 3	1 2	1 1	1 0	0 58	0 55	0 53							35
36	1 6	1 5	1 4	1 3	1 1	1 0	0 58	0 56	0 54	0 52	0 51						36
37	1 6	1 4	1 3	1 2	1 0	0 59	0 57	0 55	0 53	0 51	0 50						37
38	1 6	1 4	1 3	1 1	0 59	0 58	0 56	0 54	0 52	0 50	0 49						38
39	1 6	1 4	1 2	1 0	0 59	0 57	0 55	0 53	0 51	0 49	0 47						39
40	1 6	1 4	1 2	1 0	0 58	0 57	0 55	0 52	0 50	0 48	0 46	0 44					40
41	1 6	1 4	1 2	1 0	0 58	0 56	0 54	0 51	0 49	0 47	0 45	0 43					41
42	1 5	1 4	1 2	0 59	0 57	0 55	0 53	0 50	0 48	0 46	0 44	0 42					42
43	1 5	1 3	1 1	0 59	0 57	0 55	0 53	0 50	0 48	0 46	0 44	0 42	0 41				43
44	1 5	1 3	1 1	0 59	0 56	0 54	0 52	0 50	0 47	0 45	0 43	0 41	0 40				44
46	1 4	1 2	1 0	0 58	0 55	0 53	0 51	0 49	0 47	0 44	0 42	0 40	0 39				46
48	1 3	1 1	0 59	0 57	0 54	0 52	0 50	0 48	0 46	0 43	0 41	0 39	0 38	0 37			48
50	1 3	1 1	0 58	0 56	0 53	0 51	0 49	0 47	0 45	0 42	0 40	0 38	0 37	0 36			50
52	1 2	1 0	0 57	0 55	0 52	0 50	0 48	0 46	0 44	0 42	0 40	0 38	0 36	0 35	0 34		52
54	1 2	0 59	0 56	0 54	0 51	0 49	0 47	0 45	0 43	0 41	0 39	0 37	0 35	0 34	0 33		54
56	1 1	0 58	0 55	0 53	0 50	0 48	0 46	0 44	0 42	0 40	0 38	0 36	0 35	0 34	0 33	0 32	56
58	1 0	0 57	0 54	0 52	0 49	0 47	0 45	0 43	0 41	0 39	0 37	0 36	0 35	0 34	0 32	0 31	58
60	0 58	0 55	0 53	0 51	0 48	0 46	0 44	0 42	0 40	0 38	0 37	0 36	0 35	0 34	0 32	0 31	60
2	0 56	0 54	0 52	0 50	0 47	0 45	0 43	0 41	0 39	0 38	0 37	0 36	0 35	0 34	0 32	0 31	62
64		0 52	0 50	0 49	0 46	0 44	0 42	0 40	0 38	0 37	0 36	0 35	0 34	0 33	0 32	0 30	64
66			0 48	0 48	0 45	0 43	0 41	0 39	0 38	0 37	0 36	0 35	0 34	0 33	0 31	0 29	66
68				0 46	0 43	0 41	0 40	0 38	0 37	0 36	0 35	0 34	0 33	0 32	0 30	0 28	68
70					0 42	0 40	0 39	0 38	0 37	0 36	0 35	0 34	0 33	0 31	0 29		70
72					0 41	0 39	0 38	0 37	0 36	0 35	0 34	0 33	0 32	0 30	0 28		72
74						0 39	0 37	0 36	0 35	0 34	0 33	0 32	0 30	0 28			74
76						0 38	0 36	0 35	0 34	0 34	0 33	0 31	0 29	0 27			76
78							0 36	0 34	0 34	0 33	0 32	0 30	0 28				78
80							0 35	0 34	0 33	0 32	0 31	0 30	0 28				80
82								0 33	0 32	0 31	0 30	0 29					82
84								0 32	0 32	0 31	0 30	0 29					84
86									0 31	0 30	0 29						86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

THIRD CORRECTION, TO APPARENT DISTANCE 32°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 18	1 21	1 25	1 30	1 37	1 47	1 59	2 23	2 48	3 13	3 39	4 5	4 30	4 55	5 20	5 45	6
7	1 23	1 18	1 21	1 24	1 28	1 33	1 42	2 0	2 18	2 37	2 58	3 20	3 42	4 4	4 25	4 46	7
8	1 30	1 22	1 18	1 20	1 22	1 25	1 29	1 42	1 57	2 14	2 32	2 50	3 8	3 26	3 44	4 2	8
9	1 38	1 27	1 20	1 18	1 19	1 21	1 23	1 31	1 44	1 58	2 12	2 26	2 41	2 56	3 11	3 26	9
10	1 47	1 33	1 23	1 20	1 18	1 19	1 20	1 25	1 34	1 45	1 57	2 9	2 21	2 34	2 46	2 59	10
11	1 57	1 41	1 28	1 23	1 19	1 17	1 18	1 21	1 27	1 36	1 46	1 56	2 6	2 17	2 28	2 39	11
12	2 9	1 50	1 34	1 27	1 22	1 19	1 17	1 19	1 23	1 29	1 37	1 46	1 55	2 4	2 13	2 23	12
13	2 21	1 59	1 41	1 32	1 26	1 21	1 18	1 17	1 20	1 24	1 30	1 37	1 45	1 53	2 1	2 9	13
14	2 34	2 8	1 50	1 38	1 30	1 24	1 20	1 16	1 18	1 21	1 25	1 30	1 36	1 43	1 51	1 58	14
15	2 47	2 18	1 59	1 45	1 35	1 28	1 22	1 17	1 16	1 18	1 21	1 25	1 30	1 35	1 42	1 49	15
16	2 59	2 28	2 7	1 52	1 41	1 32	1 25	1 19	1 15	1 16	1 18	1 21	1 25	1 29	1 35	1 41	16
17	3 12	2 38	2 16	1 59	1 47	1 36	1 28	1 21	1 16	1 15	1 16	1 18	1 21	1 25	1 30	1 35	17
18	3 25	2 48	2 25	2 7	1 52	1 41	1 32	1 23	1 17	1 14	1 15	1 17	1 19	1 22	1 25	1 29	18
19	3 38	2 58	2 34	2 14	1 58	1 46	1 36	1 25	1 18	1 15	1 14	1 15	1 17	1 19	1 22	1 25	19
20	3 50	3 9	2 43	2 21	2 4	1 51	1 40	1 27	1 20	1 16	1 13	1 14	1 15	1 17	1 19	1 21	20
21	4 3	3 19	2 52	2 28	2 10	1 56	1 45	1 30	1 22	1 17	1 14	1 13	1 14	1 15	1 16	1 18	21
22	4 15	3 30	3 0	2 35	2 17	2 2	1 50	1 33	1 24	1 18	1 14	1 11	1 12	1 13	1 14	1 16	22
23	4 28	3 40	3 9	2 42	2 24	2 7	1 55	1 36	1 26	1 19	1 15	1 12	1 11	1 12	1 13	1 14	23
24	4 40	3 51	3 17	2 50	2 30	2 13	1 59	1 39	1 28	1 21	1 16	1 12	1 10	1 11	1 11	1 12	24
25	4 52	4 1	3 26	2 57	2 36	2 18	2 4	1 42	1 30	1 22	1 17	1 13	1 11	1 10	1 10	1 10	25
26	5 4	4 12	3 34	3 5	2 43	2 24	2 8	1 46	1 32	1 24	1 18	1 13	1 11	1 9	1 9	1 9	26
27	5 16	4 22	3 43	3 12	2 50	2 30	2 13	1 50	1 34	1 26	1 19	1 14	1 11	1 9	1 8	1 8	27
28	5 28	4 33	3 52	3 20	2 57	2 35	2 17	1 53	1 37	1 27	1 20	1 15	1 11	1 9	1 7	1 8	28
29	5 41	4 44	4 1	3 28	3 3	2 41	2 21	1 57	1 40	1 29	1 21	1 16	1 12	1 10	1 8	1 7	29
30	5 53	4 54	4 10	3 35	3 9	2 46	2 26	2 0	1 43	1 31	1 23	1 17	1 13	1 10	1 8	1 6	30
31	6 5	5 4	4 19	3 42	3 15	2 52	2 31	2 4	1 46	1 33	1 24	1 18	1 13	1 10	1 8	1 6	31
32	6 17	5 14	4 27	3 49	3 21	2 57	2 36	2 8	1 49	1 36	1 26	1 19	1 14	1 11	1 9	1 7	32
33	6 29	5 23	4 35	3 56	3 27	3 2	2 41	2 12	1 52	1 38	1 27	1 20	1 15	1 11	1 9	1 7	33
34	6 40	5 32	4 43	4 3	3 32	3 7	2 46	2 15	1 55	1 40	1 29	1 21	1 16	1 12	1 9	1 7	34
35	6 50	5 40	4 50	4 9	3 38	3 12	2 50	2 19	1 58	1 43	1 31	1 22	1 17	1 13	1 9	1 7	35
36	6 59	5 48	4 57	4 15	3 43	3 16	2 54	2 22	2 1	1 45	1 32	1 23	1 18	1 13	1 10	1 7	36
37	7 7	5 56	5 4	4 21	3 49	3 21	2 59	2 25	2 4	1 47	1 34	1 24	1 19	1 14	1 10	1 7	37
38	7 15	6 3	5 10	4 29	3 54	3 25	3 3	2 28	2 6	1 49	1 35	1 25	1 19	1 14	1 10	1 7	38
39	7 22	6 10	5 16	4 33	3 59	3 30	3 7	2 31	2 8	1 51	1 36	1 26	1 20	1 15	1 10	1 7	39
40		6 17	5 21	4 38	4 4	3 34	3 11	2 34	2 10	1 52	1 38	1 27	1 20	1 15	1 11	1 8	40
41			5 26	4 43	4 8	3 38	3 15	2 36	2 13	1 54	1 39	1 28	1 21	1 16	1 12	1 8	41
42				4 47	4 12	3 42	3 18	2 39	2 16	1 56	1 41	1 29	1 22	1 16	1 12	1 8	42
43					4 16	3 46	3 21	2 42	2 18	1 58	1 42	1 30	1 22	1 16	1 12	1 8	43
44						3 50	3 24	2 45	2 20	2 0	1 43	1 31	1 23	1 17	1 12	1 8	44
46							3 27	2 50	2 23	2 2	1 45	1 32	1 24	1 17	1 12	1 8	46
48								2 54	2 26	2 4	1 47	1 34	1 25	1 18	1 12	1 8	48
50									2 29	2 6	1 49	1 36	1 26	1 19	1 13	1 8	50
52										2 8	1 51	1 38	1 28	1 19	1 13	1 8	52
54											1 53	1 39	1 29	1 20	1 14	1 8	54
56												1 40	1 30	1 21	1 14	1 8	56
58													1 30	1 21	1 14	1 8	58
60														1 21	1 14	1 8	60
62															1 14	1 8	62
64																1 8	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 32°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	6 10	6 33	6 55	7 15													6
7	5 7	5 26	5 44	6 2													7
8	4 20	4 37	4 52	5 7	5 35												8
9	3 41	3 56	4 10	4 24	4 50												9
10	3 12	3 25	3 38	3 50	4 12												10
11	2 51	3 2	3 13	3 23	3 42												11
12	2 33	2 43	2 51	3 00	3 17	3 33											12
13	2 18	2 26	2 34	2 42	2 56	3 9											13
14	2 5	2 12	2 19	2 27	2 39	2 50											14
15	1 55	2 2	2 8	2 14	2 25	2 35											15
16	1 47	1 53	1 58	2 3	2 13	2 22	2 30										16
17	1 40	1 45	1 50	1 54	2 2	2 11	2 18										17
18	1 34	1 38	1 42	1 46	1 53	2 0	2 7										18
19	1 29	1 33	1 36	1 39	1 45	1 51	1 57										19
20	1 25	1 28	1 31	1 33	1 38	1 43	1 49	1 54									20
21	1 21	1 24	1 26	1 28	1 32	1 37	1 42	1 46									21
22	1 18	1 20	1 22	1 24	1 27	1 31	1 35	1 39									22
23	1 15	1 17	1 19	1 20	1 23	1 27	1 30	1 34									23
24	1 13	1 14	1 16	1 17	1 20	1 23	1 26	1 29	1 32								24
25	1 11	1 12	1 13	1 15	1 17	1 19	1 21	1 24	1 26								25
26	1 9	1 10	1 11	1 12	1 14	1 16	1 17	1 19	1 21								26
27	1 8	1 9	1 9	1 10	1 12	1 13	1 14	1 16	1 17								27
28	1 8	1 8	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 15							28
29	1 7	1 7	1 7	1 7	1 8	1 9	1 9	1 10	1 11	1 11							29
30	1 6	1 6	1 6	1 6	1 6	1 7	1 7	1 7	1 8	1 8							30
31	1 6	1 6	1 6	1 5	1 5	1 5	1 5	1 5	1 5	1 5							31
32	1 6	1 5	1 5	1 4	1 4	1 4	1 4	1 4	1 3	1 3	1 3						32
33	1 5	1 4	1 4	1 3	1 3	1 2	1 2	1 2	1 1	1 1	1 1						33
34	1 5	1 4	1 3	1 2	1 2	1 1	1 0	1 0	0 59	0 59	0 59						34
35	1 5	1 3	1 3	1 2	1 1	1 0	0 59	0 58	0 57	0 57	0 57						35
36	1 5	1 3	1 2	1 1	1 1	1 0	0 58	0 57	0 56	0 56	0 55	0 54					36
37	1 5	1 3	1 1	1 0	1 0	0 59	0 57	0 56	0 55	0 55	0 54	0 53					37
38	1 5	1 3	1 1	1 0	0 59	0 58	0 56	0 55	0 54	0 54	0 53	0 52					38
39	1 5	1 3	1 1	0 59	0 58	0 57	0 56	0 54	0 53	0 52	0 51	0 50					39
40	1 5	1 2	1 0	0 59	0 58	0 56	0 55	0 53	0 52	0 51	0 50	0 49	0 48				40
41	1 5	1 2	1 0	0 59	0 58	0 56	0 54	0 52	0 51	0 50	0 49	0 48	0 47				41
42	1 5	1 2	1 0	0 59	0 57	0 55	0 53	0 51	0 50	0 49	0 48	0 47	0 47				42
43	1 5	1 2	1 0	0 58	0 56	0 54	0 52	0 51	0 49	0 48	0 47	0 47	0 46	0 45			43
44	1 5	1 2	1 0	0 58	0 55	0 53	0 51	0 50	0 49	0 48	0 47	0 46	0 45	0 44			44
46	1 5	1 2	1 0	0 58	0 55	0 52	0 51	0 50	0 48	0 47	0 46	0 45	0 44	0 43			46
48	1 5	1 2	0 59	0 57	0 55	0 52	0 50	0 49	0 47	0 46	0 45	0 44	0 43	0 42	0 41		48
50	1 5	1 2	0 59	0 57	0 54	0 51	0 49	0 48	0 47	0 46	0 44	0 43	0 42	0 41	0 40		50
52	1 4	1 1	0 58	0 56	0 53	0 51	0 49	0 47	0 46	0 45	0 43	0 42	0 41	0 40	0 39	0 38	52
54	1 4	1 1	0 58	0 56	0 53	0 50	0 48	0 46	0 45	0 44	0 42	0 41	0 40	0 39	0 38	0 37	54
56	1 4	1 1	0 58	0 56	0 52	0 49	0 47	0 45	0 44	0 42	0 41	0 40	0 39	0 38	0 37	0 36	56
58	1 4	1 1	0 58	0 56	0 52	0 49	0 47	0 45	0 43	0 41	0 40	0 39	0 38	0 37	0 36	0 35	58
60	1 4	1 0	0 57	0 55	0 51	0 48	0 46	0 44	0 42	0 40	0 39	0 38	0 37	0 36	0 35	0 35	60
62	1 3	0 59	0 56	0 54	0 51	0 48	0 45	0 43	0 41	0 39	0 38	0 37	0 36	0 35	0 34	0 34	62
64	1 3	0 59	0 56	0 54	0 50	0 47	0 45	0 43	0 41	0 38	0 38	0 37	0 36	0 35	0 34	0 33	64
66	1 3	0 59	0 56	0 54	0 50	0 47	0 44	0 42	0 40	0 38	0 37	0 36	0 35	0 34	0 33		66
68		0 59	0 55	0 53	0 48	0 46	0 44	0 42	0 40	0 38	0 37	0 36	0 35	0 34	0 33		68
70			0 55	0 52	0 48	0 45	0 43	0 41	0 39	0 37	0 36	0 35	0 34	0 33			70
72				0 52	0 47	0 44	0 42	0 40	0 38	0 37	0 36	0 35	0 33	0 32			72
74					47	0 44	0 42	0 40	0 38	0 36	0 35	0 34	0 32				74
76					47	0 43	0 41	0 39	0 38	0 36	0 35	0 34	0 32				76
78						0 43	0 41	0 39	0 37	0 35	0 34	0 33					78
80						0 43	0 41	0 39	0 37	0 35	0 34	0 33					80
82							0 40	0 38	0 36	0 34	0 33						82
84							0 39	0 38	0 36	0 34	0 33						84
86								0 37	0 35	0 34							86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 36°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR. 6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 17	1 19	1 22	1 27	1 33	1 42	1 52	2 13	2 34	2 56	3 19	3 43	4 7	4 31	4 55	5 18	6
7	1 20	1 17	1 19	1 22	1 26	1 31	1 37	1 52	2 10	2 28	2 48	3 8	3 27	3 46	4 6	4 25	7
8	1 25	1 20	1 17	1 19	1 21	1 23	1 27	1 39	1 53	2 8	2 24	2 40	2 57	3 14	3 30	3 46	8
9	1 32	1 24	1 19	1 17	1 18	1 19	1 21	1 29	1 40	1 52	2 5	2 19	2 33	2 47	3 2	3 16	9
10	1 42	1 30	1 23	1 19	1 16	1 17	1 18	1 23	1 31	1 40	1 51	2 2	2 14	2 27	2 40	2 52	10
11	1 52	1 37	1 28	1 22	1 18	1 16	1 17	1 19	1 25	1 33	1 42	1 51	2 1	2 12	2 23	2 33	11
12	2 3	1 45	1 34	1 26	1 20	1 17	1 15	1 17	1 21	1 27	1 34	1 41	1 50	1 59	2 8	2 17	12
13	2 14	1 53	1 40	1 30	1 23	1 19	1 16	1 15	1 18	1 23	1 28	1 34	1 41	1 49	1 57	2 5	13
14	2 25	2 1	1 47	1 35	1 26	1 21	1 18	1 14	1 16	1 19	1 24	1 29	1 35	1 41	1 49	1 55	14
15	2 36	2 10	1 54	1 41	1 30	1 25	1 21	1 16	1 15	1 17	1 21	1 25	1 30	1 35	1 41	1 46	15
16	2 48	2 20	2 2	1 47	1 35	1 29	1 24	1 18	1 13	1 15	1 18	1 21	1 25	1 29	1 34	1 39	16
17	3 0	2 30	2 10	1 53	1 40	1 33	1 28	1 20	1 15	1 14	1 16	1 18	1 21	1 24	1 28	1 33	17
18	3 12	2 40	2 18	2 0	1 46	1 38	1 32	1 22	1 16	1 13	1 15	1 16	1 18	1 20	1 23	1 27	18
19	3 24	2 49	2 27	2 7	1 51	1 43	1 36	1 25	1 18	1 15	1 14	1 15	1 16	1 18	1 20	1 23	19
20	3 35	2 59	2 35	2 14	1 57	1 48	1 40	1 28	1 21	1 16	1 12	1 13	1 14	1 16	1 18	1 20	20
21	3 46	3 9	2 43	2 21	2 3	1 53	1 44	1 31	1 23	1 17	1 13	1 12	1 13	1 14	1 16	1 18	21
22	3 57	3 18	2 51	2 28	2 9	1 58	1 48	1 34	1 25	1 18	1 14	1 11	1 12	1 13	1 14	1 15	22
23	4 9	3 28	2 59	2 35	2 16	2 3	1 52	1 36	1 26	1 19	1 14	1 11	1 10	1 11	1 12	1 13	23
24	4 20	3 37	3 7	2 42	2 22	2 8	1 56	1 39	1 28	1 20	1 15	1 11	1 9	1 9	1 10	1 11	24
25	4 32	3 47	3 15	2 49	2 28	2 13	2 0	1 42	1 30	1 22	1 15	1 11	1 9	1 8	1 8	1 9	25
26	4 43	3 56	3 23	2 56	2 34	2 18	2 4	1 45	1 32	1 23	1 16	1 12	1 9	1 7	1 7	1 7	26
27	4 55	4 6	3 31	3 3	2 40	2 23	2 9	1 48	1 35	1 25	1 17	1 12	1 9	1 7	1 6	1 6	27
28	5 6	4 15	3 39	3 10	2 46	2 28	2 13	1 52	1 38	1 27	1 19	1 13	1 9	1 7	1 6	1 6	28
29	5 17	4 25	3 47	3 17	2 52	2 34	2 18	1 56	1 40	1 29	1 20	1 13	1 9	1 7	1 6	1 5	29
30	5 28	4 34	3 54	3 24	2 58	2 39	2 23	2 0	1 43	1 31	1 21	1 14	1 10	1 8	1 6	1 5	30
31	5 39	4 43	4 2	3 31	3 4	2 44	2 28	2 4	1 46	1 33	1 23	1 16	1 11	1 8	1 6	1 5	31
32	5 49	4 52	4 10	3 37	3 10	2 49	2 33	2 7	1 49	1 35	1 25	1 17	1 12	1 9	1 7	1 5	32
33	5 59	5 0	4 18	3 44	3 16	2 54	2 37	2 10	1 51	1 37	1 27	1 19	1 14	1 10	1 7	1 5	33
34	6 9	5 8	4 25	3 50	3 22	2 59	2 41	2 13	1 53	1 39	1 29	1 21	1 15	1 11	1 8	1 6	34
35	6 19	5 16	4 32	3 56	3 28	3 4	2 46	2 16	1 56	1 41	1 30	1 22	1 16	1 11	1 8	1 6	35
36	6 28	5 24	4 38	4 2	3 33	3 9	2 50	2 19	1 59	1 43	1 32	1 23	1 17	1 12	1 9	1 6	36
37	6 38	5 32	4 45	4 8	3 39	3 14	2 54	2 22	2 1	1 45	1 33	1 24	1 18	1 13	1 9	1 6	37
38	6 47	5 40	4 52	4 14	3 44	3 18	2 58	2 25	2 4	1 47	1 35	1 26	1 19	1 14	1 10	1 6	38
39	6 57	5 48	4 59	4 20	3 49	3 23	3 2	2 28	2 6	1 49	1 36	1 27	1 20	1 14	1 10	1 7	39
40	7 6	5 56	5 5	4 25	3 54	3 27	3 6	2 31	2 8	1 51	1 38	1 28	1 21	1 15	1 11	1 7	40
41	7 16	6 4	5 12	4 31	3 59	3 31	3 10	2 33	2 11	1 53	1 40	1 30	1 22	1 15	1 11	1 8	41
42	7 25	6 12	5 18	4 36	4 3	3 35	3 13	2 36	2 14	1 55	1 42	1 31	1 22	1 16	1 11	1 8	42
43	7 33	6 19	5 24	4 41	4 8	3 39	3 17	2 39	2 16	1 57	1 43	1 32	1 23	1 16	1 11	1 8	43
44		6 26	5 30	4 46	4 12	3 43	3 20	2 42	2 18	1 59	1 45	1 33	1 24	1 17	1 12	1 9	44
46			5 41	4 55	4 20	3 50	3 26	2 47	2 22	2 2	1 47	1 35	1 25	1 18	1 13	1 9	46
48					4 27	3 57	3 32	2 52	2 26	2 5	1 49	1 37	1 27	1 20	1 14	1 10	48
50							3 38	2 57	2 30	2 8	1 51	1 39	1 29	1 21	1 15	1 10	50
52								3 1	2 33	2 11	1 53	1 41	1 31	1 22	1 16	1 11	52
54									2 36	2 13	1 55	1 43	1 32	1 23	1 16	1 11	54
56										2 15	1 57	1 44	1 33	1 24	1 17	1 11	56
											1 59	1 45	1 34	1 25	1 18	1 12	58
												1 46	1 35	1 26	1 18	1 12	60
													1 36	1 26	1 18	1 12	62
														1 26	1 19	1 12	64
															1 19	1 13	66
																1 13	68
																[illegible]	70
																	72
																	74
																	76
																	78
																	80
																	82
																	84
																	86
						11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	0	1	3	5	7					
10	1	0	2	4	5					
20	4	3	1	1	3	4				
30	6	5	3	1	0	2	3			
40	9	8	5	3	2	0	1	2		
50			7	5	4	2	1	0	1	
60				7	5	4	3	2	1	0
70					6	5	4	3	2	
80						6	4			

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 36°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 40	6 1	6 22	6 43	7 24												6
7	4 43	5 1	5 19	5 36	6 11												7
8	4 1	4 16	4 31	4 46	5 16	5 45											8
9	3 29	3 42	3 55	4 8	4 33	4 58											9
10	3 4	3 16	3 27	3 38	3 59	4 20											10
11	2 43	2 54	3 4	3 13	3 32	3 50											11
12	2 27	2 36	2 45	2 53	3 10	3 25	3 40										12
13	2 13	2 21	2 29	2 37	2 51	3 4	3 16										13
14	2 2	2 9	2 16	2 23	2 36	2 47	2 57										14
15	1 53	1 59	2 5	2 11	2 23	2 33	2 42										15
16	1 45	1 50	1 56	2 1	2 12	2 21	2 29	2 36									16
17	1 38	1 42	1 47	1 53	2 2	2 10	2 17	2 24									17
18	1 32	1 36	1 40	1 45	1 53	2 1	2 7	2 13									18
19	1 27	1 30	1 34	1 38	1 45	1 52	1 58	2 3									19
20	1 23	1 26	1 29	1 33	1 38	1 44	1 49	1 54	1 58								20
21	1 20	1 22	1 25	1 28	1 33	1 38	1 43	1 47	1 51								21
22	1 17	1 18	1 20	1 23	1 28	1 33	1 37	1 41	1 45								22
23	1 14	1 15	1 17	1 19	1 24	1 28	1 32	1 36	1 39								23
24	1 11	1 12	1 14	1 16	1 20	1 23	1 27	1 31	1 34	1 37							24
25	1 9	1 10	1 11	1 13	1 16	1 19	1 22	1 26	1 29	1 31							25
26	1 8	1 8	1 9	1 11	1 13	1 16	1 18	1 21	1 24	1 26							26
27	1 7	1 7	1 8	1 9	1 11	1 13	1 15	1 17	1 20	1 22							27
28	1 6	1 6	1 7	1 8	1 9	1 11	1 12	1 14	1 16	1 18	1 20						28
29	1 6	1 6	1 6	1 7	1 8	1 9	1 10	1 11	1 13	1 14	1 16						29
30	1 5	1 5	1 5	1 6	1 7	1 7	1 8	1 9	1 10	1 11	1 13						30
31	1 5	1 5	1 5	1 5	1 6	1 6	1 6	1 7	1 8	1 9	1 10						31
32	1 4	1 4	1 5	1 5	1 5	1 5	1 5	1 5	1 6	1 7	1 8	1 9					32
33	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 5	1 5	1 6					33
34	1 4	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3					34
35	1 4	1 3	1 3	1 3	1 2	1 1	1 1	1 1	1 1	1 1	1 1	1 1					35
36	1 4	1 3	1 2	1 2	1 1	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0				36
37	1 4	1 3	1 2	1 1	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 58				37
38	1 4	1 3	1 1	1 0	0 58	0 58	0 58	0 58	0 58	0 58	0 58	0 58	0 57				38
39	1 5	1 3	1 1	1 0	0 58	0 58	0 58	0 58	0 57	0 57	0 57	0 56	0 56				39
40	1 5	1 3	1 1	1 0	0 58	0 57	0 57	0 57	0 57	0 56	0 56	0 55	0 54	0 53			40
41	1 6	1 3	1 1	0 59	0 57	0 56	0 56	0 56	0 56	0 55	0 54	0 53	0 52	0 52			41
42	1 6	1 3	1 1	0 59	0 57	0 56	0 55	0 55	0 55	0 54	0 53	0 52	0 51	0 51			42
43	1 6	1 3	1 1	0 59	0 56	0 55	0 54	0 54	0 54	0 53	0 52	0 51	0 50	0 50	0 49		43
44	1 6	1 3	1 1	0 59	0 56	0 54	0 53	0 53	0 53	0 52	0 51	0 50	0 49	0 49	0 48		44
46	1 6	1 3	1 1	0 59	0 56	0 54	0 53	0 52	0 51	0 50	0 49	0 48	0 48	0 47	0 47		46
48	1 7	1 3	1 1	0 59	0 56	0 54	0 52	0 51	0 49	0 48	0 47	0 46	0 46	0 45	0 45	0 45	48
50	1 7	1 3	1 1	0 59	0 56	0 53	0 51	0 50	0 48	0 47	0 46	0 45	0 45	0 44	0 44	0 44	50
52	1 7	1 3	1 1	0 59	0 55	0 52	0 50	0 49	0 48	0 47	0 46	0 45	0 44	0 43	0 42	0 42	52
54	1 7	1 3	1 1	0 59	0 55	0 52	0 50	0 48	0 47	0 46	0 45	0 44	0 43	0 42	0 41	0 41	54
56	1 7	1 3	1 0	0 58	0 55	0 52	0 49	0 48	0 47	0 46	0 45	0 44	0 43	0 42	0 41	0 40	56
58	1 7	1 3	1 0	0 58	0 55	0 52	0 49	0 47	0 46	0 45	0 44	0 43	0 42	0 41	0 40	0 39	58
60	1 7	1 3	1 0	0 58	0 55	0 51	0 48	0 46	0 45	0 44	0 43	0 42	0 41	0 40	0 39	0 38	60
62	1 7	1 3	1 0	0 58	0 54	0 51	0 48	0 46	0 44	0 43	0 42	0 41	0 40	0 39	0 38		62
64	1 7	1 3	1 0	0 58	0 54	0 51	0 48	0 46	0 44	0 43	0 42	0 40	0 39	0 38	0 37		64
66	1 8	1 3	1 0	0 57	0 54	0 50	0 47	0 45	0 43	0 42	0 41	0 39	0 38	0 37			66
68	1 8	1 3	1 0	0 57	0 54	0 50	0 47	0 45	0 43	0 42	0 40	0 39	0 38	0 37			68
70	1 8	1 3	1 0	0 57	0 53	0 50	0 47	0 44	0 42	0 41	0 40	0 39	0 38				70
72		1 3	1 0	0 57	0 53	0 50	0 46	0 43	0 41	0 40	0 39	0 38					72
74			1 0	0 57	0 52	0 49	0 46	0 43	0 41	0 40	0 39	0 38					74
76				0 57	0 52	0 48	0 45	0 43	0 41	0 39	0 38	0 37					76
78					0 51	0 48	0 45	0 42	0 40	0 39	0 37						78
80					0 51	0 47	0 44	0 42	0 40	0 39	0 37						80
82						0 47	0 44	0 41	0 40	0 38							82
84						0 47	0 44	0 41	0 39	0 38							84
86							0 44	0 41	0 39								86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 40°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	' "	°
6	1 16	1 18	1 21	1 25	1 31	1 39	1 47	2 5	2 26	2 48	3 10	3 32	3 54	4 16	4 38	4 59	6
7	1 19	1 16	1 18	1 21	1 24	1 28	1 34	1 48	2 4	2 22	2 40	2 58	3 16	3 34	3 52	4 10	7
8	1 24	1 19	1 16	1 18	1 20	1 22	1 26	1 36	1 50	2 4	2 18	2 33	2 48	3 4	3 20	3 36	8
9	1 31	1 23	1 19	1 16	1 18	1 19	1 21	1 27	1 38	1 49	2 1	2 13	2 25	2 38	2 52	3 5	9
10	1 40	1 29	1 23	1 19	1 16	1 17	1 18	1 21	1 29	1 38	1 48	1 58	2 9	2 20	2 32	2 44	10
11	1 50	1 36	1 28	1 22	1 18	1 15	1 16	1 18	1 23	1 31	1 39	1 48	1 57	2 7	2 17	2 27	11
12	2 1	1 44	1 34	1 26	1 20	1 17	1 15	1 17	1 20	1 26	1 33	1 40	1 48	1 57	2 5	2 13	12
13	2 11	1 52	1 40	1 30	1 23	1 19	1 16	1 16	1 18	1 22	1 28	1 34	1 41	1 48	1 55	2 2	13
14	2 21	2 0	1 46	1 34	1 26	1 21	1 17	1 15	1 17	1 19	1 23	1 28	1 34	1 40	1 46	1 53	14
15	2 31	2 8	1 52	1 39	1 30	1 23	1 19	1 16	1 15	1 17	1 20	1 23	1 27	1 32	1 38	1 44	15
16	2 41	2 16	1 58	1 44	1 34	1 26	1 21	1 17	1 14	1 15	1 17	1 19	1 22	1 26	1 31	1 37	16
17	2 52	2 24	2 4	1 49	1 38	1 30	1 24	1 19	1 15	1 14	1 15	1 17	1 19	1 22	1 26	1 31	17
18	3 3	2 32	2 11	1 54	1 43	1 34	1 28	1 21	1 16	1 13	1 14	1 15	1 17	1 19	1 22	1 26	18
19	3 14	2 41	2 18	2 0	1 48	1 39	1 32	1 23	1 17	1 14	1 13	1 14	1 15	1 17	1 19	1 22	19
20	3 25	2 50	2 25	2 6	1 53	1 43	1 36	1 25	1 19	1 15	1 12	1 12	1 13	1 15	1 16	1 19	20
21	3 36	2 59	2 32	2 12	1 58	1 47	1 39	1 27	1 20	1 16	1 13	1 11	1 12	1 13	1 14	1 16	21
22	3 47	3 8	2 40	2 18	2 4	1 52	1 43	1 30	1 22	1 17	1 13	1 11	1 11	1 12	1 13	1 14	22
23	3 58	3 17	2 48	2 25	2 10	1 57	1 47	1 33	1 24	1 18	1 14	1 12	1 10	1 10	1 11	1 12	23
24	4 9	3 26	2 56	2 32	2 15	2 2	1 51	1 37	1 26	1 19	1 15	1 12	1 9	1 9	1 9	1 10	24
25	4 20	3 35	3 4	2 39	2 21	2 7	1 56	1 40	1 28	1 21	1 16	1 13	1 10	1 8	1 8	1 9	25
26	4 30	3 44	3 12	2 45	2 27	2 12	2 0	1 43	1 30	1 22	1 17	1 13	1 10	1 8	1 8	1 9	26
27	4 41	3 53	3 20	2 52	2 33	2 17	2 4	1 47	1 33	1 24	1 18	1 14	1 11	1 8	1 7	1 8	27
28	4 51	4 2	3 28	2 59	2 39	2 23	2 8	1 50	1 35	1 25	1 19	1 14	1 11	1 8	1 7	1 7	28
29	5 1	4 11	3 36	3 6	2 45	2 28	2 12	1 53	1 38	1 27	1 20	1 15	1 12	1 9	1 7	1 7	29
30	5 12	4 20	3 44	3 13	2 50	2 33	2 17	1 56	1 40	1 29	1 21	1 15	1 12	1 9	1 7	1 6	30
31	5 23	4 29	3 52	3 20	2 56	2 38	2 21	2 0	1 43	1 30	1 22	1 16	1 12	1 9	1 7	1 6	31
32	5 33	4 38	3 59	3 27	3 1	2 43	2 26	2 3	1 45	1 32	1 23	1 17	1 13	1 10	1 7	1 6	32
33	5 43	4 46	4 6	3 33	3 7	2 48	2 30	2 6	1 47	1 34	1 24	1 18	1 14	1 10	1 8	1 6	33
34	5 52	4 54	4 13	3 39	3 13	2 53	2 34	2 9	1 49	1 36	1 26	1 19	1 15	1 11	1 8	1 6	34
35	6 1	5 2	4 20	3 45	3 19	2 58	2 38	2 12	1 51	1 38	1 27	1 20	1 15	1 11	1 8	1 6	35
36	6 10	5 10	4 26	3 51	3 24	3 2	2 42	2 15	1 54	1 40	1 29	1 22	1 16	1 12	1 8	1 6	36
37	6 18	5 17	4 32	3 57	3 29	3 7	2 46	2 18	1 57	1 42	1 31	1 23	1 17	1 12	1 9	1 7	37
38	6 26	5 24	4 38	4 3	3 33	3 11	2 50	2 21	2 0	1 44	1 33	1 25	1 18	1 13	1 9	1 7	38
39	6 34	5 31	4 44	4 8	3 38	3 15	2 54	2 24	2 2	1 46	1 35	1 26	1 19	1 14	1 10	1 7	39
40	6 42	5 38	4 50	4 13	3 42	3 19	2 58	2 27	2 5	1 48	1 37	1 28	1 20	1 14	1 10	1 7	40
41	6 50	5 45	4 56	4 19	3 47	3 24	3 2	2 30	2 8	1 51	1 39	1 29	1 21	1 15	1 11	1 8	41
42	6 58	5 52	5 2	4 24	3 51	3 28	3 6	2 33	2 10	1 53	1 41	1 30	1 22	1 16	1 11	1 8	42
43	7 7	5 59	5 8	4 29	3 56	3 32	3 10	2 36	2 13	1 55	1 43	1 32	1 23	1 17	1 12	1 9	43
44	7 16	6 6	5 14	4 34	4 0	3 36	3 13	2 39	2 15	1 57	1 44	1 33	1 24	1 18	1 13	1 9	44
46	7 33	6 21	5 26	4 44	4 9	3 44	3 20	2 44	2 19	2 1	1 47	1 35	1 27	1 20	1 14	1 10	46
48	7 50	6 35	5 38	4 54	4 18	3 51	3 27	2 49	2 23	2 5	1 50	1 37	1 29	1 22	1 15	1 11	48
50			5 50	5 3	4 27	3 58	3 33	2 54	2 27	2 8	1 52	1 39	1 31	1 23	1 17	1 12	50
52					4 36	4 5	3 39	2 59	2 31	2 11	1 54	1 42	1 32	1 24	1 18	1 13	52
54							3 45	3 4	2 35	2 14	1 56	1 44	1 34	1 26	1 19	1 14	54
56								3 9	2 39	2 17	1 58	1 46	1 36	1 28	1 20	1 14	56
58									2 43	2 19	2 0	1 48	1 37	1 29	1 21	1 15	58
60										2 21	2 2	1 49	1 38	1 30	1 22	1 15	60
62											2 4	1 50	1 39	1 30	1 22	1 16	62
64												1 51	1 40	1 31	1 23	1 16	64
66													1 40	1 31	1 24	1 17	66
68														1 31	1 24	1 17	68
70															1 24	1 17	70
72																1 17	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
						11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE P EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	"	"	"	"	"	"	"	"	"	"
5	0	1	2	4	6					
10	1	0	1	3	4	6				
20	4	3	1	1	2	3	4			
30	6	5	3	2	0	1	2	3		
40	8	7	5	4	2	1	0	1	2	
50		9	7	5	4	2	1	0	0	0
60			9	7	5	4	3	2	2	
70				8	6	5	4	3		
80					7	6	4			
90						6				

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 40°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 19	5 39	5 59	6 19	6 57	7 33											6
7	4 27	4 44	5 1	5 18	5 51	6 20											7
8	3 51	4 6	4 20	4 34	5 1	5 26	5 50										8
9	3 20	3 34	3 46	3 58	4 22	4 44	5 5										9
10	2 56	3 8	3 19	3 30	3 50	4 9	4 27										10
11	2 37	2 47	2 57	2 6	3 25	3 42	3 58										11
12	2 22	2 30	2 39	2 48	3 5	3 20	3 33	3 46									12
13	2 10	2 17	2 25	2 32	2 47	3 1	3 13	3 25									13
14	2 0	2 6	2 12	2 18	2 32	2 44	2 55	3 4									14
15	1 50	1 56	2 1	2 7	2 19	2 30	2 40	2 48									15
16	1 42	1 47	1 52	1 58	2 8	2 18	2 27	2 35	2 42								16
17	1 36	1 40	1 45	1 50	1 59	2 8	2 16	2 23	2 30								17
18	1 31	1 34	1 38	1 43	1 51	1 59	2 6	2 12	2 19								18
19	1 26	1 29	1 33	1 36	1 44	1 51	1 58	2 3	2 9								19
20	1 22	1 24	1 27	1 30	1 37	1 44	1 50	1 55	2 0	2 5							20
21	1 18	1 20	1 23	1 26	1 32	1 38	1 44	1 49	1 53	1 57							21
22	1 15	1 17	1 19	1 22	1 28	1 33	1 38	1 43	1 47	1 50							22
23	1 13	1 14	1 16	1 19	1 24	1 29	1 33	1 38	1 42	1 45							23
24	1 11	1 12	1 14	1 16	1 21	1 25	1 29	1 33	1 37	1 40	1 43						24
25	1 10	1 11	1 12	1 14	1 18	1 21	1 25	1 29	1 32	1 35	1 37						25
26	1 9	1 10	1 11	1 12	1 15	1 18	1 21	1 25	1 28	1 30	1 32						26
27	1 8	1 9	1 9	1 10	1 13	1 15	1 18	1 21	1 24	1 26	1 27						27
28	1 7	1 8	1 8	1 9	1 11	1 13	1 16	1 18	1 20	1 22	1 23	1 24					28
29	1 7	1 7	1 7	1 8	1 9	1 11	1 13	1 15	1 16	1 18	1 19	1 20					29
30	1 6	1 6	1 6	1 7	1 8	1 9	1 11	1 12	1 13	1 15	1 16	1 17					30
31	1 6	1 6	1 6	1 7	1 7	1 8	1 9	1 10	1 11	1 13	1 14	1 15					31
32	1 6	1 6	1 6	1 6	1 6	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 13				32
33	1 5	1 5	1 5	1 5	1 5	1 5	1 6	1 6	1 7	1 8	1 9	1 10	1 10				33
34	1 5	1 4	1 4	1 4	1 4	1 4	1 5	1 5	1 6	1 7	1 7	1 8	1 8				34
35	1 5	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 4	1 5	1 5	1 6	1 6				35
36	1 5	1 4	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 4	1 4	1 4	1 4	1 4			36
37	1 5	1 4	1 3	1 2	1 2	1 2	1 2	1 1	1 1	1 2	1 2	1 2	1 2	1 2			37
38	1 5	1 4	1 2	1 1	1 1	1 1	1 1	1 0	1 0	1 0	1 0	1 1	1 1	1 1			38
39	1 5	1 4	1 2	1 1	1 0	1 0	1 0	0 59	0 59	0 59	0 59	0 59	0 59	0 59			39
40	1 5	1 4	1 2	1 1	1 0	0 59	0 59	0 58	0 58	0 57	0 57	0 57	0 57	0 57	0 57		40
41	1 6	1 4	1 2	1 1	0 59	0 58	0 58	0 57	0 57	0 56	0 56	0 56	0 56	0 56	0 56		41
42	1 6	1 4	1 2	1 0	0 58	0 57	0 57	0 56	0 56	0 55	0 55	0 55	0 55	0 55	0 55		42
43	1 6	1 4	1 2	1 0	0 58	0 57	0 56	0 55	0 55	0 54	0 54	0 54	0 54	0 54	0 54	0 54	43
44	1 6	1 4	1 2	1 0	0 58	0 56	0 55	0 54	0 54	0 53	0 53	0 53	0 53	0 53	0 53	0 53	44
46	1 7	1 4	1 2	1 0	0 58	0 56	0 54	0 53	0 53	0 52	0 52	0 51	0 51	0 51	0 51	0 51	46
48	1 8	1 5	1 2	1 0	0 58	0 55	0 53	0 52	0 52	0 51	0 51	0 50	0 49	0 49	0 49	0 49	48
50	1 8	1 5	1 2	1 0	0 57	0 54	0 52	0 51	0 51	0 50	0 49	0 48	0 48	0 48	0 48	0 48	50
52	1 9	1 5	1 2	1 0	0 57	0 54	0 52	0 50	0 50	0 49	0 48	0 47	0 47	0 46	0 46	0 46	52
54	1 9	1 5	1 2	1 0	0 57	0 54	0 51	0 49	0 49	0 48	0 47	0 46	0 46	0 45	0 45	0 45	54
56	1 10	1 6	1 3	1 0	0 56	0 53	0 51	0 49	0 48	0 47	0 46	0 45	0 45	0 44	0 44	0 44	56
58	1 10	1 6	1 3	1 0	0 56	0 53	0 50	0 48	0 47	0 46	0 45	0 45	0 44	0 43	0 43		58
60	1 10	1 7	1 4	1 1	0 56	0 52	0 50	0 48	0 47	0 45	0 44	0 44	0 43	0 42	0 42		60
62	1 11	1 7	1 4	1 1	0 56	0 52	0 50	0 48	0 46	0 45	0 44	0 43	0 42	0 42			62
64	1 11	1 7	1 4	1 1	0 56	0 52	0 49	0 47	0 45	0 44	0 43	0 42	0 41	0 41			64
66	1 12	1 7	1 4	1 1	0 56	0 52	0 49	0 47	0 45	0 43	0 42	0 42	0 41				66
68	1 12	1 8	1 4	1 1	0 56	0 52	0 49	0 47	0 45	0 43	0 42	0 42	0 41				68
70	1 12	1 8	1 4	1 1	0 55	0 51	0 48	0 46	0 44	0 43	0 42	0 42					70
72	1 13	1 8	1 4	1 1	0 55	0 51	0 48	0 46	0 44	0 43	0 42	0 41					72
74	1 13	1 8	1 4	1 1	0 55	0 51	0 48	0 46	0 44	0 43	0 42						74
76		1 8	1 4	1 1	0 55	0 51	0 48	0 46	0 44	0 42	0 41						76
78			1 4	1 1	0 55	0 51	0 48	0 46	0 43	0 42							78
80				1 1	0 55	0 51	0 48	0 46	0 43	0 41							80
82					0 55	0 51	0 48	0 46	0 43								82
84					0 55	0 51	0 48	0 46	0 43								84
86						0 51	0 48	0 45									86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 44°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR. 6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 16	1 18	1 21	1 25	1 31	1 37	1 45	2 3	2 23	2 44	3 5	3 25	3 45	4 5	4 25	4 44	6
7	1 20	1 16	1 18	1 20	1 24	1 28	1 33	1 46	2 1	2 17	2 34	2 51	3 8	3 25	3 42	3 59	7
8	1 25	1 19	1 16	1 17	1 19	1 22	1 25	1 35	1 47	2 0	2 14	2 29	2 43	2 58	3 12	3 27	8
9	1 31	1 23	1 18	1 15	1 16	1 18	1 21	1 27	1 36	1 47	1 59	2 12	2 24	2 36	2 48	3 0	9
10	1 39	1 28	1 21	1 17	1 15	1 16	1 18	1 22	1 29	1 38	1 48	1 58	2 8	2 18	2 29	2 39	10
11	1 48	1 34	1 25	1 20	1 17	1 15	1 16	1 19	1 24	1 31	1 39	1 47	1 56	2 5	2 14	2 24	11
12	1 58	1 41	1 30	1 23	1 19	1 16	1 15	1 17	1 20	1 25	1 32	1 38	1 46	1 54	2 2	2 11	12
13	2 8	1 48	1 35	1 27	1 22	1 18	1 16	1 15	1 17	1 21	1 26	1 32	1 38	1 45	1 52	1 59	13
14	2 18	1 56	1 41	1 31	1 25	1 20	1 17	1 14	1 15	1 18	1 22	1 27	1 32	1 38	1 44	1 49	14
15	2 28	2 4	1 47	1 36	1 29	1 23	1 19	1 15	1 14	1 16	1 19	1 23	1 27	1 32	1 37	1 42	15
16	2 38	2 12	1 53	1 41	1 33	1 26	1 21	1 17	1 14	1 15	1 17	1 20	1 23	1 27	1 32	1 36	16
17	2 48	2 20	2 0	1 47	1 37	1 30	1 24	1 19	1 15	1 15	1 16	1 18	1 20	1 23	1 26	1 30	17
18	2 58	2 28	2 8	1 53	1 42	1 34	1 27	1 20	1 16	1 14	1 15	1 16	1 18	1 20	1 22	1 25	18
19	3 8	2 37	2 15	1 59	1 47	1 38	1 30	1 22	1 17	1 14	1 14	1 15	1 16	1 17	1 19	1 22	19
20	3 18	2 45	2 22	2 5	1 52	1 42	1 34	1 25	1 19	1 15	1 13	1 14	1 14	1 15	1 17	1 19	20
21	3 29	2 54	2 30	2 12	1 57	1 46	1 37	1 27	1 21	1 17	1 14	1 12	1 13	1 14	1 15	1 17	21
22	3 39	3 2	2 37	2 18	2 3	1 51	1 41	1 30	1 23	1 18	1 14	1 11	1 12	1 13	1 14	1 16	22
23	3 49	3 11	2 45	2 24	2 8	1 55	1 45	1 33	1 25	1 19	1 15	1 12	1 11	1 12	1 13	1 14	23
24	4 0	3 19	2 52	2 31	2 14	2 0	1 49	1 36	1 27	1 20	1 16	1 12	1 10	1 10	1 11	1 13	24
25	4 10	3 28	2 59	2 37	2 20	2 5	1 53	1 39	1 29	1 21	1 17	1 13	1 10	1 9	1 10	1 11	25
26	4 20	3 36	3 6	2 43	2 25	2 10	1 57	1 42	1 31	1 22	1 17	1 13	1 10	1 8	1 9	1 9	26
27	4 30	3 45	3 13	2 49	2 31	2 15	2 1	1 45	1 32	1 23	1 18	1 14	1 11	1 9	1 8	1 8	27
28	4 39	3 53	3 20	2 55	2 36	2 20	2 5	1 47	1 34	1 25	1 19	1 15	1 12	1 9	1 7	1 7	28
29	4 48	4 1	3 27	3 1	2 41	2 24	2 9	1 49	1 36	1 27	1 20	1 15	1 12	1 9	1 7	1 6	29
30	4 57	4 9	3 34	3 7	2 46	2 29	2 14	1 52	1 38	1 28	1 21	1 16	1 13	1 9	1 7	1 6	30
31	5 7	4 17	3 41	3 13	2 51	2 34	2 19	1 55	1 40	1 30	1 22	1 17	1 13	1 10	1 8	1 6	31
32	5 16	4 25	3 48	3 19	2 56	2 38	2 23	1 58	1 42	1 31	1 23	1 18	1 14	1 10	1 8	1 6	32
33	5 25	4 33	3 54	3 25	3 1	2 43	2 27	2 1	1 44	1 33	1 24	1 19	1 15	1 11	1 9	1 7	33
34	5 34	4 40	4 1	3 30	3 6	2 47	2 31	2 4	1 47	1 35	1 26	1 20	1 15	1 11	1 9	1 7	34
35	5 43	4 48	4 8	3 36	3 11	2 52	2 35	2 7	1 50	1 37	1 27	1 21	1 16	1 12	1 9	1 7	35
36	5 51	4 55	4 14	3 42	3 15	2 56	2 39	2 11	1 53	1 39	1 28	1 22	1 17	1 13	1 10	1 7	36
37	6 0	5 3	4 21	3 47	3 20	3 0	2 43	2 15	1 56	1 41	1 30	1 23	1 17	1 13	1 10	1 8	37
38	6 9	5 10	4 27	3 52	3 24	3 4	2 47	2 18	1 58	1 43	1 32	1 24	1 18	1 14	1 11	1 8	38
39	6 18	5 18	4 33	3 58	3 29	3 8	2 51	2 21	2 1	1 45	1 33	1 25	1 19	1 14	1 11	1 8	39
40	6 27	5 25	4 39	4 3	3 33	3 12	2 54	2 24	2 3	1 46	1 35	1 26	1 20	1 15	1 11	1 8	40
41	6 36	5 32	4 45	4 8	3 38	3 16	2 58	2 27	2 6	1 48	1 37	1 27	1 21	1 16	1 12	1 9	41
42	6 45	5 39	4 51	4 13	3 42	3 20	3 1	2 30	2 8	1 50	1 39	1 29	1 22	1 16	1 12	1 9	42
43	6 53	5 46	4 57	4 18	3 47	3 24	3 4	2 33	2 10	1 52	1 40	1 30	1 23	1 17	1 13	1 9	43
44	7 0	5 53	5 5	4 23	3 51	3 28	3 7	2 35	2 12	1 54	1 42	1 32	1 24	1 18	1 13	1 10	44
46	7 14	6 6	5 14	4 33	4 0	3 35	3 14	2 40	2 17	1 58	1 45	1 35	1 26	1 20	1 14	1 10	46
48	7 27	6 18	5 25	4 43	4 9	3 43	3 21	2 45	2 21	2 2	1 48	1 37	1 28	1 21	1 15	1 11	48
50	7 40	6 29	5 35	4 52	4 18	3 50	3 27	2 50	2 25	2 6	1 52	1 40	1 31	1 23	1 16	1 11	50
52	7 52	6 40	5 45	5 1	4 26	3 57	3 33	2 55	2 29	2 10	1 56	1 43	1 33	1 25	1 18	1 12	52
54			5 55	5 9	4 34	4 4	3 39	3 0	2 33	2 14	1 59	1 46	1 35	1 26	1 19	1 13	54
56					4 42	4 10	3 45	3 5	2 37	2 17	2 2	1 49	1 37	1 27	1 20	1 14	56
							3 50	3 10	2 41	2 20	2 4	1 51	1 39	1 29	1 21	1 15	58
								3 14	2 44	2 22	2 5	1 52	1 40	1 30	1 22	1 16	60
									2 47	2 24	2 6	1 53	1 42	1 31	1 23	1 17	62
										2 26	2 7	1 54	1 43	1 32	1 24	1 18	64
											2 8	1 55	1 44	1 33	1 25	1 19	66
												1 56	1 45	1 34	1• 26	1 20	68
													1 45	1 35	1 27	1 21	70
														1 36	1 29	1 22	72
															1 30	1 22	74
																1 23	76
																	78
																	80
																	82
																	84
																	86
						11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	0	1	2	4	5	6				
10	1	0	1	2	4	5				
20	3	3	1	0	2	3	4			
30	5	5	3	2	0	1	2	2		
40	7	7	5	4	2	1	0	0	1	
50	9	8	7	5	4	3	3	1	1	
60			8	7	5	4	3	2	2	
70				8	6	5	4	3		
80					7	6				

THIRD CORRECTION, TO APPARENT DISTANCE 44°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 3	5 22	5 41	5 59	6 36	7 10	7 40										6
7	4 15	4 31	4 47	5 2	5 33	6 1	6 29										7
8	3 40	3 53	4 6	4 20	4 46	5 11	5 35	5 58									8
9	3 12	3 24	3 35	3 47	4 10	4 31	4 51	5 10									9
10	2 50	3 0	3 10	3 20	3 39	3 58	4 17	4 34									10
11	2 33	2 42	2 52	3 0	3 17	3 33	3 48	4 3									11
12	2 19	2 27	2 36	2 44	2 59	3 13	3 26	3 39	3 51								12
13	2 6	2 13	2 21	2 29	2 43	2 56	3 9	3 20	3 29								13
14	1 55	2 2	2 9	2 16	2 29	2 41	2 53	3 2	3 10								14
15	1 47	1 53	1 59	2 5	2 17	2 28	2 38	2 47	2 54								15
16	1 40	1 45	1 50	1 56	2 7	2 17	2 26	2 34	2 41	2 47							16
17	1 34	1 38	1 43	1 48	1 58	2 7	2 15	2 22	2 29	2 35							17
18	1 29	1 33	1 37	1 42	1 51	1 59	2 6	2 12	2 18	2 24							18
19	1 25	1 28	1 32	1 36	1 44	1 52	1 59	2 4	2 9	2 14							19
20	1 22	1 25	1 28	1 31	1 38	1 46	1 52	1 57	2 1	2 6	2 11						20
21	1 19	1 22	1 25	1 27	1 33	1 40	1 46	1 51	1 55	1 59	2 2						21
22	1 17	1 19	1 22	1 24	1 29	1 35	1 40	1 45	1 49	1 53	1 55						22
23	1 15	1 17	1 19	1 21	1 25	1 30	1 35	1 40	1 44	1 47	1 49						23
24	1 14	1 15	1 16	1 18	1 22	1 26	1 30	1 35	1 39	1 42	1 44	1 46					24
25	1 12	1 13	1 14	1 16	1 19	1 22	1 26	1 30	1 34	1 37	1 39	1 40					25
26	1 10	1 11	1 12	1 14	1 16	1 19	1 22	1 26	1 30	1 32	1 34	1 38					26
27	1 9	1 10	1 11	1 12	1 14	1 16	1 19	1 23	1 26	1 28	1 30	1 31					27
28	1 8	1 9	1 10	1 11	1 12	1 14	1 17	1 20	1 22	1 24	1 26	1 27	1 28				28
29	1 7	1 8	1 8	1 9	1 10	1 12	1 15	1 17	1 19	1 21	1 22	1 23	1 25				29
30	1 6	1 7	1 7	1 8	1 9	1 10	1 12	1 14	1 16	1 18	1 19	1 20	1 22				30
31	1 6	1 6	1 6	1 7	1 8	1 8	1 10	1 12	1 14	1 15	1 17	1 18	1 19				31
32	1 5	1 6	1 6	1 6	1 7	1 7	1 8	1 10	1 12	1 13	1 14	1 15	1 16	1 17			32
33	1 5	1 5	1 5	1 5	1 6	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 13	1 14			33
34	1 5	1 4	1 4	1 4	1 5	1 5	1 6	1 6	1 7	1 8	1 9	1 10	1 11	1 12			34
35	1 5	1 4	1 4	1 4	1 4	1 4	1 5	1 5	1 5	1 6	1 7	1 8	1 9	1 10			35
36	1 5	1 4	1 3	1 3	1 3	1 3	1 4	1 4	1 4	1 5	1 5	1 6	1 7	1 8	1 9		36
37	1 6	1 4	1 3	1 2	1 2	1 2	1 3	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 7		37
38	1 6	1 4	1 2	1 1	1 1	1 1	1 2	1 2	1 2	1 3	1 3	1 4	1 4	1 4	1 5		38
39	1 6	1 4	1 2	1 1	1 0	1 0	1 1	1 1	1 1	1 2	1 2	1 3	1 3	1 3	1 4		39
40	1 6	1 4	1 2	1 1	1 0	1 0	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 1	1 2	1 3	40
41	1 7	1 5	1 3	1 1	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 0	1 1	41
42	1 7	1 5	1 3	1 1	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	42
43	1 7	1 5	1 3	1 1	0 59	0 59	0 58	0 58	0 58	0 58	0 58	0 58	0 58	0 58	0 58	0 58	43
44	1 7	1 5	1 3	1 1	0 59	0 58	0 57	0 57	0 57	0 57	0 57	0 57	0 57	0 57	0 57	0 57	44
46	1 7	1 5	1 3	1 1	0 59	0 57	0 56	0 56	0 56	0 56	0 55	0 55	0 55	0 55	0 55	0 55	46
48	1 8	1 6	1 4	1 2	0 59	0 57	0 55	0 55	0 55	0 54	0 54	0 54	0 53	0 53	0 53	0 53	48
50	1 8	1 6	1 4	1 2	0 59	0 57	0 55	0 54	0 54	0 53	0 53	0 53	0 52	0 52	0 52	0 52	50
52	1 9	1 6	1 4	1 2	0 59	0 56	0 54	0 53	0 53	0 52	0 52	0 51	0 51	0 51	0 50	0 51	52
54	1 10	1 7	1 4	1 2	0 59	0 56	0 54	0 53	0 52	0 51	0 51	0 50	0 50	0 49	0 49		54
56	1 10	1 7	1 5	1 2	0 59	0 56	0 54	0 52	0 51	0 50	0 50	0 49	0 49	0 48	0 47		56
58	1 11	1 8	1 5	1 3	0 59	0 56	0 53	0 51	0 50	0 49	0 49	0 48	0 48	0 47			58
60	1 11	1 8	1 5	1 3	0 59	0 56	0 53	0 51	0 50	0 49	0 48	0 47	0 47	0 46			60
62	1 12	1 9	1 6	1 3	0 59	0 56	0 53	0 51	0 49	0 48	0 47	0 47	0 46				62
64	1 13	1 9	1 6	1 3	0 59	0 56	0 53	0 51	0 49	0 48	0 47	0 46	0 45				64
66	1 14	1 10	1 7	1 4	0 59	0 56	0 53	0 51	0 49	0 48	0 47	0 46					66
68	1 15	1 11	1 7	1 4	0 59	0 56	0 53	0 51	0 49	0 47	0 46	0 45					68
70	1 16	1 11	1 7	1 4	0 59	0 55	0 53	0 51	0 49	0 47	0 46						70
72	1 16	1 12	1 8	1 4	0 59	0 55	0 52	0 50	0 48	0 46	0 45						72
74	1 16	1 12	1 8	1 4	0 59	0 55	0 52	0 50	0 48	0 46							74
76	1 17	1 12	1 8	1 5	0 59	0 55	0 52	0 49	0 47	0 46							76
78	1 17	1 12	1 8	1 5	0 59	0 55	0 52	0 49	0 47								78
80		1 12	1 8	1 5	0 59	0 55	0 52	0 49	0 47								80
82			1 8	1 5	0 59	0 55	0 52	0 49									82
84				1 5	0 59	0 55	0 52	0 49									84
86					0 59	0 55	0 52										86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 48°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR A STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 16	1 17	1 19	1 23	1 29	1 36	1 43	2 1	2 20	2 39	2 58	3 16	3 35	3 54	4 13	4 32	6
7	1 19	1 16	1 17	1 19	1 23	1 28	1 33	1 46	2 0	2 16	2 32	2 47	3 2	3 18	3 34	3 50	7
8	1 24	1 19	1 16	1 17	1 19	1 22	1 26	1 35	1 47	1 59	2 12	2 25	2 39	2 53	3 7	3 21	8
9	1 30	1 23	1 18	1 16	1 17	1 19	1 21	1 28	1 37	1 47	1 58	2 9	2 20	2 32	2 44	2 55	9
10	1 37	1 27	1 21	1 18	1 16	1 17	1 18	1 23	1 30	1 38	1 47	1 56	2 6	2 16	2 26	2 36	10
11	1 45	1 33	1 25	1 21	1 18	1 16	1 17	1 20	1 25	1 32	1 39	1 47	1 55	2 4	2 13	2 22	11
12	1 53	1 39	1 30	1 24	1 21	1 18	1 16	1 19	1 22	1 27	1 33	1 40	1 47	1 54	2 2	2 10	12
13	2 2	1 46	1 36	1 28	1 24	1 20	1 18	1 17	1 19	1 23	1 28	1 34	1 40	1 46	1 53	2 0	13
14	2 11	1 54	1 42	1 33	1 27	1 23	1 20	1 16	1 17	1 20	1 24	1 29	1 34	1 39	1 45	1 51	14
15	2 20	2 1	1 48	1 37	1 30	1 26	1 22	1 17	1 16	1 18	1 21	1 24	1 29	1 33	1 38	1 43	15
16	2 30	2 9	1 54	1 42	1 34	1 29	1 24	1 18	1 16	1 17	1 18	1 20	1 24	1 28	1 32	1 37	16
17	2 40	2 17	2 0	1 47	1 38	1 32	1 27	1 20	1 17	1 16	1 17	1 18	1 21	1 25	1 28	1 32	17
18	2 50	2 25	2 7	1 52	1 42	1 35	1 30	1 22	1 18	1 15	1 16	1 17	1 19	1 22	1 25	1 28	18
19	3 0	2 32	2 14	1 58	1 46	1 39	1 33	1 24	1 19	1 16	1 15	1 16	1 17	1 19	1 22	1 24	19
20	3 9	2 40	2 20	2 3	1 51	1 43	1 36	1 27	1 21	1 17	1 14	1 15	1 16	1 17	1 19	1 21	20
21	3 18	2 48	2 26	2 9	1 56	1 47	1 40	1 30	1 23	1 18	1 15	1 14	1 15	1 16	1 17	1 19	21
22	3 27	2 56	2 33	2 15	2 2	1 52	1 43	1 32	1 24	1 19	1 16	1 13	1 14	1 15	1 16	1 18	22
23	3 37	3 3	2 40	2 21	2 7	1 56	1 46	1 35	1 26	1 20	1 16	1 14	1 13	1 14	1 15	1 16	23
24	3 46	3 11	2 47	2 26	2 12	2 0	1 50	1 37	1 27	1 21	1 17	1 14	1 12	1 13	1 13	1 14	24
25	3 56	3 19	2 54	2 32	2 17	2 5	1 54	1 40	1 29	1 22	1 18	1 15	1 13	1 12	1 12	1 13	25
26	4 5	3 27	3 1	2 38	2 22	2 9	1 58	1 42	1 31	1 24	1 19	1 16	1 13	1 11	1 11	1 12	26
27	4 15	3 34	3 8	2 44	2 27	2 14	2 2	1 44	1 33	1 25	1 20	1 16	1 13	1 11	1 10	1 11	27
28	4 24	3 42	3 15	2 50	2 32	2 18	2 6	1 47	1 35	1 27	1 21	1 17	1 14	1 12	1 10	1 10	28
29	4 33	3 50	3 21	2 56	2 37	2 23	2 10	1 50	1 37	1 28	1 22	1 18	1 15	1 12	1 10	1 9	29
30	4 42	3 58	3 28	3 2	2 42	2 27	2 13	1 53	1 40	1 30	1 23	1 19	1 15	1 12	1 10	1 9	30
31	4 51	4 6	3 35	3 8	2 47	2 31	2 17	1 57	1 42	1 32	1 25	1 20	1 16	1 13	1 11	1 9	31
32	5 0	4 13	3 42	3 14	2 52	2 35	2 20	2 0	1 44	1 33	1 26	1 21	1 16	1 13	1 11	1 9	32
33	5 9	4 21	3 49	3 20	2 57	2 39	2 23	2 3	1 46	1 35	1 27	1 22	1 17	1 14	1 12	1 10	33
34	5 18	4 28	3 55	3 25	3 2	2 44	2 27	2 6	1 49	1 37	1 28	1 23	1 18	1 14	1 12	1 10	34
35	5 27	4 36	4 1	3 31	3 7	2 48	2 31	2 9	1 52	1 39	1 30	1 24	1 19	1 15	1 12	1 10	35
36	5 35	4 43	4 8	3 37	3 12	2 52	2 35	2 12	1 54	1 41	1 31	1 25	1 19	1 15	1 12	1 10	36
37	5 44	4 50	4 14	3 42	3 17	2 57	2 39	2 16	1 56	1 43	1 33	1 26	1 20	1 16	1 13	1 11	37
38	5 52	4 57	4 20	3 47	3 22	3 1	2 43	2 19	1 59	1 45	1 34	1 27	1 21	1 17	1 14	1 11	38
39	6 0	5 4	4 26	3 53	3 26	3 5	2 47	2 22	2 2	1 47	1 35	1 28	1 22	1 17	1 14	1 11	39
40	6 8	5 11	4 32	3 58	3 30	3 10	2 51	2 25	2 5	1 49	1 37	1 29	1 23	1 18	1 15	1 12	40
41	6 16	5 18	4 38	4 3	3 35	3 14	2 55	2 28	2 7	1 51	1 39	1 31	1 24	1 19	1 16	1 13	41
42	6 24	5 24	4 44	4 8	3 40	3 18	2 58	2 31	2 10	1 53	1 41	1 33	1 26	1 20	1 16	1 13	42
43	6 32	5 31	4 50	4 13	3 44	3 22	3 2	2 33	2 12	1 55	1 43	1 34	1 27	1 21	1 17	1 14	43
44	6 39	5 37	4 55	4 18	3 48	3 26	3 5	2 36	2 14	1 57	1 45	1 36	1 28	1 22	1 18	1 15	44
46	6 53	5 49	5 5	4 28	3 56	3 34	3 12	2 41	2 18	2 1	1 48	1 38	1 30	1 23	1 18	1 15	46
48	7 7	6 1	5 15	4 37	4 4	3 41	3 18	2 46	2 22	2 5	1 51	1 40	1 31	1 24	1 19	1 16	48
50	7 21	6 13	5 25	4 46	4 12	3 47	3 24	2 51	2 26	2 8	1 53	1 42	1 33	1 25	1 20	1 16	50
52	7 34	6 24	5 34	4 54	4 20	3 53	3 30	2 56	2 30	2 12	1 56	1 44	1 35	1 27	1 22	1 17	52
54	7 47	6 35	5 43	5 1	4 27	3 59	3 36	3 1	2 34	2 15	1 59	1 46	1 37	1 29	1 23	1 19	54
56	8 0	6 46	5 51	5 8	4 34	4 5	3 41	3 6	2 38	2 18	2 2	1 49	1 39	1 31	1 25	1 20	56
58			5 59	5 15	4 40	4 11	3 46	3 10	2 42	2 21	2 4	1 51	1 41	1 32	1 26	1 21	58
					4 46	4 16	3 50	3 13	2 45	2 23	2 6	1 53	1 42	1 33	1 27	1 21	60
							3 54	3 15	2 47	2 25	2 8	1 54	1 43	1 34	1 28	1 22	62
								3 17	2 49	2 27	2 10	1 56	1 45	1 35	1 28	1 22	64
									2 51	2 29	2 11	1 57	1 46	1 36	1 29	1 23	66
										2 31	2 12	1 58	1 47	1 37	1 30	1 24	68
											2 13	1 59	1 48	1 38	1 30	1 24	70
												2 0	1 49	1 39	1 31	1 24	72
													1 50	1 40	1 32	1 25	74
														1 41	1 33	1 25	76
															1 33	1 26	78
																1 26	80
																	82
																	84
																	86
						11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	′	″	″	″	″	″		″	″
5	0	1	2	3	4	5				
10	1	1	1	2	3	4	5			
20	3	3	1	0	1	2	3	3		
30	5	5	3	2	1	0	1	2		
40	7	6	5	4	3	2	1	0	0	0
50	9	8	6	5	4	3	2	2	1	
60		9	8	6	5	4	3	3		
70			9	7	6	5	4			
80				8	7	6				
90					7					

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 48°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	
6	4 51	5 10	5 28	5 46	6 18	6 49	7 19	7 47									
7	4 6	4 21	4 36	4 51	5 19	5 45	6 11	6 35									7
8	3 34	3 48	4 1	4 14	4 38	5 1	5 22	5 42	6 1								8
9	3 7	3 19	3 30	3 41	4 3	4 24	4 43	5 0	5 17								9
10	2 47	2 57	3 7	3 17	3 36	3 54	4 11	4 26	4 40								10
11	2 31	2 40	2 49	2 57	3 14	3 30	3 44	3 57	4 10								11
12	2 17	2 25	2 33	2 40	2 55	3 9	3 22	3 34	3 45	3 55							12
13	2 6	2 13	2 20	2 27	2 40	2 52	3 4	3 15	3 25	3 32							13
14	1 57	2 4	2 10	2 16	2 27	2 38	2 49	2 59	3 8	3 15							14
15	1 49	1 55	2 1	2 6	2 16	2 26	2 35	2 44	2 53	3 0							15
16	1 42	1 47	1 52	1 57	2 7	2 15	2 23	2 32	2 40	2 46	2 52						16
17	1 36	1 41	1 45	1 50	1 59	2 6	2 14	2 22	2 29	2 34	2 40						17
18	1 31	1 35	1 39	1 43	1 51	1 59	2 6	2 13	2 19	2 24	2 29						18
19	1 27	1 31	1 34	1 38	1 45	1 52	1 58	2 4	2 10	2 15	2 19						19
20	1 24	1 27	1 30	1 33	1 39	1 45	1 51	1 57	2 2	2 7	2 11	2 15					20
21	1 22	1 24	1 27	1 29	1 34	1 40	1 45	1 51	1 56	2 0	2 4	2 7					21
22	1 20	1 22	1 24	1 26	1 30	1 35	1 40	1 45	1 50	1 54	1 57	1 59					22
23	1 18	1 19	1 21	1 23	1 27	1 31	1 36	1 40	1 45	1 49	1 51	1 53					23
24	1 16	1 17	1 19	1 21	1 25	1 28	1 32	1 36	1 40	1 44	1 46	1 48	1 50				24
25	1 14	1 15	1 16	1 18	1 22	1 25	1 29	1 32	1 36	1 39	1 41	1 43	1 45				25
26	1 12	1 13	1 14	1 16	1 19	1 23	1 26	1 29	1 32	1 34	1 36	1 38	1 40				26
27	1 11	1 12	1 13	1 14	1 17	1 20	1 23	1 26	1 28	1 30	1 32	1 34	1 36				27
28	1 10	1 11	1 12	1 13	1 15	1 18	1 20	1 23	1 25	1 27	1 28	1 30	1 32	1 34			28
29	1 9	1 10	1 11	1 12	1 14	1 16	1 18	1 20	1 22	1 24	1 25	1 27	1 28	1 30			29
30	1 9	1 10	1 10	1 11	1 12	1 14	1 16	1 18	1 19	1 21	1 22	1 24	1 25	1 26			30
31	1 9	1 9	1 9	1 10	1 11	1 12	1 14	1 16	1 17	1 19	1 20	1 21	1 22	1 23			31
32	1 8	1 8	1 8	1 9	1 10	1 11	1 13	1 14	1 15	1 17	1 18	1 19	1 19	1 20	1 21		32
33	1 8	1 7	1 7	1 8	1 9	1 10	1 11	1 12	1 13	1 15	1 16	1 17	1 17	1 17	1 18		33
34	1 8	1 6	1 6	1 7	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 14	1 15	1 15	1 16		34
35	1 8	1 6	1 5	1 6	1 7	1 8	1 9	1 9	1 10	1 11	1 12	1 12	1 13	1 13	1 14		35
36	1 8	1 6	1 5	1 5	1 5	1 6	1 7	1 7	1 8	1 9	1 10	1 10	1 11	1 11	1 12	1 13	36
37	1 9	1 7	1 5	1 4	1 4	1 5	1 6	1 6	1 7	1 7	1 8	1 8	1 9	1 9	1 10	1 11	37
38	1 9	1 7	1 5	1 3	1 3	1 4	1 5	1 5	1 6	1 6	1 7	1 7	1 8	1 8	1 8	1 9	38
39	1 9	1 7	1 5	1 3	1 3	1 3	1 4	1 4	1 5	1 5	1 6	1 6	1 6	1 7	1 7	1 7	39
40	1 9	1 7	1 5	1 3	1 2	1 2	1 3	1 3	1 4	1 4	1 5	1 5	1 5	1 6	1 6	1 6	40
41	1 10	1 8	1 5	1 3	1 1	1 1	1 2	1 2	1 3	1 3	1 4	1 4	1 4	1 5	1 5	1 5	41
42	1 10	1 8	1 5	1 3	1 1	1 1	1 1	1 2	1 2	1 2	1 3	1 3	1 3	1 4	1 4	1 4	42
43	1 11	1 8	1 6	1 4	1 1	1 0	1 0	1 1	1 1	1 1	1 2	1 2	1 2	1 3	1 3	1 3	43
44	1 12	1 9	1 6	1 4	1 1	1 0	1 0	1 0	1 0	1 0	1 1	1 1	1 1	1 1	1 1	1 1	44
46	1 12	1 9	1 6	1 4	1 1	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	0 59	46
48	1 13	1 10	1 7	1 4	1 1	0 59	0 58	0 58	0 58	0 58	0 57	0 57	0 57	0 57	0 57	0 57	48
50	1 13	1 10	1 7	1 5	1 1	0 59	0 57	0 57	0 57	0 57	0 56	0 56	0 56	0 56	0 56		50
52	1 14	1 11	1 8	1 5	1 1	0 59	0 57	0 56	0 56	0 56	0 55	0 55	0 54	0 54	0 54		52
54	1 15	1 11	1 8	1 6	1 2	0 59	0 57	0 56	0 55	0 55	0 54	0 54	0 53	0 53			54
56	1 15	1 11	1 8	1 6	1 2	0 59	0 57	0 55	0 54	0 54	0 53	0 53	0 52	0 52			56
58	1 16	1 12	1 9	1 6	1 2	0 59	0 57	0 55	0 54	0 53	0 52	0 52	0 51				58
60	1 16	1 12	1 9	1 6	1 2	0 59	0 57	0 55	0 53	0 52	0 52	0 51	0 50				60
62	1 17	1 13	1 10	1 7	1 2	0 59	0 57	0 55	0 53	0 52	0 51	0 51					62
64	1 17	1 13	1 10	1 7	1 2	0 59	0 57	0 55	0 53	0 52	0 51	0 50					64
66	1 18	1 14	1 10	1 7	1 3	0 59	0 57	0 54	0 52	0 51	0 50						66
68	1 18	1 14	1 10	1 7	1 3	0 59	0 56	0 54	0 52	0 51	0 50						68
70	1 19	1 15	1 11	1 8	1 3	0 59	0 56	0 54	0 52	0 51							70
72	1 19	1 15	1 11	1 8	1 3	0 59	0 56	0 54	0 52	0 50							72
74	1 20	1 15	1 11	1 8	1 3	0 59	0 56	0 53	0 51								74
76	1 20	1 16	1 12	1 8	1 3	0 59	0 56	0 53	0 51								76
78	1 21	1 16	1 12	1 9	1 4	0 59	0 56	0 53									78
80	1 21	1 16	1 12	1 9	1 4	0 59	0 56	0 53									80
82	1 21	1 16	1 12	1 9	1 4	0 59	0 56										82
84		1 16	1 12	1 9	1 4	0 59	0 56										84
86			1 12	1 9	1 4	0 59											86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 52°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 18	1 19	1 21	1 24	1 30	1 37	1 44	2 0	2 17	2 34	2 51	3 10	3 28	3 47	4 6	4 24	6
7	1 21	1 18	1 19	1 21	1 24	1 29	1 34	1 46	2 0	2 14	2 28	2 42	2 57	3 12	3 27	3 43	7
8	1 25	1 21	1 18	1 19	1 21	1 24	1 27	1 36	1 47	1 58	2 11	2 23	2 36	2 50	3 3	3 16	8
9	1 30	1 24	1 20	1 18	1 19	1 21	1 23	1 29	1 37	1 47	1 57	2 8	2 19	2 31	2 42	2 53	9
10	1 37	1 28	1 23	1 20	1 18	1 19	1 21	1 25	1 30	1 38	1 46	1 56	2 6	2 16	2 26	2 36	10
11	1 45	1 34	1 28	1 23	1 20	1 18	1 19	1 22	1 26	1 32	1 39	1 47	1 56	2 4	2 13	2 22	11
12	1 54	1 41	1 33	1 27	1 22	1 20	1 18	1 20	1 23	1 27	1 33	1 40	1 47	1 54	2 2	2 10	12
13	2 2	1 48	1 38	1 31	1 25	1 22	1 19	1 19	1 21	1 24	1 29	1 35	1 41	1 47	1 54	2 1	13
14	2 11	1 55	1 44	1 35	1 28	1 24	1 21	1 18	1 19	1 22	1 26	1 30	1 35	1 41	1 47	1 52	14
15	2 19	2 2	1 50	1 39	1 32	1 27	1 23	1 19	1 18	1 20	1 23	1 26	1 30	1 35	1 40	1 44	15
16	2 28	2 9	1 55	1 44	1 35	1 30	1 25	1 20	1 17	1 18	1 20	1 23	1 26	1 30	1 34	1 38	16
17	2 37	2 16	2 0	1 48	1 39	1 33	1 27	1 21	1 18	1 17	1 18	1 20	1 23	1 26	1 30	1 33	17
18	2 46	2 23	2 6	1 53	1 43	1 36	1 30	1 23	1 19	1 16	1 17	1 18	1 20	1 23	1 26	1 29	18
19	2 56	2 30	2 12	1 59	1 48	1 40	1 33	1 25	1 20	1 17	1 16	1 17	1 18	1 20	1 23	1 26	19
20	3 5	2 37	2 18	2 4	1 52	1 44	1 37	1 27	1 22	1 18	1 15	1 16	1 17	1 18	1 20	1 23	20
21	3 14	2 44	2 24	2 9	1 57	1 48	1 40	1 29	1 23	1 19	1 16	1 16	1 16	1 17	1 18	1 20	21
22	3 23	2 52	2 31	2 15	2 1	1 52	1 44	1 32	1 25	1 20	1 16	1 15	1 15	1 16	1 17	1 18	22
23	3 32	2 59	2 38	2 20	2 6	1 56	1 47	1 34	1 26	1 21	1 17	1 15	1 14	1 15	1 16	1 17	23
24	3 41	3 7	2 44	2 26	2 11	2 0	1 51	1 37	1 28	1 22	1 18	1 15	1 14	1 14	1 15	1 16	24
25	3 50	3 14	2 51	2 31	2 16	2 4	1 54	1 40	1 30	1 23	1 19	1 16	1 14	1 13	1 14	1 15	25
26	3 59	3 22	2 58	2 37	2 21	2 8	1 58	1 42	1 32	1 25	1 20	1 16	1 14	1 13	1 13	1 14	26
27	4 8	3 30	3 5	2 42	2 26	2 12	2 2	1 45	1 33	1 26	1 21	1 17	1 15	1 14	1 13	1 13	27
28	4 17	3 38	3 12	2 48	2 31	2 16	2 6	1 48	1 35	1 28	1 22	1 18	1 15	1 14	1 13	1 13	28
29	4 26	3 45	3 19	2 53	2 36	2 21	2 10	1 51	1 37	1 29	1 23	1 19	1 16	1 14	1 13	1 12	29
30	4 34	3 53	3 25	2 59	2 41	2 25	2 13	1 54	1 39	1 31	1 24	1 19	1 16	1 14	1 13	1 12	30
31	4 43	4 0	3 32	3 5	2 45	2 29	2 17	1 57	1 41	1 32	1 25	1 20	1 17	1 15	1 13	1 12	31
32	4 52	4 3	3 38	3 10	2 50	2 34	2 20	1 59	1 43	1 34	1 27	1 21	1 17	1 15	1 13	1 12	32
33	5 0	4 15	3 44	3 16	2 55	2 38	2 24	2 2	1 45	1 36	1 29	1 23	1 18	1 15	1 13	1 12	33
34	5 9	4 22	3 50	3 21	2 59	2 42	2 27	2 5	1 48	1 38	1 30	1 24	1 19	1 16	1 14	1 12	34
35	5 17	4 29	3 56	3 27	3 4	2 46	2 31	2 7	1 51	1 40	1 32	1 25	1 20	1 17	1 14	1 12	35
36	5 26	4 36	4 2	3 32	3 9	2 50	2 34	2 10	1 53	1 42	1 33	1 26	1 21	1 17	1 14	1 12	36
37	5 34	4 42	4 8	3 37	3 14	2 54	2 38	2 13	1 56	1 44	1 34	1 27	1 22	1 18	1 15	1 13	37
38	5 42	4 49	4 13	3 42	3 18	2 58	2 42	2 16	1 58	1 46	1 36	1 28	1 22	1 18	1 15	1 13	38
39	5 50	4 56	4 19	3 47	3 23	3 2	2 46	2 19	2 1	1 48	1 38	1 30	1 23	1 18	1 15	1 13	39
40	5 58	5 3	4 24	3 52	3 27	3 6	2 49	2 22	2 3	1 50	1 39	1 31	1 25	1 19	1 16	1 14	40
41	6 6	5 9	4 30	3 57	3 32	3 10	2 53	2 25	2 6	1 52	1 41	1 32	1 26	1 20	1 16	1 14	41
42	6 14	5 15	4 35	4 2	3 36	3 14	2 56	2 28	2 8	1 54	1 42	1 34	1 27	1 21	1 17	1 15	42
43	6 21	5 21	4 41	4 7	3 40	3 18	3 0	2 31	2 11	1 56	1 44	1 35	1 28	1 22	1 18	1 15	43
44	6 28	5 27	4 46	4 12	3 44	3 22	3 3	2 34	2 13	1 58	1 45	1 37	1 29	1 23	1 19	1 16	44
46	6 42	5 39	4 56	4 21	3 52	3 29	3 10	2 39	2 18	2 1	1 48	1 39	1 31	1 24	1 20	1 17	46
48	6 55	5 51	5 6	4 30	3 59	3 36	3 16	2 44	2 22	2 5	1 51	1 41	1 33	1 26	1 21	1 18	48
50	7 8	6 2	5 16	4 38	4 7	3 43	3 23	2 49	2 26	2 8	1 54	1 43	1 35	1 27	1 22	1 19	50
52	7 21	6 13	5 25	4 46	4 15	3 50	3 29	2 54	2 30	2 11	1 57	1 45	1 36	1 29	1 24	1 20	52
54	7 33	6 23	5 34	4 53	4 22	3 56	3 35	2 59	2 34	2 14	2 0	1 48	1 38	1 31	1 25	1 21	54
56	7 44	6 33	5 43	4 59	4 29	4 2	3 40	3 4	2 38	2 17	2 2	1 50	1 40	1 32	1 26	1 22	56
58	7 53	6 42	5 50	5 6	4 35	4 7	3 45	3 8	2 42	2 20	2 5	1 53	1 42	1 33	1 27	1 23	58
60	8 2	6 49	5 56	5 12	4 40	4 12	3 50	3 12	2 46	2 23	2 7	1 55	1 44	1 35	1 29	1 24	60
62			6 2	5 14	4 45	4 16	3 54	3 15	2 49	2 26	2 9	1 57	1 46	1 36	1 30	1 25	62
64					4 50	4 20	3 58	3 18	2 51	2 28	2 11	1 59	1 48	1 37	1 31	1 26	64
66							4 1	3 20	2 53	2 30	2 13	2 0	1 49	1 39	1 32	1 26	66
68								3 22	2 54	2 32	2 15	2 1	1 50	1 40	1 33	1 27	68
70									2 55	2 33	2 16	2 2	1 51	1 41	1 34	1 28	70
72										2 34	2 17	2 3	1 52	1 42	1 34	1 28	72
74											2 18	2 4	1 53	1 43	1 35	1 29	74
76												2 5	1 54	1 44	1 36	1 29	76
78													1 55	1 44	1 36	1 30	78
80														1 45	1 37	1 30	80
82															1 38	1 30	82
84																1 31	84
86																	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 52°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 43	5 1	5 18	5 34	6 6	6 36	7 4	7 29	7 53								6
7	3 59	4 14	4 29	4 43	5 9	5 34	5 58	6 20	6 42								7
8	3 30	3 43	3 55	4 8	4 30	4 52	5 13	5 32	5 50	6 6							8
9	3 4	3 15	3 26	3 37	3 58	4 17	4 36	4 51	5 5	5 18							9
10	2 45	2 54	3 4	3 14	3 32	3 48	4 4	4 20	4 33	4 45							10
11	2 30	2 38	2 47	2 55	3 11	3 26	3 40	3 54	4 6	4 10							11
12	2 17	2 25	2 32	2 40	2 54	3 7	3 20	3 32	3 43	3 52	4 1						12
13	2 7	2 13	2 20	2 26	2 39	2 51	3 3	3 14	3 24	3 32	3 38						13
14	1 58	2 3	2 9	2 14	2 26	2 37	2 48	2 58	3 7	3 14	3 20						14
15	1 49	1 54	1 59	2 4	2 15	2 26	2 35	2 44	2 52	2 59	3 5						15
16	1 42	1 47	1 51	1 56	2 7	2 16	2 24	2 32	2 40	2 46	2 52	2 57					16
17	1 37	1 41	1 45	1 50	2 0	2 8	2 15	2 22	2 29	2 35	2 40	2 44					17
18	1 32	1 36	1 40	1 45	1 53	2 0	2 7	2 13	2 19	2 25	2 30	2 33					18
19	1 29	1 32	1 36	1 40	1 47	1 53	2 0	2 6	2 11	2 10	2 21	2 24					19
20	1 26	1 29	1 32	1 35	1 41	1 47	1 53	1 59	2 4	2 9	2 13	2 16	2 19				20
21	1 23	1 26	1 28	1 31	1 37	1 42	1 47	1 53	1 58	2 2	2 6	2 9	2 11				21
22	1 21	1 23	1 25	1 28	1 33	1 37	1 42	1 47	1 52	1 56	1 59	2 2	2 4				22
23	1 19	1 21	1 23	1 25	1 29	1 33	1 38	1 42	1 47	1 51	1 54	1 56	1 58				23
24	1 17	1 19	1 21	1 23	1 26	1 30	1 34	1 38	1 42	1 46	1 49	1 51	1 53	1 55			24
25	1 16	1 17	1 19	1 20	1 23	1 27	1 30	1 34	1 37	1 41	1 44	1 46	1 48	1 49			25
26	1 15	1 16	1 17	1 18	1 21	1 24	1 27	1 30	1 33	1 36	1 39	1 41	1 43	1 44			26
27	1 14	1 15	1 16	1 17	1 19	1 22	1 24	1 27	1 30	1 32	1 35	1 37	1 39	1 40			27
28	1 13	1 14	1 15	1 16	1 17	1 20	1 22	1 24	1 27	1 29	1 31	1 33	1 35	1 36	1 37		28
29	1 12	1 13	1 14	1 15	1 16	1 18	1 20	1 22	1 24	1 26	1 28	1 30	1 31	1 32	1 33		29
30	1 12	1 12	1 13	1 13	1 14	1 16	1 18	1 20	1 22	1 24	1 25	1 27	1 28	1 29	1 30		30
31	1 11	1 11	1 12	1 12	1 13	1 15	1 16	1 18	1 20	1 22	1 23	1 24	1 25	1 26	1 27		31
32	1 11	1 11	1 11	1 11	1 12	1 14	1 15	1 16	1 18	1 20	1 21	1 22	1 23	1 23	1 24	1 25	32
33	1 11	1 10	1 10	1 10	1 11	1 13	1 14	1 15	1 17	1 18	1 19	1 20	1 21	1 21	1 22	1 22	33
34	1 11	1 10	1 10	1 10	1 11	1 12	1 13	1 14	1 16	1 17	1 17	1 18	1 19	1 19	1 20	1 20	34
35	1 11	1 10	1 10	1 10	1 10	1 11	1 12	1 13	1 14	1 15	1 15	1 16	1 17	1 17	1 18	1 18	35
36	1 11	1 10	1 9	1 9	1 9	1 10	1 11	1 11	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 16	36
37	1 11	1 10	1 9	1 9	1 9	1 9	1 10	1 10	1 11	1 11	1 12	1 12	1 13	1 13	1 14	1 14	37
38	1 11	1 10	1 9	1 8	1 8	1 9	1 9	1 9	1 10	1 10	1 11	1 11	1 11	1 11	1 12	1 12	38
39	1 11	1 10	1 9	1 8	1 8	1 8	1 8	1 8	1 9	1 9	1 10	1 10	1 10	1 10	1 10	1 10	39
40	1 12	1 10	1 9	1 8	1 7	1 7	1 7	1 7	1 8	1 8	1 9	1 9	1 9	1 9	1 9	1 9	40
41	1 12	1 11	1 9	1 8	1 7	1 7	1 7	1 7	1 7	1 7	1 8	1 8	1 8	1 8	1 8	1 8	41
42	1 13	1 11	1 9	1 8	1 6	1 6	1 6	1 6	1 6	1 6	1 7	1 7	1 7	1 7	1 7	1 7	42
43	1 13	1 11	1 9	1 8	1 6	1 6	1 6	1 6	1 6	1 6	1 6	1 6	1 6	1 6	1 6	1 6	43
44	1 14	1 11	1 9	1 8	1 6	1 5	1 5	1 5	1 5	1 5	1 5	1 5	1 5	1 5	1 5	1 5	44
46	1 14	1 12	1 10	1 9	1 6	1 4	1 4	1 4	1 4	1 4	1 4	1 3	1 3	1 3	1 3		46
48	1 15	1 13	1 11	1 9	1 6	1 4	1 3	1 3	1 3	1 2	1 2	1 1	1 1	1 1	1 1		48
50	1 16	1 14	1 11	1 9	1 6	1 4	1 2	1 2	1 2	1 1	1 1	1 0	1 0	1 0			50
52	1 17	1 15	1 12	1 9	1 6	1 4	1 2	1 1	1 1	1 0	1 0	0 59	0 58				52
54	1 18	1 15	1 12	1 9	1 6	1 4	1 2	1 1	1 0	0 59	0 59	0 58	0 57				54
56	1 18	1 15	1 12	1 10	1 6	1 4	1 2	1 0	0 59	0 58	0 58	0 57	0 56				56
58	1 19	1 16	1 13	1 10	1 6	1 4	1 2	1 0	0 59	0 58	0 57	0 56					
60	1 20	1 16	1 13	1 10	1 7	1 4	1 2	1 0	0 58	0 57	0 56	0 55					
62	1 21	1 17	1 13	1 10	1 7	1 4	1 1	0 59	0 58	0 56	0 55						
64	1 22	1 18	1 14	1 11	1 7	1 4	1 1	0 59	0 57	0 56	0 54						
66	1 22	1 18	1 14	1 11	1 7	1 4	1 1	0 59	0 57	0 55							
68	1 22	1 18	1 14	1 11	1 7	1 3	1 0	0 58	0 56	0 54							
70	1 23	1 18	1 14	1 11	1 7	1 3	1 0	0 58	0 56								
72	1 23	1 19	1 15	1 11	1 7	1 3	1 0	0 57	0 55								
74	1 24	1 19	1 15	1 11	1 7	1 3	1 0	0 57									
76	1 24	1 19	1 15	1 12	1 7	1 3	1 0	0 56									
78	1 24	1 19	1 15	1 12	1 7	1 3	1 0										
80	1 24	1 19	1 15	1 12	1 7	1 3	1 0										
82	1 25	1 20	1 16	1 12	1 7	1 3											
84	1 25	1 20	1 16	1 12	1 7	1 3											
86	1 25	1 21	1 16	1 12	1 7												
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″		″
5	0	1	2	3	4	4				
10	1	1	1	2	3	3	4			
20	3	3	1	0	1	2	2	3		
30	5	4	3	2	1	0	0	1		
40	7	6	5	4	3	2	1	1	0	0
50	8	8	6	5	4	3	3	2	2	
60		9	7	6	5	4	4	3		
70			8	7	6	5	5			
80				8	7	6				
90					7					

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 56°.

☽'s App. Alt.	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App Alt.
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 20	1 22	1 25	1 29	1 35	1 41	1 48	2 2	2 18	2 35	2 52	3 10	3 27	3 45	4 3	4 20	6
7	1 23	1 20	1 22	1 24	1 27	1 32	1 37	1 48	2 1	2 15	2 29	2 43	2 58	3 12	3 27	3 42	7
8	1 28	1 23	1 20	1 21	1 23	1 26	1 29	1 38	1 48	2 0	2 12	2 23	2 35	2 48	3 1	3 14	8
9	1 34	1 27	1 22	1 20	1 21	1 23	1 25	1 31	1 39	1 48	1 58	2 8	2 18	2 29	2 40	2 50	9
10	1 40	1 31	1 25	1 22	1 20	1 21	1 22	1 26	1 32	1 39	1 48	1 56	2 5	2 15	2 24	2 33	10
11	1 47	1 30	1 29	1 25	1 22	1 20	1 21	1 23	1 27	1 33	1 40	1 47	1 55	2 4	2 12	2 20	11
12	1 54	1 42	1 33	1 28	1 24	1 21	1 20	1 21	1 24	1 28	1 34	1 40	1 47	1 55	2 2	2 9	12
13	2 2	1 48	1 38	1 31	1 26	1 23	1 21	1 20	1 22	1 25	1 30	1 35	1 41	1 47	1 54	2 0	13
14	2 10	1 54	1 43	1 35	1 29	1 25	1 22	1 19	1 20	1 23	1 27	1 31	1 36	1 41	1 47	1 52	14
15	2 18	2 1	1 48	1 39	1 33	1 28	1 24	1 21	1 19	1 21	1 24	1 27	1 32	1 36	1 41	1 46	15
16	2 27	2 8	1 53	1 43	1 36	1 31	1 26	1 22	1 19	1 19	1 21	1 24	1 28	1 32	1 36	1 40	16
17	2 35	2 15	1 59	1 47	1 40	1 34	1 29	1 23	1 20	1 18	1 19	1 22	1 25	1 28	1 32	1 35	17
18	2 44	2 22	2 4	1 52	1 43	1 37	1 31	1 25	1 20	1 17	1 18	1 20	1 22	1 25	1 28	1 31	18
19	2 53	2 29	2 10	1 57	1 47	1 40	1 34	1 26	1 21	1 18	1 17	1 19	1 20	1 23	1 25	1 28	19
20	3 2	2 36	2 16	2 2	1 51	1 44	1 37	1 28	1 22	1 19	1 17	1 18	1 19	1 21	1 23	1 25	20
21	3 11	2 44	2 22	2 8	1 55	1 47	1 40	1 30	1 24	1 20	1 18	1 17	1 18	1 19	1 21	1 23	21
22	3 20	2 51	2 29	2 13	2 0	1 51	1 43	1 32	1 25	1 21	1 18	1 16	1 17	1 18	1 19	1 21	22
23	3 29	2 58	2 35	2 18	2 5	1 55	1 46	1 35	1 27	1 22	1 19	1 17	1 16	1 17	1 18	1 19	23
24	3 38	3 5	2 42	2 23	2 9	1 59	1 50	1 37	1 29	1 24	1 20	1 17	1 16	1 16	1 17	1 18	24
25	3 47	3 13	2 49	2 29	2 14	2 3	1 53	1 39	1 31	1 25	1 21	1 18	1 16	1 16	1 16	1 17	25
26	3 55	3 20	2 55	2 34	2 19	2 7	1 57	1 42	1 33	1 27	1 22	1 19	1 17	1 16	1 16	1 16	26
27	4 4	3 27	3 1	2 39	2 24	2 12	2 1	1 45	1 35	1 28	1 23	1 19	1 17	1 16	1 16	1 16	27
28	4 12	3 34	3 8	2 45	2 29	2 16	2 5	1 48	1 37	1 30	1 24	1 20	1 18	1 16	1 15	1 16	28
29	4 21	3 41	3 14	2 50	2 33	2 20	2 8	1 51	1 39	1 31	1 25	1 21	1 18	1 16	1 15	1 15	29
30	4 29	3 48	3 20	2 55	2 38	2 24	2 12	1 54	1 41	1 33	1 26	1 21	1 18	1 16	1 15	1 15	30
31	4 38	3 55	3 26	3 0	2 43	2 28	2 16	1 57	1 44	1 34	1 28	1 22	1 18	1 16	1 16	1 15	31
32	4 46	4 2	3 32	3 6	2 48	2 32	2 19	2 0	1 46	1 36	1 29	1 23	1 19	1 17	1 16	1 15	32
33	4 54	4 9	3 39	3 11	2 53	2 36	2 23	2 3	1 49	1 38	1 31	1 25	1 20	1 17	1 16	1 15	33
34	5 2	4 16	3 45	3 16	2 57	2 40	2 26	2 6	1 51	1 40	1 32	1 26	1 21	1 18	1 16	1 15	34
35	5 10	4 23	3 51	3 22	3 2	2 44	2 30	2 9	1 53	1 42	1 34	1 27	1 22	1 18	1 16	1 15	35
36	5 18	4 30	3 57	3 27	3 6	2 48	2 33	2 12	1 55	1 44	1 35	1 28	1 23	1 19	1 17	1 16	36
37	5 26	4 37	4 3	3 32	3 10	2 52	2 37	2 15	1 58	1 46	1 37	1 29	1 24	1 20	1 18	1 16	37
38	5 33	4 43	4 8	3 37	3 14	2 56	2 41	2 17	2 0	1 48	1 38	1 30	1 25	1 21	1 18	1 16	38
39	5 41	4 50	4 14	3 42	3 19	3 0	2 45	2 20	2 2	1 50	1 39	1 31	1 25	1 21	1 18	1 16	39
40	5 48	4 56	4 19	3 47	3 23	3 4	2 48	2 23	2 4	1 51	1 40	1 32	1 26	1 22	1 19	1 16	40
41	5 55	5 2	4 25	3 52	3 28	3 8	2 51	2 25	2 6	1 53	1 42	1 33	1 27	1 23	1 20	1 17	41
42	6 2	5 8	4 30	3 57	3 32	3 11	2 54	2 28	2 9	1 55	1 43	1 34	1 28	1 24	1 20	1 17	42
43	6 9	5 14	4 35	4 2	3 36	3 15	2 58	2 31	2 12	1 57	1 44	1 35	1 29	1 25	1 21	1 17	43
44	6 16	5 20	4 40	4 7	3 40	3 19	3 1	2 34	2 14	1 59	1 46	1 37	1 31	1 26	1 22	1 18	44
46	6 29	5 32	4 50	4 16	3 48	3 26	3 8	2 40	2 18	2 2	1 49	1 40	1 33	1 28	1 23	1 19	46
48	6 42	5 43	4 59	4 24	3 56	3 33	3 14	2 45	2 22	2 6	1 52	1 43	1 36	1 30	1 25	1 20	48
50	6 54	5 54	5 8	4 32	4 3	3 40	3 19	2 50	2 26	2 9	1 55	1 45	1 38	1 32	1 26	1 21	50
52	7 6	6 4	5 17	4 39	4 10	3 46	3 24	2 55	2 30	2 12	1 58	1 48	1 40	1 33	1 27	1 22	52
54	7 18	6 14	5 25	4 46	4 16	3 52	3 29	2 59	2 34	2 15	2 0	1 50	1 42	1 35	1 29	1 24	54
56	7 29	6 24	5 33	4 53	4 22	3 57	3 34	3 3	2 37	2 19	2 3	1 52	1 43	1 36	1 30	1 25	56
58	7 40	6 33	5 41	5 0	4 28	4 2	3 39	3 7	2 41	2 22	2 6	1 54	1 45	1 37	1 31	1 26	58
60	7 50	6 41	5 48	5 7	4 34	4 7	3 43	3 11	2 44	2 25	2 8	1 56	1 47	1 39	1 32	1 27	60
62	7 58	6 48	5 55	5 13	4 40	4 12	3 48	3 15	2 47	2 28	2 11	1 58	1 48	1 40	1 33	1 28	62
64	8 6	6 55	6 1	5 19	4 45	4 17	3 52	3 18	2 50	2 30	2 13	2 0	1 50	1 41	1 34	1 29	64
66			6 7	5 24	4 50	4 21	3 56	3 20	2 53	2 32	2 15	2 2	1 51	1 42	1 35	1 29	66
68					4 55	4 25	4 0	3 22	2 55	2 34	2 17	2 4	1 52	1 43	1 36	1 30	68
70							4 4	3 24	2 57	2 36	2 18	2 5	1 53	1 44	1 37	1 31	70
72								3 26	2 59	2 37	2 19	2 6	1 54	1 45	1 38	1 32	72
74									3 1	2 38	2 20	2 7	1 55	1 46	1 39	1 32	74
76										2 39	2 21	2 8	1 56	1 47	1 39	1 33	76
78											2 22	2 8	1 57	1 48	1 40	1 33	78
80												2 9	1 58	1 48	1 40	1 34	80
82													1 58	1 48	1 40	1 34	82
84														1 49	1 41	1 34	84
86															1 41	1 34	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 56°.

☽'s App. Alt.	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 37	4 54	5 10	5 26	5 56	6 25	6 52	7 15	7 37	7 58							6
7	3 57	4 11	4 25	4 38	5 3	5 29	5 52	6 12	6 31	6 48							7
8	3 26	3 38	3 51	4 3	4 26	4 47	5 5	5 23	5 40	5 55	6 8						8
9	3 1	3 12	3 23	3 33	3 53	4 12	4 30	4 46	5 0	5 13	5 25						9
10	2 43	2 53	3 2	3 11	3 28	3 45	4 1	4 15	4 27	4 39	4 50						10
11	2 29	2 37	2 45	2 53	3 9	3 24	3 38	3 50	4 1	4 12	4 21						11
12	2 16	2 23	2 30	2 38	2 52	3 6	3 18	3 28	3 38	3 47	3 56	4 4					12
13	2 6	2 12	2 18	2 25	2 37	2 50	3 1	3 10	3 19	3 28	3 36	3 42					13
14	1 57	2 3	2 8	2 14	2 25	2 36	2 47	2 56	3 4	3 12	3 19	3 24					14
15	1 50	1 55	1 59	2 5	2 15	2 25	2 35	2 44	2 51	2 58	3 4	3 10					15
16	1 44	1 48	1 53	1 58	2 7	2 16	2 25	2 33	2 39	2 45	2 51	2 57	3 2				16
17	1 39	1 43	1 48	1 52	2 0	2 8	2 16	2 24	2 30	2 35	2 40	2 45	2 49				17
18	1 35	1 39	1 43	1 47	1 54	2 1	2 8	2 15	2 21	2 26	2 31	2 35	2 38				18
19	1 31	1 35	1 38	1 42	1 48	1 55	2 1	2 7	2 13	2 18	2 23	2 27	2 30				19
20	1 28	1 31	1 34	1 37	1 43	1 49	1 55	2 0	2 6	2 10	2 13	2 19	2 22	2 24			20
21	1 25	1 27	1 30	1 33	1 38	1 44	1 49	1 54	1 59	2 3	2 7	2 11	2 14	2 16			21
22	1 22	1 24	1 27	1 30	1 34	1 39	1 44	1 48	1 52	1 56	2 0	2 4	2 6	2 8			22
23	1 20	1 22	1 24	1 27	1 31	1 35	1 40	1 44	1 47	1 51	1 54	1 57	2 0	2 2			23
24	1 19	1 20	1 22	1 25	1 28	1 32	1 36	1 40	1 43	1 46	1 49	1 52	1 54	1 56	1 58		24
25	1 18	1 19	1 21	1 23	1 26	1 29	1 33	1 36	1 39	1 42	1 44	1 47	1 49	1 51	1 53		25
26	1 17	1 18	1 19	1 21	1 24	1 27	1 30	1 33	1 35	1 38	1 40	1 42	1 44	1 46	1 48		26
27	1 16	1 17	1 18	1 19	1 22	1 25	1 27	1 30	1 32	1 35	1 37	1 39	1 40	1 42	1 44		27
28	1 16	1 16	1 17	1 18	1 20	1 23	1 25	1 27	1 29	1 32	1 34	1 36	1 37	1 39	1 40	1 41	28
29	1 15	1 15	1 16	1 17	1 19	1 21	1 23	1 25	1 27	1 29	1 31	1 33	1 34	1 35	1 36	1 37	29
30	1 15	1 15	1 16	1 16	1 17	1 19	1 21	1 23	1 25	1 27	1 29	1 30	1 31	1 32	1 33	1 34	30
31	1 14	1 14	1 15	1 15	1 16	1 18	1 19	1 21	1 23	1 25	1 27	1 28	1 29	1 29	1 30	1 31	31
32	1 14	1 14	1 14	1 14	1 15	1 17	1 18	1 19	1 21	1 23	1 25	1 26	1 27	1 27	1 27	1 28	32
33	1 14	1 13	1 13	1 13	1 14	1 16	1 17	1 18	1 20	1 21	1 23	1 24	1 25	1 25	1 25	1 26	33
34	1 14	1 13	1 13	1 13	1 14	1 15	1 16	1 17	1 19	1 20	1 21	1 22	1 23	1 23	1 23	1 24	34
35	1 14	1 13	1 13	1 13	1 13	1 14	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 21	1 21	1 22	35
36	1 14	1 13	1 12	1 12	1 12	1 13	1 14	1 15	1 16	1 16	1 17	1 18	1 19	1 19	1 19	1 20	36
37	1 14	1 13	1 12	1 12	1 12	1 12	1 13	1 14	1 15	1 15	1 16	1 16	1 17	1 17	1 17	1 18	37
38	1 14	1 13	1 12	1 11	1 11	1 12	1 13	1 13	1 14	1 14	1 15	1 15	1 16	1 16	1 16	1 17	38
39	1 14	1 13	1 12	1 11	1 11	1 11	1 12	1 12	1 13	1 13	1 13	1 13	1 14	1 14	1 15	1 15	39
40	1 14	1 13	1 12	1 11	1 10	1 10	1 11	1 11	1 12	1 12	1 12	1 12	1 12	1 13	1 13	1 13	40
41	1 15	1 14	1 12	1 11	1 10	1 10	1 10	1 10	1 11	1 11	1 11	1 11	1 11	1 12	1 12		41
42	1 15	1 14	1 12	1 11	1 9	1 9	1 9	1 9	1 10	1 10	1 10	1 10	1 10	1 11	1 11		42
43	1 15	1 14	1 12	1 11	1 9	1 9	1 9	1 9	1 9	1 9	1 9	1 9	1 9	1 10	1 10		43
44	1 16	1 14	1 12	1 11	1 9	1 8	1 8	1 8	1 8	1 8	1 8	1 8	1 8	1 9	1 9		44
46	1 17	1 15	1 13	1 12	1 9	1 7	1 7	1 7	1 6	1 6	1 6	1 7	1 7	1 7			46
48	1 17	1 15	1 13	1 12	1 9	1 7	1 6	1 6	1 5	1 5	1 5	1 5	1 5	1 6			48
50	1 18	1 16	1 14	1 12	1 9	1 6	1 5	1 5	1 4	1 4	1 4	1 4	1 4				50
52	1 19	1 17	1 15	1 13	1 9	1 6	1 4	1 4	1 3	1 3	1 3	1 3	1 3				52
54	1 20	1 17	1 15	1 13	1 9	1 6	1 4	1 3	1 3	1 2	1 2	1 2					54
56	1 21	1 18	1 16	1 14	1 10	1 6	1 4	1 2	1 2	1 1	1 1	1 1					56
58	1 22	1 19	1 16	1 14	1 10	1 6	1 4	1 2	1 1	1 0	1 0						58
60	1 23	1 19	1 16	1 14	1 10	1 6	1 4	1 2	1 1	1 0	1 0						60
62	1 24	1 20	1 17	1 14	1 10	1 6	1 4	1 2	1 1	1 0							62
64	1 24	1 20	1 17	1 14	1 11	1 7	1 4	1 2	1 0	1 0							64
66	1 25	1 21	1 18	1 15	1 11	1 7	1 4	1 2	1 0								66
68	1 25	1 21	1 18	1 15	1 11	1 7	1 4	1 2	1 0								68
70	1 26	1 22	1 19	1 16	1 11	1 7	1 4	1 2									70
72	1 27	1 23	1 19	1 16	1 11	1 7	1 4	1 2									72
74	1 27	1 23	1 19	1 16	1 11	1 7	1 4										74
76	1 28	1 23	1 19	1 16	1 11	1 7	1 4										76
78	1 28	1 23	1 20	1 17	1 11	1 7											78
80	1 29	1 24	1 20	1 17	1 11	1 7											80
82	1 29	1 24	1 20	1 17	1 11												82
84	1 29	1 24	1 20	1 17	1 11												84
86	1 29	1 24	1 20	1 17													86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	0	0	1	2	3	4	4			
10	1	1	0	1	2	3	3			
20	3	3	2	1	0	1	2	2		
30	5	4	3	2	1	1	0	0	1	
40	6	6	5	4	3	2	2	1	1	0
50	8	7	6	5	4	4	3	3		
60	9	8	7	6	5	5	4			
70		9	8	7	6	6				
80			8	8	7					
90				8						

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 60°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 22	1 23	1 25	1 28	1 33	1 40	1 47	2 1	2 16	2 33	2 50	3 8	3 25	3 41	3 58	4 15	6
7	1 24	1 22	1 26	1 25	1 28	1 33	1 37	1 47	1 59	2 13	2 27	2 41	2 55	3 9	3 23	3 37	7
8	1 28	1 24	1 22	1 23	1 25	1 28	1 31	1 39	1 48	1 59	2 11	2 23	2 35	2 48	3 0	3 12	8
9	1 33	1 28	1 24	1 22	1 24	1 25	1 27	1 33	1 40	1 49	1 58	2 8	2 18	2 29	2 39	2 50	9
10	1 40	1 33	1 27	1 24	1 23	1 24	1 25	1 29	1 34	1 41	1 49	1 57	2 6	2 15	2 25	2 34	10
11	1 47	1 38	1 31	1 27	1 24	1 23	1 24	1 26	1 30	1 36	1 42	1 49	1 57	2 5	2 13	2 21	11
12	1 55	1 43	1 36	1 30	1 26	1 24	1 23	1 25	1 28	1 32	1 37	1 43	1 49	1 56	2 3	2 11	12
13	2 3	1 49	1 40	1 34	1 29	1 26	1 24	1 24	1 26	1 29	1 33	1 38	1 43	1 49	1 55	2 2	13
14	2 10	1 55	1 45	1 38	1 32	1 28	1 25	1 23	1 25	1 27	1 30	1 34	1 38	1 43	1 49	1 54	14
15	2 18	2 1	1 50	1 42	1 36	1 31	1 27	1 24	1 23	1 25	1 27	1 30	1 34	1 38	1 43	1 48	15
16	2 26	2 7	1 55	1 46	1 39	1 34	1 29	1 25	1 22	1 23	1 25	1 27	1 30	1 34	1 38	1 43	16
17	2 34	2 13	2 0	1 50	1 43	1 37	1 31	1 26	1 22	1 22	1 23	1 25	1 28	1 31	1 34	1 38	17
18	2 42	2 20	2 5	1 54	1 46	1 40	1 34	1 27	1 23	1 21	1 22	1 23	1 25	1 28	1 31	1 34	18
19	2 50	2 27	2 11	1 59	1 50	1 43	1 36	1 29	1 24	1 22	1 21	1 22	1 23	1 26	1 28	1 31	19
20	2 59	2 34	2 17	2 4	1 54	1 46	1 39	1 31	1 25	1 22	1 20	1 21	1 22	1 24	1 26	1 28	20
21	3 7	2 41	2 23	2 9	1 58	1 50	1 42	1 33	1 26	1 23	1 21	1 20	1 21	1 22	1 24	1 25	21
22	3 15	2 48	2 29	2 14	2 2	1 53	1 45	1 35	1 28	1 24	1 21	1 20	1 20	1 21	1 22	1 23	22
23	3 24	2 55	2 35	2 19	2 7	1 57	1 48	1 37	1 30	1 25	1 22	1 20	1 20	1 20	1 21	1 22	23
24	3 32	3 2	2 41	2 24	2 10	2 1	1 52	1 40	1 31	1 26	1 23	1 21	1 20	1 20	1 20	1 21	24
25	3 41	3 9	2 47	2 29	2 15	2 4	1 55	1 42	1 33	1 27	1 24	1 22	1 20	1 19	1 19	1 20	25
26	3 49	3 16	2 53	2 34	2 20	2 8	1 59	1 45	1 35	1 29	1 25	1 22	1 20	1 19	1 19	1 19	26
27	3 58	3 23	2 59	2 39	2 25	2 12	2 3	1 48	1 38	1 31	1 26	1 23	1 21	1 19	1 19	1 19	27
28	4 6	3 30	3 5	2 44	2 29	2 16	2 7	1 51	1 40	1 32	1 27	1 23	1 21	1 19	1 18	1 18	28
29	4 15	3 37	3 11	2 49	2 33	2 20	2 11	1 53	1 42	1 34	1 28	1 24	1 21	1 19	1 18	1 18	29
30	4 23	3 44	3 17	2 54	2 38	2 24	2 14	1 56	1 44	1 35	1 29	1 24	1 21	1 19	1 18	1 18	30
31	4 31	3 51	3 23	2 59	2 42	2 28	2 18	1 59	1 46	1 37	1 30	1 25	1 22	1 20	1 18	1 18	31
32	4 39	3 58	3 29	3 4	2 47	2 32	2 21	2 2	1 48	1 38	1 31	1 26	1 22	1 20	1 19	1 18	32
33	4 47	4 5	3 34	3 9	2 52	2 36	2 25	2 5	1 51	1 40	1 33	1 27	1 23	1 20	1 19	1 18	33
34	4 55	4 12	3 40	3 14	2 56	2 40	2 28	2 8	1 53	1 41	1 34	1 28	1 24	1 21	1 19	1 18	34
35	5 3	4 18	3 46	3 19	3 0	2 44	2 32	2 11	1 55	1 43	1 35	1 29	1 25	1 22	1 20	1 18	35
36	5 10	4 24	3 52	3 24	3 4	2 48	2 35	2 14	1 57	1 45	1 37	1 31	1 26	1 22	1 20	1 18	36
37	5 18	4 31	3 58	3 29	3 8	2 52	2 39	2 17	1 59	1 47	1 38	1 32	1 27	1 23	1 21	1 19	37
38	5 25	4 38	4 4	3 34	3 12	2 55	2 42	2 20	2 2	1 49	1 40	1 33	1 28	1 24	1 21	1 19	38
39	5 32	4 45	4 10	3 39	3 17	2 59	2 46	2 22	2 4	1 51	1 42	1 35	1 29	1 25	1 22	1 20	39
40	5 39	4 51	4 15	3 44	3 21	3 3	2 49	2 25	2 6	1 53	1 43	1 36	1 30	1 26	1 22	1 20	40
41	5 46	4 57	4 21	3 49	3 26	3 7	2 52	2 27	2 8	1 55	1 45	1 37	1 31	1 27	1 23	1 20	41
42	5 53	5 3	4 26	3 53	3 30	3 11	2 55	2 30	2 10	1 56	1 46	1 38	1 32	1 28	1 24	1 21	42
43	6 0	5 9	4 31	3 58	3 35	3 15	2 58	2 32	2 13	1 58	1 48	1 40	1 34	1 29	1 25	1 22	43
44	6 7	5 15	4 36	4 3	3 39	3 19	3 1	2 35	2 15	2 0	1 49	1 41	1 35	1 30	1 26	1 22	44
46	6 21	5 26	4 46	4 12	3 47	3 26	3 7	2 40	2 19	2 4	1 52	1 43	1 37	1 31	1 27	1 23	46
48	6 34	5 37	4 55	4 20	3 54	3 32	3 13	2 45	2 23	2 8	1 56	1 46	1 39	1 33	1 28	1 24	48
50	6 47	5 48	5 4	4 28	4 1	3 37	3 19	2 50	2 27	2 11	1 59	1 48	1 41	1 35	1 29	1 25	50
52	6 59	5 58	5 13	4 36	4 8	3 43	3 25	2 55	2 31	2 14	2 2	1 51	1 43	1 36	1 31	1 27	52
54	7 11	6 8	5 22	4 44	4 15	3 49	3 30	2 59	2 35	2 18	2 4	1 53	1 45	1 38	1 33	1 28	54
56	7 22	6 17	5 30	4 51	4 21	3 55	3 35	3 4	2 38	2 21	2 7	1 56	1 47	1 40	1 34	1 29	56
58	7 31	6 25	5 37	4 58	4 27	4 1	3 40	3 8	2 41	2 24	2 10	1 58	1 49	1 41	1 35	1 30	58
60	7 40	6 32	5 45	5 4	4 32	4 6	3 45	3 12	2 44	2 27	2 12	2 0	1 50	1 42	1 36	1 31	60
62	7 48	6 39	5 52	5 10	4 38	4 11	3 50	3 16	2 48	2 29	2 14	2 2	1 52	1 44	1 37	1 32	62
64	7 56	6 46	5 58	5 15	4 43	4 15	3 55	3 19	2 51	2 31	2 16	2 4	1 53	1 45	1 38	1 33	64
66	8 3	6 53	6 2	5 20	4 47	4 19	3 59	3 22	2 54	2 33	2 18	2 5	1 55	1 46	1 39	1 34	66
68	8 10	6 59	6 6	5 24	4 51	4 23	4 2	3 25	2 56	2 35	2 19	2 6	1 56	1 47	1 40	1 34	68
70			6 10	5 27	4 54	4 26	4 4	3 27	2 58	2 36	2 20	2 7	1 57	1 48	1 41	1 35	70
72					4 57	4 29	4 6	3 28	3 0	2 38	2 21	2 8	1 58	1 49	1 41	1 35	72
74							4 8	3 29	3 2	2 39	2 22	2 9	1 59	1 50	1 42	1 36	74
76								3 30	3 3	2 41	2 23	2 10	1 59	1 50	1 42	1 36	76
78									3 4	2 42	2 24	2 11	2 0	1 51	1 43	1 37	78
80										2 43	2 25	2 12	2 1	1 51	1 43	1 37	80
82											2 26	2 12	2 1	1 52	1 44	1 38	82
84												2 12	2 2	1 52	1 44	1 38	84
86													2 2	1 52	1 44	1 38	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 60°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 32	4 48	5 3	5 19	5 49	6 17	6 44	7 7	7 28	7 47	8 3						6
7	3 51	4 5	4 19	4 32	4 58	5 22	5 44	6 4	6 22	6 38	6 53						7
8	3 23	3 35	3 47	3 59	4 22	4 42	5 1	5 19	5 35	5 50	6 2	6 13					8
9	3 0	3 10	3 20	3 30	3 49	4 8	4 25	4 41	4 55	5 8	5 19	5 30					9
10	2 43	2 51	3 0	3 9	3 26	3 42	3 58	4 12	4 24	4 35	4 45	4 54					10
11	2 29	2 37	2 44	2 52	3 7	3 21	3 35	3 48	3 59	4 9	4 18	4 26					11
12	2 18	2 25	2 32	2 39	2 52	3 5	3 17	3 29	3 39	3 48	3 56	4 3	4 8				12
13	2 8	2 15	2 21	2 28	2 39	2 51	3 2	3 12	3 21	3 30	3 38	3 44	3 48				13
14	2 0	2 6	2 12	2 18	2 28	2 38	2 48	2 57	3 6	3 14	3 21	3 26	3 29				14
15	1 53	1 58	2 3	2 8	2 18	2 27	2 36	2 45	2 53	3 0	3 6	3 11	3 15				15
16	1 47	1 51	1 55	2 0	2 9	2 18	2 26	2 34	2 41	2 48	2 53	2 58	3 2	3 6			16
17	1 42	1 45	1 49	1 53	2 1	2 9	2 17	2 24	2 31	2 37	2 42	2 46	2 50	2 53			17
18	1 37	1 40	1 44	1 47	1 54	2 1	2 9	2 16	2 22	2 27	2 32	2 36	2 40	2 42			18
19	1 33	1 36	1 39	1 42	1 48	1 55	2 2	2 9	2 15	2 19	2 24	2 28	2 31	2 33			19
20	1 30	1 32	1 35	1 38	1 44	1 50	1 56	2 2	2 8	2 12	2 16	2 20	2 23	2 25	2 27		20
21	1 27	1 29	1 32	1 35	1 40	1 46	1 51	1 56	2 1	2 6	2 10	2 13	2 15	2 17	2 19		21
22	1 25	1 27	1 29	1 32	1 37	1 42	1 47	1 51	1 56	2 0	2 4	2 6	2 8	2 10	2 12		22
23	1 23	1 25	1 27	1 30	1 34	1 38	1 43	1 47	1 51	1 55	1 59	2 1	2 3	2 4	2 6		23
24	1 22	1 23	1 25	1 27	1 31	1 35	1 40	1 44	1 47	1 51	1 54	1 56	1 58	1 59	2 1	2 3	24
25	1 21	1 22	1 23	1 25	1 29	1 32	1 36	1 40	1 43	1 47	1 49	1 51	1 53	1 54	1 56	1 57	25
26	1 20	1 21	1 22	1 23	1 26	1 29	1 33	1 37	1 40	1 43	1 45	1 47	1 49	1 50	1 51	1 52	26
27	1 19	1 20	1 21	1 22	1 24	1 27	1 30	1 34	1 37	1 40	1 42	1 43	1 45	1 46	1 47	1 48	27
28	1 19	1 19	1 20	1 21	1 23	1 25	1 28	1 31	1 34	1 37	1 39	1 40	1 41	1 42	1 43	1 44	28
29	1 18	1 18	1 19	1 20	1 22	1 23	1 26	1 29	1 31	1 34	1 36	1 37	1 38	1 39	1 40	1 41	29
30	1 18	1 18	1 18	1 19	1 20	1 22	1 24	1 27	1 29	1 31	1 33	1 34	1 35	1 36	1 37	1 38	30
31	1 18	1 18	1 18	1 18	1 19	1 20	1 22	1 25	1 27	1 29	1 30	1 31	1 32	1 33	1 34	1 35	31
32	1 17	1 17	1 17	1 17	1 18	1 19	1 21	1 23	1 25	1 27	1 28	1 29	1 30	1 31	1 31	1 32	32
33	1 17	1 16	1 16	1 16	1 17	1 18	1 19	1 21	1 23	1 25	1 26	1 27	1 28	1 29	1 29	1 30	33
34	1 17	1 16	1 16	1 16	1 16	1 17	1 18	1 20	1 22	1 23	1 24	1 25	1 26	1 27	1 27	1 28	34
35	1 17	1 16	1 16	1 16	1 16	1 16	1 17	1 18	1 20	1 21	1 22	1 23	1 24	1 25	1 25	1 26	35
36	1 17	1 16	1 15	1 16	1 16	1 16	1 16	1 17	1 18	1 19	1 20	1 21	1 22	1 23	1 23	1 24	36
37	1 17	1 16	1 15	1 15	1 15	1 15	1 15	1 16	1 17	1 18	1 19	1 20	1 21	1 21	1 22		37
38	1 17	1 16	1 15	1 14	1 14	1 14	1 14	1 15	1 16	1 17	1 18	1 19	1 20	1 20	1 21		38
39	1 18	1 16	1 15	1 14	1 13	1 13	1 13	1 14	1 15	1 16	1 17	1 17	1 18	1 18	1 19		39
40	1 18	1 16	1 15	1 14	1 13	1 13	1 13	1 14	1 14	1 15	1 16	1 16	1 17	1 17	1 17		40
41	1 18	1 16	1 15	1 14	1 12	1 12	1 12	1 13	1 13	1 14	1 15	1 15	1 16	1 16			41
42	1 18	1 16	1 15	1 14	1 12	1 12	1 12	1 12	1 12	1 13	1 14	1 14	1 15	1 15			42
43	1 19	1 17	1 16	1 14	1 12	1 11	1 11	1 11	1 11	1 12	1 13	1 13	1 14	1 14			43
44	1 19	1 17	1 16	1 14	1 12	1 11	1 11	1 11	1 11	1 11	1 12	1 12	1 13	1 13			44
46	1 20	1 18	1 16	1 14	1 12	1 11	1 10	1 10	1 10	1 10	1 11	1 11	1 11				46
48	1 21	1 19	1 17	1 15	1 12	1 10	1 9	1 9	1 9	1 9	1 10	1 10	1 10				48
50	1 22	1 19	1 17	1 15	1 12	1 10	1 9	1 8	1 8	1 8	1 8	1 8					50
52	1 23	1 20	1 17	1 15	1 12	1 10	1 8	1 8	1 8	1 7	1 7	1 7					52
54	1 24	1 21	1 18	1 16	1 13	1 10	1 8	1 7	1 7	1 6	1 6						54
56	1 25	1 22	1 19	1 16	1 13	1 10	1 8	1 7	1 7	1 6	1 6						56
58	1 26	1 23	1 20	1 17	1 13	1 10	1 8	1 7	1 6	1 5							
60	1 27	1 24	1 21	1 18	1 14	1 10	1 8	1 7	1 6	1 5							
62	1 28	1 24	1 21	1 18	1 14	1 10	1 8	1 6	1 5								
64	1 29	1 25	1 21	1 18	1 14	1 10	1 8	1 6	1 5								
66	1 29	1 25	1 21	1 18	1 14	1 11	1 8	1 6									
68	1 29	1 25	1 22	1 19	1 15	1 11	1 8	1 6									
70	1 30	. 26	1 22	1 19	1 15	1 11	1 8										
72	1 30	1 26	1 23	1 20	1 15	1 11	1 8										
74	1 31	1 27	1 23	1 20	1 15	1 11											
76	1 31	1 27	1 23	1 20	1 15	1 11											
78	1 32	1 28	1 24	1 20	1 15												
80	1 32	1 28	1 24	1 21	1 15												
82	1 33	1 28	1 24	1 21													
84	1 33	1 28	1 24	1 21													
86	1 33	1 28	1 24														
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	′
5	0	0	1	2	3	3	4			
10	1	1	0	1	2	2	3	3		
20	3	3	2	1	0	0	1	1	2	
30	6	4	3	3	2	2	1	1	0	
40	6	6	5	4	3	3	2	2	2	
50	7	7	6	5	5	4	3	3		
60	8	8	7	6	6	5	4			
70		9	8	7	6	6				
80			8	8	7					
90				8						

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 64°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 26	1 27	1 29	1 32	1 36	1 42	1 49	2 3	2 19	2 35	2 51	3 8	3 24	3 40	3 56	4 12	6
7	1 28	1 26	1 27	1 29	1 32	1 35	1 40	1 51	2 3	2 15	2 28	2 42	2 56	3 9	3 22	3 36	7
8	1 32	1 28	1 26	1 27	1 29	1 31	1 34	1 42	1 51	2 2	2 13	2 24	2 36	2 48	3 0	3 11	8
9	1 37	1 31	1 28	1 26	1 27	1 28	1 30	1 36	1 43	1 52	2 1	2 10	2 20	2 31	2 41	2 51	9
10	1 43	1 35	1 30	1 27	1 26	1 27	1 28	1 32	1 37	1 44	1 51	1 59	2 8	2 17	2 26	2 35	10
11	1 50	1 40	1 33	1 29	1 27	1 26	1 27	1 29	1 33	1 38	1 44	1 51	1 59	2 7	2 14	2 22	11
12	1 57	1 45	1 37	1 32	1 29	1 27	1 26	1 28	1 30	1 34	1 38	1 44	1 51	1 58	2 5	2 12	12
13	2 4	1 50	1 41	1 35	1 31	1 29	1 27	1 27	1 28	1 31	1 34	1 38	1 44	1 50	1 57	2 3	13
14	2 12	1 56	1 46	1 39	1 34	1 31	1 29	1 26	1 27	1 29	1 31	1 34	1 39	1 44	1 50	1 55	14
15	2 20	2 2	1 51	1 43	1 37	1 33	1 30	1 27	1 26	1 27	1 29	1 31	1 35	1 40	1 44	1 49	15
16	2 27	2 8	1 56	1 47	1 41	1 36	1 32	1 28	1 25	1 26	1 27	1 29	1 32	1 36	1 40	1 44	16
17	2 35	2 14	2 1	1 51	1 45	1 39	1 34	1 29	1 26	1 25	1 26	1 28	1 30	1 33	1 36	1 40	17
18	2 43	2 21	2 6	1 56	1 48	1 42	1 37	1 31	1 27	1 25	1 25	1 26	1 28	1 30	1 33	1 36	18
19	2 51	2 27	2 12	2 0	1 52	1 45	1 39	1 32	1 28	1 25	1 25	1 25	1 27	1 28	1 30	1 33	19
20	2 59	2 34	2 17	2 5	1 56	1 49	1 42	1 34	1 29	1 26	1 24	1 24	1 25	1 26	1 28	1 30	20
21	3 7	2 41	2 23	2 10	2 0	1 52	1 45	1 36	1 30	1 26	1 24	1 23	1 24	1 25	1 26	1 28	21
22	3 15	2 48	2 29	2 15	2 4	1 55	1 48	1 38	1 31	1 27	1 25	1 23	1 23	1 24	1 25	1 26	22
23	3 23	2 55	2 35	2 20	2 8	1 59	1 51	1 40	1 33	1 28	1 25	1 23	1 23	1 24	1 24	1 25	23
24	3 31	3 2	2 41	2 25	2 12	2 2	1 54	1 42	1 34	1 29	1 26	1 24	1 23	1 23	1 24	1 25	24
25	3 39	3 8	2 47	2 30	2 17	2 6	1 57	1 44	1 36	1 30	1 26	1 24	1 23	1 23	1 23	1 24	25
26	3 47	3 15	2 53	2 35	2 21	2 10	2 0	1 47	1 38	1 32	1 27	1 25	1 23	1 23	1 23	1 23	26
27	3 56	3 22	2 59	2 40	2 26	2 14	2 4	1 50	1 40	1 33	1 28	1 25	1 23	1 23	1 22	1 23	27
28	4 4	3 29	3 5	2 45	2 30	2 18	2 7	1 53	1 42	1 35	1 29	1 26	1 24	1 23	1 22	1 22	28
29	4 12	3 36	3 11	2 50	2 35	2 22	2 11	1 55	1 44	1 36	1 30	1 27	1 25	1 23	1 22	1 22	29
30	4 20	3 42	3 17	2 55	2 39	2 26	2 15	1 58	1 46	1 38	1 32	1 28	1 25	1 24	1 23	1 22	30
31	4 28	3 49	3 23	3 0	2 43	2 30	2 18	2 0	1 48	1 40	1 33	1 29	1 26	1 24	1 23	1 22	31
32	4 36	3 55	3 28	3 5	2 48	2 34	2 22	2 3	1 50	1 41	1 34	1 30	1 26	1 24	1 23	1 22	32
33	4 44	4 2	3 34	3 10	2 52	2 38	2 26	2 6	1 53	1 43	1 36	1 30	1 27	1 24	1 23	1 22	33
34	4 52	4 8	3 39	3 15	2 56	2 41	2 29	2 8	1 55	1 44	1 37	1 31	1 28	1 25	1 23	1 22	34
35	5 0	4 15	3 45	3 20	3 1	2 45	2 33	2 11	1 57	1 46	1 38	1 32	1 28	1 25	1 23	1 22	35
36	5 7	4 21	3 51	3 25	3 5	2 49	2 36	2 14	1 59	1 47	1 39	1 33	1 29	1 26	1 24	1 23	36
37	5 14	4 28	3 57	3 30	3 9	2 53	2 40	2 17	2 2	1 49	1 41	1 34	1 30	1 27	1 25	1 23	37
38	5 21	4 34	4 2	3 35	3 14	2 57	2 43	2 20	2 4	1 52	1 43	1 36	1 31	1 27	1 25	1 23	38
39	5 28	4 41	4 7	3 39	3 18	3 1	2 46	2 23	2 6	1 54	1 45	1 37	1 32	1 28	1 25	1 23	39
40	5 35	4 47	4 12	3 44	3 22	3 4	2 49	2 26	2 9	1 56	1 46	1 38	1 33	1 29	1 26	1 24	40
41	5 42	4 53	4 17	3 49	3 26	3 8	2 52	2 29	2 11	1 58	1 48	1 40	1 34	1 29	1 26	1 24	41
42	5 49	4 59	4 22	3 53	3 30	3 11	2 55	2 31	2 13	2 0	1 49	1 41	1 35	1 30	1 27	1 24	42
43	5 56	5 5	4 27	3 58	3 34	3 15	2 59	2 34	2 15	2 2	1 51	1 42	1 36	1 31	1 28	1 25	43
44	6 2	5 11	4 32	4 3	3 38	3 19	3 2	2 36	2 16	2 3	1 52	1 44	1 38	1 32	1 29	1 26	44
46	6 15	5 21	4 42	4 11	3 45	3 26	3 8	2 41	2 22	2 6	1 55	1 47	1 40	1 34	1 30	1 27	46
48	6 28	5 32	4 52	4 19	3 53	3 32	3 14	2 45	2 26	2 10	1 58	1 49	1 42	1 36	1 32	1 28	48
50	6 40	5 42	5 1	4 27	4 0	3 38	3 20	2 50	2 29	2 14	2 1	1 51	1 44	1 37	1 33	1 29	50
52	6 52	5 52	5 10	4 35	4 7	3 44	3 25	2 55	2 33	2 17	2 4	1 54	1 46	1 39	1 34	1 30	52
54	7 3	6 1	5 18	4 42	4 14	3 50	3 30	2 59	2 37	2 20	2 7	1 56	1 48	1 41	1 35	1 31	54
56	7 14	6 10	5 26	4 49	4 20	3 55	3 35	3 3	2 41	2 23	2 9	1 58	1 49	1 43	1 37	1 32	56
58	7 24	6 18	5 34	4 56	4 25	4 0	3 39	3 7	2 44	2 26	2 11	2 0	1 52	1 45	1 38	1 33	58
60	7 32	6 26	5 41	5 2	4 30	4 5	3 44	3 11	2 47	2 29	2 14	2 2	1 54	1 47	1 40	1 35	60
62	7 40	6 33	5 47	5 7	4 35	4 10	3 49	3 15	2 50	2 31	2 16	2 4	1 55	1 48	1 41	1 36	62
64	7 48	6 40	5 53	5 12	4 40	4 15	3 53	3 19	2 52	2 34	2 19	2 6	1 56	1 49	1 42	1 37	64
66	7 55	6 47	5 59	5 17	4 45	4 19	3 57	3 22	2 54	2 36	2 21	2 8	1 57	1 50	1 43	1 38	66
68	8 1	6 53	6 4	5 22	4 49	4 23	4 1	3 24	2 56	2 38	2 22	2 9	1 59	1 51	1 44	1 38	68
70	8 7	6 59	6 8	5 26	4 53	4 26	4 4	3 26	2 58	2 40	2 23	2 10	2 0	1 52	1 45	1 39	70
72	8 12	7 4	6 11	5 30	4 56	4 29	4 6	3 28	3 0	2 41	2 24	2 11	2 1	1 53	1 46	1 39	72
74			6 14	5 33	4 59	4 31	4 8	3 30	3 2	2 42	2 25	2 12	2 2	1 54	1 47	1 40	74
76					5 1	4 33	4 9	3 32	3 4	2 43	2 26	2 13	2 3	1 54	1 47	1 40	76
78							4 10	3 33	3 6	2 44	2 27	2 14	2 3	1 54	1 47	1 41	78
80								3 34	3 7	2 45	2 28	2 15	2 4	1 55	1 47	1 41	80
82									3 8	2 46	2 29	2 16	2 4	1 55	1 48	1 42	82
84										2 47	2 29	2 16	2 5	1 56	1 49	1 42	84
86											2 29	2 16	2 6	1 56	1 49	1 42	86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 64°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 29	4 45	5 0	5 15	5 43	6 10	6 36	6 59	7 20	7 39	7 54	8 7					6
7	3 49	4 2	4 15	4 28	4 53	5 16	5 37	5 57	6 15	6 32	6 46	6 59					7
8	3 22	3 34	3 45	3 56	4 18	4 38	4 57	5 15	5 31	5 46	5 58	6 7	6 16				8
9	3 6	3 10	3 20	3 30	3 49	4 7	4 23	4 38	4 52	5 5	5 16	5 26	5 34				9
10	2 43	2 52	3 1	3 10	3 27	3 42	3 56	4 9	4 21	4 32	4 42	4 51	4 59				10
11	2 30	2 37	2 45	2 54	3 9	3 22	3 35	3 47	3 57	4 7	4 16	4 24	4 31				11
12	2 19	2 25	2 33	2 40	2 53	3 5	3 17	3 27	3 37	3 47	3 56	4 3	4 8	4 13			12
13	2 9	2 15	2 22	2 28	2 40	2 51	3 1	3 11	3 20	3 29	3 37	3 43	3 47	3 51			13
14	2 1	2 7	2 13	2 18	2 29	2 39	2 48	2 57	3 6	3 14	3 20	3 25	3 29	3 33			14
15	1 54	2 0	2 5	2 10	2 19	2 29	2 37	2 45	2 53	3 0	3 5	3 10	3 14	3 18			15
16	1 48	1 53	1 58	2 3	2 11	2 20	2 28	2 35	2 42	2 48	2 53	2 57	3 1	3 5	3 8		16
17	1 43	1 47	1 52	1 56	2 4	2 12	2 20	2 26	2 32	2 38	2 43	2 47	2 51	2 54	2 56		17
18	1 39	1 43	1 47	1 50	1 58	2 5	2 12	2 18	2 24	2 30	2 35	2 39	2 42	2 44	2 46		18
19	1 36	1 39	1 42	1 46	1 52	1 59	2 5	2 11	2 17	2 22	2 27	2 31	2 34	2 36	2 38		19
20	1 33	1 36	1 38	1 42	1 48	1 54	1 59	2 5	2 11	2 15	2 20	2 23	2 26	2 28	2 30	2 32	20
21	1 30	1 33	1 35	1 38	1 44	1 49	1 54	2 0	2 5	2 9	2 13	2 16	2 18	2 20	2 22	2 23	21
22	1 28	1 30	1 33	1 35	1 40	1 45	1 50	1 55	1 59	2 3	2 6	2 9	2 11	2 13	2 15	2 16	22
23	1 27	1 28	1 30	1 32	1 37	1 41	1 46	1 51	1 54	1 58	2 1	2 3	2 5	2 7	2 9	2 10	23
24	1 26	1 27	1 28	1 30	1 34	1 38	1 42	1 47	1 50	1 54	1 57	1 59	2 0	2 2	2 4	2 5	24
25	1 25	1 26	1 27	1 28	1 32	1 35	1 39	1 43	1 47	1 50	1 53	1 55	1 56	1 58	1 59	2 0	25
26	1 24	1 25	1 26	1 27	1 30	1 33	1 36	1 40	1 44	1 47	1 49	1 51	1 52	1 54	1 55	1 56	26
27	1 23	1 24	1 25	1 26	1 28	1 31	1 34	1 37	1 41	1 44	1 46	1 47	1 49	1 50	1 51	1 52	27
28	1 23	1 23	1 24	1 25	1 26	1 29	1 32	1 35	1 38	1 41	1 43	1 44	1 45	1 46	1 47	1 48	28
29	1 22	1 22	1 23	1 24	1 25	1 27	1 30	1 32	1 35	1 38	1 40	1 41	1 42	1 43	1 44	1 45	29
30	1 22	1 22	1 23	1 23	1 24	1 26	1 28	1 30	1 33	1 35	1 37	1 38	1 39	1 40	1 41	1 42	30
31	1 22	1 22	1 22	1 22	1 23	1 24	1 26	1 28	1 31	1 33	1 34	1 35	1 36	1 37	1 38	1 40	31
32	1 21	1 21	1 21	1 21	1 22	1 23	1 25	1 27	1 29	1 31	1 32	1 33	1 34	1 35	1 36	1 38	32
33	1 21	1 21	1 21	1 21	1 21	1 22	1 24	1 26	1 27	1 29	1 30	1 31	1 32	1 33	1 34		33
34	1 21	1 20	1 20	1 20	1 20	1 21	1 23	1 25	1 26	1 27	1 28	1 29	1 30	1 31	1 32		34
35	1 21	1 20	1 20	1 20	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27	1 28	1 29	1 30		35
36	1 21	1 20	1 19	1 19	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 26	1 27	1 28		36
37	1 21	1 20	1 19	1 19	1 19	1 19	1 20	1 21	1 22	1 23	1 24	1 25	1 25	1 26			37
38	1 21	1 20	1 19	1 18	1 18	1 18	1 19	1 20	1 21	1 22	1 23	1 24	1 24	1 25			38
39	1 21	1 20	1 19	1 18	1 18	1 18	1 18	1 19	1 20	1 21	1 21	1 22	1 22	1 23			39
40	1 22	1 20	1 19	1 18	1 17	1 17	1 18	1 18	1 19	1 20	1 20	1 21	1 21	1 22			40
41	1 22	1 20	1 19	1 18	1 17	1 17	1 17	1 17	1 18	1 19	1 19	1 20	1 20				41
42	1 22	1 20	1 19	1 18	1 16	1 16	1 16	1 17	1 17	1 18	1 18	1 19	1 19				42
43	1 23	1 21	1 19	1 18	1 16	1 16	1 16	1 16	1 16	1 17	1 17	1 18	1 18				43
44	1 23	1 21	1 19	1 18	1 16	1 16	1 16	1 16	1 16	1 16	1 16	1 17	1 17				44
46	1 24	1 22	1 20	1 18	1 16	1 15	1 15	1 15	1 15	1 15	1 15	1 16					46
48	1 25	1 22	1 20	1 19	1 16	1 15	1 15	1 14	1 14	1 14	1 14	1 14					48
50	1 26	1 23	1 21	1 19	1 16	1 15	1 14	1 13	1 13	1 13	1 13						50
52	1 27	1 24	1 22	1 20	1 17	1 15	1 13	1 12	1 12	1 12	1 12						52
54	1 28	1 25	1 22	1 20	1 17	1 15	1 13	1 12	1 11	1 11							54
56	1 29	1 26	1 23	1 21	1 17	1 15	1 13	1 12	1 11	1 11							56
58	1 29	1 26	1 23	1 21	1 18	1 15	1 13	1 11	1 10								
60	1 30	1 27	1 24	1 22	1 18	1 15	1 13	1 11	1 10								
62	1 31	1 28	1 25	1 22	1 18	1 15	1 13	1 11									
64	1 32	1 28	1 25	1 22	1 18	1 15	1 13	1 11									
66	1 33	1 29	1 26	1 23	1 18	1 16	1 13										
68	1 33	1 29	1 26	1 23	1 19	1 16	1 13										
70	1 34	1 30	1 27	1 24	1 19	1 16											
72	1 34	1 30	1 27	1 24	1 19	1 16											
74	1 35	1 31	1 28	1 24	1 19												
76	1 35	1 31	1 28	1 25	1 20												
78	1 36	1 32	1 28	1 25													
80	1 36	1 32	1 28	1 25													
82	1 37	1 32	1 28														
84	1 37	1 32															
86	1 37																
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App. Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	0	0	1	1	2	3	3	3		
10	1	1	0	0	1	2	2	2		
20	3	3	2	1	1	0	0	1	1	
30	5	4	3	3	2	2	1	1	1	0
40	6	6	5	4	4	3	3	2	2	
50	7	7	6	5	5	4	4	4		
60	8	8	7	6	6	5	5			
70	9	9	8	7	7	6				
80			8	8	7					
90				8						

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 68°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 29	1 31	1 34	1 37	1 41	1 46	1 52	2 6	2 21	2 36	2 52	3 8	3 24	3 39	3 54	4 10	6
7	1 32	1 29	1 31	1 33	1 36	1 39	1 43	1 54	1 5	2 17	2 30	2 43	2 56	3 9	3 22	3 36	7
8	1 36	1 31	1 29	1 30	1 32	1 34	1 37	1 45	1 54	2 4	2 14	2 25	2 37	2 48	2 59	3 11	8
9	1 41	1 34	1 31	1 29	1 30	1 31	1 33	1 38	1 46	1 54	2 3	2 12	2 22	2 32	2 42	2 52	9
10	1 46	1 38	1 33	1 30	1 29	1 30	1 31	1 34	1 40	1 47	1 54	2 2	2 10	2 19	2 28	2 36	10
11	1 52	1 43	1 36	1 32	1 30	1 29	1 30	1 32	1 36	1 41	1 47	1 54	2 1	2 9	2 16	2 24	11
12	1 59	1 48	1 40	1 35	1 32	1 30	1 29	1 30	1 33	1 37	1 42	1 48	1 54	2 0	2 7	2 14	12
13	2 6	1 53	1 44	1 38	1 34	1 32	1 30	1 29	1 31	1 34	1 38	1 43	1 48	1 53	1 59	2 5	13
14	2 14	1 59	1 49	1 42	1 37	1 34	1 31	1 29	1 30	1 32	1 35	1 39	1 44	1 48	1 53	1 58	14
15	2 21	2 5	1 54	1 46	1 40	1 36	1 33	1 30	1 30	1 31	1 33	1 36	1 40	1 44	1 48	1 53	15
16	2 28	2 11	1 59	1 50	1 44	1 39	1 35	1 31	1 29	1 30	1 32	1 34	1 37	1 40	1 44	1 48	16
17	2 36	2 17	2 4	1 54	1 47	1 42	1 38	1 32	1 29	1 29	1 30	1 32	1 34	1 37	1 40	1 44	17
18	2 44	2 24	2 10	1 59	1 51	1 45	1 40	1 34	1 30	1 28	1 29	1 30	1 32	1 35	1 37	1 40	18
19	2 52	2 30	2 15	2 4	1 55	1 48	1 43	1 35	1 31	1 28	1 28	1 29	1 31	1 33	1 35	1 37	19
20	3 0	2 36	2 21	2 8	1 59	1 52	1 46	1 37	1 32	1 29	1 28	1 29	1 30	1 31	1 33	1 35	20
21	3 8	2 43	2 26	2 13	2 3	1 55	1 48	1 39	1 33	1 30	1 28	1 28	1 29	1 30	1 31	1 33	21
22	3 15	2 49	2 32	2 17	2 7	1 58	1 51	1 41	1 35	1 31	1 29	1 27	1 28	1 29	1 30	1 31	22
23	3 23	2 56	2 37	2 22	2 11	2 2	1 54	1 43	1 37	1 32	1 29	1 27	1 27	1 28	1 29	1 30	23
24	3 31	3 3	2 43	2 27	2 15	2 5	1 57	1 46	1 39	1 34	1 30	1 28	1 27	1 28	1 28	1 29	24
25	3 39	3 9	2 48	2 32	2 19	2 9	2 0	1 48	1 41	1 35	1 31	1 29	1 27	1 27	1 27	1 28	25
26	3 47	3 16	2 54	2 37	2 23	2 12	2 4	1 51	1 43	1 36	1 32	1 30	1 28	1 27	1 27	1 27	26
27	3 55	3 23	3 0	2 42	2 27	2 16	2 7	1 54	1 44	1 37	1 33	1 30	1 28	1 27	1 26	1 27	27
28	4 2	3 29	3 5	2 47	2 31	2 19	2 10	1 56	1 46	1 39	1 34	1 31	1 29	1 27	1 26	1 26	28
29	4 10	3 36	3 11	2 52	2 35	2 23	2 14	1 59	1 48	1 41	1 35	1 32	1 29	1 27	1 26	1 26	29
30	4 17	3 42	3 16	2 57	2 40	2 27	2 17	2 1	1 50	1 42	1 36	1 32	1 29	1 27	1 26	1 26	30
31	4 25	3 49	3 22	3 2	2 44	2 31	2 20	2 3	1 52	1 43	1 37	1 33	1 30	1 28	1 27	1 26	31
32	4 32	3 55	3 27	3 7	2 49	2 34	2 23	2 6	1 54	1 45	1 38	1 33	1 30	1 28	1 27	1 26	32
33	4 40	4 2	3 33	3 12	2 53	2 38	2 26	2 9	1 56	1 47	1 39	1 34	1 31	1 29	1 27	1 26	33
34	4 48	4 8	3 39	3 16	2 57	2 42	2 30	2 12	1 58	1 48	1 41	1 35	1 32	1 30	1 28	1 26	34
35	4 55	4 15	3 45	3 21	3 2	2 46	2 34	2 15	2 0	1 50	1 43	1 37	1 33	1 30	1 28	1 26	35
36	5 2	4 21	3 50	3 26	3 6	2 50	2 37	2 17	2 3	1 52	1 44	1 38	1 34	1 31	1 28	1 26	36
37	5 10	4 27	3 56	3 30	3 10	2 53	2 41	2 20	2 5	1 54	1 46	1 39	1 35	1 31	1 28	1 26	37
38	5 17	4 33	4 1	3 35	3 14	2 57	2 44	2 22	2 7	1 56	1 48	1 41	1 36	1 32	1 29	1 27	38
39	5 24	4 39	4 6	3 40	3 18	3 1	2 47	2 25	2 9	1 58	1 50	1 43	1 37	1 33	1 30	1 27	39
40	5 31	4 45	4 11	3 45	3 22	3 5	2 50	2 27	2 11	2 0	1 51	1 44	1 38	1 34	1 31	1 28	40
41	5 38	4 51	4 16	3 49	3 26	3 9	2 53	2 30	2 14	2 2	1 53	1 45	1 39	1 35	1 31	1 28	41
42	5 44	4 57	4 21	3 53	3 30	3 12	2 56	2 32	2 16	2 4	1 54	1 46	1 40	1 36	1 32	1 29	42
43	5 50	5 2	4 26	3 58	3 34	3 16	2 59	2 34	2 19	2 6	1 56	1 48	1 41	1 37	1 33	1 30	43
44	5 57	5 8	4 31	4 2	3 38	3 19	3 3	2 37	2 21	2 8	1 57	1 49	1 43	1 38	1 34	1 31	44
46	6 10	5 19	4 41	4 10	3 46	3 26	3 9	2 42	2 25	2 11	1 59	1 51	1 45	1 40	1 35	1 31	46
48	6 22	5 29	4 50	4 18	3 53	3 32	3 15	2 47	2 29	2 14	2 2	1 54	1 47	1 41	1 36	1 32	48
50	6 34	5 39	4 59	4 26	3 59	3 38	3 21	2 52	2 33	2 18	2 5	1 56	1 49	1 43	1 38	1 33	50
52	6 45	5 48	5 7	4 33	4 6	3 44	3 26	2 56	2 36	2 21	2 8	1 58	1 51	1 45	1 39	1 35	52
54	6 56	5 57	5 14	4 40	4 12	3 50	3 31	3 0	2 39	2 24	2 11	2 0	1 52	1 46	1 40	1 36	54
56	7 6	6 6	5 21	4 46	4 18	3 55	3 36	3 4	2 42	2 27	2 14	2 2	1 54	1 47	1 41	1 37	56
58	7 15	6 14	5 28	4 52	4 24	4 0	3 41	3 8	2 45	2 29	2 16	2 4	1 56	1 49	1 43	1 38	58
60	7 24	6 22	5 35	4 58	4 29	4 5	3 45	3 12	2 48	2 32	2 18	2 6	1 58	1 51	1 45	1 39	60
62	7 33	6 29	5 42	5 3	4 34	4 10	3 49	3 15	2 51	2 34	2 20	2 8	1 59	1 52	1 46	1 40	62
64	7 41	6 35	5 48	5 8	4 39	4 14	3 53	3 18	2 54	2 36	2 22	2 10	2 1	1 53	1 47	1 41	64
66	7 48	6 41	5 53	5 13	4 43	4 18	3 57	3 21	2 56	2 38	2 24	2 12	2 2	1 54	1 48	1 42	66
68	7 55	6 47	5 58	5 17	4 47	4 22	4 0	3 24	2 59	2 40	2 26	2 14	2 3	1 55	1 49	1 43	68
70	8 1	6 52	6 3	5 21	4 51	4 25	4 3	3 27	3 1	2 42	2 27	2 15	2 4	1 56	1 50	1 44	70
72	8 7	6 57	6 8	5 25	4 55	4 28	4 6	3 30	3 3	2 44	2 28	2 15	2 5	1 57	1 51	1 45	72
74	8 12	7 1	6 12	5 29	4 58	4 30	4 8	3 32	3 5	2 45	2 29	2 16	2 5	1 57	1 51	1 45	74
76	8 17	7 5	6 15	5 32	5 1	4 32	4 10	3 34	3 7	2 46	2 30	2 17	2 6	1 58	1 51	1 45	76
78			6 18	5 35	5 3	4 34	4 12	3 35	3 9	2 47	2 31	2 18	2 7	1 58	1 52	1 46	78
80					5 5	4 36	4 13	3 36	3 10	2 48	2 32	2 18	2 7	1 59	1 52	1 46	80
82							4 14	3 37	3 11	2 49	2 32	2 19	2 8	1 59	1 52	1 46	82
84								3 38	3 11	2 50	2 33	2 20	2 9	2 0	1 53	1 46	84
86									3 12	2 50	2 33	2 20	2 9	2 0	1 53		86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 68°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 25	4 40	4 55	5 11	5 40	6 5	6 29	6 51	7 11	7 29	7 45	8 0	8 14				6
7	3 49	4 1	4 14	4 27	4 52	5 15	5 35	5 53	6 10	6 25	6 38	6 50	7 1				7
8	3 22	3 33	3 44	3 55	4 17	4 37	4 55	5 11	5 25	5 38	5 51	6 2	6 10	6 18			8
9	3 1	3 11	3 21	3 30	3 48	4 6	4 22	4 36	4 49	5 0	5 10	5 19	5 28	5 30			9
10	2 44	2 53	3 2	3 10	3 25	3 41	3 55	4 9	4 21	4 31	4 40	4 49	4 57	5 3			10
11	2 31	2 39	2 47	2 54	3 8	3 22	3 35	3 47	3 58	4 8	4 16	4 23	4 29	4 34			11
12	2 20	2 27	2 34	2 41	2 53	3 6	3 18	3 29	3 39	3 48	3 55	4 2	4 7	4 11	4 15		12
13	2 11	2 17	2 23	2 29	2 41	2 52	3 2	3 12	3 22	3 30	3 37	3 43	3 48	3 52	3 56		13
14	2 3	2 9	2 14	2 19	2 30	2 40	2 49	2 58	3 6	3 14	3 20	3 26	3 31	3 35	3 38		14
15	1 57	2 2	2 6	2 11	2 21	2 30	2 38	2 46	2 54	3 1	3 7	3 12	3 16	3 20	3 23		15
16	1 52	1 56	2 0	2 4	2 13	2 21	2 29	2 37	2 44	2 50	2 55	3 0	3 4	3 8	3 10	3 12	16
17	1 47	1 51	1 55	1 58	2 6	2 14	2 21	2 29	2 35	2 40	2 45	2 49	2 53	2 57	2 59	3 0	17
18	1 43	1 47	1 50	1 54	2 1	2 8	2 14	2 21	2 27	2 32	2 36	2 40	2 44	2 47	2 49	2 50	18
19	1 40	1 43	1 46	1 50	1 56	2 2	2 8	2 15	2 20	2 25	2 29	2 32	2 36	2 39	2 41	2 42	19
20	1 37	1 40	1 43	1 46	1 52	1 57	2 3	2 9	2 14	2 18	2 22	2 25	2 28	2 31	2 33	2 34	20
21	1 35	1 37	1 40	1 43	1 48	1 53	1 58	2 3	2 8	2 12	2 16	2 19	2 21	2 23	2 25	2 26	21
22	1 33	1 35	1 37	1 40	1 44	1 49	1 54	1 58	2 2	2 6	2 10	2 13	2 15	2 17	2 19	2 20	22
23	1 31	1 33	1 35	1 37	1 41	1 46	1 50	1 54	1 57	2 1	2 5	2 8	2 10	2 12	2 14	2 15	23
24	1 30	1 31	1 33	1 35	1 39	1 43	1 47	1 50	1 53	1 57	2 0	2 3	2 5	2 7	2 9	2 10	24
25	1 29	1 30	1 31	1 33	1 37	1 40	1 44	1 47	1 50	1 53	1 56	1 59	2 1	2 2	2 4	2 5	25
26	1 28	1 29	1 30	1 32	1 35	1 38	1 41	1 44	1 47	1 50	1 53	1 55	1 57	1 58	1 59	2 0	26
27	1 27	1 28	1 29	1 30	1 33	1 36	1 38	1 41	1 44	1 47	1 50	1 52	1 53	1 54	1 55	1 56	27
28	1 27	1 27	1 28	1 29	1 31	1 34	1 36	1 39	1 41	1 44	1 47	1 49	1 50	1 51	1 52	1 52	28
29	1 26	1 26	1 27	1 28	1 29	1 32	1 34	1 37	1 39	1 41	1 44	1 46	1 47	1 48	1 49		29
30	1 26	1 26	1 26	1 27	1 28	1 30	1 32	1 35	1 37	1 39	1 41	1 43	1 44	1 45	1 46		30
31	1 25	1 25	1 26	1 26	1 27	1 29	1 31	1 33	1 35	1 37	1 39	1 40	1 41	1 42	1 43		31
32	1 25	1 25	1 25	1 25	1 26	1 28	1 29	1 31	1 33	1 35	1 37	1 38	1 39	1 40	1 41		32
33	1 25	1 24	1 25	1 25	1 26	1 27	1 28	1 30	1 31	1 33	1 35	1 36	1 37	1 38			33
34	1 25	1 24	1 24	1 24	1 25	1 26	1 27	1 29	1 30	1 31	1 33	1 34	1 35	1 36			34
35	1 25	1 24	1 24	1 24	1 24	1 25	1 26	1 28	1 29	1 30	1 31	1 32	1 33	1 34			35
36	1 25	1 24	1 23	1 23	1 23	1 24	1 25	1 27	1 28	1 29	1 30	1 30	1 31	1 32			36
37	1 25	1 24	1 23	1 23	1 23	1 23	1 24	1 26	1 27	1 28	1 29	1 29	1 30				37
38	1 25	1 24	1 23	1 22	1 22	1 23	1 24	1 25	1 26	1 27	1 28	1 28	1 29				38
39	1 25	1 24	1 23	1 22	1 22	1 23	1 23	1 24	1 25	1 26	1 27	1 27	1 27				39
40	1 26	1 25	1 24	1 23	1 22	1 22	1 23	1 23	1 24	1 25	1 26	1 26	1 26				40
41	1 26	1 25	1 24	1 23	1 21	1 21	1 22	1 22	1 23	1 24	1 25	1 25					41
42	1 27	1 25	1 24	1 23	1 21	1 21	1 21	1 22	1 23	1 23	1 24	1 24					42
43	1 27	1 25	1 24	1 23	1 21	1 21	1 21	1 21	1 22	1 22	1 23	1 23					43
44	1 28	1 26	1 24	1 23	1 21	1 20	1 20	1 20	1 21	1 21	1 22	1 22					44
46	1 28	1 26	1 25	1 24	1 21	1 19	1 19	1 19	1 20	1 20	1 20						46
48	1 29	1 27	1 25	1 24	1 22	1 19	1 18	1 18	1 19	1 19	1 19						48
50	1 30	1 28	1 26	1 25	1 22	1 20	1 18	1 18	1 18	1 18							50
52	1 31	1 29	1 27	1 25	1 22	1 20	1 18	1 17	1 17	1 17							52
54	1 32	1 29	1 27	1 26	1 23	1 20	1 18	1 17	1 16								54
56	1 33	1 30	1 28	1 26	1 23	1 20	1 18	1 16	1 15								56
58	1 34	1 31	1 29	1 27	1 23	1 20	1 18	1 16									
60	1 35	1 32	1 29	1 27	1 23	1 20	1 18	1 16									
62	1 36	1 33	1 30	1 28	1 23	1 20	1 18										
64	1 37	1 33	1 30	1 28	1 24	1 20	1 17										
66	1 38	1 34	1 31	1 28	1 24	1 20											
68	1 38	1 34	1 31	1 28	1 24	1 20											
70	1 39	1 35	1 32	1 29	1 24												
72	1 39	1 35	1 32	1 29	1 24												
74	1 40	1 36	1 32	1 29													
76	1 40	1 36	1 32	1 29													
78	1 41	1 36	1 32														
80	1 41	1 36															
82	1 41																
84																	
86																	
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	′	″
5	1	0	0	1	1	2	2	3		
10	2	1	0	0	1	1	1	2	2	
20	3	3	2	1	1	0	0	0	0	0
30	4	4	4	3	2	2	2	1	1	
40	6	6	5	4	4	3	3	3		
50	7	7	6	6	5	5	4			
60	8	8	7	7	6	6				
70	9	8	8	7	7					
80		9	8	8						
90			8							

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 72°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 33	1 35	1 37	1 40	1 44	1 50	1 56	2 9	2 23	2 38	2 53	3 9	3 24	3 40	3 56	4 12	6
7	1 35	1 33	1 34	1 36	1 39	1 43	1 47	1 56	2 8	2 21	2 34	2 47	3 0	3 12	3 25	3 38	7
8	1 39	1 35	1 33	1 34	1 36	1 38	1 41	1 48	1 58	2 8	2 19	2 30	2 41	2 52	3 3	3 14	8
9	1 44	1 38	1 35	1 33	1 34	1 35	1 37	1 42	1 50	1 58	2 7	2 17	2 26	2 35	2 44	2 54	9
10	1 50	1 42	1 37	1 34	1 33	1 34	1 35	1 38	1 44	1 50	1 58	2 6	2 14	2 22	2 30	2 39	10
11	1 56	1 46	1 40	1 36	1 34	1 33	1 34	1 36	1 40	1 45	1 51	1 58	2 5	2 12	2 20	2 27	11
12	2 2	1 51	1 44	1 39	1 36	1 34	1 33	1 35	1 37	1 41	1 46	1 52	1 58	2 4	2 11	2 17	12
13	2 9	1 56	1 48	1 42	1 39	1 36	1 34	1 34	1 35	1 38	1 42	1 47	1 52	1 58	2 4	2 9	13
14	2 16	2 2	1 53	1 46	1 42	1 39	1 36	1 33	1 34	1 36	1 39	1 43	1 47	1 52	1 57	2 2	14
15	2 23	2 8	1 58	1 50	1 45	1 41	1 38	1 34	1 33	1 34	1 36	1 39	1 43	1 47	1 51	1 56	15
16	2 30	2 14	2 3	1 54	1 48	1 43	1 40	1 35	1 33	1 33	1 34	1 36	1 39	1 43	1 47	1 52	16
17	2 37	2 20	2 8	1 58	1 51	1 46	1 42	1 36	1 34	1 33	1 34	1 35	1 37	1 40	1 44	1 48	17
18	2 45	2 27	2 13	2 2	1 54	1 48	1 44	1 37	1 34	1 33	1 33	1 34	1 36	1 38	1 41	1 44	18
19	2 53	2 33	2 18	2 7	1 58	1 51	1 46	1 39	1 35	1 33	1 33	1 34	1 35	1 37	1 39	1 41	19
20	3 1	2 40	2 24	2 11	2 2	1 54	1 49	1 41	1 36	1 34	1 33	1 33	1 34	1 35	1 37	1 39	20
21	3 9	2 46	2 29	2 16	2 6	1 58	1 52	1 43	1 37	1 34	1 33	1 33	1 33	1 34	1 35	1 37	21
22	3 17	2 53	2 35	2 20	2 10	2 2	1 55	1 45	1 39	1 35	1 33	1 32	1 33	1 33	1 34	1 35	22
23	3 25	2 59	2 40	2 25	2 14	2 5	1 58	1 47	1 40	1 36	1 34	1 32	1 32	1 33	1 33	1 34	23
24	3 33	3 6	2 46	2 30	2 18	2 8	2 1	1 50	1 42	1 37	1 34	1 32	1 32	1 32	1 33	1 34	24
25	3 41	3 12	2 51	2 35	2 23	2 12	2 4	1 52	1 44	1 38	1 35	1 33	1 32	1 32	1 32	1 33	25
26	3 48	3 18	2 57	2 40	2 27	2 16	2 8	1 55	1 46	1 40	1 36	1 33	1 32	1 31	1 31	1 32	26
27	3 56	3 25	3 2	2 45	2 31	2 20	2 12	1 57	1 48	1 41	1 37	1 34	1 32	1 31	1 31	1 31	27
28	4 3	3 31	3 7	2 49	2 35	2 24	2 15	2 0	1 50	1 43	1 38	1 34	1 32	1 31	1 30	1 31	28
29	4 11	3 37	3 13	2 54	2 39	2 27	2 18	2 2	1 52	1 45	1 39	1 35	1 33	1 32	1 31	1 30	29
30	4 18	3 44	3 19	2 59	2 43	2 31	2 21	2 5	1 54	1 46	1 40	1 36	1 34	1 32	1 31	1 30	30
31	4 26	3 50	3 24	3 4	2 47	2 34	2 24	2 8	1 56	1 48	1 41	1 37	1 34	1 32	1 31	1 30	31
32	4 33	3 56	3 29	3 9	2 51	2 38	2 27	2 11	1 58	1 50	1 43	1 38	1 35	1 33	1 32	1 31	32
33	4 40	4 2	3 35	3 14	2 56	2 42	2 30	2 14	2 0	1 51	1 44	1 39	1 35	1 33	1 32	1 31	33
34	4 47	4 9	3 41	3 18	3 0	2 45	2 33	2 16	2 2	1 53	1 46	1 40	1 36	1 34	1 32	1 31	34
35	4 54	4 15	3 46	3 23	3 4	2 49	2 37	2 18	2 4	1 54	1 47	1 41	1 37	1 34	1 32	1 31	35
36	5 1	4 21	3 51	3 27	3 8	2 53	2 40	2 20	2 7	1 56	1 48	1 42	1 38	1 35	1 33	1 32	36
37	5 9	4 27	3 56	3 32	3 12	2 57	2 43	2 23	2 9	1 58	1 50	1 44	1 39	1 36	1 33	1 32	37
38	5 16	4 33	4 1	3 37	3 16	3 0	2 47	2 26	2 11	2 0	1 52	1 45	1 40	1 37	1 34	1 32	38
39	5 23	4 39	4 6	3 41	3 20	3 4	2 50	2 28	2 13	2 2	1 53	1 46	1 41	1 38	1 34	1 32	39
40	5 30	4 45	4 11	3 46	3 24	3 7	2 54	2 30	2 15	2 4	1 54	1 48	1 43	1 39	1 35	1 33	40
41	5 37	4 51	4 16	3 50	3 28	3 11	2 57	2 32	2 18	2 6	1 56	1 49	1 44	1 40	1 36	1 33	41
42	5 44	4 57	4 21	3 54	3 32	3 15	3 0	2 35	2 20	2 8	1 58	1 50	1 45	1 41	1 37	1 34	42
43	5 51	5 2	4 26	3 59	3 36	3 18	3 3	2 37	2 22	2 10	1 59	1 51	1 46	1 42	1 38	1 34	43
44	5 57	5 7	4 30	4 3	3 40	3 22	3 6	2 41	2 24	2 12	2 1	1 53	1 47	1 43	1 39	1 35	44
46	6 9	5 17	4 39	4 11	3 47	3 29	3 12	2 45	2 28	2 15	2 4	1 55	1 49	1 44	1 40	1 36	46
48	6 21	5 27	4 48	4 19	3 54	3 35	3 18	2 50	2 32	2 18	2 7	1 58	1 51	1 45	1 41	1 38	48
50	6 32	5 37	4 57	4 26	4 1	3 41	3 23	2 55	2 35	2 21	2 10	2 0	1 53	1 47	1 43	1 39	50
52	6 43	5 46	5 6	4 33	4 7	3 46	3 28	2 59	2 39	2 24	2 12	2 2	1 55	1 49	1 44	1 40	52
54	6 54	5 55	5 14	4 40	4 13	3 52	3 33	3 3	2 43	2 27	2 15	2 5	1 57	1 50	1 45	1 41	54
56	7 4	6 4	5 22	4 47	4 19	3 57	3 38	3 7	2 47	2 31	2 18	2 7	1 59	1 52	1 46	1 42	56
58	7 13	6 12	5 29	4 53	4 25	4 2	3 43	3 11	2 50	2 34	2 21	2 9	2 0	1 53	1 47	1 43	58
60	7 22	6 20	5 35	4 58	4 30	4 7	3 47	3 15	2 53	2 37	2 23	2 11	2 2	1 54	1 49	1 44	60
62	7 31	6 27	5 41	5 3	4 35	4 11	3 51	3 19	2 56	2 39	2 25	2 13	2 4	1 56	1 50	1 45	62
64	7 39	6 33	5 47	5 8	4 40	4 15	3 55	3 22	2 59	2 41	2 27	2 15	2 5	1 57	1 51	1 46	64
66	7 46	6 39	5 53	5 13	4 44	4 19	3 59	3 25	3 1	2 43	2 29	2 16	2 6	1 58	1 52	1 47	66
68	7 52	6 45	5 58	5 18	4 48	4 23	4 2	3 28	3 3	2 45	2 30	2 18	2 7	1 59	1 52	1 47	68
70	7 58	6 50	6 3	5 22	4 52	4 26	4 4	3 30	3 5	2 47	2 31	2 19	2 8	2 0	1 53	1 48	70
72	8 4	6 55	6 7	5 26	4 55	4 29	4 7	3 32	3 7	2 48	2 33	2 20	2 9	2 1	1 54	1 48	72
74	8 9	7 0	6 10	5 30	4 58	4 31	4 9	3 34	3 9	2 49	2 34	2 21	2 10	2 2	1 55	1 49	74
76	8 13	7 4	6 14	5 33	5 1	4 33	4 11	3 35	3 11	2 50	2 35	2 22	2 11	2 2	1 56	1 49	76
78	8 16	7 7	6 17	5 36	5 3	4 35	4 12	3 37	3 12	2 51	2 36	2 23	2 12	2 3	1 56	1 50	78
80	8 19	7 10	6 19	5 38	5 5	4 37	4 14	3 38	3 13	2 52	2 37	2 24	2 13	2 4	1 57	1 51	80
82			6 21	5 40	5 7	4 39	4 16	3 39	3 13	2 53	2 38	2 24	2 13	2 4	1 57		82
84					5 9	4 41	4 17	3 40	3 14	2 54	2 38	2 24	2 14	2 5			84
86							4 18	3 41	3 15	2 54	2 38	2 24	2 14				86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 72°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 27	4 41	4 56	5 11	5 38	6 3	6 27	6 48	7 8	7 27	7 42	7 55	8 6	8 16			6
7	3 51	4 3	4 16	4 28	4 51	5 12	5 32	5 51	6 8	6 23	6 36	6 48	6 58	7 7			7
8	3 25	3 36	3 47	3 58	4 18	4 36	4 54	5 11	5 26	5 39	5 51	6 1	6 9	6 16	6 22		8
9	3 4	3 14	3 24	3 33	3 51	4 8	4 23	4 37	4 50	5 1	5 11	5 20	5 28	5 35	5 41		9
10	2 48	2 57	3 6	3 14	3 29	3 44	3 58	4 10	4 22	4 33	4 42	4 50	4 57	5 3	5 7		10
11	2 35	2 43	2 51	2 58	3 11	3 25	3 37	3 48	3 59	4 9	4 17	4 24	4 30	4 35	4 39		11
12	2 24	2 31	2 38	2 45	2 57	3 9	3 20	3 31	3 41	3 49	3 57	4 3	4 8	4 12	4 16	4 20	12
13	2 15	2 21	2 27	2 33	2 45	2 56	3 6	3 16	3 24	3 32	3 39	3 45	3 49	3 53	3 56	3 59	13
14	2 7	2 13	2 18	2 24	2 34	2 44	2 54	3 2	3 10	3 18	3 24	3 29	3 33	3 36	3 39	3 41	14
15	2 1	2 6	2 11	2 16	2 25	2 34	2 43	2 51	2 58	3 5	3 11	3 16	3 20	3 23	3 25	3 27	15
16	1 56	2 1	2 5	2 9	2 18	2 26	2 33	2 41	2 48	2 54	2 59	3 4	3 8	3 11	3 13	3 15	16
17	1 52	1 56	1 59	2 3	2 11	2 19	2 25	2 32	2 39	2 45	2 50	2 54	2 57	3 0	3 2	3 4	17
18	1 48	1 51	1 54	1 58	2 6	2 13	2 19	2 25	2 31	2 37	2 42	2 46	2 48	2 50	2 52	2 54	18
19	1 44	1 47	1 50	1 54	2 1	2 7	2 13	2 19	2 25	2 30	2 35	2 38	2 40	2 42	2 44	2 45	19
20	1 41	1 44	1 47	1 50	1 56	2 2	2 7	2 13	2 19	2 23	2 28	2 31	2 33	2 35	2 36	2 37	20
21	1 39	1 41	1 44	1 46	1 52	1 57	2 2	2 8	2 13	2 17	2 21	2 24	2 26	2 28	2 29	2 30	21
22	1 37	1 39	1 41	1 43	1 48	1 53	1 58	2 3	2 7	2 11	2 15	2 18	2 20	2 22	2 23	2 24	22
23	1 36	1 37	1 39	1 41	1 45	1 50	1 54	1 59	2 2	2 6	2 10	2 13	2 15	2 16	2 17	2 18	23
24	1 35	1 36	1 37	1 39	1 43	1 47	1 51	1 55	1 58	2 2	2 5	2 8	2 10	2 11	2 12	2 13	24
25	1 34	1 35	1 36	1 38	1 41	1 44	1 48	1 51	1 54	1 58	2 1	2 3	2 5	2 6	2 8		25
26	1 33	1 34	1 35	1 36	1 39	1 42	1 45	1 48	1 51	1 54	1 57	1 59	2 1	2 2	2 4		26
27	1 32	1 33	1 34	1 35	1 37	1 40	1 43	1 45	1 48	1 51	1 54	1 56	1 57	1 58	2 0		27
28	1 32	1 32	1 33	1 34	1 35	1 38	1 41	1 43	1 46	1 48	1 51	1 53	1 54	1 55	1 56		28
29	1 31	1 32	1 32	1 33	1 34	1 36	1 39	1 41	1 44	1 46	1 48	1 50	1 52	1 53			29
30	1 31	1 31	1 32	1 32	1 33	1 35	1 37	1 39	1 42	1 44	1 46	1 47	1 49	1 50			30
31	1 30	1 31	1 31	1 31	1 32	1 34	1 36	1 38	1 40	1 42	1 44	1 45	1 46	1 47			31
32	1 29	1 30	1 30	1 30	1 31	1 33	1 35	1 36	1 38	1 40	1 42	1 43	1 44	1 45			32
33	1 29	1 29	1 29	1 30	1 31	1 32	1 33	1 34	1 36	1 38	1 40	1 41	1 42				33
34	1 30	1 29	1 29	1 29	1 30	1 31	1 32	1 33	1 34	1 36	1 38	1 39	1 40				34
35	1 30	1 29	1 29	1 29	1 30	1 30	1 31	1 32	1 33	1 35	1 36	1 37	1 38				35
36	1 31	1 29	1 28	1 28	1 29	1 30	1 31	1 32	1 33	1 34	1 35	1 36	1 36				36
37	1 31	1 30	1 28	1 28	1 29	1 29	1 30	1 31	1 32	1 33	1 34	1 35					37
38	1 31	1 30	1 28	1 27	1 29	1 28	1 30	1 31	1 32	1 33	1 33	1 34					38
39	1 31	1 30	1 29	1 28	1 28	1 28	1 29	1 30	1 31	1 32	1 32	1 32					39
40	1 31	1 30	1 29	1 28	1 27	1 28	1 28	1 29	1 30	1 30	1 30	1 30					40
41	1 31	1 30	1 29	1 28	1 27	1 27	1 27	1 28	1 28	1 29	1 29						41
42	1 32	1 31	1 29	1 28	1 26	1 26	1 26	1 27	1 27	1 28	1 28						42
43	1 32	1 31	1 29	1 28	1 26	1 26	1 26	1 26	1 26	1 27	1 27						43
44	1 33	1 31	1 30	1 28	1 26	1 26	1 25	1 25	1 25	1 26	1 26						44
46	1 34	1 32	1 30	1 29	1 27	1 25	1 25	1 25	1 25	1 25							46
48	1 35	1 32	1 30	1 29	1 27	1 25	1 24	1 24	1 24	1 24							48
50	1 36	1 33	1 31	1 30	1 27	1 25	1 24	1 23	1 23								50
52	1 37	1 34	1 31	1 30	1 27	1 25	1 23	1 22	1 23								52
54	1 37	1 34	1 32	1 31	1 28	1 25	1 23	1 22									54
56	1 38	1 35	1 33	1 31	1 28	1 25	1 23	1 22									56
58	1 39	1 36	1 34	1 32	1 28	1 25	1 23										
60	1 39	1 36	1 34	1 32	1 28	1 25	1 23										
62	1 40	1 37	1 35	1 32	1 28	1 25											
64	1 41	1 38	1 36	1 33	1 28	1 25											
66	1 42	1 38	1 36	1 33	1 28												
68	1 43	1 39	1 36	1 34	1 29												
70	1 43	1 39	1 36	1 34													
72	1 44	1 40	1 36	1 34													
74	1 44	1 40	1 36														
76	1 45	1 40															
78	1 45																
80																	
82																	
84																	
86																	
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°					

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	0	0	1	1	2	2	2		
10	2	1	1	0	0	1	1	1	1	
20	3	3	2	2	1	1	1	1	0	0
30	4	4	4	3	3	2	2	2	2	
40	6	6	5	5	4	4	4	3		
50	7	7	6	6	5	5	5			
60	8	8	7	7	6	6				
70	9	8	8	7	7					
80		9	8	8						
90			9							

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 76°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.															☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 37	1 39	1 41	1 44	1 48	1 54	2 0	2 13	2 27	2 42	2 57	3 13	3 28	3 43	3 58	4 13	6
7	1 40	1 37	1 38	1 40	1 43	1 47	1 51	2 1	2 12	2 24	2 37	2 50	3 3	3 15	3 28	3 40	7
8	1 44	1 40	1 37	1 38	1 40	1 42	1 45	1 52	2 2	2 12	2 22	2 33	2 44	2 54	3 5	3 16	8
9	1 49	1 43	1 39	1 37	1 38	1 39	1 41	1 46	1 54	2 2	2 11	2 20	2 30	2 39	2 48	2 58	9
10	1 54	1 46	1 41	1 39	1 37	1 38	1 39	1 42	1 48	1 55	2 2	2 10	2 18	2 26	2 34	2 43	10
11	2 0	1 50	1 44	1 41	1 39	1 37	1 38	1 40	1 44	1 49	1 55	2 2	2 9	2 16	2 23	2 31	11
12	2 6	1 55	1 48	1 44	1 41	1 38	1 37	1 38	1 41	1 45	1 50	1 56	2 2	2 8	2 15	2 21	12
13	2 12	2 0	1 52	1 47	1 43	1 40	1 38	1 37	1 39	1 42	1 46	1 51	1 56	2 2	2 8	2 13	13
14	2 19	2 6	1 56	1 50	1 45	1 42	1 40	1 37	1 38	1 40	1 43	1 47	1 52	1 57	2 2	2 7	14
15	2 26	2 12	2 1	1 54	1 48	1 44	1 42	1 38	1 37	1 39	1 41	1 45	1 49	1 53	1 57	2 1	15
16	2 34	2 18	2 6	1 58	1 51	1 47	1 44	1 39	1 37	1 38	1 40	1 43	1 46	1 49	1 53	1 56	16
17	2 41	2 24	2 11	2 4	1 54	1 49	1 46	1 40	1 38	1 37	1 39	1 41	1 43	1 46	1 49	1 52	17
18	2 49	2 30	2 17	2 6	1 58	1 52	1 48	1 42	1 39	1 36	1 38	1 39	1 41	1 43	1 46	1 49	18
19	2 57	2 36	2 22	2 10	2 2	1 55	1 50	1 43	1 40	1 37	1 37	1 38	1 39	1 41	1 43	1 46	19
20	3 5	2 43	2 27	2 15	2 6	1 58	1 52	1 49	1 41	1 38	1 36	1 37	1 38	1 39	1 41	1 43	20
21	3 12	2 49	2 33	2 20	2 10	2 2	1 55	1 47	1 42	1 39	1 37	1 36	1 37	1 38	1 39	1 41	21
22	3 20	2 50	2 38	2 24	2 14	2 5	1 58	1 49	1 44	1 40	1 38	1 36	1 36	1 37	1 38	1 39	22
23	3 28	3 3	2 44	2 39	2 18	2 9	2 1	1 51	1 45	1 41	1 38	1 36	1 35	1 36	1 37	1 38	23
24	3 36	3 9	2 49	2 34	2 22	2 12	2 4	1 54	1 47	1 42	1 39	1 37	1 35	1 36	1 36	1 37	24
25	3 44	3 15	2 54	2 39	2 26	2 16	2 7	1 56	1 45	1 44	1 40	1 37	1 36	1 36	1 36	1 37	25
26	3 51	3 21	3 0	2 44	2 30	2 20	2 11	1 59	1 51	1 45	1 41	1 38	1 36	1 35	1 35	1 36	26
27	3 59	3 28	3 5	2 49	2 34	2 23	2 14	2 2	1 53	1 47	1 42	1 39	1 37	1 36	1 35	1 35	27
28	4 6	3 34	3 10	2 54	2 38	2 27	2 17	2 4	1 54	1 48	1 43	1 39	1 37	1 36	1 35	1 35	28
29	4 13	3 40	3 15	2 58	2 42	2 31	2 21	2 7	1 56	1 49	1 44	1 40	1 38	1 36	1 35	1 34	29
30	4 20	3 46	3 21	3 3	2 47	2 34	2 24	2 9	1 58	1 51	1 45	1 41	1 39	1 37	1 35	1 34	30
31	4 27	3 52	3 26	3 7	2 51	2 38	2 28	2 12	2 0	1 52	1 46	1 42	1 39	1 37	1 35	1 34	31
32	4 34	3 58	3 31	3 12	2 55	2 42	2 31	2 14	2 2	1 54	1 48	1 43	1 40	1 38	1 36	1 35	32
33	4 41	4 4	3 37	3 16	2 59	2 45	2 34	2 17	2 4	1 55	1 49	1 44	1 41	1 38	1 36	1 35	33
34	4 48	4 10	3 42	3 20	3 3	2 49	2 37	2 19	2 6	1 57	1 50	1 45	1 42	1 39	1 37	1 35	34
35	4 55	4 16	3 47	3 25	3 7	2 52	2 41	2 22	2 8	1 59	1 52	1 46	1 42	1 39	1 37	1 35	35
36	5 2	4 22	3 53	3 29	3 11	2 56	2 44	2 24	2 11	2 1	1 53	1 47	1 43	1 40	1 38	1 36	36
37	5 9	4 27	3 58	3 34	3 15	3 0	2 47	2 27	2 13	2 3	1 55	1 48	1 44	1 41	1 38	1 36	37
38	5 16	4 33	4 3	3 38	3 19	3 3	2 50	2 29	2 15	2 4	1 56	1 49	1 45	1 42	1 39	1 37	38
39	5 23	4 38	4 8	3 43	3 23	3 7	2 53	2 31	2 17	2 6	1 58	1 51	1 46	1 42	1 39	1 37	39
40	5 30	4 44	4 13	3 47	3 27	3 10	2 56	2 34	2 19	2 8	1 59	1 52	1 47	1 43	1 40	1 38	40
41	5 37	4 50	4 18	3 51	3 31	3 14	2 59	2 36	2 22	2 10	2 0	1 53	1 48	1 44	1 41	1 38	41
42	5 43	4 55	4 23	3 55	3 34	3 17	3 2	2 39	2 24	2 12	2 1	1 54	1 49	1 45	1 42	1 39	42
43	5 49	5 1	4 28	3 59	3 38	3 20	3 5	2 41	2 26	2 14	2 3	1 56	1 50	1 46	1 43	1 40	43
44	5 55	5 6	4 33	4 3	3 41	3 24	3 8	2 44	2 28	2 15	2 4	1 57	1 51	1 47	1 43	1 40	44
46	6 7	5 16	4 42	4 11	3 49	3 31	3 14	2 49	2 32	2 18	2 7	1 59	1 53	1 48	1 44	1 41	46
48	6 19	5 26	4 51	4 19	3 56	3 37	3 20	2 54	2 35	2 21	2 10	2 2	1 55	1 50	1 46	1 43	48
50	6 30	5 36	4 59	4 27	4 3	3 43	3 25	2 58	2 39	2 25	2 13	2 4	1 57	1 51	1 47	1 44	50
52	6 41	5 46	5 7	4 34	4 10	3 49	3 30	3 3	2 43	2 28	2 16	2 6	1 59	1 53	1 49	1 45	52
54	6 51	5 55	5 15	4 41	4 17	3 55	3 35	3 7	2 47	2 31	2 19	2 9	2 1	1 55	1 50	1 46	54
56	7 1	6 4	5 22	4 48	4 23	4 0	3 40	3 11	2 50	2 34	2 22	2 12	2 3	1 56	1 51	1 47	56
58	7 11	6 12	5 29	4 54	4 28	4 5	3 45	3 15	2 53	2 37	2 25	2 14	2 5	1 57	1 52	1 48	58
60	7 20	6 20	5 36	5 0	4 33	4 9	3 49	3 19	2 56	2 40	2 27	2 16	2 6	1 59	1 53	1 49	60
62	7 28	6 27	5 42	5 5	4 37	4 14	3 53	3 22	2 59	2 43	2 29	2 18	2 8	2 0	1 54	1 50	62
64	7 36	6 34	5 48	5 10	4 41	4 18	3 57	3 25	3 2	2 45	2 31	2 20	2 10	2 2	1 56	1 51	64
66	7 43	6 40	5 54	5 15	4 45	4 22	4 1	3 28	3 5	2 47	2 33	2 21	2 11	2 3	1 57	1 52	66
68	7 49	6 45	5 59	5 19	4 49	4 26	4 5	3 31	2 8	2 49	2 35	2 23	2 13	2 4	1 58	1 53	68
70	7 55	6 50	6 3	5 23	4 53	4 29	4 8	3 34	2 10	2 51	2 36	2 24	2 14	2 5	1 58	1 53	70
72	8 1	6 54	6 7	5 27	4 57	4 32	4 11	3 37	3 12	2 52	2 37	2 25	2 15	2 6	1 59	1 54	72
74	8 6	6 58	6 10	5 30	5 0	4 34	4 13	3 39	3 13	2 53	2 38	2 26	2 16	2 7	2 0	1 54	74
76	8 11	7 2	6 13	5 33	5 3	4 36	4 15	3 41	3 14	2 54	2 39	2 26	2 16	2 7	2 1	1 55	76
78	8 15	7 6	6 16	5 36	5 5	4 38	4 17	3 42	3 15	2 55	2 40	2 27	2 17	2 8	2 1		78
80	8 18	7 9	6 19	5 38	5 7	4 40	4 19	3 43	3 16	2 56	2 40	2 28	2 18	2 9			80
82	8 20	7 11	6 21	5 40	5 9	4 42	4 20	3 44	3 17	2 57	2 41	2 28	2 18				82
84	8 22	7 13	6 23	5 42	5 10	4 43	4 21	3 45	3 18	2 58	2 41	2 28					84
86			6 25	5 44	5 11	4 44	4 22	3 45	3 18	2 58	2 42						86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 76°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 28	4 42	4 57	5 11	5 37	6 2	6 26	6 47	7 6	7 24	7 40	7 54	8 5	8 13	8 20		6
7	3 53	4 5	4 17	4 29	4 52	5 13	5 33	5 52	6 9	6 24	6 37	6 48	6 57	7 5	7 12		7
8	3 27	3 38	3 49	3 59	4 19	4 38	4 56	5 12	5 26	5 39	5 51	6 1	6 9	6 16	6 21	6 26	8
9	3 8	3 17	3 26	3 35	3 52	4 8	4 24	4 38	4 51	5 3	5 13	5 22	5 29	5 35	5 40	5 44	9
10	2 52	3 0	3 8	3 16	3 31	3 46	4 1	4 14	4 25	4 35	4 44	4 52	4 59	5 4	5 8	5 11	10
11	2 39	2 46	2 53	3 0	3 14	3 27	3 40	3 51	4 2	4 12	4 20	4 27	4 33	4 38	4 42	4 45	11
12	2 28	2 34	2 41	2 47	3 0	3 12	3 23	3 34	3 43	3 52	4 0	4 6	4 11	4 15	4 19	4 22	12
13	2 19	2 25	2 30	2 36	2 48	2 59	3 9	3 19	3 28	3 36	3 43	3 48	3 53	3 57	4 0	4 2	13
14	2 12	2 17	2 22	2 27	2 38	2 48	2 58	3 6	3 14	3 22	3 28	3 33	3 37	3 41	3 43	3 45	14
15	2 5	2 10	2 15	2 19	2 29	2 38	2 47	2 55	3 3	3 9	3 15	3 20	3 24	3 27	3 29	3 31	15
16	2 0	2 4	2 9	2 13	2 21	2 29	2 37	2 45	2 52	2 58	3 4	3 8	3 12	3 15	3 17	3 19	16
17	1 56	1 59	2 3	2 7	2 14	2 22	2 29	2 36	2 43	2 49	2 54	2 58	3 2	3 4	3 6	3 8	17
18	1 52	1 55	1 58	2 2	2 9	2 16	2 23	2 30	2 36	2 42	2 46	2 50	2 53	2 55	2 57	2 58	18
19	1 49	1 51	1 54	1 58	2 4	2 11	2 17	2 24	2 30	2 35	2 39	2 42	2 45	2 47	2 49	2 50	19
20	1 46	1 48	1 51	1 54	2 0	2 6	2 12	2 18	2 24	2 28	2 32	2 35	2 37	2 39	2 41	2 42	20
21	1 43	1 45	1 48	1 51	1 56	2 2	2 7	2 13	2 18	2 22	2 26	2 29	2 31	2 33	2 34		21
22	1 41	1 43	1 46	1 48	1 53	1 58	2 3	2 8	2 13	2 17	2 20	2 23	2 25	2 27	2 28		22
23	1 40	1 42	1 44	1 46	1 50	1 55	1 59	2 3	2 8	2 12	2 15	2 17	2 19	2 21	2 23		23
24	1 39	1 40	1 42	1 44	1 48	1 52	1 56	1 59	2 4	2 7	2 10	2 12	2 14	2 16	2 18		24
25	1 38	1 39	1 40	1 42	1 46	1 49	1 53	1 56	2 0	2 3	2 6	2 8	2 10	2 12			25
26	1 37	1 38	1 39	1 41	1 44	1 47	1 50	1 53	1 56	1 59	2 2	2 4	2 6	2 8			26
27	1 36	1 37	1 38	1 40	1 42	1 45	1 48	1 50	1 53	1 56	1 59	2 1	2 3	2 5			27
28	1 36	1 37	1 38	1 39	1 41	1 43	1 46	1 48	1 50	1 53	1 56	1 58	2 0	2 2			28
29	1 35	1 36	1 37	1 38	1 40	1 42	1 44	1 46	1 48	1 50	1 53	1 55	1 57				29
30	1 35	1 35	1 36	1 37	1 38	1 40	1 42	1 44	1 46	1 48	1 50	1 52	1 54				30
31	1 34	1 34	1 35	1 36	1 37	1 39	1 40	1 42	1 44	1 46	1 48	1 50	1 52				31
32	1 34	1 34	1 34	1 35	1 36	1 38	1 39	1 41	1 43	1 44	1 46	1 48	1 50				32
33	1 34	1 33	1 34	1 35	1 35	1 37	1 38	1 40	1 42	1 43	1 45	1 46					33
34	1 34	1 33	1 33	1 34	1 35	1 36	1 37	1 39	1 41	1 42	1 44	1 45					34
35	1 34	1 33	1 33	1 33	1 34	1 35	1 36	1 38	1 39	1 40	1 42	1 43					35
36	1 35	1 34	1 33	1 33	1 33	1 34	1 35	1 37	1 38	1 39	1 40	1 41					36
37	1 35	1 34	1 33	1 32	1 33	1 33	1 34	1 36	1 37	1 38	1 39						37
38	1 35	1 34	1 33	1 32	1 32	1 33	1 34	1 35	1 36	1 37	1 38						38
39	1 36	1 34	1 33	1 32	1 32	1 33	1 33	1 34	1 35	1 36	1 36						39
40	1 36	1 35	1 34	1 33	1 32	1 32	1 33	1 34	1 34	1 35	1 35						40
41	1 37	1 35	1 34	1 33	1 32	1 32	1 32	1 33	1 33	1 34							41
42	1 37	1 35	1 34	1 33	1 31	1 31	1 32	1 32	1 33	1 33							42
43	1 37	1 35	1 34	1 33	1 31	1 30	1 31	1 31	1 32	1 32							43
44	1 38	1 36	1 34	1 33	1 31	1 30	1 30	1 31	1 31	1 31							44
46	1 39	1 37	1 35	1 34	1 31	1 29	1 29	1 30	1 30								46
48	1 40	1 38	1 36	1 34	1 31	1 29	1 29	1 29	1 29								48
50	1 41	1 38	1 37	1 35	1 32	1 30	1 29	1 29									50
52	1 42	1 39	1 37	1 35	1 32	1 30	1 29	1 28									52
54	1 43	1 40	1 38	1 36	1 33	1 30	1 29										54
56	1 44	1 41	1 38	1 36	1 33	1 30	1 29										56
58	1 45	1 42	1 39	1 37	1 33	1 30											58
60	1 46	1 43	1 40	1 37	1 33	1 30											60
62	1 46	1 43	1 40	1 37	1 33												62
64	1 47	1 44	1 41	1 38	1 33												64
66	1 48	1 44	1 41	1 38													66
68	1 49	1 45	1 41	1 38													68
70	1 49	1 45	1 41														70
72	1 49	1 45															72
74	1 50																74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°						

TABLE P. EFFECT OF SUN'S PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	0	0	1	1	1	1	1	
10	1	1	1	0	0	0	0	0	1	
15	2	2	2	1	1	0	0	0	0	0
20	3	3	2	2	2	1	1	1	1	
25	4	4	3	3	2	2	2	2	2	
30	4	4	4	3	3	3	3	3		
35	5	5	4	4	4	4	3	3		
40	6	6	5	5	4	4	4			
45	6	6	6	5	5	5	5			
50	7	7	6	6	6	5				
55	7	7	7	6	6	6				
60	8	8	7	7	7					
65	8	8	8	7	7					
70	8	8	8	8						
75	9	9	8	8						
80	9	9	8							
90		9	8							

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 80°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 41	1 43	1 46	1 50	1 54	1 59	2 4	2 17	2 32	2 47	3 2	3 17	3 32	3 47	4 2	4 16	6
7	1 44	1 41	1 43	1 45	1 48	1 51	1 55	2 5	2 17	2 29	2 41	2 54	3 6	3 19	3 31	3 44	7
8	1 48	1 43	1 41	1 42	1 44	1 46	1 49	1 56	2 6	2 16	2 26	2 37	2 48	2 59	3 10	3 20	8
9	1 52	1 46	1 43	1 41	1 42	1 44	1 46	1 51	1 58	2 6	2 15	2 25	2 34	2 43	2 52	3 1	9
10	1 57	1 50	1 46	1 43	1 41	1 42	1 44	1 47	1 54	1 59	2 6	2 14	2 22	2 30	2 38	2 46	10
11	2 3	1 54	1 49	1 45	1 43	1 41	1 42	1 45	1 49	1 54	1 59	2 6	2 13	2 20	2 27	2 34	11
12	2 9	1 59	1 52	1 48	1 45	1 43	1 41	1 43	1 46	1 50	1 54	2 0	2 6	2 12	2 19	2 25	12
13	2 16	2 4	1 56	1 51	1 48	1 45	1 42	1 42	1 44	1 47	1 51	1 56	2 1	2 6	2 12	2 18	13
14	2 23	2 10	2 0	1 54	1 50	1 47	1 44	1 41	1 43	1 45	1 48	1 52	1 57	2 2	2 7	2 12	14
15	2 30	2 16	2 5	1 58	1 53	1 49	1 46	1 42	1 42	1 44	1 46	1 49	1 53	1 58	2 2	2 7	15
16	2 37	2 22	2 10	2 2	1 56	1 52	1 48	1 43	1 41	1 43	1 45	1 47	1 50	1 54	1 58	2 2	16
17	2 45	2 28	2 15	2 6	1 59	1 54	1 50	1 45	1 42	1 42	1 43	1 45	1 48	1 51	1 54	1 58	17
18	2 53	2 34	2 21	2 11	2 3	1 57	1 52	1 47	1 43	1 41	1 42	1 44	1 46	1 48	1 51	1 54	18
19	3 0	2 41	2 26	2 15	2 7	2 0	1 54	1 48	1 44	1 42	1 41	1 43	1 44	1 46	1 49	1 51	19
20	3 8	2 47	2 31	2 20	2 10	2 3	1 57	1 50	1 46	1 43	1 41	1 42	1 43	1 45	1 47	1 49	20
21	3 16	2 54	2 37	2 24	2 14	2 6	1 59	1 52	1 47	1 44	1 42	1 41	1 42	1 43	1 45	1 47	21
22	3 23	3 0	2 43	2 29	2 18	2 9	2 2	1 54	1 49	1 45	1 42	1 40	1 41	1 42	1 43	1 45	22
23	3 31	3 6	2 47	2 33	2 22	2 13	2 5	1 57	1 51	1 47	1 43	1 41	1 40	1 41	1 42	1 44	23
24	3 38	3 12	2 53	2 38	2 25	2 16	2 8	1 59	1 52	1 48	1 44	1 41	1 40	1 41	1 42	1 43	24
25	3 46	3 18	2 58	2 42	2 29	2 19	2 12	2 1	1 54	1 49	1 45	1 42	1 40	1 40	1 41	1 42	25
26	3 53	3 24	3 4	2 47	2 33	2 23	2 15	2 3	1 55	1 50	1 46	1 43	1 41	1 40	1 41	1 42	26
27	4 1	3 31	3 10	2 52	2 37	2 26	2 19	2 6	1 57	1 51	1 47	1 43	1 41	1 40	1 40	1 41	27
28	4 8	3 37	3 15	2 56	2 41	2 30	2 22	2 8	1 59	1 53	1 48	1 44	1 42	1 41	1 40	1 40	28
29	4 15	3 43	3 20	3 1	2 46	2 34	2 26	2 11	2 1	1 55	1 49	1 45	1 43	1 41	1 40	1 39	29
30	4 22	3 49	3 25	3 5	2 50	2 38	2 29	2 14	2 3	1 56	1 50	1 46	1 44	1 42	1 40	1 39	30
31	4 29	3 55	3 30	3 10	2 54	2 41	2 32	2 17	2 5	1 58	1 52	1 47	1 44	1 42	1 40	1 39	31
32	4 36	4 1	3 35	3 14	2 58	2 45	2 35	2 19	2 7	1 59	1 53	1 48	1 45	1 43	1 41	1 39	32
33	4 43	4 7	3 40	3 19	3 2	2 49	2 38	2 22	2 9	2 1	1 54	1 49	1 46	1 44	1 42	1 40	33
34	4 50	4 12	3 45	3 23	3 6	2 52	2 41	2 24	2 11	2 2	1 56	1 50	1 47	1 44	1 42	1 40	34
35	4 57	4 18	3 50	3 28	3 10	2 56	2 44	2 27	2 14	2 4	1 57	1 51	1 47	1 44	1 42	1 40	35
36	5 4	4 24	3 55	3 32	3 14	3 0	2 47	2 29	2 16	2 6	1 58	1 52	1 48	1 45	1 43	1 41	36
37	5 11	4 29	4 0	3 37	3 19	3 3	2 50	2 32	2 18	2 8	2 0	1 53	1 49	1 46	1 44	1 42	37
38	5 18	4 35	4 5	3 42	3 23	3 7	2 54	2 34	2 20	2 9	2 1	1 54	1 49	1 46	1 44	1 42	38
39	5 25	4 41	4 10	3 46	3 27	3 11	2 58	2 36	2 22	2 10	2 2	1 55	1 50	1 47	1 45	1 43	39
40	5 31	4 47	4 15	3 50	3 31	3 14	3 1	2 38	2 24	2 12	2 4	1 57	1 51	1 47	1 45	1 43	40
41	5 38	4 52	4 20	3 54	3 35	3 18	3 4	2 41	2 26	2 14	2 5	1 58	1 52	1 48	1 46	1 44	41
42	5 44	4 57	4 25	3 58	3 38	3 21	3 7	2 44	2 28	2 16	2 7	1 59	1 53	1 49	1 46	1 44	42
43	5 51	5 3	4 30	4 2	3 42	3 25	3 10	2 46	2 30	2 17	2 8	2 1	1 55	1 50	1 47	1 45	43
44	5 57	5 8	4 35	4 6	3 46	3 28	3 13	2 48	2 32	2 19	2 10	2 2	1 56	1 51	1 48	1 45	44
46	6 9	5 18	4 44	4 14	3 53	3 35	3 19	2 53	2 36	2 23	2 13	2 4	1 58	1 53	1 49	1 46	46
48	6 20	5 28	4 53	4 22	4 0	3 41	3 25	2 58	2 39	2 26	2 15	2 7	2 0	1 55	1 51	1 48	48
50	6 31	5 38	5 1	4 30	4 6	3 47	3 30	3 3	2 43	2 29	2 18	2 9	2 2	1 56	1 52	1 49	50
52	6 41	5 47	5 9	4 37	4 12	3 53	3 35	3 7	2 47	2 32	2 21	2 12	2 4	1 58	1 54	1 50	52
54	6 51	5 56	5 17	4 44	4 18	3 58	3 39	3 11	2 51	2 35	2 24	2 14	2 6	1 59	1 55	1 52	54
56	7 1	6 5	5 24	4 50	4 24	4 3	3 44	3 15	2 54	2 38	2 26	2 17	2 8	2 1	1 57	1 53	56
58	7 11	6 14	5 31	4 56	4 30	4 8	3 49	3 19	2 57	2 41	2 29	2 19	2 10	2 3	1 58	1 54	58
60	7 20	6 22	5 38	5 2	4 35	4 13	3 54	3 23	3 0	2 44	2 31	2 21	2 12	2 5	1 59	1 55	60
62	7 28	6 29	5 44	5 7	4 40	4 18	3 58	3 27	3 3	2 47	2 33	2 22	2 13	2 6	2 0	1 56	62
64	7 36	6 35	5 50	5 12	4 44	4 22	4 2	3 31	3 6	2 49	2 35	2 24	2 15	2 7	2 1	1 56	64
66	7 43	6 41	5 55	5 17	4 49	4 26	4 6	3 34	3 9	2 51	2 37	2 26	2 16	2 8	2 2	1 57	66
68	7 49	6 46	6 0	5 21	4 53	4 30	4 9	3 37	3 12	2 53	2 39	2 27	2 17	2 9	2 3	1 58	68
70	7 55	6 51	6 5	5 25	4 57	4 33	4 12	3 39	3 14	2 55	2 41	2 29	2 19	2 10	2 4	1 59	70
72	8 0	6 55	6 9	5 29	5 0	4 36	4 14	3 41	3 16	2 57	2 42	2 30	2 20	2 11	2 5	2 0	72
74	8 5	6 59	6 13	5 32	5 3	4 38	4 16	3 43	3 18	2 58	2 43	2 31	2 21	2 12	2 5		74
76	8 9	7 3	6 16	5 35	5 6	4 40	4 18	3 44	3 19	2 59	2 44	2 32	2 22	2 13			76
78	8 13	7 6	6 19	5 37	5 8	4 42	4 19	3 45	3 20	3 0	2 45	2 32	2 22				78
80	8 16	7 9	6 21	5 40	5 10	4 44	4 21	3 46	3 21	3 1	2 45	2 33					80
82	8 19	7 12	6 23	5 42	5 12	4 45	4 22	3 47	3 22	3 2	2 46						82
84	8 22	7 14	6 25	5 44	5 13	4 46	4 23	3 48	3 23	3 3							84
86	8 24	7 16	6 27	5 46	5 14	4 47	4 24	3 49	3 24								86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 80°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 30	4 44	4 58	5 12	5 39	6 4	6 28	6 49	7 8	7 26	7 41	7 54	8 5	8 13	8 19	8 24	6
7	3 56	4 8	4 19	4 30	4 52	5 14	5 35	5 54	6 11	6 26	6 39	6 50	6 59	7 6	7 12	7 16	7
8	3 31	3 41	3 52	4 2	4 23	4 42	4 59	5 15	5 29	5 42	5 54	6 4	6 12	6 18	6 23	6 27	8
9	3 11	3 21	3 30	3 39	3 56	4 12	4 28	4 42	4 54	5 5	5 15	5 24	5 32	5 38	5 43	5 46	9
10	2 54	3 3	3 12	3 20	3 35	3 50	4 4	4 16	4 28	4 39	4 48	4 56	5 2	5 7	5 11	5 14	10
11	2 42	2 49	2 57	3 5	3 19	3 32	3 44	3 56	4 7	4 16	4 24	4 31	4 36	4 41	4 45	4 47	11
12	2 32	2 38	2 45	2 52	3 5	3 17	3 28	3 38	3 48	3 57	4 5	4 11	4 15	4 19	4 22	4 25	12
13	2 24	2 30	2 36	2 42	2 53	3 4	3 14	3 23	3 32	3 40	3 47	3 53	3 57	4 1	4 4	4 6	13
14	2 18	2 23	2 28	2 33	2 43	2 53	3 2	3 11	3 19	3 26	3 32	3 38	3 42	3 46	3 48	3 49	14
15	2 12	2 16	2 21	2 25	2 34	2 43	2 52	3 0	3 7	3 13	3 19	3 25	3 29	3 32	3 34	3 36	15
16	2 6	2 10	2 14	2 18	2 26	2 34	2 42	2 50	2 56	3 2	3 8	3 13	3 17	3 20	3 22	3 24	16
17	2 1	2 4	2 8	2 12	2 20	2 27	2 34	2 41	2 47	2 53	2 58	3 3	3 6	3 9	3 11		17
18	1 57	2 0	2 3	2 7	2 14	2 21	2 28	2 34	2 40	2 46	2 50	2 54	2 57	3 0	3 2		18
19	1 54	1 56	1 59	2 2	2 9	2 16	2 22	2 28	2 34	2 39	2 43	2 47	2 50	2 52	2 53		19
20	1 51	1 53	1 56	1 58	2 5	2 11	2 17	2 22	2 28	2 33	2 37	2 40	2 43	2 45	2 46		20
21	1 49	1 51	1 53	1 55	2 1	2 7	2 12	2 17	2 22	2 27	2 31	2 34	2 37	2 38			21
22	1 47	1 49	1 51	1 53	1 58	2 3	2 8	2 13	2 17	2 21	2 25	2 28	2 31	2 32			22
23	1 46	1 47	1 49	1 51	1 55	2 0	2 4	2 9	2 13	2 17	2 20	2 23	2 26	2 27			23
24	1 45	1 46	1 47	1 49	1 53	1 57	2 1	2 5	2 9	2 13	2 16	2 19	2 21	2 22			24
25	1 44	1 45	1 46	1 48	1 51	1 54	1 58	2 1	2 5	2 9	2 12	2 14	2 16				25
26	1 43	1 44	1 45	1 46	1 49	1 52	1 55	1 58	2 2	2 5	2 8	2 10	2 12				26
27	1 42	1 43	1 44	1 45	1 47	1 50	1 53	1 56	1 59	2 2	2 5	2 7	2 8				27
28	1 41	1 42	1 43	1 44	1 46	1 48	1 51	1 54	1 57	1 59	2 2	2 4	2 5				28
29	1 40	1 41	1 41	1 42	1 44	1 46	1 49	1 52	1 55	1 57	1 59	2 1					29
30	1 39	1 40	1 40	1 41	1 43	1 45	1 48	1 51	1 53	1 55	1 57	1 59					30
31	1 39	1 40	1 40	1 41	1 42	1 44	1 46	1 49	1 51	1 53	1 55	1 57					31
32	1 39	1 39	1 39	1 40	1 41	1 43	1 45	1 47	1 49	1 51	1 53	1 55					32
33	1 39	1 39	1 39	1 40	1 41	1 42	1 44	1 46	1 48	1 49	1 51						33
34	1 39	1 39	1 39	1 40	1 41	1 42	1 43	1 45	1 47	1 48	1 49						34
35	1 39	1 39	1 39	1 39	1 40	1 41	1 42	1 44	1 45	1 46	1 47						35
36	1 40	1 39	1 39	1 39	1 40	1 41	1 42	1 43	1 44	1 45	1 46						36
37	1 41	1 40	1 39	1 38	1 39	1 40	1 41	1 42	1 43	1 44							37
38	1 41	1 40	1 39	1 38	1 39	1 40	1 41	1 42	1 42	1 43							38
39	1 41	1 40	1 39	1 38	1 39	1 39	1 40	1 41	1 41	1 42							39
40	1 41	1 40	1 39	1 38	1 38	1 38	1 39	1 40	1 40	1 41							40
41	1 42	1 41	1 40	1 39	1 38	1 38	1 38	1 39	1 39								41
42	1 42	1 41	1 40	1 39	1 37	1 37	1 37	1 38	1 38								42
43	1 43	1 41	1 40	1 39	1 37	1 37	1 37	1 37	1 38								43
44	1 43	1 42	1 40	1 39	1 37	1 37	1 36	1 37	1 37								44
46	1 44	1 42	1 41	1 40	1 38	1 37	1 36	1 36									46
48	1 45	1 43	1 41	1 40	1 38	1 37	1 36	1 36									48
50	1 46	1 44	1 42	1 41	1 38	1 36	1 36										50
52	1 47	1 45	1 43	1 41	1 38	1 36	1 35										52
54	1 48	1 46	1 44	1 42	1 38	1 36											54
56	1 49	1 47	1 44	1 42	1 38	1 36											56
58	1 50	1 47	1 45	1 42	1 38												58
60	1 51	1 48	1 45	1 43	1 38												60
62	1 52	1 49	1 46	1 43													62
64	1 52	1 49	1 46	1 43													64
66	1 53	1 49	1 46														66
68	1 54	1 50															68
70	1 55																70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°						

TABLE P. EFFECT OF SUN's PAR

Add the Numbers above the lines to 3rd Correction, subtract the others.

☽'s App. Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	0	0	1	1	1	1	
10	1	1	1	1	1	0	0	0	0	
15	2	2	2	2	1	1	1	1	1	0
20	3	3	3	2	2	2	2	2	2	
25	4	4	3	3	3	3	3	2		
30	4	4	4	4	4	3	3	3		
35	5	5	5	4	4	4	4			
40	6	6	5	5	5	5	4			
45	6	6	6	6	5	5				
50	7	7	6	6	6	6				
55	7	7	7	7	6					
60	8	8	7	7	7					
65	8	8	8	8						
70	8	8	8	8						
75	9	9	8							
80	9	9	8							
90		9								

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 84°.

☽'s App. Alt.	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App. Alt.
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 47	1 49	1 51	1 54	1 59	2 4	2 10	2 22	2 36	2 50	3 5	3 20	3 35	3 50	4 5	4 20	6
7	1 50	1 47	1 48	1 50	1 53	1 56	2 0	2 10	2 21	2 33	2 45	2 57	3 10	3 23	3 35	3 48	7
8	1 53	1 49	1 47	1 48	1 50	1 52	1 55	2 2	2 11	2 21	2 31	2 42	2 53	3 3	3 14	3 25	8
9	1 57	1 52	1 49	1 47	1 48	1 50	1 52	1 57	2 4	2 12	2 21	2 30	2 39	2 48	2 58	3 7	9
10	2 2	1 55	1 51	1 49	1 47	1 48	1 50	1 53	1 59	2 5	2 12	2 20	2 27	2 35	2 44	2 52	10
11	2 8	1 59	1 54	1 51	1 49	1 47	1 48	1 51	1 55	1 59	2 5	2 12	2 18	2 36	2 33	2 41	11
12	2 14	2 4	1 57	1 53	1 51	1 48	1 47	1 49	1 52	1 55	1 59	2 5	2 11	2 18	2 25	2 31	12
13	2 20	2 9	2 1	1 56	1 53	1 50	1 48	1 48	1 50	1 52	1 55	2 0	2 6	2 11	2 17	2 23	13
14	2 27	2 14	2 5	1 59	1 55	1 52	1 50	1 47	1 48	1 50	1 53	1 57	2 2	2 6	2 11	2 16	14
15	2 34	2 20	2 10	2 3	1 58	1 54	1 51	1 48	1 47	1 49	1 51	1 54	1 58	2 2	2 7	2 11	15
16	2 42	2 26	2 15	2 7	2 1	1 56	1 53	1 49	1 47	1 48	1 50	1 52	1 55	1 59	2 3	2 7	16
17	2 49	2 32	2 20	2 11	2 4	1 59	1 55	1 50	1 48	1 47	1 48	1 50	1 53	1 56	2 0	2 3	17
18	2 57	2 38	2 25	2 16	2 8	2 2	1 57	1 52	1 49	1 46	1 47	1 49	1 51	1 54	1 57	2 0	18
19	3 4	2 44	2 31	2 20	2 12	2 5	1 59	1 53	1 50	1 47	1 46	1 48	1 49	1 52	1 54	1 57	19
20	3 12	2 50	2 36	2 25	2 15	2 8	2 2	1 55	1 51	1 48	1 46	1 47	1 48	1 50	1 52	1 55	20
21	3 20	2 57	2 42	2 29	2 19	2 11	2 5	1 57	1 52	1 49	1 47	1 46	1 47	1 48	1 50	1 52	21
22	3 27	3 3	2 47	2 34	2 23	2 14	2 8	1 59	1 54	1 50	1 47	1 46	1 46	1 47	1 49	1 50	22
23	3 35	3 9	2 52	2 38	2 27	2 18	2 11	2 1	1 56	1 52	1 48	1 46	1 46	1 47	1 48	1 49	23
24	3 42	3 15	2 57	2 42	2 30	2 21	2 14	2 3	1 57	1 53	1 49	1 46	1 46	1 46	1 47	1 48	24
25	3 49	3 21	3 3	2 47	2 34	2 25	2 17	2 6	1 59	1 54	1 50	1 47	1 46	1 46	1 46	1 47	25
26	3 56	3 27	3 8	2 52	2 38	2 28	2 20	2 8	2 0	1 55	1 51	1 48	1 47	1 46	1 46	1 46	26
27	4 4	3 34	3 13	2 56	2 42	2 32	2 24	2 11	2 2	1 56	1 52	1 49	1 47	1 46	1 45	1 46	27
28	4 11	3 40	3 18	3 1	2 46	2 35	2 27	2 13	2 4	1 58	1 53	1 49	1 47	1 46	1 45	1 45	28
29	4 19	3 47	3 24	3 5	2 51	2 39	2 30	2 16	2 6	1 59	1 54	1 50	1 48	1 46	1 45	1 45	29
30	4 26	3 53	3 29	3 10	2 55	2 43	2 33	2 18	2 8	2 1	1 55	1 51	1 49	1 47	1 46	1 45	30
31	4 33	3 59	3 35	2 14	2 59	2 46	2 36	2 21	2 10	2 3	1 57	1 52	1 49	1 47	1 46	1 45	31
32	4 40	4 5	3 40	3 19	3 3	2 50	2 39	2 24	2 12	2 4	1 58	1 53	1 50	1 48	1 46	1 45	32
33	4 47	4 11	3 45	3 24	3 7	2 54	2 42	2 27	2 14	2 5	1 59	1 54	1 50	1 48	1 46	1 45	33
34	4 54	4 16	3 50	3 28	3 11	2 57	2 45	2 29	2 16	2 7	2 0	1 55	1 51	1 48	1 47	1 46	34
35	5 1	4 22	3 55	3 33	3 15	3 1	2 49	2 32	2 19	2 9	2 2	1 56	1 52	1 49	1 47	1 46	35
36	5 8	4 28	4 0	3 37	3 19	3 5	2 52	2 34	2 21	2 10	2 3	1 58	1 53	1 49	1 47	1 46	36
37	5 15	4 34	4 5	3 42	3 23	3 8	2 56	2 37	2 23	2 12	2 4	1 59	1 54	1 50	1 48	1 47	37
38	5 21	4 40	4 10	3 46	3 27	3 12	2 59	2 39	2 25	2 14	2 6	2 0	1 55	1 51	1 49	1 47	38
39	5 28	4 45	4 15	3 51	3 31	3 15	3 2	2 42	2 27	2 16	2 7	2 1	1 56	1 52	1 49	1 47	39
40	5 34	4 51	4 20	3 55	3 35	3 19	3 5	2 44	2 29	2 18	2 9	2 3	1 57	1 52	1 49	1 47	40
41	5 41	4 56	4 25	3 59	3 39	3 23	3 8	2 47	2 31	2 20	2 11	2 4	1 58	1 53	1 50	1 48	41
42	5 47	5 1	4 30	4 3	3 43	3 26	3 11	2 49	2 33	2 21	2 12	2 5	1 59	1 54	1 51	1 49	42
43	6 53	5 7	4 35	4 7	3 47	3 30	3 14	2 52	2 35	2 23	2 13	2 7	2 0	1 55	1 52	1 50	43
44	6 0	5 12	4 40	4 11	3 50	3 34	3 17	2 54	2 37	2 25	2 15	2 8	2 1	1 56	1 53	1 51	44
46	6 12	5 22	4 49	4 19	3 57	3 40	3 23	2 59	2 41	2 29	2 18	2 10	2 3	1 58	1 55	1 52	46
48	6 24	5 32	4 58	4 27	4 4	3 46	3 29	3 4	2 45	2 32	2 21	2 12	2 5	2 0	1 56	1 53	48
50	6 35	5 42	5 6	4 35	4 11	3 52	3 35	3 9	2 49	2 35	2 24	2 15	2 8	2 2	1 58	1 55	50
52	6 45	5 51	5 14	4 42	4 17	3 58	3 40	3 13	2 53	2 38	2 27	2 18	2 10	2 4	2 0	1 57	52
54	6 55	6 0	5 22	4 49	4 23	4 4	3 45	3 17	2 57	2 41	2 30	2 20	2 12	2 6	2 2	1 58	54
56	7 5	6 9	5 29	4 55	4 29	4 9	3 50	3 21	3 1	2 44	2 32	2 22	2 14	2 8	2 3	1 59	56
58	7 14	6 17	5 36	5 1	4 34	4 14	3 55	3 25	3 4	2 47	2 35	2 24	2 16	2 9	2 4	2 0	58
60	7 22	6 25	5 42	5 6	4 39	4 19	3 59	3 29	3 7	2 50	2 37	2 26	2 17	2 10	2 5	2 1	60
62	7 30	6 32	5 48	5 11	4 44	4 23	4 3	3 33	3 10	2 53	2 39	2 28	2 19	2 12	2 7	2 2	62
64	7 38	6 39	5 54	5 16	4 49	4 27	4 7	3 36	3 13	2 56	2 41	2 29	2 20	2 13	2 8	2 3	64
66	7 45	6 45	6 0	5 21	4 54	4 31	4 11	3 39	3 16	2 58	2 43	2 31	2 22	2 15	2 9	2 3	66
68	7 51	6 50	6 5	5 25	4 58	4 35	4 15	3 41	3 19	3 0	2 45	2 33	2 24	2 16	2 10	2 4	68
70	7 57	6 54	6 9	5 29	5 2	4 39	4 18	3 44	3 21	3 2	2 46	2 34	2 25	2 17	2 10		70
72	8 2	6 58	6 13	5 33	5 6	4 42	4 21	3 46	3 23	3 3	2 47	2 35	2 26	2 18			72
74	8 6	7 2	6 17	5 36	5 9	4 44	4 23	3 48	3 24	3 4	2 48	2 36	2 27				74
76	8 10	7 5	6 20	5 39	5 11	4 46	4 25	3 50	3 25	3 5	2 49	2 37					76
78	8 14	7 8	6 23	5 42	5 13	4 48	4 26	3 51	3 26	3 6	2 50						78
80	8 18	7 11	6 26	5 45	5 15	4 50	4 27	3 52	3 27	3 7							80
82	8 21	7 14	6 28	5 47	5 17	4 51	4 28	3 53	3 28								82
84	8 24	7 17	6 30	5 49	5 18	4 52	4 29	3 54									84
86	8 26	7 19	6 31	5 50	5 19	4 53	4 30										86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 84°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 34	4 48	5 2	5 15	5 41	6 6	6 29	6 51	7 10	7 27	7 42	7 55	8 6	8 14	8 21	8 27	6
7	4 0	4 12	4 24	4 36	4 58	5 19	5 39	5 58	6 15	6 30	6 42	6 53	7 2	7 9	7 15	7 19	7
8	3 36	3 47	3 57	4 7	4 27	4 46	5 4	5 20	5 34	5 46	5 58	6 9	6 17	6 23	6 28	6 31	8
9	3 16	3 25	3 34	3 43	4 0	4 17	4 33	4 47	4 59	5 10	5 20	5 29	5 36	5 42	5 47	5 50	9
10	3 1	3 9	3 17	3 25	3 41	3 55	4 9	4 21	4 33	4 43	4 53	5 1	5 7	5 13	5 17	5 19	10
11	2 48	2 55	3 3	3 10	3 24	3 37	3 50	4 2	4 12	4 21	4 30	4 37	4 43	4 48	4 51	4 54	11
12	2 38	2 44	2 51	2 58	3 10	3 22	3 34	3 45	3 54	4 2	4 10	4 16	4 22	4 26	4 28	4 30	12
13	2 29	2 35	2 41	2 47	2 58	3 9	3 20	3 29	3 38	3 45	3 52	3 58	4 3	4 7	4 9		13
14	2 22	2 27	2 33	2 38	2 48	2 58	3 8	3 16	3 24	3 31	3 37	3 43	3 47	3 51	3 53		14
15	2 16	2 21	2 26	2 30	2 39	2 48	2 57	3 5	3 12	3 19	3 25	3 30	3 34	3 37	3 40		15
16	2 11	2 15	2 20	2 24	2 32	2 40	2 48	2 56	3 2	3 9	3 15	3 19	3 23	3 26	3 29		16
17	2 7	2 10	2 14	2 18	2 26	2 34	2 41	2 48	2 54	3 0	3 5	3 9	3 13	3 15			17
18	2 3	2 6	2 10	2 13	2 21	2 28	2 34	2 40	2 46	2 52	2 57	3 1	3 4	3 6			18
19	2 0	2 3	2 6	2 9	2 16	2 23	2 29	2 34	2 40	2 45	2 49	2 53	2 56	2 58			19
20	1 57	2 0	2 2	2 5	2 12	2 18	2 24	2 29	2 34	2 38	2 42	2 45	2 48	2 50			20
21	1 54	1 57	1 59	2 2	2 8	2 13	2 19	2 24	2 29	2 33	2 36	2 39	2 41				21
22	1 52	1 54	1 56	1 59	2 4	2 9	2 14	2 19	2 24	2 28	2 31	2 34	2 36				22
23	1 50	1 52	1 54	1 56	2 1	2 5	2 10	2 15	2 19	2 23	2 26	2 29	2 32				23
24	1 49	1 50	1 52	1 54	1 58	2 2	2 7	2 11	2 15	2 19	2 22	2 25	2 28				24
25	1 48	1 49	1 50	1 52	1 56	2 0	2 4	2 8	2 12	2 15	2 18	2 21					25
26	1 47	1 48	1 49	1 51	1 54	1 58	2 2	2 5	2 9	2 12	2 15	2 17					26
27	1 47	1 48	1 49	1 50	1 53	1 56	2 0	2 3	2 6	2 9	2 12	2 14					27
28	1 46	1 47	1 48	1 49	1 51	1 54	1 58	2 1	2 3	2 6	2 9	2 11					28
29	1 46	1 47	1 47	1 48	1 50	1 53	1 56	1 59	2 1	2 4	2 6						29
30	1 45	1 46	1 46	1 47	1 49	1 52	1 55	1 57	2 0	2 2	2 3						30
31	1 45	1 45	1 46	1 47	1 49	1 51	1 54	1 56	1 58	2 0	2 1						31
32	1 45	1 45	1 45	1 46	1 48	1 50	1 52	1 54	1 56	1 58	1 59						32
33	1 45	1 45	1 45	1 46	1 47	1 49	1 51	1 53	1 54	1 56							33
34	1 45	1 44	1 44	1 45	1 46	1 48	1 50	1 52	1 53	1 54							34
35	1 45	1 44	1 44	1 45	1 46	1 47	1 49	1 50	1 51	1 52							35
36	1 46	1 45	1 44	1 44	1 45	1 46	1 48	1 49	1 50	1 50							36
37	1 46	1 45	1 44	1 44	1 45	1 45	1 47	1 48	1 49								37
38	1 46	1 45	1 44	1 44	1 44	1 45	1 46	1 47	1 48								38
39	1 46	1 45	1 44	1 44	1 44	1 44	1 45	1 46	1 47								39
40	1 46	1 45	1 45	1 45	1 44	1 44	1 45	1 45	1 46								40
41	1 47	1 46	1 45	1 45	1 44	1 44	1 44	1 44									41
42	1 48	1 47	1 46	1 45	1 43	1 43	1 44	1 44									42
43	1 49	1 48	1 46	1 45	1 43	1 43	1 44	1 44									43
44	1 49	1 48	1 47	1 45	1 43	1 43	1 43										44
46	1 50	1 49	1 47	1 45	1 43	1 43	1 43										46
48	1 51	1 50	1 48	1 46	1 44	1 43	1 42										48
50	1 53	1 51	1 49	1 47	1 44	1 43											50
52	1 54	1 51	1 49	1 47	1 44	1 42											52
54	1 55	1 52	1 49	1 47	1 44												54
56	1 56	1 53	1 50	1 48	1 44												56
58	1 56	1 53	1 50	1 48													58
60	1 57	1 54	1 51	1 48													60
62	1 58	1 54	1 51														62
64	1 59	1 55															64
66	1 59																66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	0	0	0	0	0	0	
10	1	1	1	1	1	1	1	1	1	0
15	2	2	2	2	2	2	2	2	1	
20	3	3	3	3	2	2	2	2		
25	4	4	3	3	3	3	3	3		
30	4	4	4	4	4	4	4	4		
35	5	5	5	5	5	4	4			
40	6	6	5	5	5	5	5			
45	6	6	6	6	6	6				
50	7	7	7	6	6					
55	7	7	7	7	7					
60	8	8	7	7						
65	8	8	8	8						
70	8	8	8							
75	9	9	8							
80	9	9								
90	9									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 88°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 53	1 54	1 56	1 59	2 4	2 10	2 16	2 28	2 42	2 56	2 11	3 26	3 41	3 56	4 11	4 25	6
7	1 55	1 53	1 54	1 56	1 59	2 3	2 7	2 16	2 27	2 39	2 51	3 4	3 16	3 28	3 40	3 52	7
8	1 58	1 55	1 53	1 54	1 56	1 59	2 2	2 8	2 17	2 27	2 37	2 48	2 59	3 9	3 19	3 30	8
9	2 2	1 58	1 55	1 53	1 54	1 56	1 58	2 3	2 10	2 18	2 26	2 35	2 45	2 54	3 3	3 12	9
10	2 7	2 1	1 57	1 55	1 53	1 54	1 56	2 0	2 5	2 11	2 18	2 25	2 34	2 43	2 50	2 58	10
11	2 13	2 5	2 0	1 57	1 55	1 53	1 54	1 57	2 1	2 6	2 12	2 18	2 25	2 32	2 39	2 47	11
12	2 19	2 10	2 4	2 0	1 57	1 54	1 53	1 55	1 58	2 2	2 7	2 12	2 18	2 24	2 30	2 37	12
13	2 26	2 15	2 8	2 3	1 59	1 56	1 54	1 54	1 56	1 59	2 3	2 7	2 12	2 18	2 23	2 29	13
14	2 33	2 21	2 12	2 6	2 1	1 58	1 56	1 53	1 55	1 57	2 0	2 3	2 7	2 12	2 17	2 22	14
15	2 40	2 26	2 16	2 9	2 4	2 0	1 57	1 54	1 54	1 55	1 58	2 0	2 4	2 8	2 13	2 17	15
16	2 47	2 32	2 20	2 13	2 7	2 2	1 59	1 55	1 53	1 54	1 56	1 58	2 1	2 5	2 9	2 13	16
17	2 54	2 37	2 25	2 17	2 10	2 5	2 1	1 56	1 53	1 53	1 55	1 57	1 59	2 2	2 5	2 9	17
18	3 2	2 43	2 30	2 21	2 13	2 7	2 3	1 58	1 54	1 52	1 54	1 56	1 58	2 0	2 2	2 5	18
19	3 10	2 49	2 35	2 25	2 16	2 10	2 5	1 59	1 55	1 53	1 53	1 54	1 56	1 58	2 0	2 3	19
20	3 17	2 55	2 41	2 29	2 20	2 13	2 8	2 1	1 56	1 54	1 52	1 53	1 54	1 56	1 58	2 1	20
21	3 25	3 2	2 46	2 34	2 24	2 17	2 11	2 3	1 58	1 55	1 53	1 52	1 53	1 55	1 57	1 59	21
22	3 32	3 8	2 52	2 39	2 28	2 20	2 14	2 5	1 59	1 56	1 53	1 52	1 53	1 54	1 55	1 57	22
23	3 40	3 15	2 57	2 43	2 32	2 24	2 17	2 7	2 1	1 57	1 54	1 52	1 52	1 53	1 54	1 55	23
24	3 47	3 21	3 2	2 48	2 36	2 27	2 20	2 9	2 2	1 58	1 55	1 53	1 52	1 52	1 53	1 54	24
25	3 55	3 27	3 8	2 52	2 40	2 31	2 23	2 11	2 4	2 0	1 56	1 53	1 52	1 52	1 53	1 54	25
26	4 2	3 33	2 13	2 57	2 44	2 35	2 27	2 14	2 6	2 1	1 57	1 54	1 53	1 52	1 52	1 53	26
27	4 10	3 39	3 18	3 2	2 48	2 38	2 30	2 17	2 8	2 2	1 58	1 55	1 53	1 52	1 52	1 52	27
28	4 17	3 45	3 23	3 6	2 52	2 42	2 33	2 19	2 10	2 4	1 59	1 55	1 53	1 52	1 52	1 52	28
29	4 24	3 51	3 28	3 11	2 56	2 46	2 37	2 22	2 12	2 5	2 0	1 56	1 53	1 52	1 52	1 52	29
30	4 31	3 57	3 34	3 15	3 0	2 49	2 40	2 24	2 14	2 6	2 1	1 57	1 54	1 53	1 52	1 52	30
31	4 39	4 3	3 40	3 20	3 4	2 53	2 43	2 27	2 16	2 8	2 2	1 58	1 55	1 53	1 52	1 52	31
32	4 46	4 9	3 45	3 25	3 8	2 56	2 46	2 29	2 18	2 9	2 3	1 59	1 56	1 54	1 53	1 52	32
33	4 53	4 15	3 51	3 29	3 12	3 0	2 50	2 31	2 20	2 11	2 5	2 0	1 56	1 54	1 53	1 53	33
34	5 0	4 21	3 56	3 34	3 17	3 4	2 53	2 34	2 22	2 13	2 7	2 1	1 57	1 55	1 54	1 53	34
35	5 7	4 27	4 1	3 38	3 21	3 7	2 56	2 37	2 24	2 15	2 8	2 2	1 58	1 56	1 54	1 53	35
36	5 13	4 33	4 6	3 43	3 25	3 11	2 59	2 40	2 26	2 17	2 10	2 4	1 59	1 56	1 54	1 53	36
37	5 20	4 39	4 11	3 48	3 29	3 15	3 2	2 43	2 28	2 19	2 11	2 5	2 0	1 57	1 55	1 54	37
38	5 27	4 45	4 16	3 52	3 33	3 18	3 5	2 46	2 31	2 21	2 13	2 6	2 1	1 58	1 56	1 54	38
39	5 34	4 51	4 21	3 57	3 37	3 22	3 8	2 49	2 33	2 22	2 14	2 7	2 2	1 58	1 56	1 55	39
40	5 40	4 56	4 26	4 1	3 41	3 25	3 11	2 51	2 35	2 24	2 16	2 9	2 3	1 59	1 57	1 55	40
41	5 47	5 2	4 31	4 5	3 45	3 29	3 14	2 54	2 38	2 26	2 17	2 10	2 4	2 0	1 57	1 55	41
42	5 53	5 7	4 36	4 9	3 49	3 32	3 17	2 56	2 40	2 28	2 19	2 11	2 5	2 1	1 58	1 56	42
43	6 0	5 13	4 41	4 14	3 53	3 36	3 20	2 59	2 42	2 30	2 20	2 12	2 6	2 2	1 59	1 57	43
44	6 6	5 19	4 46	4 18	3 57	3 39	3 23	3 1	2 44	2 32	2 22	2 13	2 7	2 3	2 0	1 58	44
46	6 18	5 29	4 55	4 26	4 4	3 46	3 29	3 6	2 48	2 35	2 25	2 16	2 9	2 5	2 2	1 59	46
48	6 29	5 39	5 4	4 34	4 11	3 52	3 35	3 11	2 52	2 39	2 28	2 18	2 11	2 7	2 3	2 0	48
50	6 40	5 48	5 12	4 41	4 17	3 58	3 41	3 15	2 56	2 42	2 31	2 21	2 13	2 9	2 5	2 2	50
52	6 51	5 57	5 20	4 48	4 23	4 2	3 47	3 19	2 59	2 45	2 34	2 24	2 16	2 10	2 6	2 3	52
54	7 1	6 6	5 28	4 55	4 29	4 8	3 52	3 23	3 3	2 48	2 36	2 27	2 18	2 12	2 8	2 4	54
56	7 10	6 15	5 35	5 1	4 35	4 14	3 57	3 27	3 7	2 51	2 39	2 29	2 20	2 14	2 9	2 5	56
58	7 19	6 23	5 42	5 7	4 40	4 19	4 2	3 31	3 10	2 54	2 42	2 31	2 22	1 16	2 11	2 6	58
60	7 28	6 31	5 48	5 12	4 45	4 24	4 6	3 35	3 13	2 57	2 44	2 33	2 24	1 17	2 12	2 7	60
62	7 36	6 38	5 54	5 17	4 50	4 29	4 10	3 38	3 16	2 59	2 46	2 35	2 26	2 19	2 13	2 8	62
64	7 44	6 45	6 0	5 22	4 55	4 33	4 14	3 42	3 19	3 2	2 48	2 37	2 28	2 20	2 14	2 9	64
66	7 51	6 51	6 5	5 27	5 0	4 37	4 18	3 45	3 22	3 4	2 50	2 39	2 30	2 22	2 15		66
68	7 58	6 56	6 10	5 32	5 4	4 41	4 21	3 48	3 25	3 6	2 51	2 40	2 31	2 23			68
70	8 4	7 1	6 15	5 36	5 8	4 44	4 23	3 50	3 27	3 8	2 53	2 41	2 32				70
72	8 10	7 5	6 19	5 40	5 11	4 47	4 25	3 52	3 29	3 9	2 53	2 42					72
74	8 15	7 9	6 23	5 43	5 14	4 49	4 27	3 54	3 30	3 10	2 54						74
76	8 19	7 13	6 26	5 46	5 17	4 51	4 29	3 56	3 31	3 11							76
78	8 22	7 16	6 29	5 49	5 19	4 53	4 31	3 57	3 32								78
80	8 25	7 19	6 31	5 52	5 21	4 55	4 33	3 58									80
82	8 28	7 22	6 33	5 54	5 23	4 57	4 35										82
84	8 30	7 24	6 35	5 56	5 15												84
86	8 32	7 26	6 37														86
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 88°

☽'s App. Alt.	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	86°	☽'s App Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 40	4 54	5 8	5 22	5 48	6 13	6 36	6 57	7 16	7 34	7 49	8 2	8 13	8 21	8 27	8 32	6
7	4 4	4 16	4 28	4 40	5 3	5 25	5 45	6 4	6 21	6 36	6 49	7 0	7 9	7 16	7 22	7 27	7
8	3 41	3 52	4 3	4 13	4 33	4 52	5 10	5 26	5 40	5 53	6 5	6 15	6 23	6 29	6 34	6 37	8
9	3 22	3 31	3 41	3 50	4 8	4 24	4 39	4 53	5 5	5 16	5 26	5 35	5 43	5 49	5 54		9
10	3 6	3 14	3 22	3 30	3 46	4 1	4 15	4 27	4 38	4 49	4 58	5 7	5 14	5 19	5 23		10
11	2 54	3 2	3 9	3 16	3 30	3 43	3 56	4 7	4 17	4 27	4 36	4 43	4 49	4 53	4 57		11
12	2 44	2 51	2 58	3 4	3 16	3 28	3 40	3 50	4 0	4 8	4 16	4 23	4 28	4 32	4 36		12
13	2 35	2 41	2 47	2 53	3 4	3 15	3 26	3 35	3 44	3 52	3 59	4 5	4 10	4 13			13
14	2 27	2 33	2 38	2 44	2 54	3 4	3 14	3 22	3 30	3 37	3 44	3 50	3 54	3 57			14
15	2 22	2 27	2 32	2 36	2 46	2 55	3 4	3 11	3 18	3 25	3 31	3 37	3 41	3 44			15
16	2 17	2 21	2 26	2 30	2 39	2 47	2 55	3 2	3 9	3 15	3 21	3 26	3 30	3 33			16
17	2 12	2 16	2 21	2 25	2 33	2 40	2 47	2 54	3 0	3 6	3 12	3 16	3 19				17
18	2 8	2 12	2 16	2 20	2 27	2 34	2 41	2 47	2 53	2 58	2 3	3 7	3 10				18
19	2 5	2 8	2 12	2 16	2 22	2 29	2 35	2 41	2 47	2 52	2 56	2 59	3 2				19
20	2 3	2 6	2 9	2 12	2 18	2 24	2 30	2 35	2 41	2 46	2 49	2 52	2 54				20
21	2 1	2 3	2 6	2 8	2 14	2 19	2 25	2 30	2 35	2 40	2 43	2 46					21
22	1 59	2 1	2 3	2 5	2 10	2 15	2 20	2 25	2 30	2 35	2 38	2 41					22
23	1 57	1 59	2 1	2 3	2 7	2 12	2 16	2 21	2 26	2 30	2 33	2 36					23
24	1 56	1 57	1 59	2 1	2 5	2 9	2 13	2 17	2 22	2 26	2 29	2 31					24
25	1 55	1 56	1 57	1 59	2 3	2 6	2 10	2 14	2 18	2 22	2 25						25
26	1 54	1 55	1 56	1 58	2 1	2 4	2 8	2 12	2 15	2 18	2 21						26
27	1 53	1 54	1 55	1 57	2 0	2 3	2 6	2 10	2 13	2 15	2 17						27
28	1 53	1 54	1 55	1 56	1 58	2 1	2 4	2 8	2 11	2 13	2 14						28
29	1 52	1 53	1 54	1 55	1 57	2 0	2 3	2 6	2 8	2 10							29
30	1 52	1 53	1 53	1 54	1 56	1 59	2 2	2 4	2 6	2 8							30
31	1 52	1 52	1 52	1 53	1 55	1 58	2 0	2 2	2 4	2 5							31
32	1 51	1 52	1 52	1 53	1 55	1 57	1 59	2 1	2 2	2 3							32
33	1 52	1 51	1 51	1 52	1 54	1 56	1 58	1 59	2 0								33
34	1 52	1 51	1 51	1 52	1 53	1 55	1 57	1 58	1 59								34
35	1 52	1 51	1 51	1 51	1 52	1 54	1 56	1 57	1 57								35
36	1 53	1 52	1 51	1 51	1 52	1 53	1 55	1 56	1 56								36
37	1 53	1 52	1 51	1 51	1 51	1 52	1 54	1 56									37
38	1 53	1 52	1 51	1 50	1 51	1 52	1 53	1 54									38
39	1 54	1 52	1 51	1 50	1 51	1 52	1 52	1 53									39
40	1 54	1 53	1 52	1 51	1 50	1 51	1 52	1 52									40
41	1 54	1 53	1 52	1 51	1 50	1 51	1 51										41
42	1 54	1 53	1 52	1 51	1 50	1 51	1 51										42
43	1 55	1 54	1 53	1 52	1 51	1 51	1 51										43
44	1 56	1 54	1 53	1 52	1 51	1 50	1 50										44
46	1 57	1 55	1 53	1 52	1 51	1 50											46
48	1 58	1 56	1 54	1 53	1 51	1 50											48
50	1 59	1 57	1 55	1 53	1 51												50
52	2 0	1 58	1 55	1 53	1 52												52
54	2 1	1 58	1 56	1 54													54
56	2 2	1 59	1 56	1 54													56
58	2 3	1 59	1 56														58
60	2 3	1 59															60
62	2 4																62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
84																	84
86																	86
	32°	34°	36°	38°	42°	46°	50°	54°	58°	62°	66°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	1	1	1	1	0	0	
10	2	1	1	1	1	1	1	1	1	0
15	2	2	2	2	2	2	2	2	2	
20	3	3	3	3	3	3	3	3		
25	4	4	4	4	4	4	4	4		
30	4	4	4	4	4	4	4			
35	5	5	5	5	5	5	5			
40	6	6	6	6	6					
45	6	6	6	6	6					
50	7	7	7	7	7					
55	7	7	7	7	7					
60	8	8	8	8						
65	8	8	8							
70	8	8	8							
75	9	9								
80	9	9								
90	9									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 92°.

☽'s App. Alt.	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	☽'s App. Alt.
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	1 59	2 1	2 3	2 6	2 10	2 15	2 21	2 34	2 48	3 3	3 18	3 33	3 48	4 3	4 18	4 33	6
7	2 1	1 59	2 1	2 3	2 5	2 9	2 13	2 22	2 33	2 45	2 58	3 11	3 24	3 36	3 48	4 0	7
8	2 4	2 1	1 59	2 0	2 2	2 4	2 7	2 14	2 23	2 33	2 44	2 55	3 5	3 16	3 26	3 37	8
9	2 8	2 4	2 1	1 59	2 0	2 2	2 4	2 9	2 16	2 24	2 33	2 42	2 51	3 1	3 10	3 19	9
10	2 13	2 7	2 3	2 1	1 59	2 0	2 2	2 6	2 11	2 17	2 24	2 32	2 40	2 48	2 57	3 5	10
11	2 19	2 11	2 6	2 3	2 1	1 59	2 0	2 3	2 7	2 12	2 18	2 24	2 31	2 39	2 46	2 54	11
12	2 25	2 16	2 10	2 6	2 3	2 1	1 59	2 1	2 4	2 8	2 13	2 18	2 24	2 31	2 37	2 44	12
13	2 32	2 21	2 14	2 9	2 5	2 2	2 0	2 0	2 2	2 5	2 9	2 14	2 19	2 24	2 30	2 36	13
14	2 39	2 27	2 18	2 12	2 7	2 4	2 2	1 59	2 1	2 3	2 6	2 10	2 14	2 19	2 24	2 29	14
15	2 46	2 32	2 22	2 15	2 10	2 6	2 3	2 0	2 0	2 1	2 4	2 7	2 10	2 15	2 19	2 24	15
16	2 53	2 38	2 27	2 19	2 13	2 8	2 5	2 1	1 59	2 0	2 2	2 4	2 7	2 11	2 15	2 19	16
17	3 0	2 44	2 32	2 23	2 16	2 11	2 7	2 3	2 0	1 59	2 1	2 3	2 5	2 8	2 12	2 15	17
18	3 8	2 50	2 37	2 27	2 19	2 14	2 9	2 4	2 1	1 59	2 0	2 2	2 4	2 6	2 9	2 12	18
19	3 16	2 56	2 42	2 31	2 22	2 16	2 11	2 6	2 2	2 0	2 0	2 1	2 2	2 4	2 7	2 10	19
20	3 23	3 2	2 48	2 36	2 26	2 19	2 14	2 8	2 3	2 0	1 59	2 0	2 1	2 3	2 5	2 8	20
21	3 31	3 9	2 54	2 41	2 30	2 23	2 17	2 10	2 5	2 1	1 59	1 59	2 0	2 2	2 4	2 6	21
22	3 38	3 15	2 59	2 45	2 34	2 26	2 20	2 12	2 6	2 2	2 0	1 59	2 0	2 1	2 2	2 4	22
23	3 46	3 22	3 4	2 50	2 38	2 30	2 23	2 14	2 8	2 3	2 0	1 59	1 59	2 0	2 1	2 2	23
24	3 53	3 28	3 9	2 54	2 42	2 34	2 27	2 16	2 9	2 4	2 1	2 0	1 59	1 59	2 0	2 1	24
25	4 1	3 34	3 15	2 59	2 46	2 37	2 30	2 19	2 11	2 5	2 2	2 0	1 59	1 59	2 0	2 0	25
26	4 9	3 40	3 20	3 3	2 50	2 41	2 33	2 22	2 13	2 7	2 4	2 1	1 59	1 59	1 59	2 0	26
27	4 17	3 46	3 26	3 8	2 55	2 45	2 36	2 24	2 15	2 9	2 5	2 2	2 0	1 59	1 59	2 0	27
28	4 24	3 52	3 31	3 13	2 59	2 48	2 39	2 27	2 17	2 11	2 6	2 2	2 0	1 59	1 59	1 59	28
29	4 31	3 58	3 36	3 18	3 3	2 52	2 43	2 29	2 19	2 12	2 7	2 3	2 1	2 0	1 59	1 59	29
30	4 38	4 4	3 41	3 22	3 7	2 56	2 46	2 32	2 21	2 13	2 8	2 4	2 1	2 0	1 59	1 59	30
31	4 46	4 10	3 47	3 27	3 12	3 0	2 50	2 35	2 23	2 15	2 9	2 5	2 2	2 0	1 59	1 59	31
32	4 53	4 16	3 52	3 32	3 16	3 4	2 53	2 37	2 25	2 16	2 11	2 7	2 3	2 1	2 0	1 59	32
33	5 0	4 22	3 58	3 37	3 20	3 8	2 57	2 40	2 27	2 18	2 12	2 8	2 4	2 1	2 0	1 59	33
34	5 7	4 28	4 3	3 41	3 24	3 11	3 0	2 42	2 29	2 20	2 14	2 9	2 5	2 2	2 1	2 0	34
35	5 14	4 34	4 8	3 46	3 28	3 15	3 3	2 45	2 31	2 22	2 15	2 10	2 6	2 3	2 1	2 0	35
36	5 21	4 40	4 13	3 50	3 32	3 18	3 6	2 47	2 33	2 24	2 17	2 11	2 7	2 4	2 2	2 1	36
37	5 28	4 46	4 18	3 55	3 36	3 22	3 9	2 50	2 36	2 25	2 18	2 12	2 8	2 5	2 3	2 1	37
38	5 34	4 52	4 23	4 0	3 40	3 25	3 12	2 53	2 38	2 27	2 20	2 14	2 9	2 6	2 4	2 2	38
39	5 41	4 58	4 28	4 4	3 44	3 29	3 15	2 55	2 40	2 29	2 21	2 15	2 10	2 7	2 4	2 2	39
40	5 47	5 3	4 33	4 8	3 48	3 32	3 18	2 58	2 42	2 31	2 22	2 16	2 11	2 7	2 5	2 3	40
41	5 54	5 9	4 38	4 12	3 52	3 35	3 21	3 0	2 45	2 33	2 24	2 17	2 12	2 8	2 5	2 3	41
42	6 0	5 14	4 43	4 16	3 55	3 39	3 24	3 2	2 47	2 34	2 25	2 18	2 13	2 9	2 6	2 4	42
43	6 7	5 20	4 48	4 21	3 59	3 42	3 27	3 5	2 49	2 36	2 27	2 20	2 14	2 10	2 7	2 4	43
44	6 13	5 25	4 53	4 25	4 3	3 46	3 30	3 8	2 51	2 38	2 28	2 21	2 15	2 11	2 8	2 5	44
45	6 19	5 31	4 58	4 29	4 7	3 49	3 33	3 11	2 53	2 40	2 30	2 22	2 16	2 12	2 8	2 5	45
46	6 25	5 36	5 2	4 33	4 10	3 52	3 36	3 13	2 55	2 42	2 31	2 24	2 18	2 13	2 9	2 6	46
47	6 31	5 41	5 7	4 37	4 13	3 55	3 39	3 16	2 57	2 44	2 33	2 25	2 19	2 14	2 10	2 7	47
48	6 37	5 46	5 11	4 41	4 17	3 59	3 42	3 18	2 59	2 46	2 35	2 27	2 20	2 15	2 11	2 8	48
50	6 47	5 56	5 19	4 48	4 24	4 5	3 48	3 22	3 4	2 49	2 37	2 29	2 22	2 16	2 12	2 9	50
52	6 57	6 5	5 27	4 55	4 30	4 11	3 53	3 26	3 8	2 53	2 41	2 32	2 24	2 18	2 13	2 10	52
54	7 7	6 14	5 35	5 2	4 36	4 16	3 58	3 30	3 11	2 56	2 44	2 34	2 26	2 20	2 15	2 11	54
56	7 17	6 23	5 42	5 9	4 42	4 21	4 3	3 34	3 14	2 59	2 47	2 37	2 29	2 22	2 16	2 12	56
58	7 27	6 31	5 49	5 15	4 47	4 26	4 8	3 38	3 17	3 2	2 49	2 39	2 31	2 24	2 18	2 13	58
60	7 36	6 39	5 56	5 21	4 53	4 31	4 13	3 42	3 20	3 5	2 52	2 41	2 32	2 25	2 20	2 14	60
62	7 45	6 46	6 2	5 26	4 58	4 36	4 17	3 46	3 23	3 8	2 54	2 43	2 34	2 26	2 21		62
64	7 53	6 53	6 8	5 31	5 3	4 41	4 21	3 50	3 26	3 10	2 56	2 44	2 35	2 27			64
66	8 1	6 59	6 13	5 36	5 8	4 45	4 25	3 53	3 29	3 12	2 57	2 45	2 37				66
68	8 8	7 5	6 18	5 41	5 12	4 49	4 28	3 56	3 32	3 14	2 58	2 46					68
70	8 14	7 10	6 23	5 45	5 16	4 52	4 31	3 58	3 34	3 15	2 59						70
72	8 20	7 15	6 28	5 49	5 19	4 55	4 33	4 0	3 35	3 16							72
74	8 25	7 19	6 31	5 53	5 22	4 57	4 35	4 1	3 36								74
76	8 29	7 23	6 34	5 56	5 25	4 59	4 37	4 2									76
78	8 32	7 26	6 37	5 58	5 27	5 1	4 39										78
80	8 34	7 28	6 39	6 0	5 29												80
82	8 36	7 30	6 41														82
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 92°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	40°	42°	46°	50°	54°	58°	62°	66°	70°	74°	78°	82°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 47	5 2	5 16	5 30	5 44	5 57	6 21	6 44	7 5	7 24	7 42	7 59	8 12	8 22	8 30	8 36	6
7	4 12	4 24	4 36	4 48	5 0	5 11	5 33	5 53	6 12	6 29	6 44	6 58	7 10	7 18	7 25	7 30	7
8	3 48	3 59	4 10	4 20	4 30	4 40	4 59	5 17	5 33	5 48	6 1	6 13	6 23	6 31	6 37	6 41	8
9	3 29	3 38	3 48	3 57	4 6	4 14	4 30	4 45	5 0	5 13	5 25	5 35	5 44	5 52	5 58		9
10	3 13	3 21	3 30	3 38	3 45	3 52	4 8	4 22	4 34	4 46	4 57	5 7	5 15	5 22	5 27		10
11	3 1	3 8	3 16	3 22	3 29	3 36	3 50	4 3	4 14	4 24	4 34	4 43	4 51	4 57	5 2		11
12	2 51	2 57	3 4	3 10	3 17	3 23	3 35	3 47	3 57	4 6	4 15	4 23	4 30	4 36	4 41		12
13	2 42	2 47	2 53	2 59	3 6	3 12	3 23	3 33	3 42	3 51	4 0	4 7	4 13	4 17			13
14	2 34	2 39	2 44	2 50	2 56	3 2	3 12	3 21	3 30	3 38	3 46	3 52	3 57	4 1			14
15	2 28	2 33	2 38	2 43	2 48	2 53	3 2	3 11	3 19	3 26	3 33	3 39	3 44	3 49			15
16	2 23	2 28	2 32	2 37	2 42	2 46	2 54	3 2	3 9	3 16	3 22	3 28	3 33	3 38			16
17	2 19	2 23	2 27	2 32	2 36	2 40	2 47	2 54	3 1	3 7	3 13	3 19	3 24				17
18	2 16	2 19	2 23	2 27	2 31	2 34	2 41	2 48	2 54	3 0	3 6	3 11	3 15				18
19	2 13	2 16	2 19	2 23	2 26	2 29	2 36	2 42	2 48	2 54	2 59	3 4	3 7				19
20	2 10	2 13	2 16	2 19	2 22	2 25	2 31	2 37	2 43	2 48	2 53	2 57	3 0				20
21	2 8	2 10	2 13	2 16	2 18	2 21	2 26	2 32	2 38	2 43	2 47	2 51					21
22	2 6	2 8	2 10	2 13	2 15	2 17	2 22	2 28	2 33	2 38	2 42	2 45					22
23	2 4	2 6	2 8	2 10	2 12	2 14	2 19	2 24	2 29	2 34	2 38	2 41					23
24	2 2	2 4	2 6	2 8	2 10	2 12	2 16	2 21	2 26	2 30	2 34	2 38					24
25	2 1	2 3	2 4	2 6	2 8	2 10	2 14	2 18	2 22	2 26	2 30						25
26	2 1	2 2	2 3	2 5	2 6	2 8	2 12	2 15	2 19	2 23	2 26						26
27	2 0	2 1	2 2	2 4	2 5	2 7	2 10	2 13	2 16	2 20	2 23						27
28	1 59	2 0	2 1	2 3	2 4	2 6	2 8	2 11	2 14	2 17	2 20						28
29	1 59	1 59	2 0	2 2	2 3	2 5	2 7	2 10	2 12	2 15							29
30	1 59	1 59	2 0	2 1	2 2	2 4	2 6	2 9	2 11	2 13							30
31	1 59	1 59	1 59	2 0	2 1	2 3	2 5	2 7	2 9	2 11							31
32	1 59	1 59	1 59	2 0	2 1	2 2	2 4	2 6	2 7	2 9							32
33	1 59	1 59	1 59	1 59	2 0	2 1	2 3	2 5	2 6								33
34	1 59	1 58	1 59	1 59	2 0	2 1	2 2	2 4	2 5								34
35	1 59	1 58	1 59	1 59	2 0	2 0	2 1	2 3	2 4								35
36	2 0	1 59	1 59	1 59	2 0	2 0	2 1	2 2	2 3								36
37	2 0	1 59	1 59	1 58	1 59	1 59	2 0	2 1									37
38	2 0	1 59	1 59	1 58	1 59	1 59	2 0	2 1									38
39	2 1	2 0	1 59	1 58	1 58	1 59	1 59	2 0									39
40	2 1	2 0	1 59	1 58	1 58	1 58	1 59	2 0									40
41	2 1	2 0	1 59	1 59	1 58	1 58	1 58										41
42	2 2	2 0	1 59	1 59	1 58	1 58	1 58										42
43	2 2	2 1	2 0	1 59	1 58	1 58	1 58										43
44	2 3	2 1	2 0	1 59	1 58	1 58	1 57										44
45	2 3	2 2	2 1	2 0	1 59	1 58											45
46	2 4	2 2	2 1	2 0	1 59	1 58											46
47	2 4	2 2	2 1	2 0	1 59	1 58											47
48	2 5	2 3	2 2	2 1	1 59	1 59											48
50	2 6	2 4	2 2	2 1	2 0												50
52	2 7	2 5	2 3	2 1													52
54	2 8	2 5	2 3														54
56	2 9	2 5															56
58	2 10																58
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
80																	80
82																	82
	32°	34°	36°	38°	40°	42°	46°	50°	54°	58°	62°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	1	1	1	1	1	1	
10	2	2	2	2	2	2	2	2	2	0
15	2	2	2	2	3	3	3	3		
20	3	3	3	3	3	3	3	3		
25	4	4	4	4	4	4	4			
30	4	4	5	5	5	5	5			
35	5	5	5	5	5	5				
40	6	6	6	6	6	6				
45	6	6	6	7	7					
50	7	7	7	7	7					
55	7	7	7	8						
60	8	8	8	8						
65	8	8	8							
70	9	8	8							
75	9	9								
80	9	9								
90										

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 96°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 6	2 8	2 10	2 13	2 17	2 22	2 28	2 41	2 55	3 10	3 26	3 41	3 56	4 11	4 26	4 41	6
7	2 9	2 6	2 8	2 10	2 12	2 16	2 20	2 29	2 40	2 52	3 5	3 18	3 31	3 43	3 56	4 8	7
8	2 12	2 8	2 6	2 7	2 9	2 12	2 15	2 22	2 31	2 40	2 51	2 2	3 13	3 24	3 35	3 45	8
9	2 16	2 11	2 8	2 6	2 7	2 9	2 12	2 17	2 24	2 31	2 40	2 49	2 59	3 8	3 18	3 27	9
10	2 20	2 14	2 10	2 8	2 6	2 7	2 9	2 13	2 18	2 24	2 32	2 40	2 48	2 56	3 4	3 12	10
11	2 26	2 18	2 13	2 10	2 7	2 6	2 7	2 10	2 14	2 19	2 25	2 32	2 39	2 46	2 53	3 1	11
12	2 32	2 23	2 17	2 13	2 9	2 7	2 6	2 8	2 11	2 15	2 20	2 26	2 32	2 38	2 45	2 52	12
13	2 39	2 28	2 21	2 16	2 12	2 9	2 7	2 7	2 9	2 12	2 16	2 21	2 26	2 32	2 38	2 44	13
14	2 46	2 33	2 25	2 19	2 14	2 11	2 9	2 6	2 8	2 10	2 13	2 18	2 22	2 27	2 32	2 37	14
15	2 53	2 39	2 29	2 22	2 17	2 14	2 11	2 7	2 7	2 9	2 11	2 15	2 19	2 23	2 28	2 32	15
16	3 1	2 45	2 34	2 26	2 20	2 16	2 13	2 8	2 5	2 8	2 10	2 13	2 16	2 20	2 24	2 28	16
17	3 8	2 51	2 39	2 30	2 23	2 19	2 15	2 9	2 7	2 7	2 9	2 11	2 14	2 17	2 21	2 24	17
18	3 15	2 57	2 44	2 34	2 26	2 21	2 17	2 11	2 8	2 6	2 8	2 10	2 12	2 15	2 18	2 21	18
19	3 23	3 3	2 49	2 38	2 30	2 24	2 19	2 13	2 9	2 7	2 7	2 8	2 10	2 13	2 15	2 18	19
20	3 30	3 9	2 54	2 43	2 34	2 27	2 22	2 15	2 11	2 8	2 6	2 7	2 9	2 11	2 13	2 15	20
21	3 38	3 16	3 0	2 48	2 37	2 30	2 25	2 17	2 12	2 9	2 7	2 7	2 8	2 9	2 11	2 13	21
22	3 46	3 22	3 5	2 52	2 41	2 33	2 28	2 19	2 14	2 10	2 8	2 6	2 7	2 8	2 10	2 12	22
23	3 54	3 28	3 11	2 57	2 45	2 37	2 31	2 21	2 15	2 11	2 8	2 6	2 6	2 7	2 9	2 11	23
24	4 1	3 34	3 16	3 1	2 49	2 41	2 35	2 23	2 17	2 12	2 9	2 7	2 6	2 7	2 8	2 10	24
25	4 9	3 41	3 22	3 6	2 53	2 45	2 38	2 26	2 19	2 14	2 11	2 8	2 6	2 7	2 8	2 9	25
26	4 16	3 47	3 27	3 11	2 57	2 48	2 41	2 29	2 21	2 16	2 12	2 9	2 7	2 6	2 7	2 8	26
27	4 24	3 53	3 33	3 15	3 1	2 52	2 44	2 31	2 23	2 17	2 13	2 10	2 8	2 6	2 6	2 7	27
28	4 31	4 0	3 38	3 20	3 6	2 55	2 47	2 34	2 24	2 18	2 14	2 11	2 9	2 7	2 6	2 7	28
29	4 39	4 6	3 44	3 25	3 10	2 59	2 50	2 36	2 26	2 20	2 15	2 12	2 10	2 8	2 7	2 6	29
30	4 46	4 12	3 49	3 29	3 14	3 3	2 53	2 38	2 28	2 21	2 16	2 13	2 10	2 8	2 7	2 6	30
31	4 53	4 18	3 55	2 34	3 18	3 7	2 57	2 41	2 30	2 23	2 18	2 14	2 11	2 9	2 8	2 7	31
32	5 0	4 24	4 0	3 39	3 23	3 11	3 1	2 44	2 32	2 25	2 19	2 15	2 12	2 9	2 8	2 7	32
33	5 7	4 30	4 5	3 44	3 27	3 15	3 4	2 46	2 34	2 26	2 20	2 16	2 13	2 10	2 8	2 7	33
34	5 14	4 36	4 11	3 49	3 32	3 19	3 7	2 48	2 36	2 28	2 21	2 17	2 14	2 11	2 9	2 8	34
35	5 21	4 42	4 16	3 54	3 36	3 23	3 11	2 51	2 38	2 30	2 23	2 18	2 15	2 12	2 10	2 8	35
36	5 28	4 48	4 21	3 59	3 40	3 26	3 14	2 54	2 40	2 32	2 25	2 20	2 16	2 13	2 11	2 9	36
37	5 35	4 54	4 26	4 3	3 44	3 29	3 17	2 57	2 43	2 33	2 26	2 21	2 17	2 14	2 11	2 9	37
38	5 42	5 0	4 31	4 8	3 48	3 33	3 20	2 59	2 45	2 35	2 27	2 22	2 18	2 15	2 12	2 10	38
39	5 49	5 6	4 36	4 12	3 52	3 36	3 23	3 2	2 47	2 37	2 29	2 23	2 19	2 16	2 13	2 11	39
40	5 55	5 12	4 41	4 16	3 56	3 40	3 26	3 5	2 50	2 39	2 30	2 24	2 20	2 16	2 13	2 11	40
41	6 2	5 18	4 46	4 20	4 0	3 44	3 30	3 7	2 52	2 41	2 32	2 25	2 21	2 17	2 14	2 12	41
42	6 8	5 23	4 51	4 24	4 4	3 47	3 33	3 10	2 54	2 43	2 34	2 27	2 22	2 18	2 15	2 13	42
43	6 14	5 29	4 56	4 29	4 8	3 51	3 36	3 13	2 55	2 45	2 35	2 28	2 23	2 19	2 16	2 13	43
44	6 20	5 34	5 1	4 33	4 11	3 54	3 39	3 16	2 59	2 47	2 37	2 29	2 24	2 20	2 17	2 14	44
45	6 26	5 39	5 6	4 37	4 14	3 57	3 42	3 19	3 1	2 48	2 38	2 30	2 25	2 21	2 17	2 14	45
46	6 32	5 44	5 10	4 41	4 18	4 0	3 45	3 21	3 3	2 50	2 39	2 31	2 26	2 22	2 18	2 15	46
47	6 38	5 49	5 15	4 45	4 22	4 3	3 48	3 24	3 5	2 52	2 41	2 33	2 27	2 23	2 19	2 16	47
48	6 44	5 54	5 19	4 49	4 25	4 7	3 51	3 26	3 7	2 53	2 42	2 34	2 28	2 24	2 20	2 16	48
49	6 50	5 59	5 23	4 53	4 29	4 10	3 54	3 28	3 9	2 55	2 44	2 36	2 29	2 25	2 21	2 17	49
50	6 55	6 4	5 27	4 57	4 32	4 13	3 57	3 30	3 11	2 56	2 45	2 37	2 31	2 26	2 21	2 17	50
51	7 0	6 9	5 31	5 1	4 36	4 16	4 0	3 32	3 13	2 58	2 47	2 38	2 32	2 27	2 22	2 18	51
52	7 5	6 14	5 35	5 4	4 39	4 19	4 3	3 34	3 15	3 0	2 48	2 39	2 33	2 28	2 23	2 18	52
54	7 15	6 23	5 43	5 11	4 45	4 25	4 8	3 38	3 19	3 2	2 51	2 42	2 35	2 29	2 24	2 19	54
56	7 25	6 31	5 51	5 18	4 51	4 30	4 13	3 42	3 22	3 6	2 54	2 45	2 37	2 30	2 25	2 19	56
58	7 35	6 39	5 58	5 24	4 56	4 35	4 17	3 46	3 26	3 9	2 57	2 47	2 39	2 31	2 25		58
60	7 45	6 46	6 4	5 30	5 1	4 39	4 21	3 50	3 29	3 12	2 59	2 49	2 41	2 32			60
62	7 54	6 53	6 10	5 35	5 6	4 44	4 25	3 54	3 32	3 15	3 1	2 50	2 42				62
64	8 2	7 0	6 16	5 40	5 11	4 48	4 29	3 58	3 35	3 17	3 3	2 51					64
66	8 10	7 7	6 21	5 45	5 16	4 52	4 33	4 1	3 38	3 19	3 4						66
68	8 17	7 13	6 26	5 50	5 21	4 56	4 36	4 3	3 40	3 21							68
70	8 24	7 18	6 31	5 54	5 25	5 0	4 39	4 5	3 42								70
72	8 29	7 23	6 36	5 58	5 28	5 3	4 41	4 7									72
74	8 33	7 27	6 40	6 1	5 31	5 6	4 43										74
76	8 37	7 21	6 43	6 4	5 34												76
78	8 40	7 34	6 46														78
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 96°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	40°	42°	44°	46°	50°	54°	58°	62°	66°	70°	74°	78°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	4 56	5 10	5 24	5 38	5 51	6 4	6 17	6 29	6 52	7 14	7 34	7 52	8 9	8 23	8 33	8 40	6
7	4 20	4 32	4 44	4 56	5 8	5 20	5 31	5 42	6 2	6 20	6 37	6 52	7 6	7 18	7 28	7 35	7
8	3 56	4 7	4 18	4 29	4 39	4 49	4 59	5 8	5 26	5 42	5 56	6 9	6 21	6 31	6 40	6 47	8
9	3 37	3 46	3 55	4 4	4 13	4 23	4 32	4 40	4 56	5 10	5 23	5 34	5 44	5 53	6 1		9
10	3 22	3 30	3 37	3 45	3 53	4 2	4 10	4 17	4 31	4 43	4 55	5 6	5 16	5 24	5 31		10
11	3 9	3 17	3 24	3 31	3 38	3 45	3 52	3 59	4 11	4 22	4 33	4 43	4 52	5 0	5 7		11
12	2 59	3 6	3 12	3 19	3 25	3 32	3 38	3 45	3 55	4 5	4 15	4 24	4 32	4 39	4 46		12
13	2 50	2 56	3 2	3 8	3 14	3 20	3 26	3 32	3 42	3 51	4 0	4 8	4 15	4 21			13
14	2 42	2 48	2 53	2 58	3 4	3 9	3 15	3 20	3 30	3 39	3 48	3 55	4 1	4 6			14
15	2 36	2 41	2 46	2 50	2 55	3 0	3 5	3 10	3 19	3 28	3 36	3 43	3 49	3 54			15
16	2 32	2 36	2 40	2 44	2 48	2 53	2 57	3 2	3 10	3 18	3 25	3 32	3 38	3 44			16
17	2 28	2 31	2 35	2 39	2 43	2 47	2 51	2 55	3 3	3 10	3 16	3 22	3 28				17
18	2 24	2 27	2 31	2 35	2 38	2 42	2 45	2 49	2 56	3 2	3 8	3 14	3 19				18
19	2 21	2 24	2 27	2 31	2 34	2 37	2 40	2 44	2 50	2 56	3 2	3 7	3 11				19
20	2 18	2 21	2 24	2 27	2 30	2 33	2 36	2 39	2 45	2 51	2 56	3 1	3 4				20
21	2 16	2 19	2 21	2 24	2 26	2 29	2 32	2 35	2 41	2 46	2 51	2 55					21
22	2 14	2 17	2 19	2 21	2 23	2 26	2 28	2 31	2 37	2 42	2 46	2 50					22
23	2 13	2 15	2 17	2 19	2 21	2 23	2 25	2 28	2 33	2 38	2 42	2 45					23
24	2 11	2 13	2 15	2 17	2 19	2 21	2 23	2 25	2 30	2 35	2 38	2 41					24
25	2 10	2 11	2 13	2 15	2 17	2 19	2 21	2 23	2 27	2 31	2 35						25
26	2 9	2 10	2 12	2 13	2 15	2 17	2 19	2 21	2 25	2 28	2 31						26
27	2 8	2 9	2 11	2 12	2 14	2 16	2 18	2 20	2 23	2 25	2 27						27
28	2 8	2 9	2 10	2 11	2 13	2 15	2 17	2 18	2 21	2 23	2 24						28
29	2 7	2 8	2 9	2 10	2 12	2 13	2 15	2 17	2 19	2 21							29
30	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 15	2 17	2 19							30
31	2 6	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 16	2 17							31
32	2 6	2 7	2 7	2 8	2 9	2 10	2 11	2 12	2 14	2 16							32
33	2 6	2 6	2 7	2 7	2 8	2 9	2 10	2 11	2 13								33
34	2 7	2 6	2 7	2 7	2 8	2 9	2 10	2 11	2 12								34
35	2 7	2 6	2 6	2 7	2 7	2 8	2 9	2 10	2 11								35
36	2 8	2 7	2 6	2 6	2 7	2 8	2 9	2 9	2 10								36
37	2 8	2 7	2 6	2 6	2 7	2 7	2 8	2 8									37
38	2 9	2 8	2 7	2 6	2 6	2 7	2 8	2 8									38
39	2 9	2 8	2 7	2 6	2 6	2 7	2 7	2 8									39
40	2 10	2 8	2 7	2 6	2 6	2 6	2 7	2 7									40
41	2 10	2 9	2 8	2 7	2 7	2 6	2 6										41
42	2 11	2 9	2 8	2 7	2 7	2 6	2 6										42
43	2 11	2 10	2 8	2 7	2 7	2 6											43
44	2 12	2 10	2 8	2 7	2 7	2 6											44
45	2 12	2 10	2 9	2 8	2 7												45
46	2 13	2 11	2 9	2 8	2 7												46
47	2 13	2 11	2 9	2 8													47
48	2 13	2 11	2 9	2 8													48
49	2 14	2 12	2 10														49
50	2 14	2 12	2 10														50
51	2 14	2 12															51
52	2 15	2 12															52
54	2 15																54
56																	56
58																	58
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
76																	76
78																	78
	32°	34°	36°	38°	40°	42°	44°	46°	50°	54°	58°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App. Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	1	1	1	1	2	2	
10	2	2	2	2	2	2	2	3		
15	2	2	3	3	3	3	3	3		
20	3	3	3	4	4	4	4			
25	4	4	4	4	4	5	5			
30	5	5	5	5	5	5				
35	5	5	5	6	6	6				
40	6	6	6	6	6					
45	6	7	7	7	7					
50	7	7	7	7						
55	7	8	8	8						
60	8	8	8							
65	8	8	8							
70	9	9								
75	9	9								
80	9									
90										

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 100°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 13	2 15	2 18	2 21	2 25	2 31	2 37	2 49	3 3	3 18	3 33	3 48	4 4	4 19	4 34	4 49	6
7	2 16	2 13	2 15	2 17	2 20	2 24	2 29	2 38	2 49	3 1	3 13	3 25	3 38	3 50	4 3	4 16	7
8	2 19	2 15	2 13	2 14	2 16	2 19	2 23	2 31	2 39	2 49	2 59	3 10	3 21	3 32	3 43	3 54	8
9	2 23	2 18	2 15	2 13	2 14	2 16	2 19	2 25	2 32	2 40	2 48	2 58	3 7	3 16	3 26	3 35	9
10	2 28	2 22	2 18	2 15	2 13	2 14	2 16	2 21	2 26	2 33	2 40	2 48	2 56	3 4	3 13	3 21	10
11	2 33	2 26	2 21	2 17	2 15	2 13	2 14	2 18	2 22	2 27	2 33	2 40	2 47	2 54	3 2	3 10	11
12	2 40	2 30	2 24	2 20	2 17	2 14	2 13	2 16	2 19	2 23	2 28	2 34	2 40	2 46	2 53	3 0	12
13	2 47	2 35	2 28	2 23	2 19	2 16	2 14	2 14	2 17	2 20	2 24	2 29	2 34	2 40	2 45	2 51	13
14	2 54	2 40	2 32	2 26	2 21	2 18	2 16	2 13	2 15	2 18	2 21	2 25	2 30	2 35	2 39	2 44	14
15	3 1	2 46	2 36	2 29	2 24	2 21	2 18	2 14	2 14	2 16	2 19	2 22	2 26	2 30	2 34	2 39	15
16	3 8	2 52	2 41	2 33	2 27	2 23	2 20	2 16	2 13	2 15	2 17	2 20	2 23	2 26	2 30	2 35	16
17	3 15	2 58	2 46	2 37	2 30	2 25	2 22	2 17	2 14	2 14	2 16	2 18	2 21	2 24	2 27	2 31	17
18	3 23	3 4	2 51	2 41	2 33	2 28	2 24	2 19	2 15	2 13	2 15	2 17	2 19	2 22	2 25	2 28	18
19	3 30	3 11	2 56	2 45	2 37	2 31	2 26	2 20	2 16	2 14	2 14	2 16	2 17	2 20	2 22	2 25	19
20	3 38	3 17	3 2	2 50	2 41	2 34	2 29	2 22	2 18	2 15	2 13	2 15	2 16	2 18	2 20	2 23	20
21	3 45	3 24	3 8	2 54	2 45	2 38	2 32	2 24	2 19	2 16	2 14	1 14	2 15	2 17	2 19	2 21	21
22	3 53	3 30	3 13	2 59	2 49	2 41	2 35	2 26	2 21	2 18	2 15	1 13	2 14	2 16	2 18	2 20	22
23	4 1	3 36	3 19	3 4	2 53	2 45	2 38	2 28	2 23	2 19	2 16	1 13	2 13	2 15	2 17	2 19	23
24	4 9	3 42	3 24	3 9	2 58	2 49	2 42	2 31	2 24	2 20	2 17	2 14	2 13	2 14	2 16	2 18	24
25	4 16	3 49	3 30	3 14	3 2	2 53	2 45	2 33	2 26	2 21	2 18	2 15	2 14	2 14	2 15	2 17	25
26	4 24	3 55	3 35	3 19	3 6	2 56	2 48	2 36	2 28	2 23	2 19	2 16	2 14	2 14	2 15	2 16	26
27	4 31	4 2	3 41	3 24	3 11	3 0	2 51	2 38	2 30	2 24	2 20	2 17	2 15	2 14	2 14	2 15	27
28	4 39	4 8	3 46	3 28	3 15	3 4	2 54	2 40	2 32	2 25	2 21	2 18	2 16	2 15	2 14	2 15	28
29	4 46	4 14	3 52	3 33	3 19	3 7	2 58	2 43	2 34	2 26	2 22	2 19	2 17	2 15	2 14	2 14	29
30	4 54	4 20	3 57	3 38	3 23	3 11	3 1	2 45	2 36	2 28	2 24	2 21	2 18	2 16	2 15	2 14	30
31	5 1	4 26	4 3	3 42	3 27	3 15	3 5	2 48	2 38	2 30	2 25	2 22	2 19	2 17	2 15	2 14	31
32	5 8	4 33	4 8	3 47	3 31	3 18	3 8	2 51	2 40	2 32	2 27	2 23	2 20	2 17	2 16	2 15	32
33	5 16	4 39	4 14	3 52	3 36	3 22	3 11	2 54	2 42	2 33	2 28	2 24	2 21	2 18	2 16	2 15	33
34	5 23	4 45	4 19	3 57	3 40	3 26	3 15	2 56	2 44	2 35	2 29	2 25	2 22	2 19	2 17	2 16	34
35	5 30	4 51	4 24	4 2	3 44	3 30	3 18	2 59	2 46	2 37	2 31	2 26	2 23	2 20	2 18	2 16	35
36	5 37	4 57	4 29	4 7	3 48	3 34	3 22	3 2	2 49	2 39	2 32	2 28	2 24	2 20	2 18	2 17	36
37	5 44	5 3	4 35	4 12	3 52	3 38	3 25	3 5	2 51	2 41	2 34	2 29	2 25	2 21	2 19	2 18	37
38	5 51	5 9	4 40	4 16	3 56	3 41	3 28	3 8	2 54	2 43	2 36	2 30	2 26	2 22	2 20	2 18	38
39	5 58	5 15	4 45	4 21	4 0	3 45	3 31	3 11	2 56	2 45	2 37	2 31	2 27	2 23	2 21	2 19	39
40	6 4	5 21	4 50	4 25	4 4	3 48	3 34	3 14	2 58	2 47	2 38	2 32	2 28	2 24	2 22	2 20	40
41	6 11	5 27	4 55	4 29	4 8	3 52	3 38	3 17	3 1	2 49	2 40	2 34	2 29	2 25	2 22	2 20	41
42	6 18	5 33	5 0	4 33	4 12	3 55	3 41	3 19	3 3	2 51	2 41	2 35	2 30	2 26	2 23	2 21	42
43	6 24	5 38	5 5	4 38	4 16	3 59	3 44	3 22	3 6	2 53	2 43	2 36	2 31	2 27	2 24	2 22	43
44	6 30	5 44	5 9	4 42	4 20	4 2	3 47	3 24	3 8	2 55	2 45	2 38	2 32	2 28	2 25	2 22	44
45	6 36	5 49	5 14	4 46	4 24	4 6	3 50	3 27	3 10	2 57	2 47	2 39	2 33	2 29	2 26	2 23	45
46	6 42	5 54	5 18	4 50	4 27	4 9	3 53	3 29	3 12	2 59	2 48	2 41	2 35	2 30	2 27	2 24	46
47	6 48	5 59	5 23	4 54	4 31	4 12	3 56	3 32	3 14	3 0	2 50	2 42	2 36	2 31	2 28	2 25	47
48	6 54	6 4	5 27	4 58	4 34	4 15	3 59	3 34	3 16	3 2	2 51	2 43	2 37	2 32	2 28	2 25	48
49	7 0	6 9	5 32	5 2	4 38	4 18	4 2	3 37	3 18	3 4	2 53	2 45	2 38	2 33	2 29	2 26	49
50	7 5	6 14	5 36	5 6	4 41	4 21	4 5	3 39	3 20	3 5	2 54	2 46	2 39	2 34	2 30	2 26	50
51	7 11	6 19	5 41	5 10	4 45	4 24	4 8	3 42	3 22	3 7	2 55	2 47	2 40	2 35	2 31	2 27	51
52	7 16	6 24	5 45	5 14	4 48	4 27	4 11	3 44	3 24	3 9	2 57	2 49	2 42	2 36	2 31	2 27	52
53	7 21	6 29	5 49	5 17	4 52	4 30	4 14	3 46	3 26	3 11	2 59	2 50	2 43	2 37	2 32		53
54	7 26	6 34	5 53	5 21	4 55	4 33	4 16	3 48	3 28	3 12	3 0	2 51	2 44	2 37	2 32		54
55	7 31	6 39	5 57	5 24	4 58	4 36	4 19	3 50	3 30	3 14	3 1	2 52	2 45	2 38			55
56	7 36	6 43	6 0	5 27	5 1	4 39	4 22	3 52	3 32	3 16	3 2	2 53	2 46	2 39			56
58	7 46	6 51	6 7	5 33	5 7	4 44	4 26	3 56	3 36	3 19	3 5	2 55	2 47				58
60	7 56	6 58	6 14	5 39	5 12	4 49	4 31	4 0	3 39	3 22	3 8	2 57					60
62	8 5	7 5	6 10	5 45	5 17	4 54	4 36	4 4	3 42	3 24	3 10						62
64	8 13	7 12	6 26	5 51	5 22	4 59	4 40	4 7	3 45	3 26							64
66	8 21	7 19	6 32	5 57	5 27	5 3	4 43	4 10	3 47								66
68	8 28	7 25	6 38	6 2	5 32	5 7	4 45	4 13									68
70	8 35	7 30	6 43	6 7	5 36	5 11	4 48										70
72	8 40	7 35	6 47	6 11	5 40												72
74	8 44	7 40	6 51														74
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 100°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	54°	58°	62°	66°	70°	74°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 4	5 19	5 34	5 48	6 2	6 15	6 28	6 41	6 53	7 4	7 25	7 46	8 5	8 20	8 33	8 44	6
7	4 29	4 41	4 54	5 6	5 18	5 30	5 41	5 52	6 3	6 13	6 32	6 50	7 6	7 19	7 30	7 40	7
8	4 5	4 16	4 27	4 38	4 48	4 58	5 8	5 17	5 26	5 35	5 52	6 7	6 20	6 32	6 43	7 52	8
9	3 45	3 55	4 5	4 15	4 24	4 32	4 41	4 49	4 57	5 4	5 19	5 33	5 45	5 56	6 7		9
10	3 30	3 39	3 47	3 55	4 3	4 11	4 19	4 26	4 33	4 40	4 54	5 6	5 16	5 26	5 36		10
11	3 18	3 26	3 33	3 40	3 47	3 54	4 1	4 8	4 15	4 21	4 33	4 44	4 54	5 3	5 12		11
12	3 7	3 14	3 21	3 27	3 34	3 40	3 47	3 53	3 59	4 4	4 15	4 25	4 34	4 43	4 52		12
13	2 58	3 4	3 10	3 16	3 22	3 28	3 34	3 40	3 46	3 51	4 0	4 9	4 17	4 25			13
14	2 50	2 56	3 1	3 7	3 12	3 18	3 23	3 29	3 34	3 39	3 48	3 56	4 4	4 10			14
15	2 44	2 49	2 54	2 59	3 4	3 9	3 14	3 19	3 24	3 28	3 37	3 45	3 52	3 59			15
16	2 39	2 44	2 48	2 52	2 57	3 2	3 7	3 11	3 15	3 19	3 27	3 35	3 42	3 49			16
17	2 35	2 39	2 43	2 47	2 51	2 56	3 0	3 4	3 8	3 12	3 19	3 26	3 33				17
18	2 31	2 35	2 38	2 42	2 46	2 50	2 54	2 58	3 1	3 5	3 12	3 18	3 24				18
19	2 28	2 31	2 34	2 38	2 42	2 45	2 49	2 52	2 55	2 59	3 5	3 11	3 16				19
20	2 25	2 28	2 31	2 35	2 38	2 41	2 44	2 47	2 50	2 54	3 0	3 5	3 10				20
21	2 23	2 26	2 29	2 32	2 35	2 38	2 40	2 43	2 46	2 49	2 55	3 0					21
22	2 22	2 24	2 27	2 29	2 32	2 35	2 37	2 40	2 43	2 45	2 50	2 55					22
23	2 21	2 23	2 25	2 27	2 29	2 32	2 34	2 37	2 40	2 42	2 46	2 50					23
24	2 20	2 22	2 23	2 25	2 27	2 29	2 32	2 35	2 37	2 39	2 43	2 46					24
25	2 19	2 20	2 21	2 23	2 25	2 27	2 30	2 32	2 34	2 36	2 40						25
26	2 18	2 19	2 20	2 21	2 23	2 25	2 28	2 30	2 32	2 34	2 37						26
27	2 17	2 18	2 19	2 20	2 22	2 24	2 26	2 28	2 30	2 32	2 34						27
28	2 16	2 17	2 18	2 19	2 21	2 23	2 24	2 26	2 28	2 30	2 31						28
29	2 15	2 16	2 17	2 18	2 20	2 22	2 23	2 25	2 26	2 28							29
30	2 15	2 16	2 17	2 18	2 19	2 21	2 22	2 24	2 25	2 26							30
31	2 14	2 15	2 16	2 17	2 18	2 20	2 21	2 22	2 23	2 24							31
32	2 14	2 15	2 16	2 17	2 18	2 19	2 20	2 21	2 22	2 23							32
33	2 15	2 15	2 15	2 16	2 17	2 18	2 19	2 20	2 21								33
34	2 15	2 15	2 15	2 16	2 17	2 18	2 19	2 19	2 20								34
35	2 15	2 15	2 15	2 15	2 16	2 17	2 18	2 18									35
36	2 16	2 15	2 15	2 15	2 16	2 17	2 17	2 18									36
37	2 17	2 16	2 15	2 15	2 16	2 16	2 17										37
38	2 17	2 16	2 15	2 15	2 16	2 16	2 17										38
39	2 18	2 17	2 16	2 16	2 16	2 16											39
40	2 18	2 17	2 16	2 16	2 16	2 16											40
41	2 19	2 18	2 17	2 16	2 16												41
42	2 19	2 18	2 17	2 16	2 16												42
43	2 20	2 18	2 17	2 16													43
44	2 20	2 19	2 17	2 16													44
45	2 21	2 19	2 17														45
46	2 21	2 19	2 17														46
47	2 22	2 19															47
48	2 22	2 19															48
49	2 23																49
50	2 23																50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
58																	58
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
72																	72
74																	74
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	54°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App. Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	75	80
	″	″	″	″	″	″	″	″	″	″
5	1	1	1	2	2	2	2	2	2	
10	2	2	2	2	3	3	3	3		
15	2	3	3	3	3	4	4	4		
20	3	3	4	4	4	4	4			
25	4	4	4	5	5	5	5			
30	5	5	5	5	6	6				
35	5	5	6	6	6	6				
40	6	6	6	7	7					
45	7	7	7	7						
50	7	7	7	8						
55	8	8	8							
60	8	8	8							
65	8	9								
70	9	9								
75	9									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 104°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 20	2 22	2 25	2 29	2 33	2 39	2 45	2 58	3 13	3 28	3 43	3 59	4 15	4 30	4 46	5 1	6
7	2 23	2 20	2 22	2 25	2 28	2 32	2 36	2 46	2 57	3 10	3 23	3 36	3 48	4 1	4 14	4 27	7
8	2 26	2 22	2 20	2 22	2 24	2 27	2 30	2 38	2 47	2 57	3 8	3 20	3 31	3 42	3 53	4 4	8
9	2 30	2 25	2 22	2 21	2 22	2 24	2 26	2 32	2 39	2 48	2 57	3 7	3 17	3 26	3 36	3 46	9
10	2 36	2 29	2 25	2 22	2 21	2 22	2 24	2 28	2 34	2 41	2 48	2 56	3 5	3 14	3 23	3 31	10
11	2 42	2 34	2 28	2 24	2 22	2 21	2 22	2 25	2 30	2 35	2 41	2 48	2 55	3 4	3 11	3 19	11
12	2 48	2 39	2 32	2 27	2 24	2 22	2 21	2 23	2 27	2 31	2 36	2 42	2 48	2 56	3 2	3 9	12
13	2 55	2 44	2 36	2 30	2 26	2 24	2 22	2 22	2 25	2 28	2 32	2 38	2 43	2 49	2 55	3 1	13
14	3 2	2 49	2 40	2 33	2 29	2 26	2 24	2 22	2 23	2 26	2 30	2 34	2 39	2 43	2 48	2 54	14
15	3 9	2 54	2 45	2 37	2 32	2 28	2 26	2 23	2 22	2 25	2 28	2 31	2 35	2 39	2 43	2 48	15
16	3 16	3 0	2 50	2 41	2 35	2 31	2 28	2 24	2 22	2 24	2 26	2 29	2 32	2 35	2 39	2 44	16
17	3 23	3 6	2 55	2 45	2 38	2 33	2 30	2 26	2 23	2 23	2 25	2 27	2 30	2 33	2 36	2 40	17
18	3 31	3 13	3 0	2 49	2 41	2 36	2 33	2 27	2 24	2 22	2 24	2 26	2 28	2 31	2 34	2 37	18
19	3 38	3 19	3 5	2 53	2 45	2 39	2 35	2 29	2 25	2 23	2 23	2 24	2 26	2 29	2 31	2 34	19
20	3 46	3 25	3 11	2 58	2 49	2 43	2 38	2 31	2 27	2 24	2 22	2 23	2 25	2 27	2 29	2 32	20
21	3 54	3 32	3 16	3 3	2 53	2 46	2 41	2 33	2 28	2 25	2 23	1 22	2 24	2 26	2 28	2 30	21
22	4 2	3 38	3 22	3 8	2 57	2 50	2 44	2 35	2 30	2 26	2 24	1 22	2 23	2 25	2 27	2 29	22
23	4 10	3 45	3 27	3 13	3 2	2 54	2 47	2 38	2 32	2 28	2 25	1 23	2 22	2 24	2 26	2 28	23
24	4 18	3 51	3 33	3 18	3 6	2 57	2 50	2 40	2 33	2 29	2 26	2 24	2 22	2 23	2 25	2 27	24
25	4 26	3 58	3 39	3 22	3 10	3 1	2 54	2 42	2 35	2 30	2 27	2 24	2 23	2 23	2 24	2 26	25
26	4 33	4 4	3 44	3 27	3 15	3 5	2 57	2 44	2 36	2 31	2 28	2 25	2 24	2 23	2 24	2 26	26
27	4 41	4 11	3 50	3 32	3 19	3 9	3 0	2 47	2 38	2 32	2 29	2 26	2 24	2 23	2 24	2 25	27
28	4 49	4 18	3 56	3 37	3 23	3 12	3 3	2 49	2 40	2 34	2 30	2 27	2 25	2 24	2 24	2 25	28
29	4 57	4 24	4 1	3 42	3 28	3 16	3 7	2 52	2 42	2 35	2 31	2 28	2 26	2 25	2 24	2 25	29
30	5 4	4 30	4 7	3 47	3 32	3 20	3 10	2 55	2 44	2 37	2 33	2 30	2 27	2 25	2 24	2 24	30
31	5 12	4 37	4 13	3 52	3 36	3 24	3 14	2 58	2 46	2 39	2 34	2 31	2 28	2 26	2 25	2 24	31
32	5 19	4 44	4 19	3 57	3 41	3 28	3 17	3 0	2 49	2 41	2 36	2 32	2 29	2 27	2 26	2 25	32
33	5 27	4 51	4 25	4 2	3 46	3 32	3 21	3 3	2 51	2 43	2 37	2 33	2 30	2 28	2 26	2 25	33
34	5 34	4 58	4 30	4 7	3 50	3 36	3 24	3 5	2 54	2 45	2 39	2 34	2 31	2 29	2 27	2 26	34
35	5 42	5 4	4 36	4 12	3 55	3 40	3 27	3 8	2 56	2 47	2 40	2 35	2 32	2 30	2 28	2 27	35
36	5 49	5 10	4 41	4 17	3 59	3 44	3 31	3 11	2 58	2 49	2 42	2 37	2 33	2 30	2 28	2 27	36
37	5 56	5 16	4 46	4 21	4 3	3 47	3 35	3 14	3 1	2 51	2 43	2 38	2 34	2 31	2 29	2 27	37
38	6 3	5 22	4 51	4 26	4 7	3 51	3 38	3 17	3 4	2 53	2 45	2 39	2 35	2 32	2 30	2 28	38
39	6 10	5 28	4 56	4 31	4 11	3 55	3 41	3 20	3 6	2 55	2 47	2 41	2 36	2 33	2 31	2 29	39
40	6 16	5 33	5 1	4 36	4 15	3 59	3 45	3 23	3 9	2 57	2 49	2 42	2 37	2 34	2 32	2 30	40
41	6 23	5 39	5 6	4 40	4 19	4 3	3 49	3 26	3 11	2 59	2 51	2 44	2 39	2 35	2 32	2 30	41
42	6 30	5 44	5 11	4 44	4 23	4 6	3 53	3 29	3 13	3 1	2 52	2 45	2 40	2 36	2 33	2 31	42
43	6 37	5 50	5 16	4 49	4 27	4 10	3 56	3 32	3 15	3 3	2 54	2 47	2 41	2 37	2 34	2 31	43
44	6 43	5 55	5 21	4 53	4 31	4 13	3 59	3 35	3 18	3 5	2 55	2 48	2 42	2 38	2 35	2 32	44
45	6 50	6 1	5 26	4 58	4 35	4 17	4 2	3 38	3 20	3 6	2 57	2 50	2 44	2 39	2 35	2 32	45
46	6 56	6 6	5 31	5 2	4 39	4 20	4 5	3 40	3 22	3 8	2 58	2 51	2 45	2 40	2 36	2 33	46
47	7 2	6 12	5 36	5 6	4 43	4 24	4 8	3 43	3 24	3 10	3 0	2 52	2 46	2 41	2 37	2 34	47
48	7 8	6 17	5 40	5 10	4 46	4 27	4 11	3 45	3 26	3 12	3 1	2 53	2 48	2 42	2 38	2 34	48
49	7 14	6 23	5 45	5 14	4 50	4 30	4 14	3 47	3 28	3 14	3 3	2 55	2 49	2 43	2 38		49
50	7 20	6 28	5 49	5 18	4 53	4 33	4 17	3 50	3 30	3 16	3 4	2 56	2 50	2 44	2 39		50
51	7 26	6 33	5 53	5 22	4 57	4 36	4 20	3 52	3 32	3 18	3 6	2 58	2 51	2 45			51
52	7 32	6 38	5 57	5 26	5 0	4 39	4 23	3 54	3 34	3 20	3 8	2 59	2 52	2 45			52
53	7 37	6 43	6 2	5 29	5 4	4 42	4 26	3 56	3 36	3 22	3 9	3 0	2 52				53
54	7 42	6 48	6 6	5 33	5 7	4 45	4 29	3 58	3 38	3 23	3 10	3 1	2 53				54
55	7 47	6 53	6 10	5 36	5 10	4 48	4 32	4 0	3 40	3 25	3 12	3 1					55
56	7 52	6 57	6 14	5 40	5 13	4 51	4 34	4 2	3 42	3 26	3 13	3 2					56
57	7 57	7 1	6 18	5 44	5 16	4 54	4 37	4 5	3 44	3 28	3 14						57
58	8 2	7 5	6 22	5 47	5 19	4 57	4 39	4 7	3 46	3 29	3 15						58
59	8 6	7 9	6 26	5 50	5 22	5 0	4 41	4 9	3 48	3 31							59
60	8 10	7 13	6 30	5 53	5 25	5 2	4 43	4 11	3 50	3 32							60
62	8 19	7 19	6 36	5 59	5 30	5 6	4 47	4 15	3 52								62
64	8 27	7 26	6 42	6 4	5 35	5 10	4 51	4 19									64
66	8 35	7 33	6 47	6 9	5 40	5 14	4 54										66
68	8 43	7 39	6 52	6 14	5 45												68
70	8 49	7 45	6 57														70
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 104°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	58°	62°	66°	70°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 16	5 31	5 45	6 0	6 14	6 28	6 41	6 54	7 6	7 18	7 29	7 40	8 0	8 19	8 35	8 49	6
7	4 42	4 56	5 8	5 20	5 31	5 42	5 53	6 4	6 15	6 26	6 37	6 47	7 4	7 19	7 33	7 46	7
8	4 16	4 28	4 39	4 49	4 59	5 9	5 19	5 28	5 38	5 47	5 57	6 6	6 21	6 34	6 46	6 57	8
9	3 55	4 5	4 15	4 25	4 34	4 43	4 52	5 0	5 8	5 16	5 24	5 32	5 46	5 58	6 9		9
10	3 40	3 49	3 58	4 7	4 15	4 23	4 31	4 38	4 45	4 52	4 59	5 6	5 18	5 30	5 40		10
11	3 27	3 35	3 43	3 51	3 58	4 5	4 12	4 19	4 26	4 32	4 38	4 44	4 55	5 6	5 16		11
12	3 16	3 23	3 30	3 37	3 44	3 51	3 58	4 4	4 10	4 17	4 23	4 28	4 38	4 47	4 56		12
13	3 7	3 13	3 20	3 26	3 33	3 39	3 45	3 51	3 56	4 2	4 7	4 12	4 22	4 30			13
14	2 59	2 5	3 11	3 17	3 23	3 29	3 34	3 39	3 44	3 49	3 54	3 59	4 8	4 15			14
15	2 53	2 58	3 4	3 9	3 15	3 20	3 25	3 29	3 34	3 38	3 43	3 47	3 56	3 3			15
16	2 48	2 53	2 58	3 3	3 8	3 12	3 17	3 21	3 25	3 29	3 33	3 37	3 45	3 52			16
17	2 44	2 49	2 53	2 58	3 2	3 6	3 10	3 14	3 17	3 21	3 25	3 29	3 36				17
18	2 41	2 45	2 49	2 53	2 57	3 1	3 4	3 8	3 11	3 15	3 18	3 22	3 29				18
19	2 38	2 41	2 45	2 49	2 53	2 56	2 59	3 3	3 6	3 9	3 12	3 16	3 22				19
20	2 35	2 38	2 42	2 45	2 49	2 52	2 55	2 58	3 1	3 4	3 7	3 10	3 16				20
21	2 33	2 36	2 39	2 42	2 45	2 48	2 51	2 54	2 57	3 0	3 3	3 5					21
22	2 31	2 34	2 36	2 39	2 42	2 45	2 47	2 50	2 53	2 56	2 59	2 1					22
23	2 30	2 32	2 34	2 37	2 39	2 42	2 44	2 47	2 50	2 53	2 55	2 57					23
24	2 29	2 31	2 33	2 35	2 37	2 40	2 42	2 44	2 47	2 50	2 52	2 54					24
25	2 28	2 29	2 31	2 33	2 35	2 38	2 40	2 42	2 44	2 47	2 49						25
26	2 27	2 28	2 30	2 32	2 34	2 36	2 38	2 40	2 42	2 44	2 46						26
27	2 26	2 27	2 29	2 31	2 32	2 34	2 36	2 38	2 40	2 41							27
28	2 26	2 27	2 28	2 30	2 31	2 33	2 35	2 36	2 38	2 39							28
29	2 25	2 26	2 27	2 29	2 30	2 32	2 33	2 34	2 36								29
30	2 25	2 26	2 27	2 28	2 29	2 31	2 32	2 33	2 34								30
31	2 24	2 25	2 26	2 27	2 28	2 30	2 31	2 32									31
32	2 24	2 25	2 26	2 27	2 28	2 29	2 30	2 31									32
33	2 24	2 24	2 25	2 26	2 27	2 28	2 29										33
34	2 25	2 24	2 25	2 26	2 27	2 27	2 28										34
35	2 26	2 25	2 25	2 26	2 26	2 27											35
36	2 26	2 25	2 25	2 26	2 26	2 27											36
37	2 26	2 25	2 25	2 26	2 26												37
38	2 27	2 26	2 26	2 26	2 26												38
39	2 27	2 26	2 26	2 26													39
40	2 28	2 27	2 26	2 26													40
41	2 28	2 27	2 26														41
42	2 29	2 27	2 26														42
43	2 29	2 27															43
44	2 30	2 28															44
45	2 30																45
46	2 31																46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
62																	62
64																	64
66																	66
68																	68
70																	70
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	2	2	2	2	3	3		
10	2	2	2	3	3	3	4	4		
15	2	3	3	3	4	4	4	4		
20	3	4	4	4	5	5	5			
25	4	4	5	5	5	6				
30	5	5	5	6	6	6				
35	6	6	6	6	7					
40	6	6	7	7	7					
45	7	7	7	8						
50	7	8	8							
55	8	8	8							
60	8	8								
65	9	9								
70	9									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 108°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 30	2 32	2 35	2 39	2 44	2 50	2 56	3 9	3 24	3 39	3 55	4 11	4 27	4 43	4 59	5 15	6
7	2 33	2 30	2 32	2 35	2 39	2 43	2 48	2 58	3 10	3 22	3 35	3 48	4 2	4 15	4 28	4 41	7
8	2 36	2 32	2 30	2 32	2 35	2 38	2 42	2 49	2 58	3 9	3 20	3 31	3 42	3 54	4 6	4 17	8
9	2 40	2 35	2 32	2 31	2 33	2 35	2 38	2 43	2 50	2 58	3 8	3 18	3 28	3 38	3 48	3 58	9
10	2 46	2 39	2 35	2 33	2 31	2 33	2 35	2 39	2 44	2 51	2 59	3 7	3 16	3 25	3 34	3 43	10
11	2 52	2 44	2 38	2 35	2 33	2 32	2 33	2 37	2 41	2 46	2 53	3 0	3 7	3 15	3 23	3 30	11
12	2 59	2 49	2 42	2 38	2 35	2 33	2 32	2 35	2 39	2 43	2 48	2 54	3 0	3 7	3 14	3 20	12
13	3 6	2 54	2 46	2 41	2 37	2 35	2 33	2 34	2 37	2 40	2 44	2 49	2 54	3 0	3 6	3 12	13
14	3 13	2 59	2 54	2 44	2 40	2 37	2 35	2 33	2 35	2 38	2 41	2 45	2 49	2 54	2 59	3 5	14
15	3 20	3 5	2 56	2 48	2 43	2 39	2 37	2 34	2 34	2 36	2 39	2 42	2 46	2 50	2 54	2 59	15
16	3 28	3 11	3 1	2 52	2 46	2 42	2 39	2 35	2 33	2 35	2 37	2 40	2 43	2 46	2 50	2 54	16
17	3 35	3 17	3 6	2 56	2 49	2 45	2 42	2 37	2 34	2 34	2 35	2 38	2 40	2 43	2 47	2 50	17
18	3 43	3 24	3 11	3 0	2 53	2 48	2 44	2 39	2 35	2 33	2 34	2 36	2 38	2 41	2 44	2 47	18
19	3 50	3 31	3 17	3 5	2 57	2 51	2 46	2 40	2 36	2 34	2 33	2 35	2 37	2 39	2 42	2 45	19
20	3 58	3 37	3 22	3 10	3 1	2 54	2 49	2 42	2 38	2 35	2 33	2 34	2 36	2 38	2 40	2 43	20
21	4 6	3 44	3 28	3 14	3 4	2 57	2 52	2 44	2 39	2 36	2 34	2 34	2 35	2 37	2 39	2 41	21
22	4 14	3 51	3 31	3 19	3 8	3 0	2 55	2 46	2 41	2 37	2 35	2 34	2 35	2 36	2 38	2 40	22
23	4 22	3 58	3 40	3 24	3 12	3 4	2 58	2 48	2 42	2 38	2 36	2 34	2 34	2 35	2 37	2 39	23
24	4 30	4 4	3 46	3 29	3 17	3 8	3 1	2 50	2 44	2 40	2 37	2 35	2 34	2 35	2 36	2 38	24
25	4 38	4 11	3 51	3 34	3 22	3 12	3 4	2 53	2 46	2 41	2 38	2 36	2 34	2 34	2 35	2 37	25
26	4 46	4 18	3 57	3 39	3 26	3 16	3 8	2 55	2 48	2 43	2 39	2 37	2 35	2 34	2 35	2 36	26
27	4 54	4 25	4 3	3 44	3 31	3 20	3 11	2 58	2 50	2 44	2 40	2 38	2 36	2 35	2 34	2 35	27
28	5 2	4 31	4 9	3 49	3 35	3 24	3 15	3 0	2 52	2 46	2 42	2 39	2 37	2 35	2 34	2 35	28
29	5 10	4 37	4 15	3 54	3 40	3 28	3 18	3 3	2 54	2 47	2 43	2 40	2 38	2 36	2 35	2 35	29
30	5 18	4 44	4 21	3 59	3 44	3 32	3 22	3 6	2 56	2 49	2 45	2 41	2 38	2 36	2 35	2 35	30
31	5 26	4 51	4 27	4 4	3 48	3 36	3 25	3 9	2 58	2 50	2 46	2 42	2 39	2 37	2 36	2 35	31
32	5 33	4 58	4 33	4 9	3 52	3 40	3 28	3 11	3 0	2 52	2 47	2 43	2 40	2 38	2 37	2 36	32
33	5 41	5 5	4 38	4 14	3 57	3 44	3 32	3 14	3 2	2 54	2 48	2 44	2 41	2 39	2 37	2 36	33
34	5 48	5 11	4 43	4 19	4 1	3 47	3 36	3 17	3 5	2 56	2 50	2 45	2 42	2 40	2 38	2 37	34
35	5 56	5 18	4 49	4 24	4 5	3 51	3 39	3 20	3 7	2 58	2 51	2 46	2 43	2 41	2 39	2 37	35
36	6 3	5 24	4 55	4 29	4 10	3 55	3 42	3 23	2 9	3 0	2 53	2 48	2 44	2 42	2 40	2 38	36
37	6 10	5 30	5 0	4 34	4 14	3 59	3 46	3 26	3 12	3 2	2 55	2 49	2 45	2 42	2 40	2 38	37
38	6 17	5 36	5 5	4 39	4 19	4 3	3 50	3 29	3 15	3 4	2 57	2 51	2 46	2 43	2 41	2 39	38
39	6 24	5 42	5 10	4 44	4 24	4 7	3 54	3 32	3 17	3 6	2 58	2 52	2 47	2 44	2 42	2 40	39
40	6 31	5 48	5 15	4 49	4 28	4 11	3 57	3 35	3 20	3 8	3 0	2 54	2 49	2 45	2 43	2 40	40
41	6 38	5 54	5 20	4 54	4 33	4 15	4 1	3 38	3 22	3 10	3 1	2 55	2 50	2 46	2 43	2 41	41
42	6 45	5 59	5 25	4 58	4 37	4 18	4 5	3 41	3 24	3 12	3 3	2 56	2 51	2 47	2 44	2 41	42
43	6 52	6 5	5 30	5 3	4 41	4 22	4 9	3 44	3 27	3 14	3 5	2 58	2 52	2 48	2 45	2 42	43
44	6 59	6 11	5 36	5 7	4 45	4 26	4 12	3 47	3 29	3 16	3 6	2 59	2 53	2 49	2 46	2 43	44
45	7 6	6 17	5 41	5 12	4 49	4 30	4 16	3 50	3 31	3 18	3 8	3 1	2 55	2 50	2 47		45
46	7 12	6 22	5 46	5 16	4 53	4 34	4 19	3 52	3 33	3 20	2 10	3 2	2 56	2 51	2 47		46
47	7 18	6 27	5 51	5 20	4 57	4 37	4 22	3 55	3 36	3 22	3 12	3 4	2 58	2 52			47
48	7 24	6 32	5 56	5 24	5 0	4 41	4 25	3 57	3 38	3 24	3 13	3 5	2 59	2 53			48
49	7 30	6 37	6 1	5 28	5 4	4 44	4 28	4 0	3 41	3 26	3 15	3 7	3 0				49
50	7 36	6 42	6 5	5 32	5 7	4 47	4 31	4 2	3 43	3 28	3 17	3 8	3 1				50
51	7 42	6 47	6 10	5 36	4 11	4 50	4 34	4 5	3 45	3 30	3 18	3 9					51
52	7 47	6 52	6 14	5 40	5 14	4 53	4 37	4 7	3 47	3 32	3 19	3 10					52
53	7 53	6 57	6 18	5 43	5 18	4 56	4 39	4 10	3 49	3 34	3 20						53
54	7 58	7 2	6 22	5 47	5 21	4 59	4 42	4 12	3 51	3 35	3 21						54
55	8 4	7 7	6 26	5 51	5 24	5 2	4 45	4 14	3 53	3 36							55
56	8 9	7 11	6 30	5 54	5 27	5 5	4 47	4 16	3 55	3 38							56
57	8 14	7 16	6 34	5 58	5 30	5 8	4 50	4 18	3 57								57
58	8 19	7 20	6 38	6 1	5 33	5 11	4 52	4 20	3 58								58
59	8 24	7 25	6 42	6 4	5 36	5 14	4 54	4 22									59
60	8 28	7 29	6 45	6 8	5 39	5 16	4 56	4 24									60
61	8 33	7 33	6 48	6 11	5 42	5 19	4 58										61
62	8 37	7 37	6 51	6 14	5 45	5 21	5 0										62
63	8 41	7 40	6 54	6 17	5 48	5 23											63
64	8 45	7 43	6 57	6 20													64
66	8 53	7 46	7 0														66
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 108°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	58°	62°	66°	☽'s App Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 30	5 45	6 0	6 15	6 29	6 44	6 58	7 11	7 23	7 34	7 45	7 56	8 6	8 16	8 35	8 53	6
7	4 55	5 8	5 21	5 34	5 46	5 58	6 10	6 22	6 33	6 43	6 53	7 2	7 11	7 20	7 35	7 47	7
8	4 29	4 41	4 52	5 3	5 13	5 23	5 34	5 44	5 54	6 4	6 13	6 22	6 30	6 38	6 51	7 1	8
9	4 8	4 18	4 28	4 38	4 48	4 57	5 6	5 15	5 23	5 31	5 38	5 45	5 53	6 1	6 14		9
10	3 52	4 0	4 9	4 18	4 27	4 36	4 44	4 52	4 59	5 6	5 [illegible]	5 20	5 27	5 33	5 45		10
11	3 38	3 46	3 54	4 2	4 10	4 18	4 25	4 33	4 40	4 47	4 53	4 59	5 5	5 11	5 20		11
12	3 27	3 34	3 41	3 48	3 56	4 4	4 11	4 18	4 21	4 30	4 36	4 42	4 47	4 52	5 0		12
13	3 18	3 24	3 30	3 37	3 44	3 51	3 58	4 4	4 10	4 15	4 21	4 26	4 30	4 34			13
14	3 10	3 16	3 22	3 28	3 34	3 40	3 46	3 52	3 58	4 3	4 8	4 12	4 16	4 20			14
15	3 4	3 9	3 14	3 20	3 25	3 31	3 36	3 42	3 47	3 52	3 56	4 1	4 5	4 8			15
16	2 59	3 3	3 8	3 13	3 18	3 23	3 28	3 33	3 38	3 43	3 47	3 51	3 55	3 58			16
17	2 54	2 58	3 3	3 7	3 12	3 17	3 21	3 26	3 30	3 35	3 39	3 43	3 46				17
18	2 51	2 54	2 59	3 3	3 7	3 11	3 15	3 20	3 24	3 28	3 32	3 35	3 38				18
19	2 48	2 51	2 55	2 59	3 3	3 6	3 10	3 14	3 18	3 22	3 25	3 28					19
20	2 46	2 49	2 52	2 56	2 59	3 2	3 6	3 9	3 13	3 16	3 19	3 22					20
21	2 44	2 47	2 50	2 53	2 56	2 59	3 2	3 5	3 9	3 12	3 14						21
22	2 42	2 45	2 48	2 50	2 53	2 56	2 59	3 2	3 5	3 8	3 10						22
23	2 41	2 43	2 46	2 48	2 50	2 53	2 56	2 59	3 2	3 4							23
24	2 40	2 42	2 44	2 46	2 48	2 51	2 53	2 56	2 59	3 1							24
25	2 39	2 40	2 42	2 44	2 46	2 49	2 51	2 53	2 56								25
26	2 38	2 39	2 41	2 43	2 45	2 47	2 49	2 51	2 54								26
27	2 37	2 38	2 40	2 42	2 44	2 45	2 47	2 49									27
28	2 36	2 38	2 39	2 41	2 42	2 44	2 46	2 47									28
29	2 36	2 37	2 38	2 40	2 41	2 42	2 44										29
30	2 35	2 36	2 37	2 39	2 40	2 41	2 43										30
31	2 35	2 36	2 37	2 38	2 39	2 40											31
32	2 35	2 36	2 37	2 38	2 39	2 40											32
33	2 36	2 36	2 36	2 37	2 38												33
34	2 36	2 36	2 36	2 37	2 38												34
35	2 36	2 36	2 36	2 37													35
36	2 37	2 36	2 36	2 36													36
37	2 38	2 37	2 36														37
38	2 38	2 37	2 36														38
39	2 39	2 38															39
40	2 39	2 38															40
41	2 40																41
42	2 40																42
43																	43
44																	44
45																	45
46																	46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
66																	66
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude. 5	10	20	30	40	50	60	65	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	1	2	2	3	3	3	3		
10	2	2	3	3	4	4	4			
15	3	3	3	4	4	5	5			
20	4	4	4	5	5	5				
25	4	4	5	6	6	6				
30	5	5	6	6	7					
35	6	6	6	7	7					
40	6	7	7	8						
45	7	7	8	8						
50	8	8	8							
55	8	8	9							
60	8	9								
65	9									
70										

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 112°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 40	2 42	2 43	2 45	2 51	3 0	3 7	3 21	3 36	3 52	4 8	4 24	4 40	4 56	5 12	5 28	6
7	2 42	2 40	2 42	2 42	2 49	2 53	2 58	3 8	3 20	3 33	3 46	3 59	4 13	4 26	4 40	4 54	7
8	2 46	2 42	2 41	2 43	2 45	2 48	2 52	3 0	3 9	3 19	3 31	3 42	3 54	4 6	4 18	4 30	8
9	2 51	2 45	2 43	2 41	2 43	2 45	2 48	2 54	3 1	3 9	3 19	3 29	3 40	3 50	4 0	4 11	9
10	2 57	2 49	2 45	2 43	2 42	2 43	2 45	2 49	2 55	3 2	3 10	3 19	3 28	3 37	3 46	3 56	10
11	3 3	2 54	2 48	2 45	2 43	2 42	2 43	2 46	2 50	2 56	3 3	3 11	3 19	3 27	3 35	3 44	11
12	3 9	2 59	2 52	2 48	2 45	2 43	2 42	2 44	2 47	2 52	2 58	3 5	3 12	3 19	3 26	3 34	12
13	3 16	3 4	2 56	2 51	2 47	2 45	2 43	2 43	2 45	2 49	2 54	3 0	3 6	3 12	3 18	3 25	13
14	3 23	3 10	3 0	2 54	2 50	2 47	2 45	2 43	2 44	2 47	2 51	2 56	3 1	3 6	3 12	3 17	14
15	3 31	3 16	3 5	2 58	2 53	2 49	2 47	2 44	2 44	2 46	2 49	2 53	2 57	3 1	3 6	3 11	15
16	3 39	3 22	3 10	3 2	2 56	2 51	2 48	2 45	2 43	2 45	2 47	2 50	2 54	2 57	3 2	3 6	16
17	3 47	3 29	3 15	3 6	2 59	2 54	2 50	2 46	2 44	2 44	2 46	2 48	2 51	2 54	2 58	3 2	17
18	3 55	3 35	3 20	3 10	3 2	2 57	2 53	2 48	2 45	2 44	2 45	2 47	2 49	2 52	2 55	2 59	18
19	4 3	3 41	3 26	3 15	3 6	3 0	2 56	2 50	2 46	2 45	2 44	2 46	2 48	2 50	2 53	2 56	19
20	4 11	4 48	3 32	3 20	3 10	3 3	2 58	2 52	2 48	2 45	2 44	2 45	2 47	2 49	2 51	2 54	20
21	4 19	3 54	3 38	3 25	3 15	3 7	3 1	2 54	2 49	2 46	2 44	2 44	2 46	2 48	2 50	2 52	21
22	4 27	4 1	3 44	3 30	3 20	3 11	3 5	2 56	2 51	2 47	2 45	2 44	2 45	2 47	2 49	2 51	22
23	4 35	4 8	3 50	3 35	3 24	3 15	3 8	2 58	2 52	2 48	2 46	2 45	2 44	2 46	2 48	2 50	23
24	4 43	4 15	3 56	3 40	3 28	3 19	3 11	3 1	2 54	2 49	2 47	2 45	2 44	2 45	2 47	2 49	24
25	4 52	4 22	4 3	3 46	3 33	3 23	3 15	3 3	2 55	2 51	2 48	2 46	2 45	2 44	2 46	2 48	25
26	5 0	4 29	4 9	3 51	3 38	3 27	3 18	3 5	2 57	2 52	2 49	2 47	2 45	2 44	2 45	2 47	26
27	5 8	4 37	4 15	3 56	3 42	3 31	3 22	3 8	2 59	2 54	2 51	2 48	2 45	2 45	2 45	2 46	27
28	5 16	4 44	4 21	4 2	3 47	3 36	3 26	3 11	3 2	2 56	2 52	2 49	2 46	2 46	2 45	2 46	28
29	5 24	4 51	4 27	4 7	3 52	3 40	3 31	3 14	3 5	2 58	2 53	2 50	2 46	2 46	2 45	3 46	29
30	5 32	4 57	4 33	4 12	3 57	3 45	3 35	3 17	3 7	3 0	2 55	2 52	2 47	2 47	2 46	3 46	30
31	5 40	5 4	4 39	4 17	4 2	3 49	3 39	3 20	3 9	3 2	2 57	2 53	2 49	2 48	2 47	2 46	31
32	5 48	5 10	4 45	4 22	4 7	3 54	3 43	3 23	3 12	3 4	2 58	2 54	2 51	2 49	2 47	2 46	32
33	5 56	5 17	5 51	4 28	4 12	3 58	3 46	3 26	3 14	3 6	3 0	2 55	2 52	2 50	2 48	2 47	33
34	6 4	5 24	5 56	4 33	4 16	4 2	3 50	3 29	3 17	3 8	3 2	2 57	2 53	2 51	2 49	2 48	34
35	6 11	5 31	5 2	4 38	4 21	4 6	3 53	3 32	3 19	3 10	3 4	2 59	2 55	2 52	2 50	2 49	35
36	6 19	5 37	5 7	4 43	4 25	4 10	3 57	3 35	3 21	3 12	3 5	3 0	2 56	2 53	2 51	2 49	36
37	6 26	5 44	5 13	4 48	4 29	4 14	4 1	3 38	3 24	3 14	3 7	3 1	2 57	2 54	2 52	2 50	37
38	6 33	5 50	5 18	4 53	4 33	4 17	4 4	3 41	3 26	3 16	3 9	3 3	2 58	2 55	2 53	2 51	38
39	6 41	5 56	5 24	4 58	4 37	4 21	4 8	3 44	3 29	3 18	3 10	3 4	2 59	2 56	2 54	2 52	39
40	6 48	6 2	5 29	5 3	4 41	4 25	4 11	3 47	3 32	3 20	3 12	3 6	3 1	2 57	2 55	2 53	40
41	6 55	6 8	5 35	5 8	4 45	4 28	4 15	3 50	3 35	3 22	3 13	3 7	3 2	2 58	2 55		41
42	7 2	6 14	5 40	5 13	4 49	4 32	4 18	3 53	3 38	3 25	3 15	3 8	3 3	2 59	2 56		42
43	7 8	6 20	5 46	5 18	4 53	4 36	4 22	3 56	3 40	3 27	3 17	3 10	3 5	3 0			43
44	7 15	6 26	5 51	5 23	4 58	4 40	4 25	3 59	3 42	3 29	3 19	3 12	3 6	3 1			44
45	7 22	6 32	5 56	5 28	5 3	4 44	4 28	4 2	3 45	3 31	3 21	3 14	3 8				45
46	7 28	6 38	6 2	5 33	5 8	4 47	4 31	4 5	3 47	3 33	3 23	3 15	3 9				46
47	7 35	6 44	6 7	5 37	5 12	4 51	4 34	4 8	3 50	3 36	3 25	3 16					47
48	7 42	6 49	6 12	5 41	5 16	4 55	4 38	4 11	3 52	3 38	3 26	3 17					48
49	7 48	6 54	6 16	5 45	5 20	4 58	4 41	4 14	3 55	3 40	3 28						49
50	7 55	6 59	6 21	5 49	5 23	5 2	4 44	4 17	3 57	3 42	3 29						50
51	8 1	7 4	6 25	5 53	5 27	5 5	4 47	4 19	3 59	3 44							51
52	8 7	7 9	6 29	5 57	5 30	5 8	4 50	4 22	4 1	3 46							52
53	8 13	7 14	6 34	6 1	5 34	5 12	4 53	4 24	4 3								53
54	8 19	7 19	6 38	6 5	5 37	5 15	4 56	4 26	4 4								54
55	8 25	7 23	6 42	6 8	5 41	5 18	4 59	4 28									55
56	8 30	7 28	6 47	6 12	5 44	5 21	5 1	4 30									56
57	8 35	7 33	6 51	6 15	5 47	5 24	5 4										57
58	8 40	7 38	6 55	6 19	5 50	5 27	5 6										58
59	8 45	7 43	6 59	6 22	5 53	5 29											59
60	8 50	7 48	7 2	6 25	5 56												60
61	8 54	7 52	7 5	6 28													61
62	8 58	7 56	7 8														62
63	9 2	7 59															63
64	9 5																64
65																	65
	6°	7°	8°	9°	10°	11°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	

THIRD CORRECTION, TO APPARENT DISTANCE 112°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	58°	60°	62°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 44	6 0	6 16	6 31	6 46	7 0	7 14	7 27	7 40	7 53	8 5	8 18	8 30	8 41	8 50	8 58	6
7	5 7	5 21	5 34	5 47	6 0	6 13	6 25	6 37	6 49	7 0	7 10	7 20	7 30	7 39	7 47	7 55	7
8	4 42	4 54	5 5	5 16	5 27	5 38	5 49	6 0	6 10	6 20	6 29	6 38	6 47	6 55	7 2	7 8	8
9	4 21	4 32	4 42	4 52	5 1	5 11	5 21	5 31	5 40	5 48	5 56	6 4	6 11	6 18	6 24		9
10	4 5	4 14	4 23	4 32	4 40	4 49	4 58	5 7	5 15	5 23	5 31	5 38	5 44	5 50	5 55		10
11	3 52	4 0	4 8	4 16	4 23	4 31	4 39	4 47	4 55	5 2	5 8	5 14	5 19	5 24			11
12	3 41	3 48	3 55	4 2	4 9	4 16	4 24	4 31	4 38	4 44	4 50	4 56	5 1	5 5			12
13	3 31	3 38	3 44	3 50	3 57	4 4	4 10	4 17	4 23	4 29	4 35	4 40	4 45				13
14	3 23	3 29	3 35	3 41	3 47	3 53	3 59	4 6	4 12	4 17	4 22	4 26	4 30				14
15	3 16	3 21	3 27	3 33	3 38	3 44	3 50	3 56	4 1	4 6	4 10	4 14					15.
16	3 10	3 15	3 21	3 26	3 31	3 37	3 42	3 47	3 52	3 57	4 1	4 4					16
17	3 6	3 11	3 16	3 20	3 25	3 30	3 35	3 40	3 45	3 49	3 53						17
18	3 3	3 7	3 12	3 16	3 20	3 25	3 29	3 34	3 38	3 42	3 46						18
19	3 0	3 4	3 8	3 12	3 16	3 20	3 24	3 28	3 32	3 35							19
20	2 57	3 1	3 5	3 8	3 12	3 16	3 20	3 23	3 26	3 29							20
21	2 55	2 58	3 2	3 5	3 9	3 12	3 16	3 19	3 22								21
22	2 53	2 56	3 0	3 3	3 6	3 9	3 12	3 15	3 18								22
23	2 52	2 55	2 58	3 1	3 3	3 6	3 9	3 12									23
24	2 51	2 53	2 56	2 59	3 1	3 4	3 7	3 9									24
25	2 50	2 52	2 54	2 57	2 59	3 1	3 4										25
26	2 49	2 51	2 53	2 55	2 57	2 59	3 1										26
27	2 48	2 50	2 52	2 54	2 56	2 57											27
28	2 47	2 49	2 51	2 53	2 55	2 56											28
29	2 47	2 48	2 50	2 52	2 54												29
30	2 47	2 48	2 49	2 51	2 53												30
31	2 47	2 48	2 49	2 50													31
32	2 47	2 48	2 49	2 50													32
33	2 47	2 48	2 49														33
34	2 48	2 48	2 49														34
35	2 48	2 48															35
36	2 49	2 48															36
37	2 49																37
38	2 50																38
39																	39
40																	40
41																	41
42																	42
43																	43
44																	44
45																	45
46																	46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	60	65	80	90
	″	″	″	″	″	″	″	″	″	″
5	1	2	2	3	3	4	4	4		
10	2	2	3	4	4	5	5			
15	3	3	4	4	5	5				
20	4	4	4	5	6	6				
25	4	5	5	6	6					
30	5	5	6	7	7					
35	6	6	7	7						
40	7	7	7	8						
45	7	7	8							
50	8	8	8							
55	8	9								
60	9	9								
65	9									

THIRD CORRECTION, TO APPARENT DISTANCE 116°

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App. Alt.
	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	18°	20°	22°	24°	26°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	2 50	2 52	2 55	2 59	3 4	3 10	3 17	3 25	3 33	3 41	3 49	4 5	4 22	4 39	4 56	5 13	6
7	2 52	2 50	2 52	2 55	2 58	3 2	3 8	3 13	3 19	3 25	3 32	3 46	4 0	4 14	4 28	4 42	7
8	2 56	2 52	2 50	2 52	2 54	2 57	3 1	3 5	3 10	3 15	3 21	3 32	3 44	3 56	4 8	4 20	8
9	3 1	2 55	2 52	2 50	2 52	2 54	2 57	3 0	3 4	3 8	3 13	3 21	3 31	3 42	3 53	4 4	9
10	3 7	2 59	2 55	2 52	2 51	2 52	2 54	2 57	3 0	3 3	3 7	3 14	3 22	3 31	3 41	3 50	10
11	3 13	3 4	2 58	2 54	2 52	2 51	2 53	2 55	2 57	3 0	3 3	3 9	3 16	3 23	3 31	3 39	11
12	3 20	3 9	3 2	2 57	2 54	2 53	2 52	2 53	2 55	2 57	3 0	3 5	3 10	3 16	3 23	3 30	12
13	3 27	3 15	3 6	3 1	2 57	2 55	2 53	2 52	2 53	2 55	2 58	3 2	3 6	3 11	3 17	3 23	13
14	3 35	3 21	3 11	3 5	3 0	2 57	2 55	2 53	2 52	2 54	2 56	2 59	3 3	3 7	3 12	3 18	14
15	3 43	3 27	3 16	3 9	3 4	3 0	2 57	2 55	2 53	2 53	2 54	2 57	3 0	3 4	3 8	3 14	15
16	3 51	3 33	3 21	3 13	3 7	3 3	3 0	2 57	2 55	2 54	2 53	2 55	2 58	3 1	3 5	3 10	16
17	3 59	3 40	3 27	3 17	3 11	3 6	3 2	2 59	2 57	2 55	2 54	2 55	2 57	2 59	3 3	3 7	17
18	4 7	3 47	3 33	3 22	3 14	3 9	3 5	3 1	2 59	2 56	2 55	2 54	2 56	2 58	3 1	3 5	18
19	4 16	3 54	3 39	3 27	3 18	3 12	3 8	3 4	3 1	2 58	2 56	2 55	2 55	2 57	3 0	3 3	19
20	4 24	4 1	3 45	3 32	3 22	3 16	3 11	3 7	3 3	3 0	2 58	2 56	2 55	2 57	2 59	3 2	20
21	4 33	4 8	3 51	3 37	3 27	3 20	3 14	3 9	3 5	3 2	3 0	2 57	2 56	2 57	2 59	3 1	21
22	4 41	4 15	3 57	3 43	3 32	3 24	3 17	3 12	3 7	3 4	3 2	2 59	2 57	2 56	2 58	3 0	22
23	4 49	4 22	4 4	3 49	3 37	3 28	3 21	3 15	3 10	3 7	3 4	3 0	2 58	2 57	2 58	3 0	23
24	4 58	4 29	4 10	3 54	3 42	3 32	3 24	3 18	3 13	3 10	3 7	3 2	2 59	2 58	2 57	2 59	24
25	5 6	4 36	4 16	4 0	3 47	3 37	3 28	3 21	3 16	3 12	3 9	3 4	3 1	2 59	2 58	2 59	25
26	5 15	4 43	4 22	4 5	3 52	3 41	3 32	3 24	3 18	3 14	3 11	3 6	3 2	3 0	2 59	2 58	26
27	5 23	4 50	4 28	4 11	3 57	3 45	3 35	3 27	3 21	3 16	3 13	3 8	3 4	3 2	3 0	2 59	27
28	5 31	4 57	4 34	4 16	4 1	3 49	3 39	3 31	3 24	3 19	3 15	3 9	3 5	3 3	3 1	2 59	28
29	5 39	5 4	4 40	4 21	4 6	3 54	3 43	3 34	3 27	3 21	3 17	3 11	3 7	3 4	3 2	3 0	29
30	5 47	5 11	4 46	4 26	4 10	3 58	3 47	3 38	3 30	3 24	3 19	3 13	3 8	3 5	3 3	3 1	30
31	5 55	5 18	4 52	4 32	4 15	4 2	3 51	3 42	2 34	3 27	3 22	3 15	3 10	3 6	3 4	3 2	31
32	6 3	5 26	4 58	4 37	4 20	4 6	3 55	3 45	3 37	3 30	3 25	3 17	3 12	3 8	3 5	3 3	32
33	6 12	5 33	5 5	4 42	4 25	4 11	3 59	3 48	3 40	3 33	3 27	3 19	3 13	3 9	3 6	3 4	33
34	6 20	5 40	5 11	4 47	4 30	4 15	4 2	3 52	3 43	3 36	3 30	3 21	3 15	3 10	3 7	3 5	34
35	6 29	5 47	5 17	4 53	4 35	4 20	4 6	3 55	3 47	3 40	3 33	3 24	3 17	3 12	3 9	3 6	35
36	6 37	5 55	5 23	4 58	4 40	4 24	4 10	3 59	3 50	3 43	3 36	3 26	3 19	3 14	3 10	3 7	36
37	6 45	6 2	5 29	5 4	4 45	4 29	4 14	4 2	3 53	3 46	3 39	3 29	3 21	3 15	3 11	3 8	37
38	6 53	6 9	5 35	5 9	4 50	4 33	4 18	4 6	3 57	3 49	3 42	3 31	3 23	3 17	3 13	3 9	38
39	7 1	6 16	5 41	5 15	4 54	4 37	4 22	4 10	4 0	3 52	3 45	3 33	3 25	3 19	3 15		39
40	7 8	6 23	5 47	5 20	4 58	4 41	4 26	4 13	4 3	3 54	3 47	3 36	3 27	3 20	3 16		40
41	7 15	6 29	5 53	5 25	5 3	4 45	4 30	4 17	4 6	3 57	3 50	3 39	3 29	3 21			41
42	7 22	6 35	5 58	5 30	5 7	4 49	4 33	4 20	4 9	4 0	3 53	3 41	3 31	3 23			42
43	7 30	6 41	6 4	5 35	5 12	4 53	4 37	4 23	4 12	4 3	3 55	3 43	3 33				43
44	7 37	6 47	6 9	5 40	5 16	4 57	4 41	4 27	4 15	4 6	3 58	3 45	3 34				44
45	7 45	6 53	6 15	5 45	5 21	5 1	4 44	4 30	4 18	4 9	4 1	3 47					45
46	7 52	6 59	6 20	5 49	5 25	5 5	4 48	4 33	4 21	4 11	4 3	3 49					46
47	7 59	7 5	6 25	5 54	5 29	5 9	4 52	4 37	4 24	4 14	4 6						47
48	8 6	7 10	6 30	5 59	5 33	5 13	4 55	4 40	4 27	4 17	4 8						48
49	8 12	7 15	6 35	6 4	5 37	5 16	4 58	4 43	4 30	4 19							49
50	8 18	7 20	6 40	6 8	5 41	5 20	5 1	4 46	4 33								50
51	8 24	7 26	6 45	6 12	5 45	5 23	5 4	4 49									51
52	8 30	7 31	6 50	6 16	5 49	5 27	5 7										52
53	8 36	7 37	6 55	6 20	5 53	5 30											53
54	8 42	7 42	6 59	6 24	5 50												54
55	8 48	7 47	7 3	6 28													55
56	8 54	7 52	7 7														56
57	8 59	7 57															57
58	9 3																58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	18°	20°	22°	24°	26°	

THIRD CORRECTION, TO APPARENT DISTANCE 116°

☽'s App. Alt.	28°	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	56°	58°	☽'s App Alt
	APPARENT ALTITUDE OF THE SUN, OR STAR.																
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 30	5 46	6 3	6 19	6 36	6 52	7 7	7 22	7 36	7 51	8 5	8 18	8 30	8 42	8 53	9 3	6
7	4 56	5 10	5 25	5 40	5 55	6 9	6 22	6 34	6 46	6 58	7 9	7 20	7 31	7 42	7 52		7
8	4 33	4 45	4 58	5 11	5 24	5 36	5 47	5 58	6 8	6 18	6 28	6 38	6 48	6 58	7 8		8
9	4 15	4 26	4 37	4 47	4 58	5 8	5 19	5 29	5 39	5 49	5 59	6 8	6 16	6 24			9
10	4 0	4 10	4 20	4 29	4 39	4 48	4 58	5 7	5 16	5 25	5 33	5 41	5 49	5 56			10
11	3 48	3 57	4 6	4 15	4 23	4 32	4 41	4 49	4 57	5 5	5 12	5 19	5 25				11
12	3 38	3 46	3 54	4 2	4 10	4 18	4 26	4 34	4 41	4 48	4 54	5 1	5 7				12
13	3 30	3 37	3 44	3 52	4 0	4 7	4 14	4 21	4 27	4 33	4 39	4 45					13
14	3 24	3 30	3 37	3 44	3 51	3 57	4 4	4 10	4 16	4 21	4 27	4 33					14
15	3 19	3 25	3 31	3 37	3 43	3 49	3 55	4 1	4 6	4 11	4 17						15
16	3 15	3 20	3 26	3 31	3 37	3 42	3 47	3 53	3 58	4 2	4 8						16
17	3 12	3 16	3 21	3 26	3 31	3 36	3 41	3 46	3 51	3 55							17
18	3 9	3 13	3 17	3 22	3 26	3 31	3 36	3 40	3 45	3 49							18
19	3 7	3 10	3 14	3 18	3 22	3 27	3 31	3 35	3 39								19
20	3 5	3 8	3 11	3 15	3 19	3 23	3 27	3 31	3 34								20
21	3 4	3 6	3 9	3 12	3 16	3 20	3 23	3 27									21
22	3 3	3 5	3 7	3 10	3 14	3 17	3 20	3 23									22
23	3 2	3 4	3 6	3 9	3 12	3 15	3 18										23
24	3 1	3 3	3 5	3 8	3 10	3 13	3 16										24
25	3 0	3 2	3 4	3 7	3 9	3 11											25
26	3 0	3 2	3 4	3 6	3 7	3 9											26
27	3 0	3 1	3 3	3 5	3 6												27
28	2 59	3 0	3 2	3 4	3 5												28
29	2 59	3 0	3 1	3 3													29
30	3 0	3 0	3 1	3 3													30
31	3 1	3 0	3 1														31
32	3 2	3 1	3 2														32
33	3 2	3 1															33
34	3 3	3 2															34
35	3 4																35
36	3 5																36
37																	37
38																	38
39																	39
40																	40
41																	41
42																	42
43																	43
44																	44
45																	45
46																	46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
	28°	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	5	10	20	30	40	50	60	70	80	90
	Sun's Apparent Altitude.									
	″	″	″	″	″	″	″	″	″	″
5	2	2	2	3	4	4	5			
10	2	2	3	4	5	5				
15	3	3	4	5	5	6				
20	4	4	5	6	6					
25	5	5	6	6	7					
30	5	6	6	7						
35	6	6	7	8						
40	7	7	8							
45	7	8	8							
50	8	8								
55	9	9								
60	9									

TABLE XXXIII.

THIRD CORRECTION, TO APPARENT DISTANCE 120°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR.																☽'s App Alt.
	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°	17°	18°	19°	20°	22°	
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	3 1	3 3	3 6	3 11	3 17	3 24	3 32	3 39	3 47	3 55	4 4	4 12	4 21	4 30	3 39	4 47	6
7	3 3	3 2	3 4	3 7	3 11	3 16	3 22	3 28	3 34	3 40	3 47	3 54	4 1	4 8	4 15	4 30	7
8	3 7	3 4	3 3	3 5	3 8	3 11	3 15	3 20	3 25	3 29	3 35	3 40	3 46	3 52	3 59	4 12	8
9	3 12	3 8	3 5	3 4	3 6	3 8	3 11	3 14	3 18	3 22	3 26	3 31	3 36	3 41	3 47	3 58	9
10	3 18	3 12	3 8	3 6	3 5	3 6	3 8	3 10	3 14	3 17	3 20	3 24	3 28	3 33	3 38	3 47	10
11	3 25	3 17	3 12	3 8	3 6	3 5	3 6	3 8	3 11	3 13	3 16	3 19	3 22	3 26	3 30	3 38	11
12	3 33	3 23	3 16	3 11	3 8	3 6	3 5	3 7	3 9	3 11	3 13	3 15	3 18	3 21	3 24	3 31	12
13	3 41	3 28	3 20	3 15	3 11	3 8	3 6	3 6	3 8	3 9	3 11	3 13	3 15	3 17	3 20	3 26	13
14	3 49	3 34	3 25	3 19	3 14	3 11	3 8	3 7	3 7	3 8	3 9	3 11	3 12	3 14	3 17	3 22	14
15	3 57	3 41	3 30	3 23	3 18	3 14	3 11	3 9	3 8	3 7	3 8	3 9	3 11	3 12	3 14	3 18	15
16	4 6	3 48	3 36	3 28	3 22	3 17	3 13	3 11	3 9	3 8	3 8	3 9	3 10	3 11	3 12	3 16	16
17	4 14	3 55	3 42	3 32	3 25	3 20	3 15	3 12	3 10	3 9	3 9	3 9	3 9	3 10	3 11	3 14	17
18	4 23	4 3	3 48	3 37	3 29	3 23	3 18	3 14	3 12	3 11	3 10	3 9	3 9	3 10	3 11	3 13	18
19	4 32	4 10	3 54	3 42	3 33	3 26	3 21	3 17	3 15	3 13	3 11	3 10	3 10	3 9	3 10	3 12	19
20	4 40	4 17	4 1	3 48	3 38	3 30	3 24	3 20	3 17	3 15	3 13	3 12	3 11	3 10	3 10	3 12	20
21	4 49	4 24	4 7	3 53	3 42	3 34	3 28	3 23	3 19	3 17	3 15	3 13	3 12	3 11	3 10	3 11	21
22	4 58	4 31	4 14	3 58	3 47	3 39	3 32	3 26	3 22	3 19	3 16	3 14	3 13	3 12	3 11	3 11	22
23	5 7	4 39	4 21	4 4	3 52	3 43	3 36	3 30	3 25	3 21	3 18	3 16	3 14	3 13	3 12	3 12	23
24	5 16	4 46	4 27	4 10	3 57	3 47	3 39	3 33	3 28	3 23	3 20	3 18	3 16	3 15	3 14	3 13	24
25	5 25	4 53	4 33	4 15	4 2	3 51	3 43	3 36	3 31	3 26	3 23	3 20	3 18	3 17	3 15	3 14	25
26	5 34	5 1	4 40	4 20	4 7	3 56	3 47	3 39	3 34	3 29	3 25	3 22	3 20	3 18	3 16	3 15	26
27	5 42	5 8	4 47	4 25	4 12	4 1	3 51	3 43	3 37	3 32	3 28	3 25	3 22	3 20	3 18	3 16	27
28	5 51	5 16	4 53	4 31	4 17	4 5	3 55	3 47	3 40	3 35	3 30	3 27	3 24	3 22	3 20	3 17	28
29	6 0	5 24	5 0	4 37	4 22	4 10	3 59	3 50	3 43	3 37	3 33	3 29	3 26	3 23	3 21	3 18	29
30	6 8	5 31	5 6	4 43	4 27	4 15	4 3	3 54	3 46	3 40	3 36	3 32	3 28	3 25	3 23	3 19	30
31	6 17	5 39	5 12	4 48	4 32	4 19	4 7	3 57	3 49	3 43	3 38	3 34	3 30	3 27	3 25	3 20	31
32	6 25	5 46	5 18	4 54	4 37	4 23	4 11	4 1	3 52	3 46	3 41	3 36	3 32	3 29	3 27	3 22	32
33	6 34	5 54	5 25	5 0	4 42	4 27	4 15	4 5	3 56	3 49	3 44	3 39	3 35	3 32	3 29	3 24	33
34	6 43	6 2	5 31	5 6	4 47	4 32	4 19	4 9	3 59	3 52	3 47	3 42	3 37	3 34	3 31	3 26	34
35	6 51	6 9	5 38	5 12	4 52	4 37	4 24	4 12	4 2	3 55	3 50	3 45	3 40	3 36	3 33	3 28	35
36	6 59	6 16	5 44	5 18	4 57	4 42	4 28	4 15	4 5	3 58	3 53	3 47	3 42	3 38	3 35	3 30	36
37	7 8	6 23	5 50	5 23	5 2	4 46	4 32	4 19	4 9	4 2	3 56	3 50	3 45	3 41	3 37	3 31	37
38	7 16	6 30	5 56	5 28	5 7	4 50	4 36	4 23	4 13	4 5	3 59	3 53	3 47	3 43	3 39	3 33	38
39	7 24	6 37	6 2	5 34	5 12	4 55	4 40	4 27	4 16	4 8	4 1	3 55	3 50	3 45	3 41		39
40	7 32	6 44	6 8	5 39	5 17	4 59	4 44	4 31	4 20	4 11	4 4	3 58	3 52	3 47	3 43		40
41	7 40	6 50	6 14	5 44	5 22	5 4	4 48	4 35	4 24	4 15	4 7	4 1	3 55	3 49			41
42	7 47	6 56	6 19	5 50	5 27	5 8	4 52	4 39	4 28	4 18	4 10	4 3	3 57				42
43	7 55	7 2	6 25	5 55	5 32	5 13	4 56	4 42	4 31	4 21	4 13	4 6					43
44	8 3	7 9	6 31	6 0	5 37	5 17	5 0	4 46	4 34	4 24	4 16						44
45	8 11	7 15	6 36	6 5	5 42	5 22	5 4	4 49	4 37	4 27							45
46	8 18	7 21	6 41	6 10	5 46	5 26	5 8	4 53	4 40								46
47	8 25	7 27	6 46	6 15	5 51	5 30	5 11	4 56									47
48	8 32	7 33	6 52	6 20	5 55	5 34	5 14										48
49	8 39	7 39	6 57	6 25	5 59	5 37											49
50	8 45	7 45	7 2	6 30	6 3												50
51	8 51	7 51	7 8	6 34													51
52	8 57	7 57	7 13														52
53	9 3	8 3															53
54	9 9																54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°	16°						

TABLE P. EFFECT OF SUN'S PAR.

To be subtracted from the Third Correction.

☽'s App Alt.	Sun's Apparent Altitude.									
	5	10	20	30	40	50	55	70	80	90
	″	″	″	″	″	″	″	″	″	″
5	2	2	3	3	4	5	5			
10	2	3	3	4	5	6				
15	3	4	4	5	6	7				
20	4	4	5	6	7					
25	5	5	6	7	7					
30	6	6	7	8						
35	6	7	8							
40	7	8	8							
45	8	8								
50	8	9								
55	9									

THIRD CORRECTION. TO APPARENT DISTANCE 120°.

☽'s App. Alt.	APPARENT ALTITUDE OF THE SUN, OR STAR. 24°	26°	28°	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	☽'s App. Alt.
°	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	′ ″	°
6	5 15	5 32	5 49	6 6	6 23	6 41	6 58	7 14	7 30	7 46	8 2	8 17	8 31	8 44	8 57	9 9	6
7	4 45	5 0	5 15	5 30	5 45	6 0	6 15	6 29	6 43	6 56	7 8	7 21	7 33	7 45	7 57		7
8	4 25	4 38	4 51	5 4	5 17	5 30	5 43	5 56	6 8	6 20	6 31	6 42	6 53	7 3	7 13		8
9	4 9	4 20	4 31	4 43	4 55	5 7	5 18	5 28	5 38	5 49	6 0	6 10	6 20	6 29			9
10	3 57	4 7	4 17	4 27	4 37	4 47	4 57	5 7	5 17	5 27	5 37	5 46	5 55	6 3			10
11	3 47	3 56	4 5	4 14	4 23	4 32	4 42	4 51	4 59	5 8	5 17	5 25	5 33				11
12	3 39	3 47	3 55	4 3	4 11	4 19	4 28	4 36	4 44	4 52	5 0	5 7	5 14				12
13	3 32	3 39	3 46	3 53	4 0	4 8	4 16	4 24	4 31	4 38	4 46	4 53					13
14	3 27	3 33	3 39	3 46	3 52	3 59	4 6	4 13	4 20	4 27	4 34	4 40					14
15	3 23	3 29	3 34	3 40	3 46	3 52	3 58	4 4	4 11	4 18	4 24						15
16	3 20	3 25	3 30	3 36	3 41	3 46	3 52	3 58	4 4	4 10	4 16						16
17	3 18	3 22	3 27	3 32	3 36	3 41	3 47	3 52	3 58	4 3							17
18	3 16	3 20	3 24	3 28	3 32	3 37	3 42	3 47	3 52	3 57							18
19	3 15	3 18	3 21	3 25	3 29	3 33	3 38	3 43	3 47								19
20	3 14	3 16	3 19	3 23	3 27	3 31	3 35	3 39	3 43								20
21	3 13	3 15	3 17	3 21	3 24	3 28	3 32	3 36									21
22	3 12	3 14	3 16	3 19	3 22	3 26	3 29	3 33									22
23	3 12	3 13	3 15	3 18	3 21	3 24	3 27										23
24	3 12	3 13	3 15	3 17	3 20	3 23	3 26										24
25	3 12	3 13	3 15	3 17	3 19	3 21											25
26	3 13	3 14	3 15	3 16	3 18	3 20											26
27	3 14	3 14	3 15	3 16	3 18												27
28	3 15	3 14	3 15	3 16	3 18												28
29	3 16	3 15	3 15	3 16													29
30	3 17	3 16	3 16	3 16													30
31	3 18	3 17	3 17														31
32	3 19	3 18	3 18														32
33	3 21	3 19															33
34	3 22	3 20															34
35	3 24																35
36	3 26																36
37																	37
38																	38
39																	39
40																	40
41																	41
42																	42
43																	43
44																	44
45																	45
46																	46
47																	47
48																	48
49																	49
50																	50
51																	51
52																	52
53																	53
54																	54
55																	55
56																	56
57																	57
58																	58
59																	59
60																	60
61																	61
62																	62
63																	63
64																	64
65																	65
	24°	26°	28°	30°	32°	34°	36°	38°	40°	42°	44°	46°	48°	50°	52°	54°	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 0 0	° ′ h. m. 0 1	° ′ h. m. 0 2	° ′ h. m. 0 3	° ′ h. m. 0 4	° ′ h. m. 0 5	° ′ h. m. 0 6	° ′ h. m. 0 7	° ′ h. m. 0 8	° ′ h. m. 0 9	″ s.
0		2.2553	1.9542	1.7782	1.6532	1.5563	1.4771	1.4102	1.3522	1.3010	0
1	4.0334	2481	9506	7757	6514	5549	4759	4091	3513	3002	1
2	3.7324	2410	9471	7734	6496	5534	4747	4081	3504	2994	2
3	5563	2341	9435	7710	6478	5520	4735	4071	3495	2986	3
4	4314	2272	9400	7686	6460	5506	4723	4061	3486	2978	4
5	3.3345	2.2205	1.9365	1.7663	1.6443	1.5491	1.4711	1.4050	1.3477	1.2970	5
6	2553	2139	9331	7639	6425	5477	4699	4040	3468	2962	6
7	1883	2073	9296	7616	6407	5463	4688	4030	3459	2954	7
8	1303	2009	9262	7593	6390	5449	4676	4020	3450	2946	8
9	0792	1946	9228	7570	6372	5435	4664	4010	3441	2939	9
10	3.0334	2.1883	1.9195	1.7547	1.6355	1.5421	1.4652	1.4000	1.3432	1.2931	10
11	2.9920	1822	9162	7524	6338	5407	4640	3989	3423	2923	11
12	9542	1761	9128	7501	6320	5393	4629	3979	3415	2915	12
13	9195	1701	9096	7479	6303	5379	4617	3969	3406	2907	13
14	8873	1642	9063	7456	6286	5365	4606	3959	3397	2899	14
15	2.8573	2.1584	1.9031	1.7434	1.6269	1.5351	1.4594	1.3949	1.3388	1.2891	15
16	8293	1526	8999	7412	6252	5337	4582	3939	3379	2883	16
17	8030	1460	8967	7390	6235	5324	4571	3929	3371	2876	17
18	7782	1413	8935	7368	6218	5310	4559	3919	3362	2868	18
19	7547	1358	8904	7346	6201	5296	4548	3910	3353	2860	19
20	2.7324	2.1303	1.8873	1.7324	1.6185	1.5283	1.4536	1.3900	1.3345	1.2852	20
21	7112	1249	8842	7302	6168	5269	4525	3890	3336	2845	21
22	6910	1196	8811	7281	6151	5256	4514	3880	3327	2837	22
23	6717	1143	8781	7259	6135	5242	4502	3870	3319	2829	23
24	6532	1091	8751	7238	6118	5229	4491	3860	3310	2821	24
25	2.6355	2.1040	1.8721	1.7217	1.6102	1.5215	1.4480	1.3851	1.3301	1.2814	25
26	6185	0989	8691	7196	6085	5202	4468	3841	3293	2806	26
27	6021	0939	8661	7175	6069	5189	4457	3831	3284	2798	27
28	5863	0889	8632	7154	6053	5175	4446	3821	3276	2791	28
29	5710	0840	8602	7133	6037	5162	4435	3812	3267	2783	29
30	2.5563	2.0792	1.8573	1.7112	1.6021	1.5149	1.4424	1.3802	1.3259	1.2775	30
31	5421	0744	8544	7091	6005	5136	4412	3792	3250	2768	31
32	5283	0696	8516	7071	5989	5123	4401	3783	3242	2760	32
33	5149	0649	8487	7050	5973	5110	4390	3773	3233	2753	33
34	5019	0603	8459	7030	5957	5097	4379	3764	3225	2745	34
35	2.4894	2.0557	1.8431	1.7010	1.5941	1.5084	1.4368	1.3754	1.3216	1.2738	35
36	4771	0512	8403	6990	5925	5071	4357	3745	3208	2730	36
37	4652	0467	8375	6970	5909	5058	4346	3735	3199	2722	37
38	4536	0422	8348	6950	5894	5045	4335	3726	3191	2715	38
39	4424	0378	8320	6930	5878	5032	4325	3716	3183	2707	39
40	2.4314	2.0334	1.8293	1.6910	1.5863	1.5019	1.4314	1.3707	1.3174	1.2700	40
41	4206	0291	8266	6890	5847	5007	4303	3697	3166	2692	41
42	4102	0248	8239	6871	5832	4994	4292	3688	3158	2685	42
43	4000	0206	8212	6851	5816	4981	4281	3678	3149	2678	43
44	3900	0164	8186	6832	5801	4969	4270	3669	3141	2670	44
45	2.3802	2.0122	1.8159	1.6812	1.5786	1.4956	1.4260	1.3660	1.3133	1.2663	45
46	3707	0081	8133	6793	5771	4943	4249	3650	3124	2655	46
47	3613	0040	8107	6774	5755	4931	4238	3641	3116	2648	47
48	3522	0000	8081	6755	5740	4918	4228	3632	3108	2640	48
49	3432	1.9960	8055	6736	5725	4906	4217	3623	3100	2633	49
50	2.3345	1.9920	1.8030	1.6717	1.5710	1.4894	1.4206	1.3613	1.3091	1.2626	50
51	3259	9881	8004	6698	5695	4881	4196	3604	3083	2618	51
52	3174	9842	7979	6679	5680	4869	4185	3595	3075	2611	52
53	3091	9803	7954	6661	5666	4856	4175	3586	3067	2604	53
54	3010	9765	7929	6642	5651	4844	4164	3576	3059	2596	54
55	2.2931	1.9727	1.7904	1.6624	1.5636	1.4832	1.4154	1.3567	1.3051	1.2589	55
56	2852	9690	7879	6605	5621	4820	4143	3558	3043	2582	56
57	2775	9652	7855	6587	5607	4808	4133	3549	3034	2574	57
58	2700	9615	7830	6568	5592	4795	4122	3540	3026	2567	58
59	2626	9579	7806	6550	5578	4783	4112	3531	3018	2560	59
	0 0	0 1	0 2	0 3	0 4	0 5	0 6	0 7	0 8	0 9	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS

″ s.	° ′ h. m. 0 10	° ′ h. m. 0 11	° ′ h. m. 0 12	° ′ h. m. 0 13	° ′ h. m. 0 14	° ′ h. m. 0 15	° ′ h. m. 0 16	° ′ h. m. 0 17	° ′ h. m. 0 18	° ′ h. m. 0 19	″ s
0	1.2553	1.2139	1.1761	1.1413	1.1091	1.0792	1.0512	1.0248	1.0000	0.9765	0
1	2545	2132	1755	1408	1086	0787	0507	0244	0.9996	9761	1
2	2538	2126	1749	1402	1081	0782	0502	0240	9992	9758	2
3	2531	2119	1743	1397	1076	0777	0498	0235	9988	9754	3
4	2524	2113	1737	1391	1071	0773	0493	0231	9984	9750	4
5	1.2517	1.2106	1.1731	1.1386	1.1066	1.0768	1.0489	1.0227	0.9980	0.9746	5
6	2510	2099	1725	1380	1061	0763	0484	0223	9976	9742	6
7	2502	2093	1719	1374	1055	0758	0480	0219	9972	9739	7
8	2495	2086	1713	1369	1050	0753	0475	0214	9968	9735	8
9	2488	2080	1707	1363	1045	0749	0471	0210	9964	9731	9
10	1.2481	1.2073	1.1701	1.1358	1.1040	1.0744	1.0467	1.0206	0.9960	0.9727	10
11	2474	2067	1695	1352	1035	0739	0462	0202	9956	9723	11
12	2467	2061	1689	1347	1030	0734	0458	0197	9952	9720	12
13	2460	2054	1683	1342	1025	0730	0453	0193	9948	9716	13
14	2453	2048	1677	1336	1020	0725	0449	0189	9944	9712	14
15	1.2445	1.2041	1.1671	1.1331	1.1015	1.0720	1.0444	1.0185	0.9940	0.9708	15
16	2438	2035	1665	1325	1009	0715	0440	0181	9936	9705	16
17	2431	2028	1660	1320	1004	0711	0435	0176	9932	9701	17
18	2424	2022	1654	1314	0999	0706	0431	0172	9928	9697	18
19	2417	2016	1648	1309	0994	0701	0426	0168	9924	9693	19
20	1.2410	1.2009	1.1642	1.1303	1.0989	1.0696	1.0422	1.0164	0.9920	0.9690	20
21	2403	2003	1636	1298	0984	0692	0418	0160	9916	9686	21
22	2396	1996	1630	1292	0979	0687	0413	0156	9912	9682	22
23	2389	1990	1624	1287	0974	0682	0409	0151	9908	9678	23
24	2382	1984	1619	1282	0969	0678	0404	0147	9905	9675	24
25	1.2375	1.1977	1.1613	1.1276	1.0964	1.0673	1.0400	1.0143	0.9901	0.9671	25
26	2368	1971	1607	1271	0959	0668	0395	0139	9897	9667	26
27	2362	1965	1601	1266	0954	0663	0391	0135	9893	9664	27
28	2355	1958	1595	1260	0949	0659	0387	0131	9889	9660	28
29	2348	1952	1589	1255	0944	0654	0382	0126	9885	9656	29
30	1.2341	1.1946	1.1584	1.1249	1.0939	1.0649	1.0378	1.0122	0.9881	0.9652	30
31	2334	1939	1578	1244	0934	0645	0374	0118	9877	9649	31
32	2327	1933	1572	1239	0929	0640	0369	0114	9873	9645	32
33	2320	1927	1566	1233	0924	0635	0365	0110	9869	9641	33
34	2313	1921	1561	1228	0919	0631	0360	0106	9865	9638	34
35	1.2307	1.1914	1.1555	1.1223	1.0914	1.0626	1.0356	1.0102	0.9861	0.9634	35
36	2300	1908	1549	1217	0909	0621	0352	0098	9858	9630	36
37	2293	1902	1543	1212	0904	0617	0347	0093	9854	9626	37
38	2286	1896	1538	1207	0899	0612	0343	0089	9850	9623	38
39	2279	1889	1532	1201	0894	0608	0339	0085	9846	9619	39
40	1.2272	1.1883	1.1526	1.1196	1.0889	1.0603	1.0334	1.0081	0.9842	0.9615	40
41	2266	1877	1520	1191	0884	0598	0330	0077	9838	9612	41
42	2259	1871	1515	1186	0880	0594	0326	0073	9834	9608	42
43	2252	1865	1509	1180	0875	0589	0321	0069	9830	9604	43
44	2245	1859	1503	1175	0870	0585	0317	0065	9827	9601	44
45	1.2239	1.1852	1.1498	1.1170	1.0865	1.0580	1.0313	1.0061	0.9823	0.9597	45
46	2232	1846	1492	1164	0860	0575	0308	0057	9819	9593	46
47	2225	1840	1486	1159	0855	0571	0304	0053	9815	9590	47
48	2218	1834	1481	1154	0850	0566	0300	0049	9811	9586	48
49	2212	1.1828	1475	1149	0845	0562	0295	0044	9807	9582	49
50	1.2205	1.1822	1.1469	1.1143	1.0840	1.0557	1.0291	1.0040	0.9803	0.9579	50
51	2198	1816	1464	1138	0835	0552	0287	0036	9800	9575	51
52	2192	1809	1458	1133	0831	0548	0282	0032	9796	9571	52
53	2185	1803	1452	1128	0826	0543	0278	0028	9792	9568	53
54	2178	1797	1447	1123	0821	0539	0274	0024	9788	9564	54
55	1.2172	1.1791	1.1441	1.1117	1.0816	1.0534	1.0270	1.0020	0.9784	0.9561	55
56	2165	1785	1436	1112	0811	0530	0265	0016	9780	9557	56
57	2159	1779	1430	1107	0806	0525	0261	0012	9777	9553	57
58	2152	1773	1424	1102	0801	0521	0257	0008	9773	9550	58
59	2145	1767	1419	1097	0797	0516	0252	0004	9769	9546	59
	0 10	0 11	0 12	0 13	0 14	0 15	0 16	0 17	0 18	0 19	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° h. 0 ′ m. 20	° h. 0 ′ m. 21	° h. 0 ′ m. 22	° h. 0 ′ m. 23	° h. 0 ′ m. 24	° h. 0 ′ m. 25	° h. 0 ′ m. 26	° h. 0 ′ m. 27	° h. 0 ′ m. 28	° h. 0 ′ m. 29	° h. 0 ′ m. 30	° h. 0 ′ m. 31	″ s.
0	0.9542	9331	9128	8935	8751	8573	8403	8239	8081	7929	7782	7639	0
1	9539	9327	9125	8932	8748	8570	8400	8236	8079	7926	7779	7637	1
2	9535	9324	9122	8929	8745	8568	8397	8234	8076	7924	7777	7634	2
3	9532	9320	9119	8926	8742	8565	8395	8231	8073	7921	7774	7632	3
4	9528	9317	9115	8923	8739	8562	8392	8228	8071	7919	7772	7630	4
5	0.9524	9313	9112	8920	8736	8559	8389	8226	8068	7916	7769	7627	5
6	9521	9310	9109	8917	8733	8556	8386	8223	8066	7914	7767	7625	6
7	9517	9306	9106	8913	8730	8253	8384	8220	8063	7911	7765	7623	7
8	9514	9303	9102	8910	8727	8550	8381	8218	8061	7909	7762	7620	8
9	9510	9300	9099	8907	8724	8547	8378	8215	8058	7906	7760	7618	9
10	0.9506	9296	9096	8904	8721	8544	8375	8212	8055	7904	7757	7616	10
11	9503	9293	9092	8901	8718	8542	8372	8210	8053	7901	7755	7613	11
12	9499	9289	9089	8898	8715	8539	8370	8207	8050	7899	7753	7611	12
13	9496	9286	9086	8895	8712	8536	8367	8204	8048	7896	7750	7609	13
14	9492	9283	9083	8892	8709	8533	8364	8202	8045	7894	7748	7607	14
15	0.9488	9279	9079	8888	8706	8530	8361	8199	8043	7891	7745	7604	15
16	9485	9276	9076	8885	8703	8527	8359	8196	8040	7889	7743	7602	16
17	9481	9272	9073	8882	8700	8524	8356	8194	8037	7887	7741	7600	17
18	9478	9269	9070	8879	8697	8522	8353	8191	8035	7884	7738	7597	18
19	9474	9266	9066	8876	8694	8519	8350	8188	8032	7882	7736	7595	19
20	0.9471	9262	9063	8873	8691	8516	8348	8186	8030	7879	7734	7593	20
21	9467	9259	9060	8870	8688	8513	8345	8183	8027	7877	7731	7590	21
22	9464	9255	9057	8867	8685	8510	8342	8181	8025	7874	7729	7588	22
23	9460	9252	9053	8864	8682	8507	8339	8178	8022	7872	7726	7586	23
24	9456	9249	9050	8861	8679	8504	8337	8175	8020	7869	7724	7583	24
25	0.9453	9245	9047	8857	8676	8502	8334	8173	8017	7867	7722	7581	25
26	9449	9242	9044	8854	8673	8499	8331	8170	8014	7864	7719	7579	26
27	9446	9238	9041	8851	8670	8496	8328	8167	8012	7862	7717	7577	27
28	9442	9235	9037	8848	8667	8493	8326	8165	8009	7859	7714	7574	28
29	9439	9232	9034	8845	8664	8490	8323	8162	8007	7857	7712	7572	29
30	0.9435	9228	9031	8842	8661	8487	8320	8159	8004	7855	7710	7570	30
31	9432	9225	9028	8839	8658	8484	8318	8157	8002	7852	7707	7567	31
32	9428	9222	9024	8836	8655	8482	8315	8154	7999	7850	7705	7565	32
33	9425	9218	9021	8833	8652	8479	8312	8152	7997	7847	7703	7563	33
34	9421	9215	9018	8830	8649	8476	8309	8149	7994	7845	7700	7560	34
35	0.9418	9212	9015	8827	8646	8473	8307	8146	7992	7842	7698	7558	35
36	9414	9208	9012	8824	8643	8470	8304	8144	7989	7840	7696	7556	36
37	9411	9205	9008	8821	8640	8467	8301	8141	7987	7837	7693	7554	37
38	9407	9201	9005	8817	8637	8465	8298	8138	7984	7835	7691	7551	38
39	9404	9198	9002	8814	8635	8462	8296	8136	7981	7832	7688	7549	39
40	0.9400	9195	8999	8811	8632	8459	8293	8133	7979	7830	7686	7547	40
41	9397	9191	8996	8808	8629	8456	8290	8131	7976	7828	7684	7544	41
42	9393	9188	8992	8805	8626	8453	8288	8128	7974	7825	7681	7542	42
43	9390	9185	8989	8802	8623	8451	8285	8125	7971	7823	7679	7540	43
44	9386	9181	8986	8799	8620	8448	8282	8123	7969	7820	7677	7538	44
45	0.9383	9178	8983	8796	8617	8445	8279	8120	7966	7818	7674	7535	45
46	9379	9175	8980	8793	8614	8442	8277	8117	7964	7815	7672	7533	46
47	9376	9172	8977	8790	8611	8439	8274	8115	7961	7813	7670	7531	47
48	9372	9168	8973	8787	8608	8437	8271	8112	7959	7811	7667	7528	48
49	9369	9165	8970	8784	8605	8434	8269	8110	7956	7808	7665	7526	49
50	0.9365	9162	8967	8781	8602	8431	8266	8107	7954	7806	7663	7524	50
51	9362	9158	8964	8778	8599	8428	8263	8104	7951	7803	7660	7522	51
52	9358	9155	8961	8775	8597	8425	8261	8102	7949	7801	7658	7519	52
53	3955	9152	8958	8772	8594	8423	8258	8099	7946	7798	7655	7517	53
54	9351	9148	8954	8769	8591	8420	8255	8097	7944	7796	7653	7515	54
55	0.9348	9145	8951	8766	8588	8417	8253	8094	7941	7794	7651	7513	55
56	9344	9142	8948	8763	8585	8414	8250	8091	7939	7791	7648	7510	56
57	9341	9138	8945	8760	8582	8411	8247	8089	7936	7789	7646	7508	57
58	9337	9135	8942	8757	8579	8409	8244	8086	7934	7786	7644	7506	58
59	9334	9132	8939	8754	8576	8406	8242	8084	7931	7784	7641	7503	59
	0 20	0 21	0 22	0 23	0 24	0 25	0 26	0 27	0 28	0 29	0 30	0 31	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

s.	h. m. 0 32	h. m. 0 33	h. m. 0 34	h. m. 0 35	h. m. 0 36	h. m. 0 37	h. m. 0 38	h. m. 0 39	h. m. 0 40	h. m. 0 41	h. m. 0 42	h. m. 0 43	s.
0	0.7501	7368	7238	7112	6990	6871	6755	6642	6532	6425	6320	6218	0
1	7499	7365	7236	7110	6988	6869	6753	6640	6530	6423	6319	6216	1
2	7497	7363	7234	7108	6986	6867	6751	6638	6529	6421	6317	6215	2
3	7494	7361	7232	7106	6984	6865	6749	6637	6527	6420	6315	6213	3
4	7492	7359	7229	7104	6982	6863	6747	6635	6525	6418	6313	6211	4
5	0.7490	7357	7227	7102	6980	6861	6745	6633	6523	6416	6312	6210	5
6	7488	7354	7225	7100	6978	6859	6743	6631	6521	6414	6310	6208	6
7	7485	7352	7223	7098	6976	6857	6742	6629	6519	6413	6308	6206	7
8	7483	7350	7221	7096	6974	6855	6740	6627	6518	6411	6306	6205	8
9	7481	7348	7219	7093	6972	6853	6738	6625	6516	6409	6305	6203	9
10	0.7479	7346	7217	7091	6970	6851	6736	6624	6514	6407	6303	6201	10
11	7476	7344	7215	7089	6968	6849	6734	6622	6612	6406	6301	6200	11
12	7474	7341	7212	7087	6966	6847	6732	6620	6510	6404	6300	6198	12
13	7472	7339	7210	7085	6964	6845	6730	6618	6509	6402	6298	6196	13
14	7470	7337	7208	7083	6962	6843	6728	6616	6507	6400	6296	6195	14
15	0.7467	7335	7206	7081	6960	6841	6726	6614	6505	6398	6294	6193	15
16	7465	7333	7204	7079	6958	6840	6725	6612	6503	6397	6293	6191	16
17	7463	7330	7202	7077	6956	6838	6723	6611	6501	6395	6291	6190	17
18	7461	7328	7200	7075	6954	6836	6721	6609	6500	6393	6289	6188	18
19	7458	7326	7198	7073	6952	6834	6719	6607	6498	6391	6288	6186	19
20	0.7456	7324	7196	7071	6950	6832	6717	6605	7496	6390	6286	6185	20
21	7454	7322	7193	7069	6948	6830	6715	6603	6494	6388	6284	6183	21
22	7452	7320	7191	7067	6946	6828	6713	6601	6492	6386	6282	6181	22
23	7450	7317	7189	7065	6944	6826	6711	6600	6491	6384	6281	6179	23
24	7447	7315	7187	7063	6942	6824	6709	6598	6489	6383	6279	6178	24
25	0.7445	7313	7185	7061	6940	6822	6708	6596	6487	6381	6277	6176	25
26	7443	7311	7183	7059	6938	6820	6706	6594	6485	6379	6276	6174	26
27	7441	7309	7181	7057	6936	6818	6704	6592	6484	6377	6274	6173	27
28	7438	7307	7179	7055	6934	6816	6702	6590	6482	6376	6272	6171	28
29	7436	7304	7177	7052	6932	6814	6700	6589	6480	6374	6271	6169	29
30	0.7434	7302	7175	7050	6930	6812	6698	6587	6478	6372	6269	6168	30
31	7432	7300	7172	7048	6928	6810	6696	6585	6476	6371	6267	6166	31
32	7429	7298	7170	7046	6926	6809	6694	6583	6475	6369	6265	6165	32
33	7427	7296	7168	7044	6924	6807	6692	6581	6473	6367	6264	6163	33
34	7425	7294	7166	7042	6922	6805	6691	6579	6471	6365	6262	6161	34
35	0.7423	7291	7164	7040	6920	6803	6689	6578	6469	6364	6260	6160	35
36	7421	7289	7162	7038	6918	6801	6687	6576	6467	6362	6259	6158	36
37	7418	7287	7160	7036	6916	6799	6685	6574	6466	6360	6257	6156	37
38	7416	7285	7158	7034	6914	6797	6683	6572	6464	6358	6255	6155	38
39	7414	7283	7156	7032	6912	6795	6681	6570	6462	6357	6354	6153	39
40	0.7412	7281	7154	7030	6910	6793	6679	6568	6460	6355	6252	6151	40
41	7409	7279	7152	7028	6908	6791	6677	6567	6459	6353	6250	6150	41
42	7407	7276	7149	7026	6906	6789	6676	6565	6457	6351	6248	6148	42
43	7405	7274	7147	7024	6904	6787	6674	6563	6455	6350	6247	6146	43
44	7403	7272	7145	7022	6902	6785	6672	6561	6453	6348	6245	6145	44
45	0.7401	7270	7143	7020	6900	6784	6670	6559	6451	6346	6243	6143	45
46	7398	7268	7141	7018	6898	6782	6668	6558	6450	6344	6242	6141	46
47	7396	7266	7139	7016	6896	6780	6666	6556	6448	6343	6240	6140	47
48	7394	7264	7137	7014	6894	6778	6664	6554	6446	6341	6238	6138	48
49	7392	7261	7135	7012	6892	6776	6663	6552	6444	6339	6237	6136	49
50	0.7390	7259	7133	7010	6890	6774	6661	6550	6443	6338	6235	6135	50
51	7387	7257	7131	7008	6888	6772	6659	6548	6441	6336	6233	6133	51
52	7385	7255	7129	7006	6886	6770	6657	6547	6439	6334	6232	6131	52
53	7383	7253	7127	7004	6884	6768	6655	6545	6437	6332	6230	6130	53
54	7381	7251	7124	7002	6882	6766	6653	6543	6435	6331	6228	6128	54
55	0.7379	7249	7122	7000	6881	6764	6651	6541	6434	6329	6226	6126	55
56	7376	7246	7120	6998	6879	6763	6650	6539	6432	6327	6225	6125	56
57	7374	7244	7118	6996	6877	6761	6648	6538	6430	6325	6223	6123	57
58	7372	7242	7116	6994	6875	6759	6646	6536	6428	6324	6221	6121	58
59	7370	7240	7114	6992	6873	6757	6644	6534	6427	6322	6220	6120	59
	0 32	0 33	0 34	0 35	0 36	0 37	0 38	0 39	0 40	0 41	0 42	0 43	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

s.	h. m. 0 44	h. m. 0 45	h. m. 0 46	h. m. 0 47	h. m. 0 48	h. m. 0 49	h. m. 0 50	h. m. 0 51	h. m. 0 52	h. m. 0 53	h. m. 0 54	h. m. 0 55	s.
0	0.6118	6021	5925	5832	5740	5651	5563	5477	5393	5310	5229	5149	0
1	6117	6019	5924	5830	5739	5649	5562	5476	5391	5309	5227	5148	1
2	6115	6017	5922	5829	5737	5648	5560	5474	5390	5307	5226	5146	2
3	6113	6016	5920	5827	5736	5646	5559	5473	5389	5306	5225	5145	3
4	6112	6014	5919	5826	5734	5645	5557	5471	5387	5305	5223	5144	4
5	0·6110	6013	5917	5824	5733	5643	5556	5470	5386	5303	5222	5143	5
6	6108	6011	5916	5823	5731	5642	5554	5469	5384	5302	5221	5141	6
7	6107	6009	5914	5821	5730	5640	5553	5467	5383	5300	5219	5140	7
8	6105	6008	5913	5819	5728	5639	5551	5466	5382	5299	5218	5139	8
9	6103	6006	5911	5818	5727	5637	5550	5464	5380	5298	5217	5137	9
10	0.6102	6005	5909	5816	5725	5636	5549	5463	5379	5296	5215	5136	10
11	6100	6003	5908	5815	5724	5635	5547	5461	5377	5295	5214	5135	11
12	6099	6001	5906	5813	5722	6633	5546	5460	5376	5294	5213	5133	12
13	6097	6000	5905	5812	5721	5632	5544	5459	5375	5292	5211	5132	13
14	6095	5998	5903	5810	5719	5630	5543	5457	5373	5291	5210	5131	14
15	0.6094	5997	5902	5809	5718	5629	5541	5456	5372	5290	5209	5129	15
16	6092	5995	5900	5807	5716	5627	5540	5454	5370	5288	5207	5128	16
17	6090	5993	5898	5806	5715	5626	5538	5453	5369	5287	5206	5127	17
18	6089	5992	5897	5804	5713	5624	5537	5452	5368	5285	5205	5125	18
19	6087	5990	5895	5803	5712	5623	5536	5450	5366	5284	5203	5124	19
20	0.6085	5989	5894	5801	5710	5621	5534	5449	5365	5283	5202	5123	20
21	6084	5987	5892	5800	5709	5620	5533	5447	5364	5281	5201	5122	21
22	6082	5985	5891	5798	5707	5618	5531	5446	5362	5280	5199	5120	22
23	6081	5984	5889	5796	5706	5617	5530	5445	5361	5279	5198	5119	23
24	6079	5982	5888	5795	5704	5615	5528	5443	5359	5277	5197	5118	24
25	0.6077	5981	5886	5793	5703	5614	5527	5442	5358	5276	5195	5116	25
26	6076	5979	5884	5792	5701	5613	5526	5440	5357	5275	5194	5115	26
27	6074	5977	5883	5790	5700	5611	5524	5439	5355	5273	5193	5114	27
28	6072	5976	5881	5789	5698	5610	5522	5437	5354	5272	5191	5112	28
29	6071	5974	5880	5787	5697	5608	5521	5436	5353	5271	5190	5111	29
30	0.6069	5973	5878	5786	5695	5607	5520	5435	5351	5269	5189	5110	30
31	6067	5971	5877	5784	5694	5605	5518	5433	5350	5268	5187	5108	31
32	6066	5969	5875	5783	5692	5604	5517	5432	5348	5266	5186	5107	32
33	6064	5968	5874	5781	5691	5602	5516	5430	5347	5265	5185	5106	33
34	6063	5966	5872	5780	5689	5601	5514	5429	5346	5264	5183	5105	34
35	0.6061	5965	5870	5778	5688	5599	5513	5428	5344	5262	5182	5103	35
36	6059	5963	5869	5777	5686	5598	5511	5426	5343	5261	5181	5102	36
37	6058	5961	5867	5775	5685	5596	5510	5425	5341	5260	5179	5101	37
38	6056	5960	5866	5774	5683	5595	5508	5423	5340	5258	5178	5099	38
39	6055	5958	5864	5772	5682	5594	5507	5422	5339	5257	5177	5098	39
40	0.6053	5957	5863	5771	5680	5592	5506	5421	5337	5256	5175	5097	40
41	6051	5955	5861	5769	5679	5591	5504	5419	5336	5254	5174	5095	41
42	6050	5954	5860	5768	5677	5589	5503	5418	5335	5253	5173	5094	42
43	6048	5952	5858	5766	5676	5588	5501	5416	5333	5252	5172	5093	43
44	6046	5950	5856	5765	5674	5586	5500	5415	5332	5250	5170	5092	44
45	0.6045	5949	5855	5763	5673	5585	5498	5414	5331	5249	5169	5090	45
46	6043	5947	5853	5761	5671	5583	5497	5412	5329	5248	5168	5089	46
47	6042	5946	5852	5760	5670	5582	5496	5411	5328	5246	5166	5088	47
48	6040	5944	5850	5758	5669	5580	5494	5409	5326	5245	5165	5086	48
49	6038	5942	5849	5757	5667	5579	5493	5408	5325	5244	5164	5085	49
50	0.6037	5941	5847	5755	5666	5578	5491	5407	5324	5242	5162	5084	50
51	6035	5939	5846	5754	5664	5576	5490	5405	5322	5241	5161	5082	51
52	6033	5938	5844	5752	5663	5575	5488	5404	5321	5240	5160	5081	52
53	6032	5936	5843	5751	5661	5573	5487	5402	5320	5238	5158	5080	53
54	6030	5935	5841	5749	5660	5572	5486	5401	5318	5237	5157	5079	54
55	0.6029	5933	5839	5748	5658	5570	5484	5400	5317	5235	5156	5077	55
56	6027	5931	5838	5746	5657	5569	5483	5398	5315	5234	5154	5076	56
57	6025	5930	5836	5745	5655	5567	5481	5397	5314	5233	5153	5075	57
58	6024	5928	5835	5743	5654	5566	5480	5395	5313	5231	5152	5073	58
59	6022	5927	5833	5742	5652	5564	5478	5394	5311	5230	5150	5072	59
	0 44	0 45	0 46	0 47	0 48	0 49	0 50	0 51	0 52	0 53	0 54	0 55	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 0 56	° ′ h. m. 0 57	° ′ h. m. 0 58	° ′ h. m. 0 59	° ′ h. m. 1 0	° ′ h. m. 1 1	° ′ h. m. 1 2	° ′ h. m. 1 3	° ′ h. m. 1 4	° ′ h. m. 1 5	° ′ h. m. 1 6	° ′ h. m. 1 7	″ s.
0	0.5071	4994	4918	4844	4771	4699	4629	4559	4491	4424	4357	4292	0
1	5070	4993	4917	4843	4770	4698	4628	4558	4490	4422	4356	4291	1
2	5068	4991	4916	4842	4769	4697	4626	4557	4489	4421	4355	4290	2
3	5067	4990	4915	4841	4768	4696	4625	4556	4488	4420	4354	4289	3
4	5066	4989	4913	4839	4766	4695	4624	4555	4486	4419	4353	4288	4
5	0.5064	4988	4912	4838	4765	4693	4623	4554	4485	4418	4352	4287	5
6	5063	4986	4911	4837	4764	4692	4622	4552	4484	4417	4351	4285	6
7	5062	4985	4910	4836	4763	4691	4621	4551	4483	4416	4350	4284	7
8	5061	4984	4908	4834	4762	4690	4619	4550	4482	4415	4349	4283	8
9	5059	4983	4907	4833	4760	4689	4618	4549	4481	4414	4347	4282	9
10	0.5058	4981	4906	4832	4759	4688	4617	4548	4480	4412	4346	4281	10
11	5057	4980	4905	4831	4758	4686	4616	4547	4479	4411	4345	4280	11
12	5055	4979	4903	4830	4757	4685	4615	4546	4477	4410	4344	4279	12
13	5054	4977	4902	4828	4756	4684	4614	4544	4476	4409	4343	4278	13
14	5053	4976	4901	4827	4754	4683	4612	4543	4475	4408	4342	4277	14
15	0.5051	4975	4900	4826	4753	4682	4611	4542	4474	4407	4341	4276	15
16	5050	4974	4899	4825	4752	4680	4610	4541	4473	4406	4340	4275	16
17	5049	4972	4897	4823	4751	4679	4609	4540	4472	4405	4339	4274	17
18	5048	4971	4896	4822	4750	4678	4608	4539	4471	4404	4338	4273	18
19	5046	4970	4895	4821	4748	4677	4607	4538	4469	4402	4336	4271	19
20	0.5045	4969	4894	4820	4747	4676	4606	4536	4468	4401	4335	4270	20
21	5044	4967	4892	4819	4746	4675	4604	4535	4467	4400	4334	4269	21
22	5043	4966	4891	4817	4745	4673	4603	4534	4466	4399	4333	4268	22
23	5041	4965	4890	4816	4744	4672	4602	4533	4465	4398	4332	4267	23
24	5040	4964	4889	4815	4742	4671	4601	4532	4464	4397	4331	4266	24
25	0.5039	4962	4887	4814	4741	4670	4600	4531	4463	4396	4330	4265	25
26	5037	4961	4886	4812	4740	4669	4599	4530	4462	4395	4329	4264	26
27	5036	4960	4885	4811	4739	4668	4597	4528	4460	4394	4328	4263	27
28	5035	4959	4884	4810	4738	4666	4596	4527	4459	4393	4327	4262	28
29	5034	4957	4882	4809	4736	4665	4595	4526	4458	4391	4326	4261	29
30	0.5032	4956	4881	4808	4735	4664	4594	4525	4457	4390	4325	4260	30
31	5031	4955	4880	4806	4734	4663	4593	4524	4456	4389	4323	4259	31
32	5030	4954	4879	4805	4733	4662	4592	4523	4455	4388	4322	4258	32
33	5028	4952	4877	4804	4732	4660	4590	4522	4454	4387	4321	4256	33
34	5027	4951	4876	4803	4730	4659	4589	4520	4453	4386	4320	4255	34
35	0.5026	4950	4875	4801	4729	4658	4588	4519	4452	4385	4319	4254	35
36	5025	4949	4874	4800	4728	4657	4587	4518	4450	4384	4318	4253	36
37	5023	4947	4873	4799	4727	4656	4586	4517	4449	4383	4317	4252	37
38	5022	4946	4871	4798	4726	4655	4585	4516	4448	4381	4316	4251	38
39	5021	4945	4870	4797	4724	4653	4584	4515	4447	4380	4315	4250	39
40	0.5019	4943	4869	4795	4723	4652	4582	4514	4446	4379	4314	4249	40
41	5018	4942	4868	4794	4722	4651	4581	4512	4445	4378	4313	4248	41
42	5017	4941	4866	4793	4721	4650	4580	4511	4444	4377	4311	4247	42
43	5016	4940	4865	4792	4720	4649	4579	4510	4443	4376	4310	4246	43
44	5014	4938	4864	4791	4718	4648	4578	4509	4441	4375	4309	4245	44
45	0.5013	4937	4863	4789	4717	4646	4577	4508	4440	4374	4308	4244	45
46	5012	4936	4861	4788	4716	4645	4575	4507	4439	4373	4307	4243	46
47	5011	4935	4860	4787	4715	4644	4574	4506	4438	4372	4306	4241	47
48	5009	4933	4859	4786	4714	4643	4573	4505	4437	4370	4305	4240	48
49	5008	4932	4858	4785	4712	4642	4572	4503	4436	4369	4304	4239	49
50	0.5007	4931	4856	4783	4711	4640	4571	4502	4435	4368	4303	4238	50
51	5005	4930	4855	4782	4710	4639	4570	4501	4434	4367	4302	4237	51
52	5004	4928	4854	4781	4709	4638	4569	4500	4433	4366	4301	4236	52
53	5003	4927	4853	4780	4708	4637	4567	4499	4431	4365	4300	4235	53
54	5002	4926	4852	4778	4707	4636	4566	4498	4430	4364	4298	4234	54
55	0.5000	4925	4850	4777	4705	4635	4565	4497	4429	4363	4297	4233	55
56	4999	4923	4849	4776	4704	4633	4564	4495	4428	4362	4296	4232	56
57	4998	4922	4848	4775	4703	4632	4563	4494	4427	4361	4295	4231	57
58	4997	4921	4847	4774	4702	4631	4562	4493	4426	4359	4294	4230	58
59	4995	4920	4845	4772	4701	4630	4560	4492	4425	4358	4293	4229	59
	0 56	0 57	0 58	0 59	1 0	1 1	1 2	1 3	1 4	1 5	1 6	1 7	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 1 8	° ′ h. m. 1 9	° ′ h. m. 1 10	° ′ h. m. 1 11	° ′ h. m. 1 12	° ′ h. m. 1 13	° ′ h. m. 1 14	° ′ h. m. 1 15	° ′ h. m. 1 16	° ′ h. m. 1 17	° ′ h. m. 1 18	° ′ h. m. 1 19	″ s.
0	0.4228	4164	4102	4040	3979	3919	3860	3802	3745	3688	3632	3576	0
1	4227	4163	4101	4039	3978	3919	3859	3801	3744	3687	3631	3576	1
2	4226	4162	4100	4038	3977	3918	3858	3800	3743	3686	3630	3575	2
3	4224	4161	4099	4037	3976	3917	3857	3799	3742	3685	3629	3574	3
4	4223	4160	4098	4036	3975	3916	3856	3798	3741	3684	3628	3573	4
5	0.4222	4159	4097	4035	3974	3915	3856	3797	3740	3683	3627	3572	5
6	4221	4158	4096	4034	3973	3914	3855	3796	3739	3682	3626	3571	6
7	4220	4157	4095	4033	3972	3913	3854	3795	3738	3681	3625	3570	7
8	4219	4156	4093	4032	3971	3912	3853	3794	3737	3680	3624	3569	8
9	4218	4155	4092	4031	3970	3911	3852	3793	3736	3679	3623	3568	9
10	0.4217	4154	4091	4030	3969	3910	3851	3792	3735	3678	3623	3567	10
11	4216	4153	4090	4029	3968	3909	3850	3792	3734	3677	3622	3566	11
12	4215	4152	4089	4028	3967	3908	3849	3791	3733	3677	3621	3565	12
13	4214	4151	4088	4027	3966	3907	3848	3790	3732	3676	3620	3565	13
14	4213	4150	4087	4026	3965	3906	3847	3789	3731	3675	3619	3564	14
15	0.4212	4149	4086	4025	3964	3905	3846	3788	3730	3674	3618	3563	15
16	4211	4147	4085	4024	3963	3904	3845	3787	3729	3673	3617	3562	16
17	4210	4146	4084	4023	3962	3903	3844	3786	3728	3672	3616	3561	17
18	4209	4145	4083	4022	3961	3902	3843	3785	3727	3671	3615	3560	18
19	4207	4144	4082	4021	3960	3901	3842	3784	3727	3670	3614	3559	19
20	0.4206	4143	4081	4020	3959	3900	3841	3783	3726	3669	3613	3558	20
21	4205	4142	4080	4019	3958	3899	3840	3782	3725	3668	3612	3557	21
22	4204	4141	4079	4018	3957	3898	3839	3781	3724	3667	3611	3556	22
23	4203	4140	4078	4017	3956	3897	3838	3780	3723	3666	3610	3555	23
24	4202	4139	4077	4016	3955	3896	3837	3779	3722	3665	3610	3555	24
25	0.4201	4138	4076	4015	3954	3895	3836	3778	3721	3664	3609	3554	25
26	4200	4137	4075	4014	3953	3894	3835	3777	3720	3663	3608	3553	26
27	4199	4136	4074	4013	3952	3893	3834	3776	3719	3663	3607	3552	27
28	4198	4135	4073	4012	3951	3892	3833	3775	3718	3662	3606	3551	28
29	4197	4134	4072	4011	3950	3891	3832	3774	3717	3661	3605	3550	29
30	0.4196	4133	4071	4010	3949	3890	3831	3773	3716	3660	3604	3549	30
31	4195	4132	4070	4009	3948	3889	3830	3772	3715	3659	3603	3548	31
32	4194	4131	4069	4008	3947	3888	3829	3771	3714	3658	3602	3547	32
33	4193	4130	4068	4007	3946	3887	3828	3770	3713	3657	3601	3546	33
34	4192	4129	4067	4006	3945	3886	3827	3769	3712	3656	3600	3545	34
35	0.4191	4128	4066	4005	3944	3885	3826	3768	3711	3655	3599	3545	35
36	4189	4127	4065	4004	3943	3884	3825	3768	3710	3654	3598	3544	36
37	4188	4126	4064	4003	3942	3883	3824	3767	3709	3653	3598	3543	37
38	4187	4125	4063	4002	3941	3882	3823	3766	3709	3652	3597	3542	38
39	4186	4124	4062	4001	3940	3881	3822	3765	3708	3651	3596	3541	39
40	0.4185	4122	4061	4000	3939	3880	3821	3764	3707	3650	3595	3540	40
41	4184	4121	4060	3999	3938	3879	3820	3763	3706	3649	3594	3539	41
42	4183	4120	4059	3998	3937	3878	3820	3762	3705	3649	3593	3538	42
43	4182	4119	4058	3997	3936	3877	3819	3761	3704	3648	3592	3537	43
44	4181	4118	4056	3996	3935	3876	3818	3760	3703	3647	3591	3536	44
45	0.4180	4117	4055	3995	3934	3875	3817	3759	3702	3646	3590	3535	45
46	4179	4116	4054	3993	3933	3874	3816	3758	3701	3645	3589	3535	46
47	4178	4115	4053	3992	3932	3873	3815	3757	3700	3644	3588	3534	47
48	4177	4114	4052	3991	3931	3872	3814	3756	3699	3643	3587	3533	48
49	4176	4113	4051	3990	3930	3871	3813	3755	3698	3642	3587	3532	49
50	0.4175	4112	4050	3989	3929	3870	3812	3754	3697	3641	3586	3531	50
51	4174	4111	4049	3988	3928	3869	3811	3753	3696	3640	3585	3530	51
52	4173	4110	4048	3987	3927	3868	3810	3752	3695	3639	3584	3529	52
53	4172	4109	4047	3986	3926	3867	3809	3751	3694	3638	3583	3528	53
54	4171	4108	4046	3985	3925	3866	3808	3750	3693	3637	3582	3527	54
55	0.4169	4107	4045	3984	3924	3865	3807	3749	3693	3636	3581	3526	55
56	4168	4106	4044	3983	3923	3864	3806	3748	3692	3635	3580	3525	56
57	4167	4105	4043	3982	3922	3863	3805	3747	3691	3635	3579	3525	57
58	4166	4104	4042	3981	3921	3862	3804	3746	3690	3634	3578	3524	58
59	4165	4103	4041	3980	3920	3861	3803	3746	3689	3633	3577	3523	59
	1 8	1 9	1 10	1 11	1 12	1 13	1 14	1 15	1 16	1 17	1 18	1 19	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 1 20	° ′ h. m. 1 21	° ′ h. m. 1 22	° ′ h. m. 1 23	° ′ h. m. 1 24	° ′ h. m. 1 25	° ′ h. m. 1 26	° ′ h. m. 1 27	° ′ h. m. 1 28	° ′ h. m. 1 29	° ′ h. m. 1 30	° ′ h. m. 1 31	″ s.
0	0.3522	3468	3415	3362	3310	3259	3208	3158	3108	3059	3010	2962	0
1	3521	3467	3414	3361	3309	3258	3207	3157	3107	3058	3009	2062	1
2	3520	3466	3413	3360	3308	3257	3206	3156	3106	3057	3009	2961	2
3	3519	3465	3412	3359	3307	3256	3205	3155	3105	3056	3008	2960	3
4	3518	3464	3411	3358	3306	3255	3204	3154	3105	3056	3007	2959	4
5	0.3517	3463	3410	3358	3306	3254	3204	3153	3104	3055	3006	2958	5
6	3516	3463	3409	3357	3305	3253	3203	3153	3103	3054	3005	2958	6
7	3515	3462	3408	3356	3304	3253	3202	3152	3102	3053	3005	2957	7
8	3514	3461	3408	3355	3303	3252	3201	3151	3101	3052	3004	2956	8
9	3514	3460	3407	3354	3302	3251	3200	3150	3101	3052	3003	2955	9
10	0.3513	3459	3406	3353	3301	3250	3199	3149	3100	3051	3002	2954	10
11	3512	3458	3405	3352	3300	3249	3198	3148	3099	3050	3001	2954	11
12	3511	3457	3404	3351	3300	3248	3198	3148	3098	3049	3001	2953	12
13	3510	3456	3403	3351	3299	3247	3197	3147	3097	3048	3000	2952	13
14	3509	3455	3402	3350	3298	3247	3196	3146	3096	3047	2999	2951	14
15	0.3508	3454	3401	3349	3297	3246	3195	3145	3096	3047	2998	2950	15
16	3507	3454	3400	3348	3296	3245	3194	3144	3095	3046	2997	2950	16
17	3506	3453	3400	3347	3295	3244	3193	3143	3094	3045	2997	2949	17
18	3506	3452	3399	3346	3294	3243	3193	3143	3093	3044	2996	2948	18
19	3505	3451	3398	3345	3294	3242	3192	3142	3092	3043	2995	2947	19
20	0.3504	3450	3397	3345	3293	3242	3191	3141	3091	3043	2994	2946	20
21	3503	3449	3396	3344	3292	3241	3190	3140	3091	3042	2993	2946	21
22	3502	3448	3395	3343	3291	3240	3189	3139	3090	3041	2993	2945	22
23	3501	3447	3394	3342	3290	3239	3188	3138	3089	3040	2992	2944	23
24	3500	3446	3393	3341	3289	3238	3188	3138	3088	3039	2991	2943	24
25	0.3499	3446	3393	3340	3288	3237	3187	3137	3087	3039	2990	2942	25
26	3498	3445	3392	3339	3288	3236	3186	3136	3087	3038	2989	2942	26
27	3497	3444	3391	3338	3287	3236	3185	3135	3086	3037	2989	2941	27
28	3497	3443	3390	3338	3286	3235	3184	3134	3085	3036	2988	2940	28
29	3496	3442	3389	3337	3285	3234	3183	3133	3084	3035	2987	2939	29
30	0.3495	3441	3388	3336	3284	3233	3183	3133	3083	3034	2986	2939	30
31	3494	3440	3387	3335	3283	3232	3182	3132	3082	3034	2985	2938	31
32	3493	3439	3386	3334	3282	3231	3181	3131	3082	3033	2985	2937	32
33	3492	3438	3386	3333	3282	3231	3180	3130	3081	3032	2984	2936	33
34	3491	3438	3385	3332	3281	3230	3179	3129	3080	3031	2983	2935	34
35	0.3490	3437	3384	3332	3280	3229	3178	3129	3079	3030	2982	2935	35
36	3489	3436	3383	3331	3279	3228	3178	3128	3078	3030	2981	2934	36
37	3488	3435	3382	3330	3278	3227	3177	3127	3078	3029	2981	2933	37
38	3488	3434	3381	3329	3277	3226	3176	3126	3077	3028	2980	2932	38
39	3487	3433	3380	3328	3276	3225	3175	3125	3076	3027	2979	2931	39
40	0.3486	3432	3379	3327	3276	3225	3174	3124	3075	3026	2978	2931	40
41	3485	3431	3379	3326	3275	3224	3173	3124	3074	3026	2977	2930	41
42	3484	3431	3378	3325	3274	3223	3173	3123	3073	3025	2977	2929	42
43	3483	3430	3377	3325	3273	3222	3172	3122	3073	3024	2976	2928	43
44	3482	3429	3376	3324	3272	3221	3171	3121	3072	3023	2975	2927	44
45	0.3481	3428	3375	3323	3271	3220	3170	3120	3071	3022	2974	2927	45
46	3480	3427	3374	3322	3270	3220	3169	3119	3070	3022	2973	2926	46
47	3480	3426	3373	3321	3270	3219	3168	3119	3069	3021	2973	2925	47
48	3479	3425	3372	3320	3269	3218	3168	3118	3069	3020	2972	2924	48
49	3478	3424	3372	3319	3268	3217	3167	3117	3068	3019	2971	2924	49
50	0.3477	3423	3371	3319	3267	3216	3166	3116	3067	3018	2970	2923	50
51	3476	3423	3370	3318	3266	3215	3165	3115	3066	3018	2969	2922	51
52	3475	3422	3369	3317	3265	3214	3164	3114	3065	3017	2969	2921	52
53	3474	3421	3368	3316	3265	3214	3163	3114	3065	3016	2968	2920	53
54	3473	3420	3367	3315	3264	3213	3163	3113	3064	3015	2967	2920	54
55	0.3472	3419	3366	3314	3263	3212	3162	3112	3063	3014	2966	2919	55
56	3471	3418	3365	3313	3262	3211	3161	3111	3062	3014	2965	2918	56
57	3471	3417	3365	3313	3261	3210	3160	3110	3061	3013	2965	2917	57
58	3470	3416	3364	3312	3260	3209	3159	3110	3060	3012	2964	2916	58
59	3469	3415	3363	3311	3259	3209	3158	3109	3060	3011	2963	2916	59
	1 20	1 21	1 22	1 23	1 24	1 25	1 26	1 27	1 28	1 29	1 30	1 31	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 1 32	° ′ h. m. 1 33	° ′ h. m. 1 34	° ′ h. m. 1 35	° ′ h. m. 1 36	° ′ h. m. 1 37	° ′ h. m. 1 38	° ′ h. m. 1 39	° ′ h. m. 1 40	° ′ h. m. 1 41	° ′ h. m. 1 42	° ′ h. m. 1 43	″ s.
0	0.2915	2868	2821	2775	2730	2685	2640	2596	2553	2510	2467	2424	0
1	2914	2867	2821	2775	2729	2684	2640	2596	2552	2509	2466	2424	1
2	2913	2866	2820	2774	2729	2684	2639	2595	2551	2508	2465	2423	2
3	2912	2866	2819	2773	2728	2683	2638	2594	2551	2507	2465	2422	3
4	2912	2865	2818	2772	2727	2682	2638	2593	2550	2507	2464	2422	4
5	0.2911	2864	2818	2772	2726	2681	2637	2593	2549	2506	2463	2421	5
6	2910	2863	2817	2771	2725	2681	2636	2592	2548	2505	2462	2420	6
7	2909	2862	2816	2770	2725	2680	2635	2591	2548	2504	2462	2419	7
8	2909	2862	2815	2769	2724	2679	2635	2591	2547	2504	2461	2419	8
9	2908	2861	2815	2769	2723	2678	2634	2590	2546	2503	2460	2418	9
10	0.2907	2860	2814	2768	2722	2678	2633	2589	2545	2502	2460	2417	10
11	2906	2859	2813	2767	2722	2677	2632	2588	2545	2502	2459	2417	11
12	2905	2859	2812	2766	2721	2676	2632	2588	2544	2501	2458	2416	12
13	2905	2858	2811	2766	2720	2675	2631	2587	2543	2500	2458	2415	13
14	2904	2857	2811	2765	2719	2675	2630	2586	2543	2499	2457	2415	14
15	0.2903	2856	2810	2764	2719	2674	2629	2585	2542	2499	2456	2414	15
16	2902	2855	2809	2763	2718	2673	2629	2585	2541	2498	2455	2413	16
17	2901	2855	2808	2763	2717	2672	2628	2584	2540	2497	2455	2412	17
18	2901	2854	2808	2762	2716	2672	2627	2583	2540	2497	2454	2412	18
19	2900	2853	2807	2761	2716	2671	2626	2583	2539	2496	2453	2411	19
20	0.2899	2852	2806	2760	2715	2670	2626	2582	2538	2495	2453	2410	20
21	2898	2852	2805	2760	2714	2669	2625	2581	2538	2494	2452	2410	21
22	2898	2851	2805	2759	2713	2669	2624	2580	2537	2494	2451	2409	22
23	2897	2850	2804	2758	2713	2668	2624	2580	2536	2493	2450	2408	23
24	2896	2849	2803	2757	2712	2667	2623	2579	2535	2492	2450	2408	24
25	0.2895	2848	2802	2756	2711	2666	2622	2578	2535	2492	2449	2407	25
26	2894	2848	2801	2756	2710	2666	2621	2577	2534	2491	2448	2406	26
27	2894	2847	2801	2755	2710	2665	2621	2577	2533	2490	2448	2405	27
28	2893	2846	2800	2754	2709	2664	2620	2576	2533	2489	2447	2405	28
29	2892	2845	2799	2753	2708	2663	2619	2575	2532	2489	2446	2404	29
30	0.2891	2845	2798	2753	2707	2663	2618	2574	2531	2488	2445	2403	30
31	2891	2844	2798	2752	2707	2662	2618	2574	2530	2487	2445	2403	31
32	2890	2843	2797	2751	2706	2661	2617	2573	2530	2487	2444	2402	32
33	2889	2842	2796	2750	2705	2660	2616	2572	2529	2486	2443	2401	33
34	2888	2842	2795	2750	2704	2660	2615	2572	2528	2485	2443	2401	34
35	0.2888	2841	2795	2749	2704	2659	2615	2571	2527	2485	2442	2400	35
36	2887	2840	2794	2748	2703	2658	2614	2570	2527	2484	2441	2399	36
37	2886	2839	2793	2747	2702	2657	2613	2569	2526	2483	2441	2398	37
38	2885	2838	2792	2747	2701	2657	2612	2569	2525	2482	2440	2398	38
39	2884	2838	2792	2746	2701	2656	2612	2568	2525	2482	2439	2397	39
40	0.2883	2837	2791	2745	2700	2655	2611	2567	2524	2481	2438	2396	40
41	2883	2836	2790	2744	2699	2655	2610	2566	2523	2480	2438	2396	41
42	2882	2835	2789	2744	2698	2654	2610	2566	2522	2480	2437	2395	42
43	2881	2835	2788	2743	2698	2653	2609	2565	2522	2479	2436	2394	43
44	2880	2834	2788	2742	2697	2652	2608	2564	2521	2478	2436	2394	44
45	0.2880	2833	2787	2741	2696	2652	2607	2564	2520	2477	2435	2393	45
46	2879	2832	2786	2741	2695	2651	2607	2563	2520	2477	2434	2392	46
47	2878	2831	2785	2740	2695	2650	2606	2562	2519	2476	2433	2391	47
48	2877	2831	2785	2739	2694	2649	2605	2561	2518	2475	2433	2391	48
49	2876	2830	2784	2738	2693	2649	2604	2561	2517	2475	2432	2390	49
50	0.2876	2829	2783	2738	2692	2648	2604	2560	2517	2474	2431	2389	50
51	2875	2828	2782	2737	2692	2647	2603	2559	2516	2473	2431	2389	51
52	2874	2828	2782	2736	2691	2646	2602	2559	2515	2472	2430	2388	52
53	2873	2827	2781	2735	2690	2646	2601	2558	2515	2472	2429	2387	53
54	2873	2826	2780	2735	2689	2645	2601	2557	2514	2471	2429	2387	54
55	0.2872	2825	2779	2734	2689	2644	2600	2556	2513	2470	2428	2386	55
56	2871	2825	2779	2733	2688	2643	2599	2556	2512	2470	2427	2385	56
57	2870	2824	2778	2732	2687	2643	2599	2555	2512	2469	2426	2384	57
58	2869	2823	2777	2732	2687	2642	2598	2554	2511	2468	2426	2384	58
59	2869	2822	2776	2731	2686	2641	2597	2553	2510	2467	2425	2383	59
	1 32	1 33	1 34	1 35	1 36	1 37	1 38	1 39	1 40	1 41	1 42	1 43	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

s.	h. m. 1 44	h. m. 1 45	h. m. 1 46	h. m. 1 47	h. m. 1 48	h. m. 1 49	h. m. 1 50	h. m. 1 51	h. m. 1 52	h. m. 1 53	h. m. 1 54	h. m. 1 55	s.
0	0.2382	2341	2300	2259	2218	2178	2139	2099	2061	2022	1984	1946	0
1	2382	2340	2299	2258	2218	2178	2138	2099	2060	2021	1983	1945	1
2	2381	2339	2298	2258	2217	2177	2137	2098	2059	2021	1982	1944	2
3	2380	2339	2298	2257	2216	2176	2137	2098	2059	2020	1982	1944	3
4	2380	2338	2297	2256	2216	2176	2136	2097	2058	2019	1981	1943	4
5	0.2379	2337	2296	2256	2215	2175	2136	2096	2057	2019	1981	1943	5
6	2378	2337	2296	2255	2214	2174	2135	2096	2057	2018	1980	1942	6
7	2378	2336	2295	2254	2214	2174	2134	2095	2056	2017	1979	1941	7
8	2377	2335	2294	2253	2213	2173	2134	2094	2055	2017	1979	1941	8
9	2376	2335	2294	2253	2212	2172	2133	2094	2055	2016	1978	1940	9
10	0.2375	2334	2293	2252	2212	2172	2132	2093	2054	2016	1977	1939	10
11	2375	2333	2292	2251	2211	2171	2132	2092	2053	2015	1977	1939	11
12	2374	2333	2291	2251	2210	2170	2131	2092	2053	2014	1966	1938	12
13	2373	2332	2291	2250	2210	2170	2130	2091	2052	2014	1975	1938	13
14	2373	2331	2290	2249	2209	2169	2130	2090	2052	2013	1975	1937	14
15	0.2372	2331	2289	2249	2208	2169	2129	2090	2051	2012	1974	1936	15
16	2371	2330	2289	2248	2208	2168	2128	2089	2050	2012	1974	1936	16
17	2371	2329	2288	2247	2207	2167	2128	2088	2050	2011	1973	1935	17
18	2370	2328	2287	2247	2206	2167	2127	2088	2049	2010	1972	1934	18
19	2369	2328	2287	2246	2206	2166	2126	2087	2048	2010	1972	1934	19
20	0.2368	2327	2286	2245	2205	2165	2126	2086	2048	2009	1971	1933	20
21	2368	2326	2285	2245	2204	2165	2125	2086	2047	2009	1970	1933	21
22	2367	2326	2285	2244	2204	2164	2124	2085	2046	2008	1970	1932	22
23	2366	2325	2284	2243	2203	2163	2124	2085	2046	2007	1969	1931	23
24	2366	2324	2283	2243	2202	2163	2123	2084	2045	2007	1968	1931	24
25	0.2365	2324	2283	2242	2202	2162	2122	2083	2044	2006	1968	1930	25
26	2364	2323	2282	2241	2201	2161	2122	2083	2044	2005	1967	1929	26
27	2364	2322	2281	2241	2200	2161	2121	2082	2043	2005	1967	1929	27
28	2363	2322	2281	2240	2200	2160	2120	2081	2042	2004	1966	1928	28
29	2362	2321	2280	2239	2199	2159	2140	2081	2042	2003	1965	1928	29
30	0.2362	2320	2279	2239	2198	2159	2119	2080	2041	2003	1965	1927	30
31	2361	2320	2279	2238	2198	2158	2118	2079	2041	2002	1964	1926	31
32	2360	2319	2278	2237	2197	2157	2118	2079	2040	2001	1963	1926	32
33	2359	2318	2277	2237	2196	2157	2117	2078	2039	2001	1963	1925	33
34	2359	2317	2277	2236	2196	2156	2116	2077	2039	2000	1962	1924	34
35	0.2358	2317	2276	2235	2195	2155	2116	2077	2038	2000	1962	1924	35
36	2357	2316	2275	2235	2194	2155	2115	2076	2037	1999	1961	1923	36
37	2357	2315	2274	2234	2194	2154	2115	2075	2037	1998	1960	1923	37
38	2356	2315	2274	2233	2193	2153	2114	2073	2036	1998	1960	1922	38
39	2355	2314	2273	2233	2192	2153	2113	2074	2035	1997	1959	1921	39
40	0.2355	2313	2272	2232	2192	2152	2113	2073	2035	1996	1958	1921	40
41	2354	2313	2272	2231	2191	2151	2112	2073	2034	1996	1958	1920	41
42	2353	2312	2271	2231	2190	2151	2111	2074	2033	1995	1957	1919	42
43	2353	2311	2270	2230	2190	2150	2111	2072	2033	1994	1956	1919	43
44	2352	2311	2270	2229	2189	2149	2110	2071	2032	1994	1956	1918	44
45	0.2351	2310	2269	2229	2188	2149	2109	2070	2032	1993	1955	1918	45
46	2350	2309	2268	2228	2188	2148	2109	2070	2031	1993	1955	1917	46
47	2350	2309	2268	2227	2187	2147	2108	2069	2030	1992	1954	1916	47
48	2349	2308	2267	2227	2186	2147	2107	2068	2030	1991	1953	1916	48
49	2348	2307	2266	2226	2186	2146	2107	2068	2029	1991	1953	1915	49
50	0.2348	2307	2266	2225	2185	2145	2106	2067	2028	1990	1952	1914	50
51	2347	2306	2265	2225	2184	2145	2105	2066	2028	1989	1951	1914	51
52	2346	6305	2264	2224	2184	2144	2105	2066	2027	1989	1951	1913	52
53	2346	2304	2264	2223	2183	2143	2104	2065	2026	1988	1950	1913	53
54	2345	2304	2263	2223	2182	2143	2103	2064	2026	1987	1950	1912	54
55	0.2344	2303	2262	2222	2182	2142	2103	2064	2025	1987	1949	1911	55
56	2344	2302	2262	2221	2181	2141	2102	2063	2025	1986	1948	1911	56
57	2343	2302	2261	2220	2180	2141	2101	2062	2024	1986	1948	1910	57
58	2342	2301	2260	2220	2180	2140	2101	2062	2023	1985	1947	1909	58
59	2342	2300	2260	2219	2179	2139	2100	2061	2023	1984	1946	1909	59
	1 44	1 45	1 46	1 47	1 48	1 49	1 50	1 51	1 52	1 53	1 54	1 55	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 1 56	° ′ h. m. 1 57	° ′ h. m. 1 58	° ′ h. m. 1 59	° ′ h. m. 2 0	° ′ h. m. 2 1	° ′ h. m. 2 2	° ′ h. m. 2 3	° ′ h. m. 2 4	° ′ h. m. 2 5	° ′ h. m. 2 6	° ′ h. m. 2 7	″ s.
0	0.1908	1871	1834	1797	1761	1725	1689	1654	1619	1584	1549	1515	0
1	1908	1870	1833	1797	1760	1724	1689	1653	1618	1583	1548	1514	1
2	1907	1870	1833	1796	1760	1724	1688	1652	1617	1582	1548	1514	2
3	1906	1869	1832	1795	1759	1723	1687	1652	1617	1582	1547	1513	3
4	1906	1868	1831	1795	1759	1722	1687	1651	1616	1581	1547	1512	4
5	0.1905	1868	1831	1794	1758	1722	1686	1651	1616	1581	1546	1512	5
6	1904	1867	1830	1794	1757	1721	1686	1650	1615	1580	1546	1511	6
7	1904	1867	1830	1793	1757	1721	1685	1650	1614	1580	1545	1511	7
8	1903	1866	1829	1792	1756	1720	1684	1649	1614	1579	1544	1510	8
9	1903	1865	1828	1792	1755	1719	1684	1648	1613	1578	1544	1510	9
10	0.1902	1865	1828	1791	1755	1719	1683	1648	1613	1578	1543	1509	10
11	1901	1864	1827	1791	1754	1718	1683	1647	1612	1577	1543	1508	11
12	1901	1863	1827	1790	1754	1718	1682	1647	1612	1577	1542	1508	12
13	1900	1863	1826	1789	1753	1717	1681	1646	1611	1576	1542	1507	13
14	1899	1862	1825	1789	1752	1717	1681	1645	1610	1576	1541	1507	14
15	0.1899	1862	1825	1788	1752	1716	1680	1645	1610	1575	1540	1506	15
16	1898	1861	1824	1788	1751	1715	1680	1644	1609	1574	1540	1506	16
17	1898	1860	1823	1787	1751	1715	1679	1644	1609	1574	1539	1505	17
18	1897	1860	1823	1786	1750	1714	1678	1643	1608	1573	1539	1504	18
19	1896	1859	1822	1786	1749	1714	1678	1643	1607	1573	1538	1504	19
20	0.1896	1859	1822	1785	1749	1713	1677	1642	1607	1572	1538	1503	20
21	1895	1858	1821	1785	1748	1712	1677	1641	1606	1571	1537	1503	21
22	1894	1857	1820	1784	1748	1712	1676	1641	1606	1571	1536	1502	22
23	1894	1857	1820	1783	1747	1711	1676	1640	1605	1570	1536	1502	23
24	1893	1856	1819	1783	1746	1711	1675	1640	1605	1570	1535	1501	24
25	0.1893	1855	1819	1782	1746	1710	1675	1639	1604	1569	1535	1500	25
26	1892	1855	1818	1781	1745	1709	1674	1638	1603	1569	1534	1500	26
27	1891	1854	1818	1781	1745	1709	1673	1638	1603	1568	1534	1499	27
28	1891	1854	1817	1780	1744	1708	1673	1637	1602	1567	1533	1499	28
29	1890	1853	1816	1780	1743	1708	1672	1637	1602	1567	1532	1498	29
30	0.1889	1852	1816	1779	1743	1707	1671	1636	1601	1566	1532	1498	30
31	1889	1852	1815	1778	1742	1706	1671	1635	1600	1566	1531	1497	31
32	1888	1851	1814	1778	1742	1706	1670	1635	1600	1565	1531	1496	32
33	1888	1850	1814	1777	1741	1705	1670	1634	1599	1565	1530	1496	33
34	1887	1850	1813	1777	1740	1705	1669	1634	1599	1564	1530	1495	34
35	0.1886	1849	1812	1776	1740	1704	1668	1633	1598	1563	1529	1495	35
36	1886	1849	1812	1775	1739	1703	1668	1633	1598	1563	1528	1494	36
37	1885	1848	1811	1775	1739	1703	1667	1632	1597	1562	1528	1494	37
38	1884	1847	1811	1774	1738	1702	1667	1631	1596	1562	1527	1493	38
39	1884	1847	1810	1774	1737	1702	1666	1631	1596	1561	1527	1493	39
40	0.1883	1846	1809	1773	1737	1701	1665	1630	1595	1561	1526	1492	40
41	1883	1846	1809	1772	1736	1700	1665	1630	1595	1560	1526	1491	41
42	1882	1845	1808	1772	1736	1700	1664	1629	1594	1559	1525	1491	42
43	1881	1844	1808	1771	1735	1699	1664	1628	1593	1559	1524	1490	43
44	1881	1844	1807	1771	1734	1699	1663	1628	1593	1558	1524	1490	44
45	0.1880	1843	1806	1770	1734	1698	1663	1627	1592	1558	1523	1489	45
46	1880	1843	1806	1769	1733	1697	1662	1627	1592	1557	1523	1489	46
47	1879	1842	1805	1769	1733	1697	1661	1626	1591	1556	1522	1488	47
48	1878	1841	1805	1768	1732	1696	1661	1626	1591	1556	1522	1487	48
49	1878	1841	1804	1768	1731	1696	1660	1625	1590	1555	1521	1487	49
50	0.1877	1840	1803	1767	1731	1695	1660	1624	1589	1555	1520	1486	50
51	1876	1839	1803	1766	1730	1694	1659	1624	1589	1554	1520	1486	51
52	1876	1839	1802	1766	1730	1694	1658	1623	1588	1554	1519	1485	52
53	1875	1838	1802	1765	1729	1693	1658	1623	1588	1553	1519	1485	53
54	1875	1838	1801	1765	1728	1693	1657	1622	1587	1552	1518	1484	54
55	0.1874	1837	1800	1764	1728	1692	1657	1621	1587	1552	1518	1483	55
56	1873	1836	1800	1763	1727	1692	1656	1621	1586	1551	1517	1483	56
57	1873	1836	1799	1763	1727	1691	1655	1620	1585	1551	1516	1482	57
58	1872	1835	1798	1762	1726	1690	1655	1620	1585	1550	1516	1482	58
59	1871	1835	1798	1762	1725	1690	1654	1619	1584	1550	1515	1481	59
	1 56	1 57	1 58	1 59	2 0	2 1	2 2	2 3	2 4	2 5	2 6	2 7	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s	° ′ h. m. 2 8	° ′ h. m. 2 9	° ′ h. m. 2 10	° ′ h. m. 2 11	° ′ h. m. 2 12	° ′ h. m. 2 13	° ′ h. m. 2 14	° ′ h. m. 2 15	° ′ h. m. 2 16	° ′ h. m. 2 17	° ′ h. m. 2 18	° ′ h. m. 2 19	° ′ h. m. 2 20	″ s.
0	0.1481	1447	1413	1380	1347	1314	1282	1249	1217	1186	1154	1123	1091	0
1	1480	1446	1413	1379	1346	1314	1281	1249	1217	1185	1153	1122	1091	1
2	1479	1446	1412	1379	1346	1313	1281	1248	1216	1184	1153	1122	1090	2
3	1479	1445	1412	1378	1345	1313	1280	1248	1216	1184	1152	1121	1090	3
4	1478	1445	1411	1378	1345	1312	1280	.1247	1215	1183	1152	1120	1089	4
5	0.1478	1444	1411	1377	1344	1311	1279	1247	1215	1183	1151	1120	1089	5
6	1477	1443	1410	1377	1344	1311	1278	1246	1214	1182	1151	1119	1088	6
7	1477	1443	1409	1376	1343	1310	1278	1246	1214	1182	1150	1119	1088	7
8	1476	1442	1409	1376	1343	1310	1277	1245	1213	1181	1150	.1118	1087	8
9	1476	1442	1408	1375	1342	1309	1277	1245	1213	1181	1149	1118	1087	9
10	0.1475	1441	1408	1374	1342	1309	1276	1244	1212	1180	1149	1117	1086	10
11	1474	1441	1407	1374	1341	1308	1276	1243	1211	1180	1148	1117	1086	11
12	1474	1440	1407	1373	1340	1308	1275	1243	1211	1179	1148	1116	1085	12
13	1473	1440	1406	1373	1340	1307	1275	1242	1210	1179	1147	1116	1085	13
14	1473	1439	1406	1372	1339	1307	1274	1242	1210	1178	1147	1115	1084	14
15	0.1472	1438	1405	1372	1339	1306	1274	1241	1209	1178	1146	1115	1084	15
16	1472	1438	1404	1371	1338	1306	1273	1241	1209	1177	1146	1114	1083	16
17	1471	1437	1404	1371	1338	1305	1273	1240	1208	1177	1145	1114	1083	17
18	1470	1437	1403	1370	1337	1304	1272	1240	1208	1176	1145	1113	1082	18
19	1470	1436	1403	1370	1337	1304	1271	1239	1207	1175	1144	1113	1082	19
20	0.1469	1436	1402	1369	1336	1303	1271	1239	1207	1175	1143	1112	1081	20
21	1469	1435	1402	1368	1335	1303	1270	1238	1206	1174	1143	1112	1081	21
22	1468	1435	1401	1368	1335	1302	1270	1238	1206	1174	1142	1111	1080	22
23	1468	1434	1401	1367	1334	1302	1269	1237	1205	1173	1142	1111	1080	23
24	1467	1433	1400	1367	1334	1301	1269	1237	1205	1173	1141	1110	1079	24
25	0.1467	1433	1399	1366	1333	1301	1268	1236	1204	1172	1141	1110	1079	25
26	1466	1432	1399	1366	1333	1300	1268	1235	1204	1172	1140	1109	1078	26
27	1465	1432	1398	1365	1332	1300	1267	1235	1203	1171	1140	1109	1078	27
28	1465	1431	1398	1365	1332	1299	1267	1234	1202	1171	1139	1108	1077	28
29	1464	1431	1397	1364	1331	1298	1266	1234	1202	1170	1139	1108	1076	29
30	0.1464	1430	1397	1363	1331	1298	1266	1233	1201	1170	1138	1107	1076	30
31	1463	1429	1396	1363	1330	1297	1265	1233	1201	1169	1138	1106	1075	31
32	1463	1429	1396	1362	1329	1297	1264	1232	1200	1169	1137	1106	1075	32
33	1462	1428	1395	1362	1329	1296	1264	1232	1200	1168	1137	1105	1074	33
34	1461	1428	1394	1361	1328	1296	1263	1231	1199	1168	1136	1105	1074	34
35	0.1461	1427	1394	1361	1328	1295	1263	1231	1199	1167	1136	1104	1073	35
36	1460	1427	1393	1360	1327	1295	1262	1230	1198	1167	1135	1104	1073	36
37	1460	1426	1393	1360	1327	1294	1262	1230	1198	1166	1135	1103	1072	37
38	1459	1426	1392	1359	1326	1294	1261	1229	1197	1165	1134	1103	1072	38
39	1459	1425	1392	1359	1326	1293	1261	1229	1197	1165	1134	1102	1071	39
40	0.1458	1424	1391	1358	1325	1292	1260	1228	1196	1164	1133	1102	1071	40
41	1458	1424	1391	1357	1325	1292	1260	1227	1196	1164	1132	1101	1070	41
42	1457	1423	1390	1357	1324	1291	1259	1227	1195	1163	1132	1101	1070	42
43	1456	1423	1389	1356	1323	1291	1259	1226	1195	1163	1131	1100	1069	43
44	1456	1422	1389	1356	1323	1290	1258	1226	1194	1162	1131	1100	1069	44
45	0.1455	1422	1388	1355	1322	1290	1257	1225	1193	1162	1130	1099	1068	45
46	1455	1421	1388	1355	1322	1289	1257	1225	1193	1161	1130	1099	1068	46
47	1454	1421	1387	1354	1321	1289	1256	1224	1192	1161	1129	1098	1067	47
48	1454	1420	1387	1354	1321	1288	1256	1124	1192	1160	1129	1098	1067	48
49	1453	1419	1386	1353	1320	1288	1255	1223	1191	1160	1128	1097	1066	49
50	0.1452	1419	1386	1352	1320	1287	1255	1223	1191	1159	1128	1097	1066	50
51	1452	1418	1385	1352	1319	1287	1254	1222	1190	1159	1127	1096	1065	51
52	1451	1418	1384	1351	1319	1286	1254	1222	1190	1158	1127	1096	1065	52
53	1451	1417	1384	1351	1318	1285	1253	1221	1189	1158	1126	1095	1064	53
54	1450	1417	1383	1350	1317	1285	1253	1221	1189	1157	1126	1095	1064	54
55	0.1450	1416	1383	1350	1317	1284	1252	1220	1188	1157	1125	1094	1063	55
56	1449	1416	1382	1349	1316	1284	1252	1219	1188	1156	1125	1094	1063	56
57	1449	1415	1382	1349	1316	1283	1251	1219	1187	1156	1124	1093	1062	57
58	1448	1414	1381	1348	1315	1283	1250	1218	1187	1155	1124	1092	1062	58
59	1447	1414	1381	1348	1315	1282	1250	1218	1186	1154	1123	1092	1061	59
	2 8	2 9	2 10	2 11	2 12	2 13	2 14	2 15	2 16	2 17	2 18	2 19	2 20	

TABLE XXXIV

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 2 21	° ′ h. m. 2 22	° ′ h. m. 2 23	° ′ h. m. 2 24	° ′ h. m. 2 25	° ′ h. m. 2 26	° ′ h. m. 2 27	° ′ h. m. 2 28	° ′ h. m. 2 29	° ′ h. m. 2 30	° ′ h. m. 2 31	° ′ h. m. 2 32	° ′ h. m. 2 33	″ s.
0	0.1061	1030	0999	0969	0939	0909	0880	0850	0821	0792	0763	0734	0706	0
1	1060	1029	0999	0969	0939	0909	0879	0850	0820	0791	0762	0734	0705	1
2	1060	1029	0998	0968	0938	0908	0879	0849	0820	0791	0762	0733	0705	2
3	1059	1028	0998	0968	0938	0908	0878	0849	0819	0790	0762	0733	0704	3
4	1058	1028	0997	0967	0937	0907	0878	0848	0819	0790	0761	0732	0704	4
5	0.1058	1027	0997	0967	0937	0907	0877	0848	0818	0789	0761	0732	0703	5
6	1057	1027	0996	0966	0936	0906	0877	0847	0818	0789	0760	0731	0703	6
7	1057	1026	0996	0966	0936	0906	0876	0847	0817	0788	0760	0731	0703	7
8	1056	1026	0995	0965	0935	0905	0876	0846	0817	0788	0759	0730	0702	8
9	1056	1025	0995	0965	0935	0905	0875	0846	0816	0787	0759	0730	0702	9
10	0.1055	1025	0994	0964	0934	0904	0875	0845	0816	0787	0758	0730	0701	10
11	1055	1024	0994	0964	0934	0904	0874	0845	0816	0787	0758	0729	0701	11
12	1054	1024	0993	0963	0933	0903	0874	0844	0815	0786	0757	0729	0700	12
13	1054	1023	0993	0963	0933	0903	0873	0844	0815	0786	0757	0728	0700	13
14	1053	1023	0992	0962	0932	0902	0873	0843	0814	0785	0756	0728	0699	14
15	0.1053	1022	0992	0962	0932	0902	0872	0843	0814	0785	0756	0727	0699	15
16	1052	1022	0991	0961	0931	0901	0872	0842	0813	0784	0755	0727	0698	16
17	1052	1021	0991	0961	0931	0901	0871	0842	0813	0784	0755	0726	0698	17
18	1051	1021	0990	0960	0930	0900	1871	0841	0812	0783	0754	0726	0697	18
19	1051	1020	0990	0960	0930	0900	0870	0841	0812	0783	0754	0725	0697	19
20	0.1050	1020	0989	0959	0929	0899	0870	0840	0811	0782	0753	0725	0696	20
21	1050	1019	0989	0959	0929	0899	0869	0840	0811	0782	0753	0724	0696	21
22	1049	1019	0988	0958	0928	0898	0869	0839	0810	0781	0752	0724	0695	22
23	1049	1018	0988	0958	0928	0898	0868	0839	0810	0781	0752	0723	0695	23
24	1048	1018	0987	0957	0927	0897	0868	0838	0809	0780	0751	0723	0694	24
25	0.1048	1017	0987	0957	0927	0897	0867	0838	0809	0780	0751	0722	0694	25
26	1047	1017	0986	0956	0926	0896	0867	0837	0808	0779	0751	0722	0694	26
27	1047	1016	0986	0956	0926	0896	0866	0837	0808	0779	0750	0721	0693	27
28	1046	1016	0985	0955	0925	0895	0866	0836	0807	0778	0750	0721	0693	28
29	1046	1015	0985	0955	0925	0895	0865	0836	0807	0778	0749	0721	0692	29
30	0.1045	1015	0984	0954	0924	0894	0865	0835	0806	0777	0749	0720	0692	30
31	1045	1014	0984	0954	0924	0894	0864	0835	0806	0777	0748	0720	0691	31
32	1044	1014	0983	0953	0923	0893	0864	0834	0805	0776	0748	0719	0691	32
33	1044	1013	0983	0953	0923	0893	0863	0834	0805	0776	0747	0719	0690	33
34	1043	1013	0982	0952	0922	0892	0863	0834	0804	0775	0747	0718	0690	34
35	0.1043	1012	0982	0952	0922	0892	0862	0833	0804	0775	0746	0718	0689	35
36	1042	1012	0981	0951	0921	0891	0862	0833	0803	0774	0746	0717	0689	36
37	1042	1011	0981	0951	0921	0891	0861	0832	0803	0774	0745	0717	0688	37
38	1041	1011	0980	0950	0920	0890	0861	0832	0802	0774	0745	0716	0688	38
39	1041	1010	0980	0950	0920	0890	0860	0831	0802	0773	0744	0716	0687	39
40	0.1040	1009	0979	0949	0919	0889	0860	0831	0801	0773	0744	0715	0687	40
41	1040	1009	0979	0949	0919	0889	0859	0830	0801	0772	0743	0715	0686	41
42	1039	1008	0978	0948	0918	0888	0859	0830	0801	0772	0743	0714	0686	42
43	1039	1008	0978	0948	0918	0888	0858	0829	0800	0771	0742	0714	0686	43
44	1038	1007	0977	0947	0917	0887	0858	0829	0800	0771	0742	0713	0685	44
45	0.1037	1007	0977	0947	0917	0887	0857	0828	0799	0770	0741	0713	0685	45
46	1037	1006	0976	0946	0916	0886	0857	0828	0799	0770	0741	0712	0684	46
47	1036	1006	0976	0946	0916	0886	0856	0827	0798	0769	0740	0712	0684	47
48	1036	1005	0975	0945	0915	0885	0856	0827	0798	0769	0740	0711	0683	48
49	1035	1005	0975	0945	0915	0885	0855	0826	0797	0768	0740	0711	0683	49
50	0.1035	1004	0974	0944	0914	0884	0855	0826	0797	0768	0739	0711	0682	50
51	1034	1004	0974	0944	0914	0884	0855	0825	0796	0767	0739	0710	0682	51
52	1034	1003	0973	0943	0913	0883	0854	0825	0796	0767	0738	0710	0681	52
53	1033	1003	0973	0943	0913	0883	0854	0824	0795	0766	0738	0709	0681	53
54	1033	1002	0972	0942	0912	0883	0853	0824	0795	0766	0737	0709	0680	54
55	0.1032	1002	0972	0942	0912	0882	0853	0823	0794	0765	0737	0708	0680	55
56	1032	1001	0971	0941	0911	0882	0852	0823	0794	0765	0736	0708	0679	56
57	1031	1001	0971	0941	0911	0881	0852	0822	0793	0764	0736	0707	0679	57
58	1031	1000	0970	0940	0910	0881	0851	0822	0793	0764	0735	0707	0678	58
59	1030	1000	0970	0940	0910	0880	0851	0821	0792	0763	0735	0706	0678	59
	2 21	2 22	2 23	2 24	2 25	2 26	2 27	2 28	2 29	2 30	2 31	2 32	2 33	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 2 34	° ′ h. m. 2 35	° ′ h. m. 2 36	° ′ h. m. 2 37	° ′ h. m. 2 38	° ′ h. m. 2 39	° ′ h. m. 2 40	° ′ h. m. 2 41	° ′ h. m. 2 42	° ′ h. m. 2 43	° ′ h. m. 2 44	° ′ h. m. 2 45	° ′ h. m. 2 46	″ s.
0	0.0678	0649	0621	0594	0566	0539	0512	0484	0458	0431	0404	0378	0352	0
1	0677	0649	0621	0593	0566	0538	0511	0484	0457	0430	0404	0377	0351	1
2	0677	0648	0621	0593	0565	0538	0511	0484	0457	0430	0403	0377	0351	2
3	0676	0648	0620	0592	0565	0537	0510	0483	0456	0430	0403	0377	0350	3
4	0676	0648	0620	0592	0564	0537	0510	0483	0456	0429	0403	0376	0350	4
5	0.0675	0647	0619	0591	0564	0536	0509	0482	0455	0429	0402	0376	0349	5
6	0675	0647	0619	0591	0563	0536	0509	0482	0455	0428	0402	0375	0349	6
7	0674	0646	0618	0591	0563	0536	0508	0481	0454	0428	0401	0375	0349	7
8	0674	0646	0618	0590	0562	0535	0508	0481	0454	0427	0401	0374	0348	8
9	0673	0645	0617	0590	0562	0535	0507	0480	0454	0427	0400	0374	0348	9
10	0.0673	0645	0617	0589	0562	0534	0507	0480	0453	0426	0400	0374	0347	10
11	0672	0644	0616	0589	0561	0534	0507	0480	0453	0426	0399	0373	0347	11
12	0672	0644	0616	0588	0561	0533	0506	0479	0452	0426	0399	0373	0346	12
13	0671	0643	0615	0588	0560	0533	0506	0479	0452	0425	0399	0372	0346	13
14	0671	0643	0615	0587	0560	0532	0505	0478	0351	0425	0398	0372	0346	14
15	0.0670	0642	0615	0587	0559	0532	0505	0478	0451	0424	0398	0371	0345	15
16	0670	0642	0614	0586	0559	0531	0504	0477	0450	0424	0397	0371	0345	16
17	0670	0641	0614	0586	0558	0531	0504	0477	0450	0423	0397	0370	0344	17
18	0669	0641	0613	0585	0558	0531	0503	0476	0450	0423	0396	0370	0344	18
19	0669	0641	0613	0585	0557	0530	0503	0476	0449	0422	0396	0370	0343	19
20	0.0668	0640	0612	0585	0557	0530	0502	0475	0449	0422	0395	0369	0343	20
21	0668	0640	0612	0584	0557	0529	0502	0475	0488	0422	0395	0369	0342	21
22	0667	0639	9611	0584	0556	0529	0502	0475	0448	0421	0395	0368	0342	22
23	0667	0639	0611	0583	0556	0528	0501	0474	0447	0421	0394	0368	0342	23
24	0666	0638	0610	0583	0555	0528	0501	0474	0447	0420	0394	0367	0341	24
25	0.0666	0638	0610	0582	0555	0527	0500	0473	0446	0420	0393	0367	0341	25
26	0665	0637	0609	0582	0554	0527	0500	0473	0246	0419	0393	0366	0340	26
27	0665	0637	0609	0581	0554	0526	0499	0472	0446	0419	0392	0366	0340	27
28	0664	0636	0609	0581	0553	0526	0499	0472	0445	0418	0392	0366	0339	28
29	0664	0636	0608	0580	0553	0526	0498	0471	0445	0418	0392	0365	0339	29
30	0.0663	0635	0608	0580	0552	0525	0498	0471	0444	0418	0391	0365	0339	30
31	0663	0635	0607	0579	0552	0525	0498	0471	0444	0417	0391	0364	0338	31
32	0663	0634	0607	0579	0552	0524	0497	0470	0443	0417	0390	0364	0338	32
33	0662	0634	0606	0579	0551	0524	0497	0470	0443	0416	0390	0363	0337	33
34	0662	0634	0606	0578	0551	0523	0496	0469	0442	0416	0389	0363	0337	34
35	0.0661	0633	0605	0578	0550	0523	0496	0469	0442	0415	0389	0363	0336	35
36	0661	0633	0605	0577	0550	0522	0495	0468	0442	0415	0388	0362	0336	36
37	0660	0632	0604	0577	0549	0522	0495	0468	0441	0414	0388	0362	0336	37
38	0660	0632	0604	0576	0549	0521	0494	0467	0441	0414	0388	0361	0335	38
39	0659	0631	0603	0576	0548	0521	0494	0467	0440	0414	0387	0361	0335	39
40	0.0659	0631	0603	0575	0548	0521	0493	0466	0440	0413	0387	0360	0334	40
41	0658	0630	0602	0575	0547	0520	0493	0466	0439	0413	0386	0360	0334	41
42	0658	0630	0602	0574	0547	0520	0493	0466	0439	0412	0386	0359	0333	42
43	0657	0629	0602	0574	0546	0519	0492	0465	0438	0412	0385	0359	0333	43
44	0657	0629	0601	0573	0546	0519	0492	0465	0438	0411	0385	0359	0333	44
45	0.0656	0628	0601	0573	0546	0518	0491	0464	0438	0411	0384	0358	0332	45
46	0656	0628	0600	0573	0545	0518	0491	0464	0437	0410	0384	0358	0332	46
47	0655	0628	0600	0572	0545	0517	0490	0463	0437	0410	0384	0357	0331	47
48	0655	0627	0599	0572	0544	0517	0490	0463	0436	0410	0383	0357	0331	48
49	0655	0627	0599	0571	0544	0517	0489	0462	0436	0409	0383	0356	0330	49
50	0.0654	0626	0598	0571	0543	0516	0489	0462	0435	0409	0382	0356	0330	50
51	0654	0626	0598	0570	0543	0516	0489	0462	0435	0408	0382	0356	0329	51
52	0653	0625	0597	0570	0542	0515	0488	0461	0434	0408	0381	0355	0329	52
53	0653	0625	0597	0569	0542	0515	0488	0461	0434	0407	0381	0355	0329	53
54	0652	0624	0596	0569	0541	0514	0387	0460	0434	0407	0381	0354	0328	54
55	0 0652	0624	0596	0568	0541	0514	0487	0460	0433	0406	0380	0354	0328	55
56	0651	0623	0596	0568	0541	0513	0486	0459	0433	0406	0380	0353	0327	56
57	0651	0623	0595	0568	0540	0513	0486	0459	0432	0406	0379	0353	0327	57
58	0650	0622	0595	0567	0540	0512	0485	0458	0432	0405	0379	0353	0326	58
59	0650	0622	0594	0567	0539	0512	0485	0458	0431	0405	0378	0352	0326	59
	2 34	2 35	2 36	2 37	2 38	2 39	2 40	2 41	2 42	2 43	2 44	2 45	2 46	

TABLE XXXIV.

PROPORTIONAL LOGARITHMS.

″ s.	° ′ h. m. 2 47	° ′ h. m. 2 48	° ′ h. m. 2 49	° ′ h. m. 2 50	° ′ h. m. 2 51	° ′ h. m. 2 52	° ′ h. m. 2 53	° ′ h. m. 2 54	° ′ h. m. 2 55	° ′ h. m. 2 56	° ′ h. m. 2 57	° ′ h. m. 2 58	° ′ h. m. 2 59	″ s.
0	0.0326	0300	0274	0248	0223	0197	0172	0147	0122	0098	0073	0049	0024	0
1	0325	0299	0273	0248	0222	0197	0172	0147	0122	0097	0073	0048	0024	1
2	0325	0299	0273	0247	0222	0197	0171	0146	0122	0097	0072	0048	0023	2
3	0324	0298	0273	0247	0221	0196	0171	0146	0121	0096	0072	0047	0023	3
4	0324	0298	0272	0247	0221	0196	0171	0146	0121	0096	0071	0047	0023	4
5	0.0323	0297	0272	0246	0221	0195	0170	0145	0120	0096	0071	0046	0022	5
6	0323	0297	0271	0246	0220	0195	0170	0145	0120	0095	0071	0046	0022	6
7	0323	0297	0271	0245	0220	0194	0169	0144	0119	0095	0070	0046	0021	7
8	0322	0296	0270	0245	0219	0194	0169	0144	0119	0094	0070	0045	0021	8
9	0322	0296	0270	0244	0219	0194	0169	0143	0119	0094	0069	0045	0021	9
10	0.0321	0295	0270	0244	0219	0193	0168	0143	0118	0093	0069	0044	0020	10
11	0321	0295	0269	0244	0218	0193	0168	0143	0118	0093	0068	0044	0020	11
12	0320	0294	0269	0243	0218	0192	0167	0142	0117	0093	0068	0044	0019	12
13	0320	0294	0268	0243	0217	0192	0167	0142	0117	0092	0068	0043	0019	13
14	0319	0294	0268	0242	0217	0192	0166	0141	0117	0092	0067	0043	0019	14
15	0.0319	0293	0267	0242	0216	0191	0166	0141	0116	0091	0067	0042	0018	15
16	0319	0293	0267	0241	0216	0191	0166	0141	0116	0091	0066	0042	0018	16
17	0318	0292	0267	0241	0316	0190	0165	0140	0115	0091	0066	0042	0017	17
18	0318	0292	0266	0241	0215	0190	0165	0140	0115	0090	0066	0041	0017	18
19	0317	0291	0266	0240	0215	0189	0164	0139	0114	0090	0065	0041	0017	19
20	0.0317	0291	0265	0240	0214	0189	0164	0139	0114	0089	0065	0040	0016	20
21	0316	0291	0265	0239	0214	0189	0163	0139	0114	0089	0064	0040	0016	21
22	0316	0290	0264	0239	0213	0188	0163	0138	0113	0089	0064	0040	0015	22
23	0316	0290	0264	0238	0213	0188	0163	0138	0113	0088	0064	0039	0015	23
24	0315	0289	0264	0238	2013	0187	0162	0137	0112	0088	0063	0039	0015	24
25	0.0315	0289	0263	0238	0212	0187	0162	0137	0112	0087	0063	0038	0014	25
26	0314	0288	0263	0237	0212	0187	0161	0136	0112	0087	0062	0038	0014	26
27	0314	0288	0262	0237	0211	0186	0161	0136	0111	0087	0062	0038	0013	27
28	0313	0288	0262	0236	0211	0186	0161	0136	0111	0086	0062	0037	0013	28
29	0313	0287	0261	0236	0211	0185	0160	0135	0110	0086	0061	0037	0012	29
30	0.0313	0287	0261	0235	0210	0185	0160	0135	0110	0085	0061	0036	0012	30
31	0312	0286	0261	0235	0210	0184	0159	0134	0110	0085	0060	0036	0012	31
32	0312	0286	0260	0235	0209	0184	0159	0134	0109	0084	0060	0036	0011	32
33	0311	0285	0260	0234	0209	0184	0158	0134	0109	0084	0060	0035	0011	33
34	0311	0285	0259	0234	0208	0183	0158	0133	0108	0084	0059	0035	0010	34
35	0.0310	0285	0259	0233	0208	0183	0158	0133	0108	0083	0059	0034	0010	35
36	0310	0284	0258	0233	0208	0182	0157	0132	0107	0083	0058	0034	0010	36
37	0310	0284	0258	0233	0207	0182	0157	0132	0107	0082	0058	0034	0009	37
38	0309	0283	0258	0232	0207	0181	0156	0131	0107	0082	0057	0033	0009	38
39	0309	0283	0257	0232	0206	0181	0156	0131	0106	0082	0057	0033	0008	39
40	0.0308	0282	0257	0231	0206	0181	0156	0131	0106	0081	0057	0032	0008	40
41	0308	0282	0256	0231	0205	0180	0155	0130	0105	0081	0056	0032	0008	41
42	0307	0282	0256	0230	0205	0180	0155	0130	0105	0080	0056	0031	0007	42
43	0307	0281	0255	0230	0205	0179	0154	0129	0105	0080	0055	0031	0007	43
44	0307	0281	0255	0230	0204	0179	0154	6129	0104	0080	0055	0031	0006	44
45	0.0306	0280	0255	0229	0204	0179	0153	0129	0104	0079	0055	0030	0006	45
46	0306	0280	0254	0229	0203	0178	0153	0128	0103	0079	0054	0030	0006	46
47	0305	0279	0254	0228	0203	0178	0153	0128	0103	0078	0054	0029	0005	47
48	0305	0279	0253	0228	0202	0177	0152	0127	0103	0078	0053	0029	0005	48
49	0304	0279	0253	0227	0202	0177	0152	0127	0102	0077	0053	0029	0004	49
50	0.0304	0278	0252	0227	0202	0176	0151	0126	0102	0077	0053	0028	0004	50
51	0304	0278	0252	0227	0201	0176	0151	0126	0101	0077	0052	0028	0004	51
52	0303	0277	0252	0226	0201	0176	0151	0126	0101	0076	0052	0027	0003	52
53	0303	0277	0251	0226	0200	0175	0150	0125	0100	0076	0051	0027	0003	53
54	0302	0276	0251	0225	0200	0175	0150	0125	0100	0075	0051	0027	0002	54
55	0.0302	0276	0250	0225	0200	0174	0149	0124	0100	0075	0051	0026	0002	55
56	0301	0276	0250	0224	0199	0174	0149	0124	0099	0075	0050	0026	0002	56
57	0301	0275	0250	0224	0199	0174	0148	0124	0099	0674	0050	0025	0001	57
58	0300	0275	0249	0224	0198	0173	0148	0123	0098	0074	0049	0025	0001	58
59	0300	0274	0249	0223	0198	0173	0148	0123	0098	0073	0049	0025	0000	59
	2 47	2 48	2 49	2 50	2 51	2 52	2 53	2 54	2 55	2 56	2 57	2 58	2 59	

TABLE XXXV.

AMPLITUDES.

DECLINATION.

LAT.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°	13°	14°	15°
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0	1·0	2·0	3·0	4·0	5·0	6·0	7·0	8·0	9·0	10·0	11·0	12·0	13·0	14·0	15·0
10	0	1·0	2·0	3·0	4·1	5·1	6·1	7·0	8·1	9·1	10·1	11·2	12·2	13·2	14·2	15·2
15	0	1·0	2·1	3·1	4·2	5·2	6.2	7·2	8·3	9·3	10·4	11·4	12·5	13·5	14·5	15·6
20	0	1·1	2·1	3·2	4·3	5·3	6·4	7·5	8·5	9·6	10·6	11·7	12·8	13·8	14·9	16·0
25	0	1·1	2·2	3·3	4·4	5·5	6·6	7·7	8·8	9·9	11·1	12·4	13·3	14·4	15·5	16·6
30	0	1·2	2·3	3·4	4·6	5·8	6·9	8.1	9·3	10·3	11·6	12·7	13·9	15·0	16·2	17·4
32	0	1·2	2·4	3·5	4·7	5·9	7·1	8·3	9·5	10·6	11·8	13·0	14·2	15·4	16·6	17·8
34	0	1·2	2·4	3·6	4·8	6·0	7·2	8·4	9·7	10·8	12·1	13·3	14·5	15·7	17·0	18·2
35	0	1·2	2·4	3·7	4·9	6·1	7·3	8·5	9·8	11·0	12·2	13·5	14·7	15·9	17·2	18·4
36	0	1·2	2·5	3·7	4·9	6·2	7·4	8·7	9·9	11·1	12·4	13·6	14 9	16·1	17·4	18·7
37	0	1·2	2·5	3·7	5·0	6·3	7·5	8·8	10·0	11·3	12·6	13·8	15·1	16·4	17·6	18·9
38	0	1·3	2·5	3·8	5·1	6·3	7·6	8·9	10·2	11·4	12·7	14·0	15·3	16·6	17·9	19·2
39	0	1·3	2·6	3·8	5·1	6·4	7·7	9·0	10·3	11·6	12·9	14·2	15·5	16·8	18·1	19·4
40	0	1·3	2·6	3·9	5·2	6·5	7·8	9·1	10·5	11·8	13·1	14·4	15·7	17·1	18·4	19·7
41	0	1·3	2·6	4·0	5·3	6·6	8·0	9·3	10·6	12·0	13·3	14·6	16·0	17·3	18·7	20·0
42	0	1·4	2·7	4·0	5·4	6·7	8·1	9·4	10·8	12·1	13·5	14·8	16·2	17·6	19·0	20·4
43	0	1·4	2·7	4·1	5·5	6·8	8·2	9·6	11·0	12·3	13·7	15·1	16·5	17·9	19·3	20·7
44	0	1·4	2·8	4·2	5·6	7·0	8·3	9·7	11·1	12·6	14·0	15·4	16·8	18·2	19·6	21·1
45	0	1·4	2·8	4·2	5·7	7·1	8·5	9·9	11·3	12·8	14·2	15·6	17·1	18·5	20·0	21·5
46	0	1·4	2·9	4·3	5·8	7·2	8·6	10·1	11·5	13·0	14·5	15·9	17·4	18·9	20·4	21·9
47	0	1·5	2·9	4·4	5·8	7·3	8·8	10·3	11·8	13·3	14·7	16·2	17·7	19·3	20·8	22·3
48	0	1·5	3·0	4·5	6·0	7·5	9·0	10·5	12·0	13·5	15·0	16·6	18·1	19·5	21·2	22·7
49	0	1·5	3·0	4·6	6·1	7·6	9·2	10·7	12·2	13·8	15·3	16·9	18·5	20·0	21·6	23·2
50	0	1·6	3·1	4·7	6·2	8·8	9·3	10·9	12·5	14·1	15·7	17·3	18·9	20·5	22·1	23·7
51	0	1·6	3·2	4·8	6·4	8·0	9·6	11·2	12·8	14·4	16·0	17·6	19·3	20·9	22·6	24·3
52	0	1·6	3·3	4·9	6·5	8·1	9·7	11·4	13·1	14·7	16·4	18·0	19·7	21·4	23·1	24·9
53	0	1·7	3·3	5·0	6·7	8·3	10·0	11·7	13·4	15·1	16·8	18·5	20·2	21·9	23·7	25·5
54	0	1·7	3·4	5·1	6·8	8·5	10·2	12·0	13·7	15·4	17·2	18·9	20·7	22·5	24·3	26·1
55	0	1·8	3·5	5·2	7·0	8·7	10·5	12·3	14·0	15·8	17·6	19·4	21·2	23·1	24·9	26·8
56	0	1·8	3·6	5·4	7·2	9·0	10·7	12·6	14·4	16·2	18·1	19·9	21·8	23·7	25·6	27·6
57	0	1·9	3·7	5·5	7·4	9·2	11·1	12·9	14·8	16·7	18·3	20·5	22·4	24·4	26·4	28·4
58	0	1·9	3·8	5·7	7·6	9·5	11·4	13·3	15·2	17·2	19·1	21·1	23·1	25·1	27·2	29·2
59	0	1·9	3·8	5·8	7·8	9·7	12·0	13·7	15·7	17·7	19·7	21·7	23·8	25·9	28·0	30·2
60	0	2·0	4·0	6·0	8·0	10·0	12·1	14·1	16·2	18·2	20·3	22·4	24·6	26·7	28·9	31·2
61	0	2·1	4·1	6·2	8·3	10·3	12·5	14·6	16·7	18·8	21·0	23·1	25·4	27·6	29·0	32·2
62	0	2·1	4·3	6·4	8·5	10·7	12·9	15·1	17·3	19·4	21·9	23·9	26·3	28·5	31·0	33·4
63	0	2·2	4·5	6·7	8·8	11·1	13·4	15·6	17·9	20·1	22·5	24·8	27·3	29·6	32·3	34·7
64	0	2·3	4·6	6·9	9·1	11·5	13·9	16·2	18·5	20·9	23·3	25·7	28·3	30·9	33·5	36·2
65	0	2·4	4·8	7·1	9·5	11·9	14·4	16·8	19·3	21·7	24·2	26·8	29·5	32·5	34·9	37·8

NOTE.—The Amplitudes in this Table are expressed in degrees and tenth parts of degrees and to turn those tenths into minntes, we multiply them by six, which will give their value in mim tes.

TABLE XXXV.

AMPLITUDES.

DECLINATION.

LAT.	16°	16½°	17°	17½°	18°	18½°	19°	19½°	20°	20½°	21°	21½°	22°	22½°	23°	23½°
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	16·0	16·6	17·0	17·5	18·0	18·5	19·0	19·5	20·0	20·5	21·0	21·5	22·0	22·5	23·0	23·5
10	16·2	16·7	17·3	17·8	18·3	18·8	19·3	19·9	20·3	20·8	21·3	21·8	22·3	22·9	23·4	23·9
15	16·6	17·1	17·7	18·1	18·7	19·2	19.7	20·2	20·8	21·3	21·8	22·3	22·8	23·3	23·9	24·3
20	17·1	17·6	18·1	18·7	19·2	19·7	20·3	20·8	21·3	21·9	22·4	22·9	23·5	24·0	24·6	25·1
25	17·7	18·3	18·8	19·4	19·9	20·5	21·0	21·6	22·5	22·7	23·3	23·8	24·4	24·6	25·5	26·1
30	18·6	19·1	19·7	20·3	20·9	21·5	22·1	22.7	23·3	23·8	24·4	25·0	25·6	26·2	26·8	27·4
32	19·0	19·6	20·2	20·8	21·4	22·0	22·6	23·2	23·8	24·4	25·0	25·6	26·2	26·8	27·4	28·0
34	19·4	20·0	20·6	21·3	21·9	22·5	23·1	23·7	24·4	25·0	25·6	26·2	26·8	27·5	28·1	28·7
35	19·6	20·3	20·9	21·5	22·2	22·8	23·4	24·0	24·7	25·3	25·9	26·6	27·2	27·8	28·5	29·1
36	19·9	20·5	21·2	21·8	22·4	23·1	23·7	24·4	25·0	25·6	26·3	26·9	27·6	28·2	28·9	29·5
37	20·2	20·8	21·5	22·1	22·8	23·4	24·0	24·7	25·3	26·0	26·7	27·3	28·0	28·6	29·3	29·9
38	20·5	21·1	21·8	22·4	23·1	23·7	24·4	25·1	25·7	26·4	27·0	27·7	28·4	29·0	29·7	30·3
39	20·8	21·4	22·1	22·8	23·4	24·1	24·8	25·4	26·1	26·8	27·5	28·1	28·8	29·5	30·2	30·8
40	21·1	21·8	22·4	23·1	23·8	24·5	25·1	25·8	26·5	27·2	27·9	28·6	29·3	30·0	30·7	31·3
41	21·4	22·1	22·8	23·5	24·2	24·8	25·5	26·2	26·9	27·6	28·3	29·0	29·8	30·5	31·2	31·8
42	21·8	22·5	23·2	23·8	24·6	25·3	26·0	26·7	27·4	28·1	28·8	29·5	30·3	31·0	31·7	32·4
43	22·1	22·8	23·6	24·3	25·0	25·7	26·4	27·1	27·8	28·6	29·3	30·1	30·8	31·5	32·3	33·0
44	22·5	23·2	24·0	24·7	25·6	26·2	26·9	27·6	28·4	29·1	29·8	30·6	31·4	32·1	32·9	33·6
45	22·9	23·7	24·4	25·2	25·9	26·7	27·4	28·2	28·9	29·7	30·4	31·2	32·0	32·8	33·5	34·3
46	23·4	24·1	24·8	25·6	26·4	27·2	27·9	28·7	29·5	30·3	31·0	31·8	32·6	33·4	34·2	35·0
47	23·8	24·6	25·4	26·2	26·9	27·7	28·5	29·3	30·1	30·9	31·7	32·5	33·3	34·1	34·9	35·7
48	24·3	25·1	25·9	26·7	27·5	28·3	29·1	29·9	30·7	31·6	32·4	33·2	34·3	34·8	35·7	36·5
49	24·8	25·6	26·5	27·3	28·1	28·9	29·7	30·6	31·4	32·3	33·1	33·9	34·8	35·7	36·5	37·4
50	25·4	26·2	27·0	27·8	28·7	29·6	30·4	31·3	32·1	33·0	33·9	34·8	35·6	36·5	37·4	38·3
51	26·0	26·8	27·7	28·5	29·4	30·3	31·1	32·0	32·9	33·8	34·7	35·6	36·5	37·5	38·4	39·3
52	26·6	27·5	28·3	29·2	30·1	31·0	31·9	32·8	33·7	34·7	35·6	36·5	37·5	38·4	39·4	40·3
53	27·3	28·2	29·1	30·0	30·9	31·8	32·7	33·7	34·6	35·6	36·5	37·5	38·5	39·5	40·5	41·4
54	28·0	28·9	29·8	30·8	31·7	32·7	33·6	34·6	35·6	36·6	37·6	38·6	39·6	40·6	41·7	42·6
55	28·7	29·7	30·6	31·6	32·6	33·6	34·6	35·6	36·6	37·6	38·7	39·7	40·8	41·8	42·9	44·0
56	29·5	30·5	31·5	32·5	33·5	34·6	35·6	36·6	37·7	38·8	39·8	40·9	42·1	43·2	44·3	45·4
57	30·4	31·4	32·5	33·5	34·5	35·6	36·7	37·8	38·9	40·0	41·1	42·3	43·4	44·6	45·8	47·0
58	31·3	32·4	33·5	34·6	35·7	36·8	37·9	39·0	40·2	41·7	42·5	43·8	45·0	46·2	47·5	48·7
59	32·3	33·5	34·6	35·7	36·8	38·0	39·2	40·4	41·6	42·8	44·1	45·4	46·7	48·0	49·3	50·6
60	33·4	34·6	35·8	37·0	38·2	39·4	40·6	41·9	43·2	44·5	45·8	47·1	48·5	49·9	51·4	52·8
61	34·6	35·8	37·1	38·3	39·6	40·8	42·2	43·5	44·8	46·2	47·7	49·1	50·6	52·1	53·7	55·2
62	35·9	37·2	38·5	39·8	41·2	42·5	43·9	45·3	46·8	48·2	49·8	51·3	52·9	54·6	56·3	58·0
63	37·4	38·7	40·1	41·5	42·9	44·3	45·8	47·3	48·8	50·5	52·1	53·8	55·6	57·4	59·4	61·3
64	39·0	40·4	41·8	43·3	44·8	46·4	48·0	49·6	51·3	53·0	54·8	56·7	58·7	60·8	63·0	65·3
65	40·7	42·2	43·8	45·4	47·0	48·7	50·4	52·2	54·0	56·0	58·0	60·1	62·4	64·9	67·6	70·4

TABLE XXXVI.

THE FOLLOWING TABLE CONTAINS EXTRACTS FROM THE NAUTICAL ALMANAC FOR THE YEAR 1854, FOR THE PURPOSE OF WORKING OUT THE EXAMPLE GIVEN IN THIS WORK TO SUIT THOSE WHO MAY NOT HAVE AN ALMANAC AT HAND.

THE SUN'S RIGHT ASCENSION, DECLINATION, &c.

Day of Month.	Ap. R. Ascen.	Dif. 1 Hr.	App. Declination.	Dif. 1 Hr.	Semid.	Equa. of Time.	Dif. 1 Hr.
	H. M. S.	S.	° ′ ″	″.	′ ″	M. S.	.
JAN. 20			20 7 38 S.	33	16 17		
" 21			19 54 26 S.	33.9	16 17		
" 25			18 57 58 S.	37.5			
" 26			18 42 58 S.	38			
FEB. 7	21 23 36	10				+ 14 27.32	0.106
" 8	21 27 35	10				+ 14 29.87	072
" 9	21 31 34	10				+ 14 31.61	039
" 10	21 35 32	10				+ 14 32.55	006
" 11	21 39 28	10				+ 14 32.70	025
MARCH 5			6 3 14 S.	58	16 9	+ 11 45.76	584
" 6			5 40 1 S.	58	16 8	+ 11 31.74	602
" 10	23 21 53	9	4 6 30 S.	59		+ 10 31.55	665
" 11	23 25 33	9	3 42 59 S.	59		+ 10 15.58	679
" 23	0 9 22	9	1 0 54 N.	59		+ 6 45.27	766
" 24	0 13 0	9	1 24 32 N.	59		+ 6 26.88	767
" 25			1 48 7 N.	59		+ 6 8.46	768
" 26			2 11 40 N.	58.9		+ 5 50.02	768
" 27			2 35 11 N.	58.6		+ 5 31.56	768
" 30			3 45 22 N.	58.2		+ 4 36.36	763
" 31			4 8 58 N.	58		+ 4 18.06	759
APRIL 1			4 31 35 N.	58		+ 3 59.84	755
" 2	0 45 43	9	4 54 55 N.	58		+ 3 41.71	750
" 3	0 49 21	9	5 17 56 N.	57		+ 3 23.70	745
" 6	1 0 18	9				+ 2 30.50	725
" 7	1 3 57	9				+ 2 13.11	716
" 16						− 0 11.87	603
" 17						− 0 26.33	586
" 21			11 50 36 N.	51		− 1 20.06	514
" 22			12 10 53 N.	50		− 1 32.39	494
" 30			14 45 32 N.	46		− 2 53.58	328
MAY 1			15 3 49 N.	45		− 3 1.44	306
" 12	3 15 50	10	18 7 27 N.	37.4		− 3 52.34	053
" 13	3 19 45	10	18 22 25 N.	36.7		− 3 53.60	028
" 19			19 45 36 N.	32		− 3 48.94	116
" 20			19 58 19 N.	31		− 3 46.15	140
JUNE 1			22 3 23 N.	20		− 2 31.92	380
" 2			22 11 23 N.	19		− 2 22.80	395
" 3	4 44 13	10	22 19 0 N.	18	15 48	− 2 13.33	410
" 4	6 52 41	10	22 26 13 N.	17	15 48	−	
" 21			23 27 32 N.	0			
JULY 3	6 48 34	10				+ 3 49.25	455
" 4	6 52 41	10				+ 4 0.18	441
" 12			22 0 19 N.	21		+ 5 14.40	308
" 19			20 53 10 N.	27		+ 5 56.28	165
" 20			20 42 8 N.	28		+ 6 0.25	141
AUG. 4			17 17 7 N.	40		+ 5 50.21	233
" 5			17 1 2 N.	41		+ 5 44.64	258
" 14	9 34 48	9	14 24 30 N.	46		+ 4 28.11	469
" 15	9 38 34	9	14 5 53 N.	47		+ 4 16.86	490
" 21	10 0 54	9				+ 2 58.97	610
" 22	10 4 36	9				+ 2 44.34	628
' 31			8 41 0 N.	54			

THE SUN'S RIGHT ASCENSION, DECLINATION, &C.

Day of Month.	Ap. R. Ascen.	Dif. 1 Hr.	App. Declination.	Dif. 1 Hr.	Semid.	Equa. of Time.	Dif. 1 Hr.
	H. M. S.	S.	° ′ ″	″	′ ″	M. S.	.
Sept. 1			8 19 18 N.	54			
" 6			6 28 51 N.	56		– 1 41.97	0.841
" 7			6 6 26 N.	56		– 2 2.14	849
" 24			0 26 0 S.	58		– 7 57.03	854
" 25			0 49 26 S.	58		– 8 17.52	848
" 26	12 11 12	9	1 12 52 S.	58		– 8 37.87	840
" 27	12 14 48	9	1 36 17 S.	58		– 8 58.04	832
" 29			2 23 5 S.	58		– 9 37.78	814
" 30			2 46 27 S.	58		– 9 57.32	803
Oct. 3	12 36 31	9				– 10 54.34	767
" 4	12 40 9	9				– 11 12.74	753
" 5	12 43 47	9				– 11 30.80	738
" 9			6 14 42 S.	57		– 12 39.01	669
" 10			6 37 30 S.	57		– 12 55.18	647
" 20			10 19 47 S.	53	16 6	– 15 5.77	406
" 21			10 41 18 S.	53	16 6	– 15 15.49	378
Nov. 27			21 8 34 S.	27		– 12 12.25	842
" 28			21 19 21 S.	26		– 11 52.04	871
Dec. 5	16 46 36	11				– 9 12.43	1.049
" 6	16 50 58	11				– 8 47.26	1.071

YEAR 1851.

Day of Month.	Ap. R. Ascen.	Dif. 1 Hr.	App. Declination.	Dif. 1 Hr.	Semid.	Equa. of Time.	Dif. 1 Hr.
April 14	1 28 37.65	9.217				0 22.71	0.637
" 15	1 32 18.87	9.232				0 7.42	623
July 6	6 59 47.73	10.275				4 17.99	418
" 7	7 3 54.34	10.260				4 28.3	402

THE MOON'S RIGHT ASCENSION, DECLINATION, &C.

DATE.	SEMID. NOON	SEMID. MID.	HOR. PAR. NOON	HOR. PAR. MID.	RIGHT ASCENSION. NOON	RIGHT ASCENSION. MID.	DECLINATION. NOON	DECLINATION. MID.	MERID PASS
	′ ″	′ ″	′ ″	′ ″	H. M. S.	H. M. S.	° ′ ″	° ′ ″	H. M
Feb. 7	14 46	14 46	54 8	54 7	4 59 57	5 25 17	23 28 49 N	24 28 15 N	
March 10	14 57	15 1	54 47	55 0	8 12 21	8 38 26	24 13 39 N	23 3 42 N	
" 23		16 9		59 8		20 23 53		23 51 2 S	
" 24	16 7		59 3		20 53 47		22 19 53 S		
April 23									21 59
" 24		15 31		56 50				0 51 12 S	22 43
" 25	15 26		56 35				2 2 14 N		
June 2	15 7	15 13	55 24	55 45			18 24 3 N	16 18 30 N	5 21
" 3	15 8	15 03	55 24	55 45					6 5
" 4	15 19		56 8						
July 3	15 31	15 38	56 49	57 14					
" 4	15 45		57 41						
" 11		16 36		61 17				21 21 34 S	13 58
" 12	16 31		61 6				19 9 21 S		14 56
Aug. 14		15 15		55 52		2 52 13		15 25 35 N	
" 15	15 9		55 30		3 16 29		17 37 37 N		
" 16	14 59	14 55	54 54	54 40			21 26 15 N	22 58 45 N	19 6
" 17									19 54
Sept. 26	15 53	15 56	58 11	58 23	15 26 42	15 54 24	18 52 48 S	21 1 43 S	
Oct. 1									
" 3	16 12	16 10	50 21	59 14	22 27	22 54 4	15 9 45	12 20 27	8 11
" 4	16 8	16 4	59 5	58 54	23 20 24	23 46 9	9 22 4 S	6 17 29 S	
Dec. 5									13 3

TABLE XXXVI.

YEAR 1851.

THE MOON'S RIGHT ASCENSION, DECLINATION, &C.

DATE.	SEMID.		HOR. PAR.		R. ASCENSION.		H.	DECLINATION.	DF. 10 M.	MERID.
	NOON	MID.	NOON	MID.	NOON	MID.		NOON	MID.	MER. PAS.
	′ ″	′ ″	′ ″	′ ″				° ′ ″	″	H.
April 14		16 26		60 17			13	0 26 21.6 S	133.33	11 17.9
" 15	16 23		60 6				14	0 39 41.6 S	133.23	12 10.7
July 6	15 59	15 55	58 39.6	58 24.8			11	5 31 56.5 S	122.83	6 40.5
" 7										7 32.0

THE PLANETS 1854.

DATE.	NAMES.	MERID. PASSAGE.	RIGHT ASCENSION.	DECLINATION.
		H. M.	H. M. S.	° ′ ″
January 1	Venus,	3 15.0	21 59 15	13 4 40 S.
" 2	"	3 15.0	22 2 33	12 39 50 S.
" 28	Saturn	7 1.3	3 32 8	17 2 12 N.
" 29	"	6 57.0	3 32 9	17 2 33 N.
February 1	"	6 45.7	3 32 15	17 3 47 N.
" 2	"	6 41.8	3 32 18	17 4 15 N.
April 2	"		3 47 15	18 9 33 N.
" 3	"		3 47 41	18 11 6 N.
" 6	Venus		22 27 28	6 8 43 S.
" 7	"		22 29 44	6 6 47 S.
" 13	Jupiter	18 23.7	19 51 49	21 6 42 S.
" 14	"	18 20	19 52 36	21 5 47 S.
June 6	Mars	6 2	11 0 50	7 24 56 N.
" 7	"	5 59	11 2 28	7 13 13 N.
July 3	Jupiter		19 44 26	21 39 11 S.
" 4	"		19 43 55	21 40 38 S.
September 24	"	7 4.6	19 17 43	22 44 27 S.
" 25	"	7 0.9	19 17 52	22 44 12 S.
October 3	"	6 31.		22 41 14 S.
" 4	"	6 27.5	19 19 51	22 40 44 S.
" 5	"	6 23.8	19 20 7	22 40 13 S.
December 5	"		19 57 13	21 14 47 S.
" 6	"		19 58 4	21 12 27 S.

LUNAR DISTANCES.

DATE.	NAMES.	HOUR.	DISTANCE.	PRO LOG.	HOUR.	DISTANCE.	PRO. LOG.
			° ′ ″			° ′ ″	
June 3	Sun W.	VI.	86 48 23	.3208	IX.	88 14 23	.3193
" 3	Antares E.	MID.	85 29 55	.2843	XV.	83 56 23	.2829
July 3	Jupiter E.	III.	101 46 12	.2618	VI.	100 7 41	.2601
" 3	Sun W.	XXI.	100 13 12	.2876			
" 4	Sun W.	NOON	101 46 2	.2858			
August 14	Aldebaran E.	XVIII.	19 57 36	.3115	XXI	18 29 45	.3175
" 14	Sun E.	XXI.	92 17 18	.3235			
" 15	Sun E.	NOON	90 51 50	.3250			
September 26	Sun W.	XI.	54 10 41	.2769	IX.	55 45 50	.2760
January 30	Aldebaran E.	MID.	85 38 28	.2362	XV.	83 53 59	.2378
February 7	Sun W.	NOON	117 47 51	.3488	III.	119 8 28	.3489

STAR'S RIGHT ASCENSION AND DECLINATION, 1851.

		H. M. S.		° ′
Spica,	Right Ascension.	13 17 22	Declination	10 23 1 S.
Arcturus,	" "	14 8 53	"	19 57 43 N.

TABLE XXXVII.

APPROXIMATE VARIATION OF THE COMPASS.

N. LAT.	WEST LONGITUDE. 180°	170°	160°	150°	140°	130°	120°	110°	100°	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°
60° N	17° E	20° E	23° E	26° E	26° E	27° E	27° E	0°	0°	4° W	30° W	46° W	46° W	49° W	48° W	48° W	41° W	32° W	28° W
58	17	20	22	25	25	26	26				24	46	46	49	48	48	39	31	28
56	17	19	21	24	25	25	25				19	40	42	47	47	45	37	30	26
54	17	19	21	23	23	24	24					30	42	43	44	41	35	29	25
52	16	18	20	22	22	23	23					25	36	38	40	38	34	28	25
50	16	18	20	21	21	22	22					20	29	36	36	35	32	27	25
48	16	18	20	21	21	22	21					18	24	33	33	33	30	27	25
46	16	17	18	20	21	20	20		NORTH AMERICA.		4	15	22	30	30	31	29	26	25
44	16	17	18	19	20	20	19				4	15	19	28	28	30	28	26	25
42	16	17	18	18	19	18	18				2	12	17	24	26	28	27	25	24
40	15	16	17	17	18	17	17				1	9	16	21	25	26	26	24	22
38	15	16	17	17	17	16	16				0	6	12	20	22	25	25	23	22
36	15	15	16	16	16	15	15				1 E	4	10	18	20	24	25	22	
34	14	15	16	16	15	14	13				2	3	8	16	19	23	24	22	
32	14	14	14	15	15	14	12				3	2	6	14	17	22	24	21	
30	14	14	13	14	13	12	12			8 E	4	2	4	13	16	21	23	21	
28	13	13	12	13	12	11	11			8	4	1	3	12	15	20	23		
26	13	13	12	12	11	10	10			8	4	0	2	11	13	19	22		
24	12	12	11	11	10	10	10			9	5	1 E	1	10	12	18	21		
22	12	11	10	10	9	9	9			9	5	2	0	9	11	17	21	AFRICA.	
20	12	11	10	10	9	9	9	9 E	9 E	9	6	3	1 E	8	10	16	20		
18	12	11	10	9	9	9	9	9	9	9	6	4	2	7	9	15	20		
16	11	10	9	9	9	9	8	8	9	9	6	4	2	6	9	15	19		
14	11	10	9	8	8	8	8	8	9	10	7	5	3	5	9	14	19		
12	11	10	9	8	8	8	7	8	9	10	7	5	3	4	8	14	18		
10	10	9	8	8	7	7	7	8	9	10	7	5	3	3	7	13	18		
8	10	9	8	7	7	7	7	8	9	10	7			2	7	12	18		
6	10	9	8	7	6	7	7	8	9	10	8			0	6	12	18	20	20
4	10	9	8	7	6	6	7	7	8	9	8				5	12	17	19	20
2	10	9	8	7	6	6	6	7	8	9	8				5	11	17	19	20
0	10	9	8	7	6	6	6	7	8	9	8				5	10	17	19	20
2 S	10	9	8	6	5	6	6	7	8	9	8			1 E	4	9	16	18	20
4	10	9	8	6	5	6	6	7	8	9	8	SOUTH AMERICA.		1	4	8	14	18	20
6	10	9	8	6	5	6	6	7	8	9	8			1	3	7	12	18	20
8	9	9	8	6	5	6	6	7	8	9	8			2	3	7	12	18	20
10	9	9	8	6	5	6	6	7	8	9	9			2	2	7	12	18	20
12	9	9	8	6	5	6	6	7	8	9	9			3	2	6	11	18	20
14	9	9	8	6	5	6	6	7	9	10	9			3	1	6	11	17	20
16	10	9	8	6	5	6	6	7	9	10	10			4	1	6	11	16	20
18	10	9	8	6	5	6	6	7	9	10	10			4	0	5	10	16	20
20	10	9	8	6	5	6	6	8	10	11	11			5	1 E	5	10	16	20
22	10	9	8	7	6	6	6	8	10	11	12			5	1	5	10	16	20
24	10	10	9	7	6	7	7	8	10	12	13			6	2	5	10	15	19
26	10	10	9	7	6	7	7	8	11	12	14		10 E	6	2	4	9	15	19
28	11	10	9	7	6	7	7	8	11	13	15		10	7	3	4	9	15	19
30	11	10	9	8	7	7	7	8	11	13	15		11	7	3	3	8	14	19
32	12	11	9	8	7	7	7	9	12	14	16		12	8	4	3	8	14	19
34	12	11	9	8	7	8	8	9	13	15	17		13	8	4	2	7	14	19
36	13	11	9	9	8	8	8	9	13	15	17		13	9	5	1	6	14	19
38	13	12	10	9	8	9	8	10	13	16	17		14	9	5	1	6	14	19
40	14	13	10	9	8	9	8	11	14	17	18		15	10	6	0	6	14	19
42	15	14	11	10	9	9	8	11	14	17	18		16	10	6	1 E	5	13	18
44	15	14	12	11	10	10	9	12	15	18	19		17	11	7	2	5	13	18
46	15	14	12	11	10	10	9	13	16	19	20		18	12	8	2	5	13	18
48		15	12	13	12	11	9	13	16	19	21		19	13	9	3	5	13	18
50			13	14	13	12	10	14	17	20	22		20	14	9	4	4	12	17
52				15	14	13	11	15	18	21	23		21	15	10	5	4	12	17
54					14	13	12	16	19	22	24		21	16	11	6	4	12	17
56						14	12	16	19	22	25		22	17	12	7	4	12	17
S. LAT.	WEST LONGITUDE. 180°	170°	160°	150°	140°	130°	120°	110°	100°	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°

TABLE XXXVII.

APPROXIMATE VARIATION OF THE COMPASS.

N.	EAST LONGITUDE.																		
LAT. °	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°
60 N	26W	20W	15W													3 E	7 E	12 E	17 E
58	25	20	15													3	7	12	17
56	25	20	15													3	7	12	17
54	24	20	15	10W												3	7	12	17
52	24	20	15	10												2	7	12	16
50	23	19	15	10												2	7	12	16
48	22	18	14	10												2	7	12	16
46	22	18	12	11												3	7	12	16
44	21	17	13	11					ASIA.				1 W	1 W	1 E	3	7	12	16
42	21	17	13	11									1	1	1	3	7	12	16
40	2[illegible]	16	13	11									2	1	1	3	7	12	16
38	20	16	13	11									2	1	1	3	7	11	15
36	20	16	14	12									1	0	1	3	6	10	14
34		16	14	12									1	0	2	3	6	10	14
32		14	13	12									0	0	2	4	6	10	14
30			12	12									0	0	2	4	7	10	13
28										1 E	1 E	0	0	0	2	4	7	10	13
26							3W	0	0	1	1	0	0	0	2	4	7	10	13
24	AFRICA.						3	0	0	1	1	0	0	0	3	4	7	9	12
22							3	0	0	2	1	1 E	1 E	0	3	5	7	9	12
20							3	0	0	2	1	1	1	1 E	3	5	7	9	11
18							3	0	0	2	1	1	1	2	3	5	7	9	11
16							3	0	0	2	1	1	1	2	3	5	6	8	10
14							3	0	0	2	1	1	1	3	4	6	7	8	10
12					12W	8W	3	0	0	2	2	2	2	3	4	6	7	8	10
10					12	8	3	0	0	2	2	2	2	3	4	6	7	8	10
8					12	8	3	0	0	2	2	2	2	3	4	6	7	8	10
6	20				12	8	3	0	0	2	2	2	2	3	4	6	7	8	10
4	20				12	8	3	0	0	2	2	2	2	3	4	6	7	8	10
2	20				12	8	3	0	0	2	2	2	2	3	4	6	7	8	10
0	20				13	8	4	0	0	1	1	2	2	3	4	6	7	8	9
2 S	20	21	22		13	8	4	0	0	1	1	2	2	3	4	6	7	8	9
4	20	21	22		13	8	4	2W	0	1	1	1	1	2	4	6	7	8	9
6	20	21	22		14	9	5	2	0	0	0	0	1	2	4	6	7	8	9
8	20	21	23		15	10	6	3	0	0	0	0	0	1	4	6	7	8	9
10	20	21	23		15	10	6	3	0	0	0	0	0	1	4	6	7	8	9
12	20	21	23		16	11	7	4	2	1 W	0	0	0	1	4	6	7	8	9
14	20	22	24		17	12	8	4	3	1	1 W	1 W	1 W	0	4	6	7	8	9
16	20	22	24		18	14	9	6	4	2	1	1	1	0	3	6	7	9	10
18	20	22	24		19	14	10	7	5	3	2	1	1	0	3	6	7	9	10
20	20	22	25		20	16	12	8	6	4	3	2	1	0	3	6	7	9	10
22	20	22	25		21	17	13	9	7	5	4	3	2	1 W	4	7	8	0	10
24	20	22	25		22	18	15	10	8	6	5	4	2	1	4	7	8	9	10
26	19	22	26		23	19	16	11	9	7	5	3	2	1	4	7	8	9	10
28	19	22	26		24	20	17	12	10	8	6	4	3	1	4	7	8	9	10
30	19	22	26	29	25	22	19	14	12	10	7	5	3	1	5	8	9	10	11
32	19	23	27	30	26	24	20	16	14	11	9	7	4	2	5	8	9	10	11
34	19	23	27	30	27	24	21	18	16	13	10	7	4	2	5	8	9	10	12
36	19	24	28	31	28	26	23	20	18	15	11	7	4	2	6	9	10	11	12
38	19	24	29	32	29	26	24	21	19	16	12	9	5	3	6	9	10	12	13
40	19	24	29	32	30	28	26	23	21	18	14	11	5	3	7	10	11	12	13
42	19	25	30	33	31	29	28	25	23	20	16	11	6	4	7	10	11	13	14
44	19	25	30	33	32	30	29	27	26	24	18	12	6	4	7	10	11	14	15
46	18	24	30	33	33	30	31	29	27	26	20	14	7	5	7	10	11	14	15
48	18	24	30	33	35	34	33	31	29	28	22	16	7	5	7	10	11	14	15
50	18	24	30	33	36	36	35	33	29	30	23	17	8	6	8	11	11	14	
52	17	23	30	33	38	37	37	35	34	32	23	17	8	6	8	11	12	14	
54	17	23	30	33	39	38	38	36	34	33	24	17	9	7	8	11	12		
56	17	23	30	33	40	40	39	37	34	34	26	18	9	7	8	11			
LAT.	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°
S.	EAST LONGITUDE.																		

TABLE XXXVIII.

CONTAINING THE TIDE HOURS, OR THE TIMES OF HIGH WATER,

At the Full and Change of the Moon, (usually called the Establishment of the Port,) at the principal Ports and Harbors of the World, with the Vertical Rise of the Tide in Feet, in both Spring and Neap Range. The first two numbers, connected thus – in the Range column, denotes the Spring Range, the second the Neap Range

PLACES.	TIME.	RANGE
	H. M.	FT.
Abaco	8 0	3
Abd'l Koory	4 30	8
Aberdeen	1 12	19–14
Aberystwyth	7 31	13–6
Abrolhos	4 48	6
Acapulco	3 6	1½
Achen	9 0	7
Adelaide	5 44	6
Aden	7 0	8
Adenara		8
Agoada	10 30	9–
Akaroa	4 0	8
Akyab	9 45	9–
Albemarle	7 15	7
Alderney	6 46	17–8
Amboyna	0 33	7
Amoy	12 50	18–17
Amsterdam	3 0	18
— I., I. Oc.	11 0	3
Andamans N. Harb.	10 0	9
Andrava B.	3 30	7
Andrews, St.	10 45	25
Angra, Azores	12 32	4½
— Pequenha	2 30	8
Ann, Az.	11 59	13
— St. I., Seych.	5 30	6
Annapolis, U.S.	4 43	2½
— Nov. Scot.	11 0	30
Anticosta, W. Pt.	3 30	11
Antongil B.	4 0	5
Antonio, Cuba	9 30	1½
— Port	10 40	30–18
Antwerp	4 25	14
Aor Pulo		5
Arbroath	1 40	14–8
Apalachicola		4
Arcachon	4 37	12–7
Arcas	12 0	1½
Archangel	7 18	2
Ardglass	10 30	19
Ardrossan	11 54	10–8
Arica	8 0	5
Aroa		10
Arthur	7 52	4
Arundel	11 15	16
Ascension	5 30	2
Auckland	6 15	10
Augustine B.	4 30	13
— U. S.	8 4	6½
Awatcha	3 30	6½
Ayr	12 10	8–5?
Bab el mandeb	12 30	
— I.	11 30	6
Bahia	3 30	8
Balade	6 30	
Balasore	9 45	10–
Balbriggan	10 40	11
Bally	12 30	11
Balta	9 45	6–3
Baltimore	4 23	12
Bananas	8 15	9
Bancoot	11 0	12
Banda	4 0	6?
Banff	0 40	11–6
Banks	3 42	8
Bantam		5
Bantry B.	3 47	10–5
Barbara	11 15	6
Barbe	6 0	6–

PLACES.	TIME.	RANGE
	H. M.	FT.
Barfleur	8 54	
Barnstable	11 0	9
Barren Is.	4 45	12
Bas Is.	5 15	27
Basseen	12 30	17
Batanes		4
Batchiau		6
Bate	12 0	14
Bathurst	8 10	7
Bay of Is.	9 16	6
Bayonne	3 15	16
Beachy Hd.	11 0	21
Beaumaris	10 32	21–11
Beaufort	6 52	7
Belfast	10 43	9–6
Bell Sound	8 56	3
Belle Isle	11 30	7
Bambatooka	4 30	16
Bembridge	11 40	
Bencoolen	0 0	
Benin	4 15	7
Berbice	4 30	11
Bergen	1 30	
Bergen op Z.	3 30	
Bermuda	7 or 8	5
Berwick on Tweed	2 18	16
Bilboa	2 53	29?
Bissao	6 30	14
Blanco C.	11 46	6
Blewfields	1 50	2
Blyth	2 48	14–10
Bodega	11 30	7
Bojador	12 0	
Bombay	11 10	15–11
Bonacca	9 0	1½
Bonny	5 0	9
Bordeaux	6 55	14–11
Boston, U. S.	11 31	12
Botany B.	8 0?	7 or 4
Bow I.	2 40	3
Boyanna B.	4 30	15
Brava	4 30	8
Bray Hd.	10 45	12–7
Brehat I.	5 27	37
Brest	3 48	19–9
Bridgewater	6 50	35–18
Brielle	3 0	14
Brighton	10 6	16
Bristol	7 15	40
British Sd.	4 0	9½
Bruny	9?	9
Buenos Ayres	0 0	var.
Bulama I.	4 30	15
Buncrana	7 54	17
Bushire	7 30	6
Bussora	12 0	
Button Is.	6 50	
Cadiz	2	12–8
Caernarvon	9 33	14–8
Cajeli	1 0	6
Calcutta	3 0	
Calebar, New	5 0	9
Callao	5 47	4
Cameroons R.	6 0	7
Camiguin	6 0	6
Campbell I.	12 0	43?
Campbelton	11 45	8–4
Campobello	11 19	21–16
Cambing	noon	6
Canso, Gut	8 30	8

PLACES.	TIME.	RANGE
	H. M.	FT.
Cantin C.	10 0	
Canton	2 40	
Capricorn C.	8 0	7
Cargados Gar.	2 3	4
Cardiff	6 59	
Carlingford	11 0	18–12
Carlos St.	11 45	19
Carrickfergus	10 30	8
Cartaret		6
Castlereagh C.	2 50	4
Catherine St.	2 40	6–
Catoche, C.		1
Cayenne	3 45	6
Cayeux	11 5	27–16
Ceuta	1 55	
Chaguaramus	3 30	4
Champion B.	9 10	1
Charles, C.	7 45	5
Charleston	7 15	8
Chatham	0 54	
Chatte C.	12 0	13
Chaussey	6 9	30
Cheduba	11 30	8
Chepstow	7 30	70?
Cherbourg	7 49	17–8
Chester	10 30	26
Chichester	11 45	14
Chignecto	11 0	32
Chimmo B.	12 25	16
Chin-chew	12 25	17–
Chin-Hae	12 10	10
Chittagong	1 30	15–10
Chosan	7 30	4
Christmas	10 0	
Chusan	11 0	12–6
Circular Hd.	12	9
Clara, Sta.	4 0	7–
Coast, C.	4 45	7
Cobija	9 54	4
Cochin		6
Cockburn	4 15	12
Cod C.	11 30	13
Colorado	3 40	11
Columbia R.	12 15	7½
Comoro	4 30	12
Condore	3 0	4
Copiapó	8 30	5
Coquet	5 45	15–8
Coquimbo	9 8	5
Cordovan	3 37	14–7
Coringa	9 0	5–3
Corisco	5 0	7
Cork	5 1	11–7
Corunna	3 0	
Coupang	11 30	7
Coy Inlet	9 30	40
Cracatoa	7 0	4
Cromer	7 0	15–7
Crooked I.	7	2½
Crookhaven	4 0	12–8
Curieuse	5 10	7
Curtis, Port, Austr.	8½	10–6
Cutch, G.	11to1	15
Cuxhaven	0 44	
Dalrymple	12 5	10
Damaun Bar	1 30	17
Dampier Strait		11
Dartmouth	6 5	19–11
Darnley I.	9 30	10
Darwin, Port	5 30	24–17

PLACES.	TIME.	RANGE
	H. M.	FT.
Dauphin, Fort	4 30	7
Delagoa	4 40	13
Delaware R.C. Hen. c.	8 0	4–3
Delgado, Az.	12 30	7
— C.	4 0	16
Delhi, R.	4 0	8
Demerara	4 30	9
Desire	12 45	21
Devonport	5 43	15–7
Diamond I.	10 30	8
Diego Gar.	1 30	
— Ram.	4 0	6
— St. C.	4 30	10
Dieppe	11 6	27–15
Discovery	2 30	7
Dislocation	1 40	4
Diu I.	2 0	6
Divy		5
Douglas	11 8	22–11
Dover	11 12	20
Dragon's Mo.	3 0	4
Dublin Poolb.	10 30	13–7
Dunbar	2 0	
Duncansby	10 0	9
Dundee	2 31	15–7
Dunkirk	12 8	17–10
Dunmore	6 45	16
Durnford	4 45	12
Durien, Strait	irr.	10
Easter I.	2 0	
Edgar, Port	7 15	6
Egg Harbor	7 10	4
Elbe	12 0	12
Elena	4 0	17
Embden	12 0	
Endeavor R.	8 0	
English Rd.	7 30	5
Essington Pt.	3 24	13
Evangelists	1 0	5
Exmouth	6 29	14–8
Exuma	7 20	2½
Fairweath. C.	9 0	28
Falmouth	5 30	18
Famine	0 7	9
Fayal	11 30	4½
Fear, C.	7 0	7
Fernando Nor.	4 0	6–5
Ferrol	2 29	
Finisterre	3 0	
Flamenco	9 10	5
Fleetwood	10 53	28–21
Flushing	1 0	
Folkstone		14–
Foreland, N.	11 15	17
Fowey	5 30	16
Francisco, St.	11	8–2
Funchal	12 15	9
Fundy B.		60
Gaboon, R.	6 0	8
Gallant, Port	9 3	5
Gallegos, R.	8 50	48
Galveston		4
Galway	4 32	15–7
Gambia, *Bathurst*		
Gambier Is.	1 50	3
Gaspé B.	1 50	5
Gay Hd.	7 37	7

CONTAINING THE TIDE HOURS, OR THE TIMES OF HIGH WATER.

PLACES.	TIME H. M.	RANGE FT.
Geby I.		5–
George, St. sh.	10 30	7
Georgetown	7 0	4
Gheriah		6
Gibraltar	2 20	
Glasgow	1 25	
Gloucester	1 30	5
Goa	11 45	5
Good Hope, C.	3 0	
Good Success	4 3	9
Goree	7 48	4
Gracias, C.	10 30	2
Grand, Port		1½
Granville	6 13	37–17
Greenock	12 8	10–6
Guasco	8 30	5
Guatulco	1 30	5
Guaymes	8 03	6–
Guernsey	6 30	35
Gun Cay	7½	3
Guayaquil	7 0	11–
Haarlem	9 0	
Hague	7 45	21
Hakluyts Hd.	1 30	4
Halifax	7 39	8
Hamburgh	5 0	
Hammerfest	1 10	9
Hardy, Port	8 0	12
Hartlepool	3 28	15–8
Harwich	0 6	11–7
Hastings, St.M.	10 40	13–
Hatteras, C.	9 0	–5
Havana		3
Havre	9 51	22–12
Haytien, C.	6 0	3
Heligoland	11 0	9
Helena, St. B.	2 30	
— I.	3 11	3
Henlopen, C.	8 0	4–3
Henry, C.	7 40	4
Heradura	9 8	5
Hillsboro' Inlet	7 30	5
Hobarton	8 0	4
Hokianga	9 30	9
Holmes' Hole	11 48	2–1
Holy I.	2 30	15
Holyhead	10 26	16–8
Honduras Bay		1
Honfleur	9 30	13
Hong Ko.		9–
Houtman's Ab.	11 30	2
Honoruru	irr.	2
Horn, C.	4 40	9
Howe, C.	9 0	6
Huacho	4 44	3
Hull	6 29	22–13
Hunter, Port	10 45	6
Ilfracombe	5 45	32–13
Indus	irr.	12–4
Inhambane	4 15	10
Inverness	12 18	12–7
Iquique	8 45	5
Islay	8 53	7
Ives, St.	4 44	21–10
Jacinto	6 30	6
Jask B.	6 0	6
Jericoacoara	11 30	12
Jersey	6 30	33–14
Jervis	6 45	6
Jiddah	irr.	2
Johanna	3 30	8
John's, St. N.F.	7 30	7

PLACES.	TIME H. M.	RANGE FT.
John's, St. N.B.	11 23	23–17
Joseph, St.	5 0	8
Juan, St. P.R.	8 20	1½
— Peru	5 10	3
— de Nova		5
Julian	10 45	30
Karakakoa B.	3 49	
Katwyk	2 30	5
Kedgeree	11 30	
Keeling	4 0	5
Kelung	10 30	3
Kilduin	7 0	12
Kilrush	4 42	16
Killibeg	6 45	
King G's Sd.	irr.	3
King's I.	irr.	12
Kingston	11 10	11–6
Kinsale	4 43	11–7
Kish Lt.	10 30	10
Kishm I.	11 0	12
Kracatoa	7 0	4
Kuria Muria	8 20	6
Kykduin	7 0	12
Lagos, Afr.	4 0	6
— Portugal	2 7	13
Lambeyeque	4 0	3
Lamo	4 6	11
Latham	4 0	10
Leith	2 17	16–7
Lerwick	9 45	8
Leübu R.	10 30	5
Limerick	7 53	17
Lindy	4 30	12
Lintin	12 0	8
Lisbon	4 0	
Liscombe		7–4
Liverpool	11 16	25–14
Loando	4 30	6
Lobito	2 20	5
Loheia	1 30	3
Loire, R. mo.	3 45	19
Lomas	8 19	5
Lombock		7
London Bridge	2 7	18–
Loo Choo, *Nap.*	9 0	9
Lopez, C.	4 30	
L'Orient	3 41	20
Los Is. de	6 35	17–13
Louis, Port	1 2	2
— Falk.	5 0	7
Low, Port	0 40	7
Lowestofft	9 51	8–4
Lucas	9 20	9
Lundy I.	5 15	27–13
Macao	9 52	8
Macowa I.	12 30	2
Machias	11 0	12
Macquarrie	7 30	3
Madame	4 0	5
Madeira	12 48	7
Madras	7 34	3
Magadoxa	4 30	8
Magalhaen's St E entr.	8 56	45
Mahé I.	3 45	6
Mahon	9 37	6–4
Magnetic I.	3 10	12
Majambo	4 30	16
Magdalena B.	7 35	6
Magdalen Is.	8 20	3
Makumba	4 45	17
Malacca	9 15	8–

PLACES.	TIME H. M.	RANGE FT.
Malaga	12 0	3
Maldives	3 0	4
Malo, St.	6 5	35–17
Malpelo Pt.	4 0	10
Manila	irr.	3
Man-of-War Cay	8 10	4
Manukau	9 30	12
Maranhain	7 0	18
Marblehead	11 30	12
Marcouf, St.	9 55	20
Marosse	4 0	5
Martaban	2 20	21
Martin, Cove	3 50	8
Martin Vas	3 45	
Mary, St. C. N. Scotia	9 30	16
Matheson Har.	12 30	17
Massowah	1 0	3
May, C.	8 19	6–4
Mayotta	5 45	11
Mazatlan	9 40	3½
Mazeira	10 48	5
Meichow	12 30	17–
Melinda	4 15	11
Mergui	11 30	21–
Merjee	11 0	7
Miatau		7
Michael, St. Az.	12 30	6
Michel		
Milford Haven	5 45	22
Mindanao, S.pt.	7 0	6
Mingan	1 30	7
Min R.	10 15	19–
Minow I.	5 0	15
Mira por vos	9 30	3
Mississippi		1½
Mobile		2–
Mocha		4
Mogador	2 0	10
Molucca Is.		3
Mombaza	4 0	11
Monganui	7 50	8
Monomy	11 30	6
Monterey	7 30	
Monte Video	irr.	
Montrose	1 30	13–
Monts, de	12 0	12
Morebat	9 0	6
Moreno	10 0	4
Morlaix	4 53	24–12
Mossel B.	3 0	6
Mount Desert	11 10	13
Mourandova	4 45	12
Mozambique	4 15	12
Mugeres	9 30	1½
Musa		5
Nagore	8 15 ?	3
Nancowry	9 15	8
Nangasaki	7 52	9–1
Nanka		12
Nantucket Shl.	10 44	
Napakeang	6 30	7
Nareenda B.	4 30	15
Nassau	7 30	4–3
Natal	10 0	
Negapatam	5 0 ?	3
Negro R.	11 0	14
Nelson	9 0	11
New Bedford	7 55	5–4
Newburyport	11 15	10
New Calebar	5 30	8
Newhaven	11 9	19–14
— U. S.	11 16	6–5

PLACES.	TIME H. M.	RANGE FT.
New London	9 30	5–2
Newport	7 45	6–3
N. Providence	7 30	4–3
N. York City	8 37	6
Nicholson	4 16	6
Nicoya	2 56	10
Ninepin Is.	10 0	5
Noirmoustier	3 2	17–16
Nore Light	12 30	14–
Norfolk I.	7 45	7
Noss Bey	5 0	15
Neuva G.	7 10	10
Ocracocke	9 0	
Old Pt. Comft.	8 27	4
— Providence	irr.	1 ?
Oleron	3 50	19
Oporto	2 30	10–
Orange B.	3 30	5
Ostend	0 20	19–15
Otago	3 20	9
Otaheite	noon	1
Otway, Port	noon	6
Padstow	4 40	22–16
Palmas C.	6 30	6
Palmiras Pt.	9 30	11–7
Panama	3 9	
Paposo	9 40	5
Para	12 0	11
— Entr.	10 0	
Passamaquod.	11 30	25
Passandava	5 0	15
Patta	4 30	10
Payta	3 20	3
Pearl Cays	2 0	2
Peiho R.	3 30	7
Pelew Is.		6
Pemba	4 15	12
Pembroke	6 12	21–10
Penang	2 15	8
Peñas C.	6 42	12
Peniche	1 54	
Penmarc'h	3 16	
Pensacola		2
Pentland Sker	8 50	8–3
Pernambuco	4 23	6
Peros Banhos	1 30	5
Pescadores	10 30	9–4
Peterhead	0 48	11–6
Philadelphia	1 22	7–4
Philip	0 20	3
Pichidanque	9 20	5
Pillar C.	1 0	6
Pisco	4 50	4
Placentia	9 15	8
Plettenburg	3 10	5
Plymouth, U.S	11 30	11
Pomba	4 0	15–7
Poole	9 30	5–2
Portland, U.S.	11 10	12
Porto Rico	8 30	1
Port Royal	5 46	6
Portsmouth	11 41	12–6
— U. S.	11 30	10
Post Off. B.	2 10	6
Pouinipet	6 0	4½
Praya	0 0	5
Puget Sound	6 0	18
Pulicat Shoals	9 25	3
Quail I.	4 0	5
Quebec	6 30	17
Quentin St.	9 5	5
Quilca	8 0	6

TABLE XXXVIII.

CONTAINING THE TIDE HOURS, OR THE TIMES OF HIGH WATER.

PLACES.	TIME.	RANGE	PLACES.	TIME.	RANGE	PLACES.	TIME.	RANGE	PLACES	TIME.	RANGE
	H. M.	FT.		H. M.	FT.		H. M.	FT.		H. M.	FT.
Quillimane....	4 15	16	Sta. Maria Is. .	10 20	6	Surat........	4 15	30	Ushant......	3 32	19–8
Quiloa.......	4 45	12	Saperuah B...		6	Surinam	9 0	6			
			Saugor I.		12	Swan R.	8 50	2	Valdivia	10 35	5
Rachado C....	5 30	13–	Savannah	7 15	8½	Swansea......	5 36	30–15	Valentia	3 45	17–7
Ragged I......	8 10	3–	Santander....	3 30		Sydney.......	7 36	6	Valparaiso ..	9 32	5
— Pt., Borneo.		7	Scarborough..	4 12	18–10	— Bret. I....	9 0	6	Vera Cruz...	irr.	3
Raine I.......	8 0	10–	Searbet I.....	1 30	10				Verd C......	7 45	3
Rajahpoor....	11 0	12	Sea Bear B...	12 45	20	Table B......	2 30	5	Versavah....	12 15	16
Rangoon	5 30	20–14	Sebast. St.....	2 0	4	Tae-Chow Is..	10 0	15	Vincent, Port	8 10	5
Ras el Khyma	11 0	7	Second Bar ...	irr.	7	Talcuhuano...	10 14	5	Vingorla	10 30	6
Realejo	3 6	11–	Sein I........	3 21	17–7	Tamar.......	3 5	5	Virgin's C....	8 50	38
Rendezvous I.		8	Selsea Harb...	11 45	14–5	Tamareed....	7 20	8			
Resolution Bay			Senegal......	10 30		Tamatave....	4 18	8	Wahaay	6 0	3
Marq.	2 30	4	Serrana......		2	Tang-tang....	4 30	6	Walwich	1 54	6
Rio Janeiro...	2 0	6	Serranilla	irr.	2	Tanna	5 35	3	Wangaroa....	8 15	7
Rochefort	3 48	20	Shelburne....	8 30	8	Tarbert......	4 57	15–10	Waterford...	6 6	13–7
Rochelle......	3 39		Sheerness.....	0 37	16–11	Tarifa	11 15?	8	Welseley Is. .	8 0	12
Rodriguez ...	1 35	6	Sherbro'	6 0	11	Tavoy.......	10 0	17	Western, Port	1 10	8
Roque, C. St...		10–6	Shields.......	3 30	15–11	Teignmouth ..	6 0	13–7	Westport....	4 57	13–6
Rotterdam ...	3 45		Sierra Leone .	7 50	11	Tenerife	1 30	7	Wexford	6 30	5–3
Royal I.	7 45	3½	Simons B.....	2 30	5	Texel........	6 45	6	Weymouth ..	6 30	7
Rush, Port ...	5 50	7–4	Singapore....	9 0	9	Tien Pak.....	12 0	8	Whitby	3 45	13
			Sisal		2	Thomas, St. I..	3 25	4	Whitehaven .	11 14	23–12
Sable C.	8 0	9	Sitka	0 34		Three Pts. C. .	3 0	5	Wicklow.....	10 30	9–5
— I., N. side..	10 30	7	Sofala........	4 0	21–	Timoan.......	6 0	7	Wilson's Pro..	2 0	10
— Ditto S.side	8 30	7	Spain, Port...	3 0	4	Ting-Hae, Chu-			Woosung	1 30	16
Saintes	6 45		Spurn Pt.	5 20	23–14	san	11 0	12–6			
Salcombe	5 50	19–11	Staten I......	4 30	8	Tobago	irr.	3½	Yang-tze-ke-		
Saldanha.....	2 0	6	Stephens Port			Tongatabou ..	6 50	4	ang		15–10
Salem........	11 15	11	Falk.......	7 45	7	Torbay	6 0	20	Yarmouth ...	9 10	7-2
San Blas.....	9 45	7–	— Austr.	9 15	8	Torres Strait .		6	Yellaboi	7 10	10
Sandalwood B.	6 0	6–?	Stirrup Cay...	7 0	4	Triangles.....		1½	Ylo.........	8 20	6
San Carlos			Stonehaven...	1 17	14–8	Trincomalee...	8 18	2	York	11 15	14–10
Falk.......	7 0	8	Stockton	4 30	13	Tristan d'Ac..		8	Youghal.....	3 26	12–8
Sandy Hook, c.	7 29	6–4	Stornoway ...	6 46	15–11	Tynemouth...	2 50	13			
Sanguir I.....		6	Suez	0 30	6				Zinzibar.....	4 20	10
San Josef	10 0	30–20	Sunderland...	3 23	14–6	Union B......	3 10	12–6			
Sta. Cruz	9 30	40–18	Supà........	4 50	3	Upstart C. ...	9 0	6			

CONTAINING THE TRUE POSITIONS OF THE MOST PROMINENT AND CONSPICUOUS PLACES IN THE WORLD.

Selected on account of their height (which is given in this Table) or other remarkable appearance, with the view of their being readily identified by the Navigator when in sight, for the purpose of verifying or Rating his Chronometer, from time to time during the voyage. (See method of doing this at page 155).

The Longitudes are reckoned from the Meridian of Greenwich. The fractional parts of Minutes of Latitude and Longitude are given in tenths, which multiplied by six, will produce Seconds.

E. Coast of U. S. of America.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Isl'd of Campo Bello N. end..........	44 57	66 55
Quoddy Head Light	44 49·3	66 57
Grand Mannan S.W. end............	44 34	66 53
Mount Desart Rock Light House....	43 58	68 8·5
Martinicus Island lt.	43 46·4	68 49
Portland Lt. House.	43 36	70 12
Agamenticus Hill..	43 13	70 41
Cape Ann, Thatchchurn Island light	42 38·3	70 34·7
Salem City Hall...	42 31	70 54
Boston Light House	42 19	70 53·6
Cambridge Observatory............	42 23	71 7·4
Cape Cod Light....	42 2	70 3·3
Monomoy Light...	41 33·5	69 59·3
Nantucket Har. light	41 16·4	70 4·4
New Bedford L. H.	41 35·5	70 53·7
Newport Spire.....	41 29·2	71 18·5
Point Judith Light.	41 21·6	71 28.6
Block Island Light	41 13·4	71 34·2
New London L. H..	41 19	72 5·1
Montauk Point L. H.	41 4·2	71 51·1
N. Y. City Hall....	40 42·7	74 0·1
Sandy Hook Light.	40 27·7	73 59·8
Neversink Lights..	40 23·7	73 58·8
Barnegat Light H.	39 46	74 6
Little Egg Harb. Lt.	39 30·5	74 17·5
Cape May Light...	38 55 8	74 57·3
Cape Henlop'n L. H.	38 46·6	75 4·7
Philadelphia St.H..	39 56·9	75 8·7
Smith's Island light.	37 7·8	75 52·2
Cape Charles.....	37 7·3	75 57 9
Cape Henry light..	36 55·5	76 0·2
Richmond.........	37 32	77 27
National Obs'rvat'ry	38 53·6	77 2·8
Cape Hatteras....	35 15·2	75 30·9
Cape Lookout.....	34 37	76 33
Cape Fear........	33 48	77 57
George Town L. H.	33 12·5	79 10
Cape Roman......	33 1	79 24
Charlestown L. H..	32 41·9	79 52·5
Tybee Light......	32 0	80 52
Light on St. Simon's Island.........	31 8	81 36
Cumberland Island Light..........	30 45	81 37
St. Augustine L. H.	29 52 3	81 25
Cape Carneveral...	28 27	80 33
Bald Head.......	27 1	80 11
Cape Florida Light	25 39·9	80 5
Key West Light..	24 33	81 47·3
Tortugas Island, S. W. end.........	24 31	83 7
St. Mark's Light H.	30 4	84 10
Cape St. George...	29 35	85 4
Pensacola Light...	30 19	87 16·9
Mobile Point Light.	30 13·8	88 0·5
Mobile, Barton's Academy.........	30 41·4	88 1·9
Mississippi River..		
" a. l. Outre Pass	29 14	89 0
" Balize.......	29 8·5	89 1·4
" S. E. Pass....	29 6	88 57
" S. Pass......	28 59·7	89 7·4
" S. W. Pass...	28 58·5	89 20
New Orleans......	29 57·5	90 0
Racoon Point......	29 3	90 57
Sabine River ent...	29 40·6	93 49
Galveston entrance.	29 20·5	94 45
Rio Grande.......	25 56	97 12

Coast of California.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
St. Diego Pt. Loma	32 38·8	117 14·7
St. Catalina Island.	33 28	118 38
Santa Cruz Island, W. end.........	34 10	119 47
Point Conception..	34 31	120 30
Mount Buchon....	35 18	120 50
Point Pinos.......	36 38·5	121 55
Montery Fort.....	36 36·4	121 53
Farallones Rocks pk.	37 42	122 59
San Francisco Fort, S. side entrance.	37 48·5	122 28·5
Mt. Bolbones 3765 ft. 10 leag. inland	37 52.9	121 54·5
Cape Mendocino...	40 29	124 32
Cape Perpetua....	44 12	124 17
Pt. Adam entrance, Columbo River..	46 12	124 1
Cape Disappointm't	16 16	124 5
Astoria City......	46 10	123 49
Pacific City.......	46 20	124 3
Gray's Harbor, N. Head...........	47 0	124 7
Cape Flattery S side ent. of the Straits of Juan de Fuca.	48 9	124 46

Islands in the West Indies.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Island of Trinidad, Point Galiote....	10 9	60 59
" Point Galera....	10 50	60 54
Tobago, N. E. end..	11 20	60 27
Granada, S. end...	11 59	61 45
Barbadoes, E. end..	13 7	59 30
" Bridgtown Engineer's wharf....	13 4·2	59 37
St. Vincent, Kingst'n	13 13	61 15
" N. E. Point..	13 18	61 20
St. Lucia, N. Point.	14 5	60 57
Martinique Mt Pelcé 4450 feet.......	14 48	61 10
" Fort Royal......	14 36	61 4
Dominica, N. end...	15 38	61 26
Guadaloupe, N. end	16 31	61 35
" Mt. Souffriere, 5500 feet........	16 5	61 39
Deseada, N. end....	16 20	61 12
Antiqua, S. end....	16 59·5	61 45
" Fort James..	17 6·7	61 51·2
Montserrat N. E. end	16 50	62 12
Redonds Isl'd centre	16 55·5	62 18·7
Nevis, Charlestown.	17 8·8	62 42
St. Kitts, Mt. Misery, 3711 feet........	17 22	62 48
Barbuda, S. E. end.	17 33	61 43
St. Cruz Observat'ry	17 44·5	64 41
Anegada, W. end..	18 45	64 21
St. Thomas, Fort Christian.....	18 20·4	64 55·7
Porto Rico, Cape St. John.........	18 23	65 36
" St. Augustine Battery...........	19 29	66 7·1
" Cape Mala Pasqua	17 59	65 49
Mona Island, E. Pt..	18 5	67 50
St. Domingo, Cape Engano.........	18 35	68 20
" St. Domingo City	18 28	69 50
" Cape Tiberon...	18 22	74 28
Jamaica, Morant Pt.	17 56	76 11
" Kingston........	17 58	76 46
" Savannah la Mer..	18 12·3	78 8·5
" Montego Bay.....	18 29·4	77 56
" Falmouth Har F't.	18 30·6	77 40
" Port Antonio.....	18 11·3	76 27
Little Cayman, East end............	19 42	79 58
Grand Cayman, Fort George.........	19 17·7	81 23·5
Cuba, St. Jago De Cuba............	19 55·9	75 50·5
" Tarquina P'k., 10-700 ft..........	20 3	76 51
" Cape Cruz.......	19 50·4	77 45
" Manzanillo........	20 20	77 20
" Isle of Pines, Cabellos..........	21 57	82 53
" S. W. Point.....	21 37	83 13
" Cape St. Antonio.	21 51·5	84 57·2
" Mt. of Guagibon 2532 feet high...	22 48	83 24
" Havana, the Moro	23 9·4	82 22
" Pan of Mantanzas 1277 feet.......	23 1·9	81 45
" Matanzas.......	23 3	81 40
Turks Island, N. end	21 32	71 10
North Caycos, centre	21 56	72 0
Great Heneaga, N. E. end..........	21 20	73 0
Little Heneaga, E. Point..........	21 29	72 55
Crooked Isl. S. Point	22 7	74 21
Rum Key, S. Point.	23 37	74 50
St. Salvador, E. Pt., Laud. p. of Columb.	24 8	75 17
New Prov. Nassau L. House.......	25 5·6	77 21·2
Andros Isl., N. end.	25 4	77 57
Bemina Island, S.W. Point..........	25 41	79 20
Little Isaac, centre.	25 58·5	78 51·3
Great Isaac, centre.	26 2	79 5
Gun Key Light....	25 34	79 18·4
Key Lobas Beacon, 20 feet.........	22 22·5	77 35·5
The Hole in the Wall Lt. House..	25 51·5	77 10·6
Great Bahama, W. end............	26 42	79 1
" East end........	26 40	77 48
Double-headed Shot Keys Light......	23 56·5	80 26·5
" Salt Key, N. Point	23 41·7	80 25
" Anguilla Isl. E. Pt.	23 30	79 32

Coast of Mexico.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Tampico, N. Point..	22 15·5	97 46
Cape Roxo	21 35	97 17
Vera Cruz, St. Juan de Ulloa Lt.....	19 11·9	96 8
Ourizaba Mt. 17,400 feet............	19 2·3	97 13
Cofre del Perote Mt., 13,400 ft.......	19 29	97 7

See Position of Places, Pages 244 *and* 245.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Port Laguna Brit. Cons. Ho.	18 38·4	91 50·7
Campeachy	19 50	90 33
Sisal Fort	21 10·1	90 2.7
Cape Catoche N. Pt. Jolbos Isl.	21 36	87 6

Islands in Gulf of Mexico.

Triangles, 3 isl'ds., E. one	20 54·9	92 13
Alacranes, N. Pt.	22 35	89 49
Half Moon Key Lt.	17 12	87 33

British Honduras.

Belize, Ft. St.George	17 29·3	88 12
Cockscomb Mt. 4000 feet	16 48	88 38
Omoa, St. Fernando Fort	15 47	88 3
Saddle Hill, 1760 ft.	15 45	79 58
Cangrijo Pk., 8040 feet	15 38	86 53
Truxillo Fort	15 55·7	85 59·5
Cape Honduras	16 2	86 4

Coast of Honduras.

Port Royal harbor	16 24·3	86 19·2
Bonacco Isl'd. Sum. 1200 feet	16 28	85 55
Poyas Pk., 3700 ft., 12 m. inland	15 44	84 56
C. Gracias à Dios	14 59	83 11

Mousquito Coast.

Caxones or Hobbies E. Pt.	16 3	83 6
St. Andrew's Isl'd. S. W. cove	13 21·7	81 44
Blewfield's W. Pt. of Bluff	11 59·3	83 41·5
San Juan de Nicaragua, or Grey Town	10 55	83 43

Gautemala, N. E. Coast.

Point Arenas	10 56·7	83 42.2
Mt. Cartago, 11,100 feet	10 2	83 48
High Pk., 5251 ft., 6 m. S. S. W. from Buppan Bluff	8 42·7	81 30

Isth. of Panama, N. Coast.

Chagres, San Lorenzo Fort	9 19·7	79 59.2
Porto Bello, Fort Jeronymo	9 32·5	79 38.5
Cape Tiberun	8 41	77 25

New Granada.

Carthagena Dome	10 25·6	75 34
S'ta. Martha Morra	11 15	74 16
Pt. Gallinas	12 25	71 44
Maracaybo, bar. ent.	11 2	71 41
Town 20 m. up the lake	10 41	71 40

Coast of Venezuela.

Los Roques, S. E. pt. Light	11 48	66 33
Porto Cabello	10 29·4	68 0

Caraccas.

Caraccas, 3000 feet, 7 m inland	10 30	66 54
Pk. or Silla de Caraccas, 5 m. inland	10 32	66 50

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Morro of Barcelona City	10 13·5	64 40
Cumana Fort Boca	10 27·6	64 11
Pt. Foleto mouths of the Oronoco R.	10 0	62 18
" East Mouth, Crab Island, N. pt.	8 42	60 55

Guiana.

Demarara Bar bea	6 58	58 14
George Town Light	6 49·4	58 11·5
Berbice R., Crab Isl.	6 21	57 33
River Surinam, Fort Amsterdam	5 48	55 9
Paramaribo Ch.	5 44·3	55 13
Cayenne Fort	4 56·5	52 20
Cape Cachipour, N. E. point	3 46	51 3
Cape North, ent. to the Riv. Amazon	1 42	49 48

River Amazon.

Bailque Isl., N. pt.	1 4	49 56
Macapa Fort	0 0·8	51 2
Mexiana Isl. E. pt.	0 0	49 19

Coast of New Brunswick.

St. Andrews, S. Pt. Light	45 4·3	67 3
C. Lapreau Lights	45 3·7	66 27
St. Johns, Partridge Island Light	45 14·1	66 3·5
Cape Spencer	45 12	65 55
Cape Enrage Light	45 32	64 46
Annapolis harb. Pt. Prim	44 41	65 45
Bryer's Isl. Light	44 16	66 22

Nova Scotia.

Seal Isl. S. pt. Light	43 24	65 58
C. Sable, S. E. pt.	43 24	65 36
Shelburne Har. S. E. pt. M'Nut Isl. L'ts.	43 37·5	65 15
Sambro Isl. Light	44 26·3	63 35
Halifax Dock Yard Tablet	44 39·7	63 35·5
Cranberry Isl. Light	45 20	60 56
Cape Canso	45 18	60 56
Gut of Canso, N. W. entr. Light	45 41·8	61 29·5
Cape St. George	45 52	61 52
Pictou Har. Light	45 41·5	62 40·2

Cape Breton Island.

C. St. Lawrence	47 2	60 38
Port Hood. Just au Corps Island	46 0	61 36
Cape Hitchenbroke	45 34	60 42
Louisburg	45 53	60 0
Scatary Island N. E. Point Light	46 2	59 41
Sidney Harbor Lt.	46 16	60 8
Cape North	47 3	60 25
St. Paul's, N. pt. lt.	47 14	60 9

Magdalen Islands.

Deadman's Island	47 16	62 14
Amherst, S. W. Pt.	47 14	62 2
Entry Island	47 17	61 42
Cross Island, E. Pt.	47 48	61 25·2
Bird Islands E. one	47 51	61 9·7

Prince Edward's Island.

Charlotte Town, fort George	46 14	63 7
" East Point	46 27	61 58
" North Cape	47 4	64 1

Anticosti Island.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Heath or E. Point	49 5·4	61 45·2
S. W. Point Light	49 23.8	64 23·5

Coast.

Macquereau Point	48 12	64 48
Chaleur Bay, Carlisle	48 1	65 16
Dalhousie Island	48 4·4	66 22·2
Miramichi, Portage Island, N. Point	47 14	65 2
Pt. Escumenac light	47 5	64 46
Richibucto Harbor mouth	46 42	64 51
Fort Monckton	46 3	64 4
Cape Gaspé	48 45·2	64 10
St. Anne's Mounts, N. E. one 3973 ft.	48 52	66 49
Cape Chatte extremity	49 6	66 46
Wolfe and Montcalm Monuments	46 48·6	71 13·5
Quebec, N.E. bastion	46 49·1	71 13·7

Newfoundland.

Cape St. George	48 29	59 16
Cape Anguile	47 53	59 25
Cape Ray, S. W. extremity	47 37	59 18
Miquelon, Mt. Calvaire at N. W. Pt.	47 7	56 25
St. Pierre Isl'd, S. E. Point	46 45	56 12
Placentia Har. castle	47 15	54 4
Cape Pine Light	46 37	53 36
Cape Race	46 40	53 7
St. John's Light on South Head	47 33·6	52 43
Trinity Harbor, Hog Nose	48 21	53 24
Cape Bonavista Gull Island Light	48 42	53 8
Cape Bauld	51 38	55 24
Belle Isle, N. E. Pt.	52 1	55 17
Cape Farewell	59 49	43 54
Staten hock	59 50	40 39

Iceland.

Reikiavig	64 8·4	21 55·2
Mt. Heckla, 5364 ft.	63 58	19 41

Faroe Islands.

Fugloe Island, E. Pt.	62 20	6 13
Monk Rock	61 20	6 41

Shetland Islands.

Fitful Head, 929 ft.	59 54	1 24
Fugloe Skerry	60 20·4	1 45
Balta Island, S. end	60 44·4	0 47·7
Noss Head, 577 feet	60 8·3	1 0·5
Lerwick Fort	60 9·4	1 8·7
Sumburgh Head Lt.	59 51·3	1 17
Fair Island summit	59 33	1 38

Orkney Islands.

Moul Head	59 23	2 53
Noup Head	59 20	3 4·0
N. Ronaldsay Island, E. Point	59 23	2 24
" Stromness or S. pt.	59 20	2 26
Start Light	59 16·6	2 22
Stronsa Isl'd, Lamb Head	59 4·9	2 32
Stromness Church	58 57·8	3 17·5
Kirkwall Light	58 59·2	2 57·2

NAMES OF PLACES.	LAT. N. ° '	LON. W. ° '
Old Head	58 44·3	2 55·5
Rockal, centre	57 36	13 41
St. Kilda, pk. 1220 ft.	57 49	8 34·7
Flannen Is'ld, N. W. extremity	58 13	7 37
Rona Island, S. E. summit, 360 feet	59 7	5 48·5

Hebrides.

Butt of Lewis	58 31	6 14
Stornaway Lt. house	58 11·5	6 22·2
Shiant Isl'ds, N. W. one	57 33	6 24
Glass Island Light	57 52	6 33
S. Uist, East Point	57 13	7 11
Barra Hd. Lt. 680 ft.	56 47·1	7 39·2
Pentl'nd Skerries lts.	58 41·2	2 55

North Coast of Scotland.

Duncansby Head	58 39	3 1
Dunnit hd. lt. 346 ft.	58 40·4	3 21·2
Thurso	58 33	3 31
Cape Wrath Light, 400 feet	58 37·5	4 59
Point of Aird	57 39	6 18
Canna Island, W. Pt.	57 4	6 34
Rum Island, S. Pt.	56 56	6 23
Muck Island, W. end	56 49	6 19
Tirey Island, S. end	57 27	6 56
Skerryvore Lt. 150 feet	56 16·4	7 6·5
Ben More, 3168 feet	56 25·5	6 0·7
Isle of Mull, N. W. end	53 36	6 20

West Coast of Scotland.

Ben Nevis, 4368 feet	56 48	5 0
Fort William	56 48	5 5
Lismore Isl. Lt. 96 ft	56 27	5 36
Oban Free Church	56 25·9	5 31·7
Rhinns of Isla Light	55 40	6 33
Mull of Cantire Lt.	55 20	5 49
Campbelton Light	55 25	5 35·5
Glasgow N. Bridge	55 51·9	4 16
Greenock Spire	55 56·9	4 45·2
Cumbræ Light	55 4·6	4 59·7
Ardrossan Lights	55 38·7	4 50·5
Pladda Lights	55 25·6	5 7
Ailsa Craig summit 1098 ft.	55 15·2	5 7
Corsewall Pt. Light	55 0·5	5 9·5
Mull of Galloway Lt	34 38·1	4 51·1
Mary Port, S. Pier	54 43	3 30·5
Workington Lights	54 38·9	3 34·5
Whitehaven Lights	54 33·2	3 35·7
St. Bees Head light, 333 feet	54 30·8	3 38

Isle of Man.

Peel Light	54 13·6	4 42
N. Pt. Ayr Pt. light	54 25	4 22
Douglas Light	54 9	4 28
Calf of Man Lights	54 3·2	4 50

W. Coast of England.

Black Comb, 1919 ft.	54 15·5	3 19·5
Walney Isl. S. pt. lt.	54 2·9	3 10·5
Crosby Light	53 31	3 4
Liverpool Observatory	53 24·8	3 0·0
Bell Beacon	53 31·2	3 15·5
Formby Light	53 31	3 9·5
N. W. Light vessel	53 27·4	3 17·7
Point of Air Light	53 21·9	3 19·0

Coast of Wales.

NAMES OF PLACES.	LAT. N. ° '	LON. W. ° '
Great Orme's Head, signal staff	53 20	3 51·2
Point Lynas Light	53 25	1 14·2
Skerries Light	53 25·3	4 36·5
Holyhead Light	53 20	4 37
S. Stack Light	53 18·3	4 42
Caernarvon Light	53 8·5	4 24·7
Bardsey Island Lt.	52 45	4 48
Snowdon, 3580 feet	53 4·1	4 4·5
Cardigan Isl'd summit	52 7·9	4 41·5
South Bishop Light	51 51·4	5 24·5
Small's Rocks light	51 43·3	5 40
Pembroke Dockyard N. W. corner	51 41·8	4 57·2
Milford Church	51 42·7	5 1·5
St. Ann's Lights	51 41	5 10·5
Caldy Isl'd, S. pt. lt.	51 37·9	4 41
Worms Head	51 34	4 20
Swansea Pier Light	51 37	3 56
Mumbles Light	51 34	3 58·2
Cardiff Custom H.	51 28·6	3 10
Newport, Usk Light	51 32·4	2 59·7
Bristol Cathedral	51 26·8	2 35·5
Flatholm Isl'd light	51 22·6	3 7
Bideford or Braunton Lights	51 4·5	4 12
Lundy Isl'd Lights	51 10·1	4 40·2
Padstow Church	50 32·5	4 56
Trevose Head lights	50 33	5 2
St. Ives Steeple	50 12·3	5 26·5
Cape Cornwall	50 7·7	5 42·5

Scilly Islands.

St. Mary's flag staff.	49 55	6 19
Saint Martin's Day Mark	49 58	6 16
St. Agnes Light	49 53·6	6 20·7

South Coast of England.

Seven Stones light vessel	50 3	6 7
Longships Light	50 4·1	5 44·7
Wolf Rock Lt. to be	49 56·7	5 48·2
Penzance Lt. Pier	50 7·1	5 31·5
Lizard Lights	49 57·7	5 12
Falmouth, Pendennis Castle	50 8·8	5 2·7
" St. Anthony light	50 8·3	5 1
Deadman sum., 379 feet	50 13	4 48
Rame Head	50 19	4 13
Plymouth Breakwater, W. end Light	50 20·3	4 9·5
Bolt Head flag staff	50 13·2	3 48·7
Start Point Light	50 13·4	3 38
Dartmouth Light	50 21	3 33
Berry Hd. flag staff	50 24	3 28
Torquay	50 28	3 30
Portland Lights	50 31·4	2 26·7
St. Albans Head	50 35	2 3
Isle of Wight.		
Needles Light	50 39·9	1 34
St. Catherine's pt. lt.	50 34·5	1 18
Cowes Castle	50 46	1 17·7
Hurst Lights	50 42·4	1 32·7
Southampton, Saint Michael's Spire	50 54	1 24·2
Portsmouth, R. N. College	50 48	1 6·2
Ower's Light vessel	50 40	0 40
Brighton Pier Light	50 49	0 8

NAMES OF PLACES.	LAT. N. ° '	LON. E. ° '
Beachy Head Light	50 44·4	0 12·7
Dungeness Light	50 55	0 58
Dover Castle Light	51 7·8	1 19·5
S. Foreland Lights	51 8·4	1 22·5
S. Sand Hd. Lt. vessel Goodwin sands	51 10	1 28·2
N. Sand Lt. vessel "	51 19·5	1 33·5
Sandown Cas. center	51 14.3	1 24·2
Ramsgate Pier light	51 22·5	1 26·7
N. Foreland Light	51 22·5	1 26·7
Margate Light	51 23·4	1 23·2
Nore Light vessel	51 29	0 48
Chatham Dockyard	51 23·8	0 35
Sheerness flag staff	51 26·8	0 44·7
Greenwich Observatory	51 28·6	0 0·0
London, St. Paul's Cathedral	51 30·8	W. 0 5·7

East Coast of England.

		E.
Mouse Light vessel	51 31·8	1 0·2
Swin Middle Lt. ves.	51 39	1 7
Sunk Light vessel	51 46·7	1 28·2
Kentish Knock	51 39·7	1 39·5
Shipwash Lt. vessel	52 1·5	1 37·7
Galloper Lt. vessel	51 45	1 55·7
Harwich Lights	51 56·6	1 17·5
Orfordness Lights	52 4·8	1 34·2
Aldborough Steeple	52 9·2	1 36
Pakefield Light	52 26·2	1 43·5
Lowestoft Lights	52 29·3	1 45·5
Yarmouth Spire	52 36·8	1 43·7
Winterton Light	52 43	1 41
Hasborough Lights	52 49·4	1 32
Cromer Light	52 55·7	1 19
Leman and Owen Light vessel	53 8·5	2 1·5
Dudgeon light vessel	53 15·2	0 56·2
Spurn Light vessel	53 34	0 13·5
Spurn Lights	53 34·7	0 7·2
		W.
Hull Citadel	53 44·6	0 20
Flamborough Hd. lt.	54 7	0 5
Scarborough Light	54 17	0 23·5
Whitby Light	54 29·7	0 36·7
Redcar Church	54 36·9	1 3·5
Hartlepool Pier lt's	54 41·8	1 10·7
Sunderland, N. Pier Light	54 54·5	1 22
Newc'stle Bridge, N. end	54 58·7	1 35·5
Tynemouth Light	55 1·3	1 25
Coquet Island Light	55 20·1	1 32·2
Cheviot Hill, 2658 ft.	55 29	2 9
Longstone Light	55 38·7	1 36·5
Farne Island Lights	55 37	1 39·2
Holy Island Castle	55 40·2	1 47
Berwick Light	55 46·2	2 0

East Coast of Scotland.

St. Abb's Head, signal staff	55 55	2 8
Dunbar Church	55 59·9	2 31
Bass Rock, centre	56 4·7	2 38·2
Inch Keith Light	56 2	3 8
Edinburgh Observatory	55 57·4	3 11
Leith Pier Lights	55 58·9	3 10·5
May Island Light	56 11·1	2 33·2
Bell Rock Light	56 26	2 23
Dundee Lights	56 27·6	2 57·7
Buddoness Lights	56 28·1	2 45
Montrose Lights	56 42·5	2 28
Girdleness Lights	57 8·2	2 3·0
Aberdeen Lights	57 8·9	2 5·7

TABLE XXXIX.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Buchanness Light..	57 28	1 46
Pet'rh'ad, Keith Inch	57 30·1	1 46
Kinnaird's Head Lt.	57 41·7	2 1·5
Burgh Island......	57 42·1	3 30
Cromarty Point Lt.	57 41	4 2
Tarbetness Light..	57 50·9	3 48·5
Noss Head Light...	58 28	3 4
Shores of the North Sea.		E.
Dunkirk Light....	51 3·1	2 22
Ostend Lights.....	51 14·1	2 55
Antwerp Cathedral	51 13·2	4 24·2
Brielle Church....	51 54·2	4 10·0
Rotterdam Church.	51 55·3	4 29·5
Hague, S. James Ch.	52 4·3	4 18·7
Texel Island W. Pt	53 3	4 42
Haarlem, Great Ch. tower..........	52 22·9	4 38·5
Helgoland Isl'd Lt.	54 10·8	7 53
Elbe, outer Lt. vessel	54 0	8 18
Denmark.		
Cuxhaven Light...	55 53·7	8 43
Altona Observatory	53 32·7	9 56·7
The Skaw Pt. Light	57 43·8	10 36·5
Trindelen Lt. vessel	57 25·6	11 16
Anholt Island, E. Pt. Light....	56 44·3	11 39·2
Elsineur, Kronborg Light...........	56 2·2	12 37·5
Copenhagen Obsertory..........	55 40·9	12 34·7
Shores of the Baltic.		
Moen Isl'd, E. Pt. Lt.	54 57	12 33
Kiel Observatory..	54 19·5	10 9
Lubeck, St. Mary's Church.........	53 52·1	10 41·5
Wismar, St. Mary's Church..........	53 53·5	11 27·7
Rostock...........	54 5.5	12 9
Rugan Island, E. Pt.	54 21	13 48
Swinemünde Light.	53 56	14 17
Stettin..........	53 25	14 34
Dantzig Observat'ry	54 21·3	18 41·2
Pillau Light......	54 38·4	19 54
Memel Light......	55 43·7	21 6·2
Lyserort..........	57 34	21 34
Domesness Lights..	57 45.6	22 37
Riga Lights.......	56 57	24 6·5
Pernau, German Ch.	58 23·1	24 30·2
Dagerort Light....	58 55	22 12
Nargen Island Light	59 36·4	24 31
Revel, two Lights..	59 26·6	24 45·2
Ekholm Light.....	59 41	25 49
Rothskar Island Lt.	59 58	26 42
Hogland, two Lights	60 6·3	26 58·5
Tolbouklin Light..	60 2·6	29 34
Kronstadt Cath....	59 59·7	29 46·5
St. Petersburg Observatory.......	59 56·5	30 19
Wiborg..........	60 42·7	28 47
Sommers Isl'd Lt's.	60 12·4	27 39·5
Helsingfors Obs'rvatory...........	60 9·7	24 57·5
Sveaborg..........	60 8·4	24 59·7
Ronskar Light....	59 56	24 24
Lagskar..........	59 50·5	19 55·2
Stockholm Observatory...........	59 20·6	18 3·7
Grönskär Light....	59 17	19 2
Gothland, S. Point.	56 55·2	18 9
Oland, N. Hd. Light	57 22	17 6
Carlscrona........	56 9.7	15 35·5
Eartholms, N. Pt. Lt.	55 19	15 12

NAMES OF PLACES.	LAT. N. ° ′	LON. E. ° ′
Bornholm, N. Pt. Lt	55 17·7	14 46
" S. Point.	54 59	15 5
Falsterbo Light...	55 23	12 49·2
Helsingborg Lt....	56 2·7	12 42·2
Warberg Castle...	57 6·4	12 14·5
Niddingen two Lt's.	57 18·2	11 54·3
Coast of Norway.		
Wingo Light......	57 38	11 36·2
Gottenburg........	57 41·3	11 54·5
Christiania, New Observatory.......	59 54·7	10 43·5
Flekkero Island...	58 2	7 57
Naze Light..... ..	57 57·8	7 2
Fuglöe...........	60 1	4 59
Bergen..	60 24	5 18
Christiansund Light	63 7	7 39
Rost Islands, middle	67 31	1 7
Hammerfest Church	70 40	23 42
N. Cape of Europe.	71 10·3	25 46
White Sea.		
Orlovsk Light.....	67 11·5	41 22·2
Onega, St. Michael's Church..........	63 53·6	34 38·7
Archangel, Trinity Church.........	64 32·1	40 33·5
Moudiuga Isl'd, left entr'nce R. Dvina	64 55·8	40 16·2
West Coast of Ireland.		W.
Cape Clear Light..	51 26	9 29
Fastnet Rk. lt. to be	51 23·3	9 36·3
Mizen Head......	51 27	9 50
Bear Island, summit	51 37·5	9 52·2
Roanharrick Isl'd lt.	51 39·2	9 44·7
Skellig's Lights....	51 46	10 32
Brea Head.......	51 33	10 25
Valentia Fort Light	51 55·8	10 19
Great Blaskett N. pt.	52 6	10 21
Kerry Head, River Shannon.........	52 23	9 55
Tarbert Light.....	52 35·5	9 21·7
Loup Head Light..	52 34	9 56
S. Arran Isl'd, summit of Ilanmore lt.	53 7·6	9 42
Black Head.......	53 9	9 17
Galway Mutton Isl'd Light...........	53 15·2	9 3·5
Slyne Head Lights.	53 24	10 14
Newport.........	53 53	10 11
Achil Hd. 2222 ft .	53 58	10 16
Eagle Island Lights	54 17	10 6
Downpatrick Head	54 20	9 21
N. W. Coast of Ireland.		
Sligo Bridge......	54 16	8 28
Tillen Head 1415 ft. summit........	54 20	8 45
Bloody Farl'nd 1059 feet.............	55 8·2	8 15·7
Tory Island Light.	55 16·5	8 15
Fannet Point Light.	55 16·6	7 37·7
Innistrahul Light..	55 25·9	7 13·7
Innishowen Hd. lt's.	55 13·8	6 55·5
N. E. Coast of Ireland.		
Londonderry Bridge	54 59·6	7 19
Port Rush Pier....	55 12·4	6 39·7
Giant's Causeway pt.	55 14·7	6 30·7
Rachlin Isl'd lt. to be	55 17.6	6 11·7
Knocklayd Mt. 1690 feet............	55 9·7	6 15·2
Maiden Rocks lights	54 55·8	5 44·2
Belfast Spire......	54 36·4	5 56·2

NAMES OF PLACES.	LAT. N. ° ′	LON. W ° ′
Divis Mt. 1800 feet.	54 36·7	6 1
Copeland Lights...	54 41·7	5 31·2
Slieve Donard 2796 feet..............	54 10·8	5 55·2
Lambay Island sum.	53 29.6	6 1·0
E. Coast of Ireland.		
Howth Bailey light.	53 21·7	6 3
Dublin Observatory	53 23·2	6 20.3
Kish Light vessel..	53 19	5 56·5
Great Sugar Loaf 1651 feet.......	53 9·2	6 9
Wicklow Hd. Lights	52 57·9	6 0
Arklow Light vessel	52 42	5 59·7
W'xford, Rosslare pt.	52 10·9	6 22·2
Tuskar Rock Light.	52 12·1	6 12·2
Saltees Light vessel	52 2·3	6 40
Hook Light.......	52 7·4	6 55·7
Waterford Bridge..	52 16	7 6
S. E. Coast of Ireland.		
Duncannon Fort lt's	52 17·7	6 56·5
Roche Point Light.	51 47·5	8 15·2
Cork Custom House	51 53·8	8 27·7
Barry Head.......	51 42·1	8 23·2
Kinsale, Old Head Light...........	51 36·7	8 32·2
Galley Head, S. Pt.	51 31·8	8 57·0
Baltimore........	51 29	9 22
N. W. Coast of France.		E
Gravelines Light...	51 0.3	2 6·7
Calais Light......	50 57·6	1 51·2
Cape Grisnez Light	50 52·2	1 35·2
Boulogne Lt's N. E. Jetty..........	50 43·9	1 35·2
Dieppe, W. Jetty Lt.	49 56	1 5·2
Cape Ailly Light..	49 55·1	0 57·7
Cape de la Heve lt's	49 30·7	0 4·2
Havre, N. Jetty Lt.	49 29·3	0 6·7
Paris Observatory.	48 50·2	2 20·5
Honfleur Lights...	49 25·5	0 13·7
		W.
La Hougue Lights..	49 34·3	1 16·2
Cherbourg Church.	49 38·6	1 37·2
Cape La Hague Lt.	49 53·4	1 57
Channel Islands.		
Alderney, St. Anne's Church.........	49 42·9	2 12·2
Caskets Lights....	49 43·4	2 22·5
Guernsey, Jerbourg Tower, 390 feet..	49 25·3	2 33
" Doyle Fort, N. E. Point..........	49 30·1	2 31·2
Jersey, St. Helier's Lights.........	49 11·3	2 7
" S. E. Pt. Seymour Tower.........	49 9·4	2 1·1
W. Coast of France.		
Cape Carteret Light	49 22·4	1 48·2
St. Malo Light....	48 39	2 1·5
Cape Frehel sum. lt.	48 41·1	2 19
Morlaix Lights....	48 38·2	3 53
Ushant Light......	48 28·5	5 3·2
Brest Observatory.	48 23.6	4 29·2
Penmarc'h Rocks Lt	47 47·9	4 22·2
L'Orient tower.....	47 44·7	3 21
Port Navalo Pt. Lt.	47 32·9	2 55
Port Saint Nazaire, Mole Light.....	47 16·3	2 11·7
Rochelle Lt. Tower.	46 9·4	1 9·2
Rochford Hospital.	45 56·6	0 57·7
Bordeaux, St. André	44 50·3	0 34·5

North Coast of Spain.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
St. Sebastian Light.	43 19·2	2 0·5
Cape Villano	43 27	2 58
Bilbao St Nich. Ch.	43 15·8	2 54
Santona Mt. summit	43 27·5	3 26
Santander mole lt's.	43 27·9	3 48·7
Cape Blanco	43 35	6 47
Island Pancha, West extremity	43 34·7	6 59·2
Cape Burela	43 42	7 21
Cape Vares summit	43 48	7 41
Cape Ortegal tower	43 45·2	7 56
Ferrole Mole	43 29·5	8 12·7
Coruña, St. Antonia Castle	43 22·5	8 22·7
Cape Finisterre light to be	52 54	9 15
Mt. Louro, 787 feet.	42 44	9 44
Viana Fort, St. Jago Light to be	41 42·6	8 43·2

Coast of Portugal.

Mt. Ornellas, high	40 50	8 21
Oporto Fort, St. John	41 8·8	8 37·2
" Light	41 9·1	8 37·5
Cantaros Mt. summit 6460 feet	40 19	7 38
Cape Mondego light to be	40 12	8 54
Figueira Light to be	40 10	8 51
Burling's Light	39 25	9 30·7
Cape Roca Lt. 598 ft.	38 46	9 30
Mt. Cintra summit, 1720 feet	38 47·2	9 25
St. Julian Fort light	38 40·3	9 20·5
Lisbon, Marine Observatory	38 42·4	9 8·2
Cape Espichel Light 627 feet	38 24·9	9 13
Selubal Light, 490 feet	38 28·9	8 53
Monchique Mount'ns summit 3830 feet.	37 20	8 36
Cape St. Vincent Lt	37 2·9	9 0·0
Cape Sta. Maria Lt.	36 56	7 46
Mount Figo, 2000 ft.	37 10	7 42
Cadiz New Obs'rt'ry	36 27·7	6 12
C. Trafalgar Tower.	36 10	6 1
Tarifa Light	36 0	5 36

N. W. Coast of Africa.

Cape Spartel W. Pt.	35 48	5 55
Mt. Habile, 3000 ft.	35 28	5 43
Sallee	34 2·7	6 46
N. C. Blanco, 170 ft.	33 8	8 38
Mogador	31 30·5	9 46·2
C. Ghir, 1235 ft. pt.	30 38	9 50
Mt. Sum. East of C. Ghir, 4400 feet	30 39	9 33
Fogo Pk., 2970 ft.	29 11	10 6
C. Bajador, W. pt.	26 7	14 29
Down of Cintra or pk'd sand hill	23 5	16 10
Senegal Lt.	16 0·8	16 33
C. Verd, extreme	14 43·1	17 34
R. Gambia Bathurst flag-staff	13 28	16 35
M. Kakulimah, 2900 feet	9 45·8	13 28

Gulf of Guinea.

C. Sierra Leone Lt.	8 30	13 18
Freetown N. Battery	8 29·9	13 14·5
Bananas Is'l Gov. ho.	8 8	13 11·7
C. Mount Pk. 1060 ft.	6 43	11 21

Liberia.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
C. Mesurada Lt.	6 19	10 50
Monrovia Gov't. ho.	6 19·1	10 49
Marshall Agts. ho.	6 8·1	10 22·7
Grand Bassa Amer. Agent's ho.	5 54·1	10 4

Grain Coast.

Trade Town	5 44	9 54
Mt. Tobacco, 830 ft.	5 47	9 44
Pt. Sanguin	5 12·7	9 20·2
King William Town Eurp. Factories	4 49	8 43
Cape Palmas Lt.	4 22·1	7 44·2

Ivory Coast.

Oval Mt., 1315 ft.	4 57	6 48
King George Town.	4 58	6 3
C. Lahou	5 11	4 31
Axim, Dutch Ft.	4 52·3	2 14·7
C. Three Pts. S. extremity	4 44·7	2 5·7

Gold Coast.

Dix Cove Fort	4 47·8	1 56·7
Elmina, Dutch Ft.	5 4·8	1 22·2
C. Coast Castle Lt.	5 5·4	1 13·7
Camel's Hump, 1200 feet	5 37	0 31

Bight of Benin.

	N	E.
R. Volta W. Pt. ent.	5 46	0 41·2
Quitta, Danish Ft.	5 55	0 59·7
Whydah Flag-staff.	6 18	2 5
R. Quorra, or Niger E. Pt.	4 17	6 4
New Calebar R. entr. W. Pt.	4 23	7 1
Bonny R. entr. E. pt.	4 23	7 8
Old Calebar, Tom Shot's Pt.	4 36	8 19
Mt. Cameroons, 1376 feet	4 13	9 12
C. Cameroons	3 55	9 30
Rumby Mont's sum.	4 57	9 18
The Mitre, 3940 ft. S. Sum.	1 20	9 57
Gaboon R. S. pt. ent.	0 22	9 23
King George Tower.	0 8	9 44

Islands in the Bight of Biafra.

Fernando Po. C. Bullen, or N. Pt.	3 48	8 43
" Peak, 10710 ft.	3 35	8 47
" S. Pt. or C. Barrow	3 13	8 43
" Clarence Co. Adelaide Isle	3 46	8 47·5
Princes Isl'd Ft. Sta. Anna	1 39·5	7 26·5
" Diamond Rks. off N. E. Pt. large one.	1 40·7	7 27·7
" Brothers, 2 Isl ds. S. one	1 21·1	7 17·5
St. Thomas Island, Sum. 7020 ft.	0 14·7	6 33
Ilha das Rollas off S. Pt.	S. 0 0·5	6 30
Annobona, N. Pt.	1 24·3	5 38·2
" S. extr. rock off.	1 28·6	5 36·7

Islands in the N. Atlantic Ocean.—Madeira.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Desertas sm. 1610 ft.	32 31·3	16 30·7
Madeira, E. Pt.	32 43·4	16 39·5
Funchal, B. Cons'late	32 37·7	16 54·7
Pico Ruivo, 6100 ft.	32 45	16 57
W. End or Pargo pt.	32 48	17 17
Great Salvage W. S.	30 7·5	15 51·2
Great Piton sum.	30 1	16 0·2
Alegranza, S. W. sum. 939 ft.	29 23·3	13 31·5
Graceosa, S. W. Pt.	29 12·7	13 32·7
Lanzarote, N. W. Pt.	29 2·7	13 48
" S. pt.	28 50	13 47
Fuerteventura, N.W. Point	28 42	14 1
" Port Cabras	28 29	13 51·7
" S. Pt. or Pt. Jandia	28 3	14 31

Canary Islands.

Grand Canary, N. W. Pt.	28 9·6	15 43·2
" Palmas mole head	28 7	15 25
" South Pt.	27 43·8	15 34
" Isleta sum. 847 ft.	28 10	15 25·5
Tenerife Isl'd., N. Pt. Anaga Rk.	28 36·5	16 8·5
" Santa Cruz, Brit. Consulate	28 28·2	16 14·7
" S. Pt. or Pt. Rasca	28 0	16 41·2
" Peak 12.172 ft.	28 16·5	16 39
" W. extremity	28 20·5	16 55
Gomera W. Pt. sum. 1440 ft.	28 6·7	17 13·5
Ferro W. extr. (or Merid. of Ferro)	27 42·5	18 9·7
Palma, N. Pt.	28 51·3	17 53·5
" Santa Cruz, Fort San Miguel	28 40·5	17 44·5
Corvo, N. Pt.	39 43·5	31 7·2
Flores, N. Extr.	39 31·6	31 13
Fayal, W. Pt.	38 35·6	28 50·5
" Horta, Sta. Cruz Castle	38 31.7	28 28·5

Azores Islands.

Pico Peak, 8400 ft.	38 28	28 25
St. George, S. E. end.	38 32·5	27 46·7
Graciosa, W. Pt.	39 4·2	28 4·7
Tercera sum. 3495 ft	38 43·5	27 10·5
St. Michael, E. Pt.	37 48·3	25 8·2
" Delgada Lt.	37 44·2	25 40·7
" W. Pt. or Pt. Ferraria Lt.	37 51·7	25 52·2
S. Mary sum. 1660 ft	36 58·5	25 6·2

Cape Verd Islands.

St. Antonio, N. Pt.	17 12	25 5·7
" W. Pt.	17 4	25 22·5
" Summit 7400 ft.	17 4	25 17
" S. Pt.	16 54·7	25 18·5
" E. Pt.	17 5·5	24 59
St. Vincent, S. Pt.	16 47	24 59
St. Lucia, N. Pt.	16 49	24 47
Bianca, N. Pt.	16 41	24 41·5
St. Nicholas, N. Pt.	16 42	24 20·5
" " E. Pt.	16 34·5	24 0
" " S. Pt.	16 28	24 18·5
" " W. Pt.	16 37·7	24 26·2
Sal, N. Pt.	16 51	22 55
" Martinez Peak, 1340 ft.	16 49	22 56
" South Pt.	16 34	22 57
Bonavista, N. Pt.	16 14	22 57
" S. Pt.	15 57	22 49·5
" W. Pt.	16 2·3	22 59·5
Mayo, N. Pt.	15 19	23 12

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Mayo, S. Pt.	15 6·5	23 10·5
" English town, flag staff hill	15 8·3	23 13·2
St. Jago, E. Pt.	15 1	23 26
" Pt. Praya, Quail Is	14 54	23 30·7
" Mt. St. Antonia, 7400 ft.	15 2	23 39
" West Pt. extr.	15 17·3	23 48
" N. or Bighude Pt.	15 19	23 46
Fogo N. Pt.	15 1·5	24 21·5
" Peak, 9760 ft.	14 56	24 20
Brava, W. Pt.	14 49·7	24 45·2
" S. Pt.	14 46	24 42·7

Bermuda Islands.

Dock Yard Clock	32 19	64 52
Wreck hill	32 16·3	64 55
Light, 365 ft.	32 14·7	64 52

St. Paul's Islet.

Penedo de San Pedro, or St. Paul's Mid. Rk., 60 ft.	0 55·5	29 23

Coasts of Med. Sea.—S. Coast of Spain.

Palomos Isl'd	36 4	5 26
Gibraltar Mole	36 7·3	5 21·2
Europa Pt. Lt. 150 ft	36 6·7	5 22

Coast of Morocco.

Ceuta Lt.	35 54	5 18
Tangier Consul's ho. Lt.	35 47·2	5 48·5

S. Coast of Spain.

Estepona	36 25	5 9
Sierra Bermeja Mt.	36 29	5 12
Fuengiro Castle	36 32	4 37
Malaga Mole Light, 125 feet	36 43·5	4 26
C. Sacratif	36 41	3 28
Corchuna, Castle	36 41	3 25
Almeria, Town	36 50	2 32
Cape De Gath Cas'le	36 43	2 12
		E.
Pt. Mesa Tower	36 55	1 58
C. De Cope	37 25	1 32
Mt. Roldan	37 25	1 2

E. Coast of Spain.

Cartagena Mole Lt.	37 36	0 56
C. de Palos Tower	37 36·5	0 40
C. Cervera	38 0	0 38
Plana Isl'd, E. extre.	38 10	0 26
Alicante Castle Lt.	38 20·7	0 26
Mt. Roldan Gap	38 36	0 12
Cape St. Antonio	38 48·5	0 10
		W.
Cape Cullera Tower	39 12	0 13
Valencia Lt.	39 28·6	0 24
		E.
C. Oropesa Pt. tower	40 5·2	0 10
Columbretes Islands N. Rock	39 54	0 44
Port Alfaques, San Carlos	40 37·7	0 35
Tortosa Cath.	40 48·8	0 33
Tarragona Lt.	41 7	1 16
Barcelona Mole Lt.	41 22·6	2 11
Monserrato Mt.	41 34	1 55
Cape Tosa Tower	41 43·2	2 58
C. St. Sebastian sum.	41 53	3 13
C. de Creux, E. extr. of Spain	42 19·2	3 20

S. Coast of France.

NAMES OF PLACES.	LAT. N. ° ′	LON. E. ° ′
C. Bearn Lt. 751 ft.	42 31	3 7·5
Fort Brescon Lt.	43 15·5	3 30
Aigues Mortes Lt.	43 32	4 8
Marseille, St. John Fort	43 17·7	5 21·7
" Observatory	43 17·8	5 22·2
Planier Isl'd Lt.	43 11·9	5 14
Mt. St. Michael, Semaphore, 1341 ft.	43 13	5 22
C. Sicie Semaphore.	43 3·2	5 51
Toulon Observatory.	43 7·5	5 56
" Semaphore.	43 4·4	5 56·5
Titan Isl'd. Lt. 246 ft.	43 2·8	6 30·7

Gulf of Genoa.

C. Camarat Lt. 426 ft	43 12	6 40·7
C. Rouse sum. 1600 ft	43 28	6 55
Nice, St. Frances Ch.	43 42	7 17
Pt. Mala Lt. 225 ft.	43 40	7 19·5
C. St. Martin	43 43	7 33
Mt. Grande, 3100 ft.	43 50	7 37
Savona Citadel	44 18·4	8 27·7
Genoa 3 Lights	44 24·9	8 53
Pt. Chiapa sum.	44 20	9 10.5
Tino Isl'd Lt. 384 ft.	44 2·4	9 52
Monta Altissimo, 5213 ft.	44 3	10 14

S. W. Coast of Italy

Pisa Leaning Tower	43 33·5	10 24
Leghorn Lt.	43 32·7	10 17·7
Gorgona Isl'd centre.	43 25·8	9 53·5
Piombino Palace	42 55·7	10 31·7
Mt. Argentario tele.	42 23.7	11 10·5
Civita Vecchia Lt.	42 5·7	11 44
Rome, St. Peter's dm	41 54·1	12 27·2
Monte Circello, St. Felix Church	41 12·7	13 5·2
Gæta Lt., Orlando tr.	41 12·4	13 34·7
Ischia I. Castle, E. pt	40 43·9	13 57·7
Naples Observ. Capo di Monte	40 51·8	14 15·5
" Mole Lt.	40 50·3	14 15·7
Mt. Vesuvius, 3900 ft	40 49	14 26
Castelamare Lt.	40 41·5	14 28·2
Capr. Isl'd, S. Pt. (Lt. to be)	40 32	14 11·7
Mt. St. Angelo, 4680 feet	40 39	14 31
C. Vaticano Tower	38 37·2	15 52·
Scylla	38 14·5	15 45

African Coast.

		W.
Ceuta Lt.	35 54	5 18
Tetuan Custom Ho.	35 37	5 18
Alboran Isl'd	35 58	3 1
C. Tres Forca, N. pt. Mid.	35 28	3 0
Zafarine Isl'd. sum. W. end	35 11	2 25·7
Pt. Abuja, 2050 ft.	35 53	0 29
		E.
Algiers Mole Lt.	36 47·3	3 4·5
Mt. Azafoun, 4360 ft.	36 50	4 25
Mt. Babor, 6200 ft.	36 34	5 28
Philippsville Lt.	36 52·8	6 53
Bona Lions Pt. Lt.	36 54·5	7 46·5
Galita Isl. Pk. 1240 feet	37 31·2	8 55·5
Bizerta Castle	37 16·6	4 49·2
Cape Carthage Lt.	36 52·4	10 20·2
Zembra Island sum. 1551 ft.	37 10	10 48
C. Bon Tower 1176 ft	37 4·8	11 3 5

Islands in the Med. below Cape Bon.

NAMES OF PLACES.	LON. N. ° ′	LAT. E. ° ′
Maritimo Is. 2376 ft.	37 59 5	12 4

Sardinia.

Cape Figari sum.	40 59·9	9 39·7
Limbarra Pk. 4331 ft	40 51	9 11
Mt. Gennargentua, 6102 ft.	40 1	9 19
Mt. Seven Brothers, 3186 ft.	39 18·5	9 26·5
C. Spartivento, S. pt.	38 52·5	8 52·5
Cape Teulada sum. 725 ft.	38 51·9	8 39·2
Toro Rock, 550 feet	38 51·6	8 25·2
Mount Arcuento, or Oristano, 2713 ft.	39 35·7	8 33·5
C. Argentera sum.	40 43·7	8 9·0
Razzole Isl'd. Lt.	41 18·3	9 20·7

Minorca.

Mahon Mole Lt. to be	39 52·5	4 21
Cape Cabaleria	40 5	4 7
Cape Dartuch	39 55	3 51

Majorca.

E. extr. Cape Pera	39 42	3 27
Mt. Galatro	39 38	2 28
Dragonera Isl'd sum	39 36	2 18
S. extr. C. Salinas	39 14	3 4

Iviza.

Iviza Castle	38 54·3	1 26·7
Pt. Denserra, N. extr	39 8	1 32
Port St. Antonio, N. Pt.	39 0·4	1 14
Formentera Isl'd, S. E. Pt.	38 38	1 36

Lipari Islands.

Stromboli Is. 2570 ft	38 46·7	15 13·7
Volcano Is., Sulphur Works	38 23·3	14 56
Ustica Isl'd N. E. pt Fort	38 43·3	13 11·2

Sicily.

Faro Isl'd Lt. on E. extremity	33 15·8	15 41·2
Messina Lt.	38 11	15 34·7
Mt. Etna, 10.874 ft.	37 43·5	15 0·0
Syracuse Lt.	37 3	15 16·5
Passaro Isl'd Lt.	36 41·5	15 9
Alicata Castle Light.	37 4	13 56
Girgenti Mole, 2 Lts.	37 15·6	13 31·7
Marsala Lt.	37 47·8	12 26·2
Mt. St. Julian 2175 ft	38 3	12 35·5
Palermo Observat'y.	38 6·6	13 21·2
" Light	38 8·2	13 22·2
Pantellaria Is. sum. 2213 ft.	36 48	12 2
Linosa Isl'd. centre.	35 51·8	12 52
Lampion, centre	35 32·8	12 20
Lampedusa Is. C'st.	35 29·2	12 35·2

Malta.

Valetta Palace	35 53·8	14 31·2
Spencer's Monument	35 53	14 30·7
St. Elmo Lt.	35 54·1	14 31·5
S. E. extre. Pt. Della Mare	35 49·7	14 34·7

Goza.

N. W. Pt. or Cape Demetri	36 4	14 8

Coast of Naples.

Names of Places.	Lat. N. ° ′	Lon. E. ° ′
C. Spartivento.....	37 56	16 4
C. St. Vito Lt......	40 24	17 13
C. Otranto. (E. Pt. of Italy)........	40 8·6	18 29·7

W. Coast of the Adriatic.

Mt. St. Angelo.....	41 43	15 57
Tremiti Isl'ds Mid. Castle...........	42 7·3	15 30·5
Colonella sm. 1080 ft.	42 52·3	13 52
Ancona Lt........	43 37·7	13 30·5
San Marino, 2460 ft.	43 57	12 29
Venice, St Mark..	45 25·9	12 20·2
Trieste Light Castle.	45 38·6	13 46·5

E. Coast of the Adriatic.

Sansego Isl'd sum. 350 feet........	44 30·9	14 18·2
M. Vella Strazza, 1070 feet.......	43 59	15 2
St. Andrea in Pelago 1000 ft..........	43 1·7	15 45·7
Meleda Isl'd W. Pt.	42 47	17 18
Molonta Isl'd sum..	42 29·9	18 23·5
Vetergnach. 3960 ft.	42 19	18 52
C. Rodoni, 400 feet..	41 37·6	19 28·2

Coast of Albania.

C. Linguetta, 2290 ft	40 26·7	19 17·7
Mt. Cica, 6300 ft...	40 15	19 35
Parga Citadel.....	39 16·4	20 23·5

Ionian Islands.

Fano Isl'd S.W. sum.	39 50·2	19 20
Corfu Citadel Lt...	39 37	19 55·5
M. St. Giorgio, 1326 feet.............	39 36·5	19 48
Paxo Isl'd N. W. Pt Light..........	39 13·2	20 9
Antipaxo Isl'd. E. Pt.	39 8·7	20 5·7
Mt. Nomali, 3750 ft.	38 41·6	20 37·7
Cephalonia, N. extr.	38 28·5	20 33
Mt. Elato sum. 5246.	38 8·5	20 41
Zante, N. Pt.......	37 56·5	20 41·5
" Mt. Yeri, 2274 ft.	37 50	20 44.2
" Mt. Skopo, 1439 ft	37 44·6	20 57

W. Coast of Greece.

Oxia Is. Pk. 1257 ft.	38 18·7	21 7
Lepanto cn. Minaret	38 23·4	21 50
Morea Castle, centre	38 18·5	21 47
C. Katakolo.......	37 37·7	21 19
Stamfanes Isl'd Lt..	37 15·8	21 1·5
Navarino Mosque..	36 54·6	21 41·7
Mt. St. Nicolo, 1627 feet..........	36 53	21 42
Sapienza Isl'd sum..	36 45	21 41·2
Mt. Makrino, 7900 ft.	36 57	22 21·2
C. Matapan.......	36 23	22 29·2
C. St. Angelo......	36 26	23 12
Cerigo Isl'd N. Pt..	36 23	22 57·2
" " S. Pt...	36 7·7	52 59·7
Ovo Island, 550 ft..	36 5·5	23 0
Cerigotto sm. 1230 ft	35 50·1	23 18
Mt. Krithina, 2600 ft.	36 28·2	23 8·2
Kravi Island......	36 46·1	23 36·5
Falconera Isl'd sum.	36 50·9	23 53·7
Bello Poulo sum...	36 54·9	2 27·7

Coast of Greece.

Piræus, 2 Lts.....	37 56·2	23 38·0
Athens Parthenon..	37 58·1	23 43·7
C. Colonna Tm. 269 ft	37 38·8	24 1·7

Islands in the Archipelago.

Names of Places.	Lat. N. ° ′	Lon. E. ° ′
Hydra Island sum. 1939 ft.........	37 19·5	23 28
St. George S.E. sum 1085 ft.........	37 28	23 56
Zea Isl'd, Mount St. Elias............	37 37·3	24 21·7
" Port St. Nicolao lt	37 39·4	24 20
Hermia Island sum. 966 feet........	37 26·2	24 23·7
Milo, Mt. St. Elias on S. W. Pt. 2480 ft.	36 40·5	24 23·5
" Port W. Pt. Point Vani..........	36 45·3	24 22·7
Paros Island, Mt. St. Elias, mid. 2530 ft.	37 2·7	25 11·5
Syra Island sum. E. side, 1415 ft....	37 28·9	24 55·7
Andros Island, Mt. Kovari, 3200 ft..	37 50·1	24 50·5
C. Dora, islet off...	38 9·4	24 36·3
Mt. Delphi, 5730 ft.	38 37·4	23 50·7
Skyros Isl'd, N. end sum............	38 49·7	24 37·2
" Grand Port.....	38 45	24 37
Mt. Pelion (Patras), 5310 ft.........	39 26·5	23 3
Mt. Ossa (Kessova), 6407 ft.........	39 48	22 42
Mt. Olympus, 9754 ft	40 4·7	22 22
Salonika..........	40 38·8	22 57·2
C. Cassandra......	39 56·7	23 22·0
Mt. Athos sum. 6349	40 9·5	24 20
Lemnos, W. Pt....	39 58·7	25 2
" S. Pt....	39 46·6	25 21·5

Turkey.

Dardanelles, Asia Cs	40 9	26 24·5
Gallipoli Lt.......	40 24	26 39·7
Marmora Isl'd S. W. sum............	40 36·5	27 35
Constantinople, St. Sophia.........	41 0·3	28 59·2
Papa, or Kalolimno Isl'd N. sum.....	40 33	28 32
Buyuk Dereh, N. Minaret.........	41 10·1	29 3
Bosphorus, Europe lt	41 14	29 7·2

Black Sea.

Varna Mosque, mid.	43 12	27 26·5
Danube R. Soulineh Mo. Lt..........	45 9·3	29 40·5
Serpent Island Lt..	45 15·5	30 14·2
C. Fontane Lt.....	46 22·8	30 45·5
Odessa Cath......	46 28·9	30 54·5
Tendra Isl'd N. end.	46 21·7	31 32
C. Khersones Lt....	44 35	33 22
Sevastopol Ch.....	44 37·9	33 29·5
Mt. Tchatirdag S.W. sum............	44 44	34 17·2
Kaffa, or Theodosia.	45 1·6	35 24
Cape Takli Lt.....	45 5·9	36 27
Kertch Ch........	45 21·2	36 29·5
Yenikaleh Lt.....	45 23·1	36 39·2
Taganrog Ch......	47 12·2	38 57
Azov Cath.........	47 7	39 26·5
Anapa, E. Ch.....	44 54·1	37 18·5
High Summit, 4 ml's inland..........	43 17	40 1·5
C. Batoum Mosque.	41 39·4	41 37
Trebizonde, E. extr.	41 1	39 46
Sinope Castle.....	42 2·2	35 12·5
Cape Baba........	41 20·9	31 26
Asia Lt., entr. Bosp.	41 13	29 9·4

Coast of Asia Minor.

Names of Places.	Lat. N. ° ′	Lon. E. ° ′
Tenedos Isl'd N. W. sum............	39 50·2	26 5
Mt. Ida, 5750 feet..	39 42	26 50·5
Mitylene, E. Pt.....	39 0·7	26 37·7
Smyrna Mill, on Daragaz Pt......	38 26·5	27 9·7
Samos, W. sum....	37 43·8	26 38·5
" M. Kerki, 4725 ft.	37 43·7	26 38·7
Nicaria Beacon 3390 feet............	37 32·2	26 4·7
Patmos, S. Pt. ...	37 16	26 34·7
Mt. Samsoun, 4130 ft	37 39·8	27 9
Kos, Mt. Christos, 2760 ft..........	36 50	27 14·2
Rhodes Lt.........	36 26·9	28 16·2
" W. Pt.....	36 8·7	27 43·2

Candia.

Candia, Minaret Lt..	35 21	25 8·2
" E. extr. C. Saloman............	35 9·2	26 19·5
" Mt. Ida.......	35 13·3	24 47
Gozza Isl'd W. Pt..	34 52	24 2·2
Boudroom Castle..	37 2	27 27·5
Marmorice Cape...	36 43·9	28 20·7
Highest sum. 5980 ft.	36 31·8	29 14·2

Coast of Karamania.

Mt. Takhtalu 7800 ft.	36 31·7	30 28
C. Anamour, S. Pt. of Asia M....	36 0·8	32 49
Alexandretta Consul flag staff....	36 35·3	36 9
C. Khynzyr, 5550 ft.	36 16	35 52

Syria.

Bairont, Brit. Cou..	33 54·5	35 28·2
Tyre.............	33 17	35 12·7
St. John d'Acre, Bastion, Marine gate.	32 55	35 2·5

Island of Cyprus.

West extr. C. Epiphanius.........	35 6·3	32 14·5
N. and E. extr. C. St. Andrea.........	35 41·7	34 35·5
S. and E. extr. C. Gatto..........	34 32·8	32 59·7

Egypt.

Rosetta, Engl. Cons.	31 24·3	30 28
Aboukir Castle....	31 20·5	30 5·7
Alexandria Pt. Eunostos Lt........	31 11·5	29 51·5
Arabs Tower......	30 57·7	29 33·2
C. Razat.........	32 57	21 38

Barbary.

Jebel Zawan, 3917 feet............	36 23	10 5
Tripoli, Pasha's Cas.	32 53·9	13 11·0
Jebel Thelj, N. E. sum............	34 25	9 52
Kuryah Isl'ds, N. E. Pt. sum.........	35 48	11 3

Shores of the S. Atlantic Ocean —W. Coast of Africa.

	S.	E.
Cape Lopez.......	0 36	8 43
Loango River ent..	4 39·5	11 45
Congo River, S. ent.	6 4·6	12 15

Names of Places.	Lat. S. ° '	Lon. E. ° '
St. Paul de Loando, flag staff........	8 48·1	13 13·5
St. Philip de Benguela flag staff..	12 33·9	13 24
Cape Negro, 200 ft. Diaz's pillar....	15 40·7	11 58
Mt. Colquhoun, 17 or 18 L. inland....	22 33	11 58
Walvisch B. Pelican point............	22 52·5	14 27
Hollam's Bird Island	24 34·7	14 32
Angra Pequena, Pedestal point.....	26 38·4	15 8
Cape Voltas......	28 44	16 32

S. Coast of Africa.

Koussie R., limits of Cape Colony....	29 40	17 10
Elephant's River...	31 38	18 12
Cape Deseada......	32 18	18 23
St. Helena B., Point St. Martin......	32 40	17 59
Saldanha Bay, N. Pt	33 1·7	17 54
Dassen Island.....	33 26·2	18 6·7
Robben Island, S. pt.	33 48·2	18 22·7
Table B., Green Pt. two Lights.....	33 53·2	18 24·5
Devil's Peak, 3315 ft.	33 57·2	18 31·7
Cape Observatory.	33 56	18 28·7
Cape of Good Hope Point, 800 feet...	34 22	18 29
" Lion's Head.....	33 56	18 24
Simon's B. dockyard	34 11·3	18 26
Cape Hangklip Pt. 1800 feet.........	34 23·8	18 50·9
Dyer Island centre.	34 43·7	19 28·2
Quoin Point.......	34 48·8	19 41·7
Cape Agulhas, S. extremity of Africa Light..........	34 49·7	20 0·7

E. Coast of South America.

	S.	W.
Maranham Cath....	2 31·7	44 18·7
Fort St. Marcas Lt.	2 29	44 18
Mt. Melancias Peak, sand hill........	3 12	39 18
Point Macoripe Lt.	3 41	38 29
Morro Tibaõ, Red sand hill........	4 49	37 18
Cape St. Roque....	5 28	35 16
Pernambuco, Fort Picao...........	8 3·6	34 51·7
C. St. Augustin Ch. summit..........	8 21	34 56
Mt. Sellada, S. Peak	8 25	35 11
Mo'nt Masarandupio 10m. inland.....	12 24	38 4
Bahia, St. Antonio Light...........	13 0·7	38 31·7
Abrolhos Isl'ds., largest E. summit..	18 5	38 42
Mt. Pascoal summit	16 54	39 20
Morrc San Juan, isolated...........	22 32·5	42 0
Cape Frio, S. Pt. Lt.	23 1·3	41 58·2
Cape Negro Point..	22 57	42 39
Rio Janeiro, fort Villagagnan........	22 54·7	43 9
St. Sebastian Island, South Point.....	23 57	45 15
St. Catherine Island, North Point.....	27 22·5	48 25·7
Rio Grande de Sul, E. Point Light...	32 7	52 8

Names of Places.	Lat. S. ° '	Lon. W. ° '
Great Castillos rock (like a schooner).	34 24	53 46
Cape St. Mary.....	34 39	54 9
Maldonado Tower..	34 53·5	54 57·7
Flores Islands Light	34 56	55 55
Monte Video Rat Isl.	34 53·3	56 13·5
" summit..	34 53	56 15
Colonia Light.....	34 28	57 49·7
Buenos Ayres mole landing place....	34 35·5	58 22
Pt. Indio.........	35 15	57 9
Sierra Ventana, 3500 feet............	38 11·7	61 56·5
Sierra de San Antonio, 1700 feet..	41 41	65 12
Pt. Delgada, 200 ft. S. E. cliff.......	42 46	63 37

E. Coast of Patagonia.

Salamanca Pk., 700 feet............	45 34	67 20
C. Three Pt's 2000 ft.	47 6	65 51
Monte Video, 300 ft. 4m. inland......	48 14	66 26
Wood Mt., visible 11 leagues.........	49 13·7	67 45
C. Fairweather, 300 feet, S. Pt......	51 32·1	68 55·5
C. Possession, mid. 300 feet.........	52 17	68 56·7
Orange Peak......	52 28·3	69 25·5
Port Famine observ.	53 38·3	70 58·2
Mt. Saimento, 6800 feet, two Peaks..	54 27·2	70 51·5
Mt. Buckland 4000 ft	54 26	70 22·7
Cape Tamar......	53 55·5	73 48·5
Staten Island C. St. John.........	53 43·5	64 44·8
Cape Horn 500 feet.	55 59	67 16

Islands in S. Atlantic Ocean.

Ascension, Barrack square..........	7 55·5	14 25·5
Green Mt'n 2820 ft.	7 57	14 21
Cross Hill 850 feet.	7 55·7	14 25
St. Helena, Diana's Pk. 2700 feet....	15 57	5 42
Obs'rvat'ry, showing G. M. T.........	15 55	5 44
Fernando Noronha, S. W. Pt.........	3 52	32 28
" Pk. on S. E. side.	3 50·4	32 25·5
Trinidad Isl'd S. Pt.	20 31	29 19
Martin Vas Rocks, large one.......	20 28	28 51
Tristan d'Acunha waterfall N. side middle..........	37 6	12 2
Inaccessible Islands, West one.......	37 16	12 52
Nightingale Island.	27 26	12 8
Gough's Isl'd 4385 ft. N. Point......	40 19	9 44

Falkland Islands.

W. Falkland, Port Steph'n's entrance E Pt. summit...	52 11	60 41·2
C. Tamer N. cliff sum	51 17	60 52
Eddystone Rk 200 ft	51 10	59 2·5
East Falkland, Port Salvador, Shag Island entrance..	51 23·7	58 19
C. Carysford, N. E. cliff...........	51 25·2	57 50·5

Names of Places.	Lat. S. ° '	Lon. W. ° '
Port Louis Settlement, flag staff..	51 32	58 7
C. Pembroke beacon on S. E........	51 40·7	57 42
Port William, Gov. Store House	51 41	57 51·5
Beachene Isl'd, 200 feet, S Point....	52 55·7	59 12·7

Shores of the Indian Ocean.

	S.	E.
Cape Agulhas, S. extremity of Africa	34 49·7	20 0·7
C. St. Blaize, S. Pt. of Mossel Bay...	34 6·9	22 11·7
Plittenburg B. S. Pt	34 4·8	23 22·5
Cape St. Francis...	34 10	24 52·7
Cape Recif Light..	34 2·2	25 41·2
Algoa B. Commandant House.......	33 57·5	25 39·5
" St Croix Isl'd Pk.	33 47·6	25 46·5
Bird Island, E. one.	33 52·1	26 18
Port Hood........	33 3·8	27 58
Cape Natal.......	29 53	31 2·2
Port Natal, S. Pt. of Bay..........	29 53	31 2
Cape Vidal.......	28 9·6	32 38
St. Mary's Isl'd N. pt.	25 58·2	33 2·5
P. Melville, Elephant Isl'd, S. W. side, N. Point..........	25 58	32 57·5
Cape Corrientes...	24 7·5	35 30·5
Mt. Cockburn.....	16 29	38 56
Port Mocamba, N. Pt. Pk., 2000 ft..	15 6	40 35
Mozambique, Saint George's Island..	15 2·2	40 48·5
Mount Pao........	14 50	40 25
Loguna Peak......	14 21	40 37·5
C. Paman, Hull Rk.	10 10	40 10

Madagascar Island.

S. extremity of Cape St. Mary........	25 38·9	45 7
Leven Island, centre	25 12·5	44 18
Murderer's Bay, N. Point..........	22 12·5	43 18
Cape St. Vincent..	21 54·4	43 20·5
N. W. extremity, or Cape St. Andrew.	16 11·4	44 31
Cape St. Sebastian, (Island 5m. off the Point)	12 26·2	48 45·7
Woody Island.....	12 16·7	48 41·2
Amber Mountain..	12 34·5	49 11
Port Leven Lingo rk	12 46·5	49 54·2
Mananhar Table Hill	14 39·7	50 15·7
Tangtang flag staff.	16 42·5	49 46·2
Plum Island, visible 5 leagues.......	18 2·8	49 29·2
Port Dauphin flag staff............	25 1·3	47 2·2

Isl'ds in Mozambique Channel.

Europa Island, or Bassas da India..	22 22·5	40 24·2
St. Juan da Nova..	17 3·5	42 50
Mayotta, Valentine Peak...........	12 54	45 15
Johanna Isl'd Pk. E. Point.........	12 15	44 29·5
Comoro, S. E. Point	11 54	43 33
Assumption Island, hummock on S.E. part...........	9 46	46 34

Coast of Africa (Continued.)

NAMES OF PLACES.	LAT. S. ° '	LON. E. ° '
Mt Trinidade 1200 ft	10 4	39 44
Zanzibar Isl'd S. Pt.	6 27·7	39 33
Waseen Peaks, middle one........	4 30	39 22
Mt. Gibbous.......	1 12·2	41 28
	N.	E.
Murot Hill........	5 41·3	46 17·2
E. extrem. of Africa Ras Hafoon 600 ft. East Point......	10 26·8	51 22
C. Guardafui, N. E. extrem. of Africa.	11 50	51 16
Tocotra, W. extremity Point.......	12 33	53 18
" S. W. Point, Ras Kattanie, summit 1465 feet.......	12 22·5	53 32
Ras Feluk 800 feet.	12 0	50 51

S. Coast of Arabia.

C. St. Antony 2772 feet.............	12 41	44 10
C. Aden, sum. 1776 feet............	12 45	45 3
N. Barnlike Pk 5284 feet............	14 4	47 32
Jebel Jinjeri 1300 ft.	17 3	54 53
Kuria Muria Islands, W. one, Haski pk.	17 27·2	55 35·7
Mazeira Isl'd, S. Pt.	20 7·6	58 33
C. Mussendom, N. pt.	26 24	56 34
Great Quoin 300 ft.	26 30	56 33
Asses Ears 5m. inl'd	28 29	51 14
Hummocks of Kenn, S. one..........	28 4	51 41
High Clay Pk. white	25 23	62 30
Conical Hill.......	20 57	71 18
Cambay flag staff..	22 17	72 35·5
St. John's Highland	20 2	72 43
Terrpore Point.....	19 62	72 40
Bombay Obs'rvat'ry	18 53·7	72 48
" Lighthouse	18 51·7	72 47·7
Rajapour Harbor or Rajah Point.....	18 16	73 0
Goa, St. Ann's light.	15 28·3	73 51·2
Barsalore Pk. 4452 feet............	13 50	74 51
Mount Dilly.......	12 2	75 11
Calicut Lt. flag staff	11 15·2	75 45·5
C. Comorin Point, S. extremity of India	8 5	77 30
" Peak...........	8 23·2	77 30·5

Island of Ceylon.

Calpentyn Fort....	8 15	79 45
Colombo Light....	6 56·1	79 49
Pt. de Galli fl. st. lt.	6 1·8	80 11
Adam's Pk., 7000 ft.	6 52	80 29
S. extr. Dondra Hd.	5 55	80 34
Elephant Rk. inland	6 24	81 32
Friar's Hood......	7 29	81 40
Trincomalee Light.	8 33·7	81 14·7
Palmyra Point....	9 49	80 14

Islands in the Arabian Sea.—Lacadive Islands.

Ancutta, mid......	10 51	72 10
Kittan, S. Pt......	11 25	73 0

Maldives.

Containing 19 *Atolls, or Groups.*

NAMES OF PLACES.	LON. N. ° '	LAT. E. ° '
Malcolm Atoll, N.E. extr............	6 24·5	72 40
Powell's Is'lds N. one	5 29	72 54
Male Atoll, E. extr.	4 27	73 42
" Kings Is'ld flagstaff, N. side....	4 10	73 29

Almirante Islands.

	S.	E.
St. Joseph Island..	5 27	53 30

Seychelle Archipelago.

Frigate Isl'd, E. extr 550 feet........	4 35·2	56 1·2
Foquet Isl'd, S. extr.	5 27	71 46

Chagos Group.

Diego Garcia, S. Pt.	7 26	72 23

Cargados Garajos.

Frigate Island.....	16 36	59 33
Siren Island.......	16 28	59 37

Islands in the Indian Ocean.

Rodrigue.........	19 41	63 25
Round Isl'd, 1049 ft.	19 50	57 50
Mauritius, Peter Botte, 2600 ft....	20 11·7	57 36·7
" Port, L. Cooper's Island..........	20 9·7	57 31·7
Bourbon Isl'd, S. ex.	21 24	55 40
Bouvet's Island....	54 20	5 24
Thompson's Isl'd...	53 56	5 30
Prince Edward's Is. N. Pt..........	46 45	37 18
Marion and Crozet's Island..........	46 9	50 28
Kerguelen's Land, N. Pt............	48 41	69 6
C. St. George.....	49 54	70 10
St. Paul, 700 ft.....	38 43·8	77 38
Amsterdam summit, 2760 ft.........	37 52	77 35
Keeling Island, S. Group, S. Pt.....	12 12·6	96 54
Direction Isl'd S. W. Pt............	12 5·4	96 53
Christmas Isl'd....	10 31	105 33

Coromandel Coast.

	N.	E.
Negapatam flag st.	10 45·6	79 50·5
Five White pagodas	10 49	79 50
Pondicherry Lt....	11 55·7	79 49·2
Madras Observ....	13 4·1	80 14
" Light Ft. St. Geo.	13 4·7	80 16·2
Coringa, town Lt...	16 49	82 12
Jugurnaut Pagodas, large...........	19 50	85 56
Black Pagoda.....	19 52	86 8
False Pt. Lt.......	20 19·4	86 44
Mypurra Isl'd, S. Pt.	20 41·3	87 7
Pt. Palmiras.......	20 41	87 9
Lower float'g lt. ves.	21 3	88 12
Upper float'g lt. ves.	21 26	88 4
Kedgeree Lt......	21 50·3	87 55·7
Saugor Island Lt. tripod...........	21 37·2	88 1
Calcutta, Fort Wm.	22 33·5	88 19·2
Chittagong flag staff	22 20	91 47·7
Table land, 8300 ft.	21 9	92 23
Akyab harb. fl. st..	20 8·4	92 54
Great Savage Lt...	20 5·2	92 53·7
Kenain kown pk...	19 48	93 28
Cheduba Isl'd, S. pk. 1700 ft.........	18 40	93 41
Elephant Pt. Pagoda	16 28	96 21

NAMES OF PLACES.	LAT. N. ° '	LON. E. ° '
Rangoon city, Dagon Pagoda........	16 47	96 10
Martaban.........	16 32	97 35
Maulmain Pagoda..	16 30	97 37
Amherst Lt., to be.	16 5	97 33
Mt. sum. inland....	16 1	97 35
The cone, vis'ble 16 l	14 1	98 24
Tenasserim Island..	12 34	97 49
Junkseilon, H. Mt. S. Pt............	7 46	98 18
Pulo Pera........	5 42	98 56
Penang Island sum. 2713 ft.........	5 25	100 14
" Cornwallis fl. st.	5 25·1	100 19·7
Pulo Dinding......	4 16	100 35
Salangore Hill and Fort............	3 20	101 22
Parcler Hill sum..	2 52	101 25
C. Rachado, vis. 7 l.	2 26	101 50
Malacca flag st.....	2 10·5	102 14·2
Mt. Moar sum....	1 59	102 40
Mount Formosa....	1 49	102 54
Pulo Kissang, 200 ft	1 28	103 13
Singapore Battery..	1 17	103 50
Barbukit Hill, 645 ft	1 24	104 11
Pedra Branca, or Horsburgh Lt....	1 20	104 28
Bintang hill, 1200 ft	1 5	104 26
Preparis Isl'd Cow & Calf, N. end....	14 56	93 38
Great Andaman, N. Pt., or C. Price...	13 34	93 4
Saddle Hill, visible 20 l. N. Pk.....	13 10	93 4
Narcondam vis. 15 l.	13 36	94 18
Little Nicobar N. Pt.	7 26	93 42
G. Nicobar, S. Pt...	6 45	93 54

S. W. Coast of Sumatra.

Golden, or Queen's Mt. 8280.........	5 22	95 45
Achen Head......	5 36	95 11
Goonung Loose, 11000 ft.........	3 47	97 15
Sinkel Pt.........	2 15	97 46
Pulo Babi.........	1 44	97 37
Mt. Ophir, vis. 37 l.	0 5	99 57
	S.	E.
Padang head fl. st..	0 56	100 20
Bencoolen, Ft. Marlborough.........	3 47·6	102 19
Rajah Bassa, 1600 ft	5 49	105 4
Krakatoa Pk. 2690 ft South end.......	6 9	105 29
Anjer flag staff....	6 3·2	105 57
Banca, Parmesang hill, 1250 ft.....	2 38	105 53
" Monopin h. 1640 f.	2 0	105 12
" Goonung h. 2600 f	2 36	106 49

Coast of Java.

Java Head.......	6 47	105 13
Bantam flag staff..	6 1·7	106 10·7
Mt. Karang, 6000 ft.	6 16	106 5
Batavia Obser.....	6 8	106 50
Mt. Gede, 9380 feet.	6 45	107 0
Mt. Chermair Peak, 9730 ft.........	6 55	108 26
Mt. Fegal, 11000 ft.	7 14	109 15
Mt. Soumbing 10.700 feet	7 21	110 4
Samarang flag staff.	6 57·3	110 27
C. Sedano Pt. 4480 ft	7 49	114 30
Mt. Idjeng, 9600 ft.	8 3	114 14
Semiru Mt. 12.000 ft	8 8	112 58
Arjuno Mt. 11.930 ft	7 48	112 37
Lomboek P. 11.400 f.	8 26	116 25

Coast of China.

NAMES OF PLACES.	LAT. N. ° ′	LON. E. ° ′
Great Lema, E. Pt.	22 5	114 19
Lantao Pk. 3050 ft.	22 16	113 58
Macao flag staff....	22 11·4	113 32
Canton Eng. factory	23 6·9	113 15
Hong Kong summit, N. W. Pt. 1825 ft	22 15	114 22
A high sum. 2810 ft	22 31	114 32
Table Hill, 1767 ft.	23 39	117 9
Amoy citadel.....	24 2·8	118 4
Mt. Keu-sau pagoda 760 feet........	24 43	118 38
Double Peak Isl'd, W. Pk. 1190 feet.	26 36	120 11
Montague Isl'd, E. pt 740 feet........	29 10	122 5
Chusan Isl'd S. extr.	29 36	122 8
" Chookea 1170 ft.	29 54	122 25

Formosa.

Formosa S. Point..	21 54	120 55
Table Hill, 360 feet	24 53·5	120 59
Sum. Eastw'rd 2800 feet............	25 11	121 31
E. extr. of Formosa.	25 2	122 2
Mt. Morrison, 10,800 feet...........	23 50	120 43
Double Pk., 3m. inland, vis. 17 leag.	22 50	121 8

Borneo.

Mt. Tatau, 1900 feet	3 2	112 59
Mt. Silungun 1500 ft.	3 50	113 49
Mt. Mulu 8000 feet.	4 7	115 10
Borneo City.......	4 50	114 58
Labuan Isl'd, W. pt.	5 15·5	115 7
Castle Pk., 1500 ft.	5 47	116 1
Kini Balu Mountain, 13,700 feet......	6 8	116 36

Mindora.

High Mt'n 3126 feet	13 23	120 48
Mt. Calavite 2000 ft	13 28	120 34

Philippines.

Pt. San Diego.....	13 58	120 38
Manilla Cath. and Lt	14 36	121 0

Coast of New Guinea.

	S.	E.
Cape Sapey, summit 3020 feet.......	3 37	132 30
Island C. Katomun summit 3940 feet	3 59	132 44
Lamanchiri hill, N. W. sum. 3225 ft..	3 46	134 3
Lakahia Mt. 4564 ft.	4 13	134 52
A high sum. 9000 ft.	4 9	135 33
Mt. Cornwallis visible 9 leagues....	9 27	142 35
Aird Hill, 1260 feet	7 28	144 35
Mt. Victoria 10 l. in	8 9	146 50
C. Rodney, S. E. extr.	10 15	148 30

W. Coast of Australia.

NAMES OF PLACES.	LAT. N. ° ′	LON. E. ° ′
	N.	E.
Steep pt. W. extremity of Australia..	26 5	112 57
Mt. Fairfax, 582 feet	28 45·4	114 41·7
Wizard Peak 640 ft.	28 29·7	114 47
Mt. Peron, 3. l. inl'd	30 7	115 9
Swan R. Scott's jetty	32 3·3	115 45·5
" Perth Gov. House	31 57·4	115 52·7
C. Chatham, vis. 10 l.	35 2	116 28
Bald Head vis. 12 l. S. Point........	35 7	118 1
King George's Sound Gov. buildings...	35 2.2	117 53·7
Bald Island summit	34 55	118 27
Port Hood........	34 24	119 34
	S.	E.
Esperance B. W. pt. Island..........	33 56	121 46
Mondrain Island, S. summit........	34 10	122 14
Middle Island, S. W. summit..........	34 8	123 8
C. Pasley sum., 1½m. inland	33 56	123 28
Hd. of Great Australian Bight......	31 28	131 7
Island of St. Peter S. W. Point.....	32 22	133 27
C. Radstock.......	33 12	134 15
Pearson's Isl'd 2 pk's	33 57	134 13
Greenly Isl'd Peak, 680 feet........	34 35	134 47
Beagle Island, small	34 49	134 49
Thistle Island, vis. 12 leagues, S. Point	36 6	136 11
High Isl'ds vis. 4 l..	35 22	136 8
C. Donnington.....	34 43	135 57
Mt. Brown, 3000 ft.	32 30	138 1
Tronbridge Hill...	35 8	137 41
P'rt Adelaide, lt. ves	34 48	138 28
" Town.......	34 55	138 36
Mt. Lofty, 2200 feet	34 58·5	138 43·7
Glenelg flag staff...	34 58·5	138 32·7
Kangaroo Isl'd, Mt. Torrens..........	45 50	136 38
Mt. Gambier......	37 52	140 42
C. Otway Lt. 303 ft.	38 51	143 33
Port Philip, Pt. Nepean............	38 18·5	144 42·7
" Melbourne, Bateman's hill.......	37 48·6	144 57·7
S. Pt. of Australia.	39 8	146 23
Mt. Wilson, 2350 ft.	39 4	146 24
C. Wickham, N. Pt. summit, 595 feet.	39 35	143 57
Bl'k. Pyramid, 240 ft	40 28	144 21
Curtis Isl'd 1060 ft. Peak	39 28	146 40
Kent Isl. S.W. end lt	39 30·2	137 19
Barren Island, Mt. Munro 2300 feet.	40 23	148 6

Van Dieman's Land.

Mt. de Witt, vis. 12 leagues	43 9	145 48
S. W. Cape 1000 ft.	43 35	146 1
C. Bruny Lt. 339 ft.	43 28·7	147 8
Hobarton Fort Mulgrave..........	42 53·5	147 21·5
Port Arthur, Semaphore..........	43 9·1	147 50·7
Maria I. sum. 3500 ft	42 35	148 8
Mt. Cameron 8 l. inland, 1730 ft....	40 59	147 56
Cape Portland.....	40 44	147 57
Mt. Arthur 5 l. inland, 4300 ft.....	41 16	147 17
Port Dalrymple Lt.	41 3·4	146 48·2
" Georgetown fl. st.	41 6·3	146 50·2
Valentine pk. 7 l. inland, 4000 ft.....	41 22	145 45
Rocky Cape sum. 2 m. inland, 1000 ft.	40 53	145 29
Albatross Is. 125 ft. sum.............	40 22	144 39

Australia (Continued.)

NAMES OF PLACES.	LAT. S. ° ′	LON. E. ° ′
Cape Wellington...	39 4	146 30
Mt. Dromedary vis. 15 l. N. Pt.......	36 16	150 13
Jarvis, B. Pt. perpendicular, 650 ft	35 6	151 2
Botany Bay, N. Pt. entr.............	34 0	151 16
Pt. Jackson Lt. 350 f	33 51·2	151 18·2
Sydney, Fort Macquarrie..........	33 51·7	151 14
Paramatta Observ..	33 48·7	151 1
Pt. Hunter, Court ho	32 55·8	151 48·7
C. Hawke.........	32 14	152 35
C. Byron, E. Pt. Aus.	28 38	153 40
A High Peak......	26 20	152 56
Round Hill........	24 15	151 55
C. Keppel.........	23 27	151 7
Peaked Island.....	22 40	151 0
Pt. Bowen, N. P. en.	22 29	150 48·5
Long Hill, 2333 feet	21 34	149 20
C. Hillsborough sum 966 feet........	20 54	149 6
Cumberland Island, Shaw's pk. N. Pt 1601 feet........	20 28	149 7
M. Dryander, 4566 ft	20 14	148 31
Mt. Abbott, 3460 ft.	20 3	147 48
Mt. Eliot, 4075 ft...	19 33	146 59
Mount Hitchinbrook, 3500 ft.........	18 22	146 17
Fitz Roy Isl'd, N. E. pk. 550 feet.....	16 55	146 0
C. Tribulation finger pk. 3350 feet....	16 4	145 26
C. Flattery, 2 pks. 855 feet........	14 52	145 21
Lizard I. sm, 1200 ft	14 41·4	145 28·5
C. Bowen.........	14 34	144 41
C. Weymouth, Restoration Isl'd pk. 360 ft. W. Pt....	12 37·5	143 27·5
Forbes I. sm. 340 ft.	12 16	143 27
Orfordness, Pudding pan hill, 354 feet.	11 19	142 51
Mt. Adolphus, 548 ft	10 37	142 41
Mt. Bremer, 420 ft..	10 41	142 35
N. extr. of Australia C. York.........	10 41·6	142 34
Murray Isl'd gr. one pk. 700 feet.....	9 56·5	144 5
Balls Pyramid v. 12 l	31 43	159 20
Lord Howe I. 2500 f	31 37	159 14
Prince of Wales Is. N. E. pt. Horned Hill, 430 feet....	10 57	142 13

Torres Straits.

Booby I. 30 ft. Post Office..........	10 36·7	141 56
Darnley I. hill 580 ft	9 35·3	143 49
Turtle Backed Isl'd, 368 feet........	9 54	142 48
Mt. Ernest, 807 feet.	10 16	142 31
Mt. Augustus, 1310 f	10 9	142 21

Gulf of Carpentaria.

Wellesly Is. Sweers Island Inspection Hill, 105 feet....	17 8·2	139 41
C. Shield.........	13 20	136 28
Mt. Caledon.......	12 53	136 38
C. Arnheim.......	12 17	137
C. Wilberforce.....	11 53	136 34
Pt. Dale..........	11 36	136 7

N. Coast of Australia.

NAMES OF PLACES.	LAT. S. ° ′	LON. E. ° ′
C. Cockburn……..	11 18	132 51
Pt. Essington gov. h.	11 22·3	132 10·7
C. Don…………	11 19	131 48
Cape Hotham…..	12 3	131 20
Bathurst Is'ld S. extr C. Fourcroy……	11 51	129 57
P. Darwin, P. Emery on E. side of entr.	12 27	130 51
Pt. Blaze………	12 51	130 11

N. W. Coast.

Mt. Casuarina……	14 23	127 40
C. Bernier………	14 0	127 28
C. Talbot……….	13 47	126 46
Port Warrander, Chrystal Hd…..	14 28	125 58
Port Nelson Careening beach…….	15 6	125 4
Pr. Regent, R. Mt. Trafalgar summit.	15 16·6	125 7
C. Borda………..	16 36	122 49
C. Baskerville…….	17 9	122 19
C. Vellaret, 150 ft..	18 19	122 7
C. Jaubert, 45 feet..	18 58	121 40
Mt. Blaze, 60 ft….	20 0	119 38
Depuch Island, 514 feet………….	20 38·4	117 46
C. Lambert………	20 36	117 11
C. Preston………	20 30	116 5
Barrow Island, N. Pt………….	20 40	115 27

New Zealand.

Cape Farewell…..	40 31	172 47
Cape Foulwind….	41 46	171 29
The Five Fingers…	42 4	171 25
Bold Head………	42 57	170 40
Cape Paterson…..	45 24	166 30
Cape West………	45 56	166 8
Pt. Macquarrie…..	46 20	168 10
South Cape…….	47 17	167 32
Molyneux Har. N. pt.	46 25	169 55
Saddle Hill…….	45 55	170 31
East extreme Pt…	43 46	173 14
Mt. Tako, a high pk.	41 42	174 25
Pt. Hardy, Nelson's Monument at entr.	40 44	173 57
Nelson, Aglionby pt.	41 14	173 16
C. Egmont, or Borul	39 20	173 39
M. Egmont, 8.9000 f.	39 15	174 4
Entry Isl'd W. Pt. 1800 ft………	40 54	174 55
Port Nicholson, Pencarrow Head….	41 27	174 53
Black Hd………	40 14	176 55
C. Gable………	38 31	178 26
Mt. Ikourangi…..	37 55	178 16
Mt. Edgecumbe….	38 0	177 2
Cuvier Isl'd sm….	36 26	175 42
Auckland flag staff.	36 51·5	174 45
C. Tewara Pt……	35 51	174 35
C. Motou-aro…….	35 26	174 27
Wangaroa Hb. N. hd	35 0	173 45
Mt. Ohoura or Campbell………….	34 49	173 2
C. Otou, or N. Cape.	34 24	173 1
Three Rings, l. one.	34 13	172 10
Mt. Manganui…..	35 52	173 40
Lymond's Hb. Beacon Bluff…….	37 6	174 32
Kawia Harb. Albatross Pt……..	38 6	174 52

Loo-Choo Islands.

NAMES OF PLACES.	LAT. N. ° ′	LON. E. ° ′
Koomisang, N.W. Pt	26 24	126 47
Loo-Choo, Gr. Isl'd vis. 19 l………	26 12·5	127 41·5
E. extr. C. Sidmouth	26 47	128 21
Herbert Isl'd entr. to Pt. Melville…..	26 44	127 58
Sugar-loaf, mark for Pt. Melville……	26 43	127 48
Montgomery Island N. Pt……….	27 4	128 2

Coast of China (continued.)

Nankin city, porcel'n Tower………	32 2	118 49
Urh Taou, or Staunton Isl'd…….	36 50	122 15
Saddle Island……	37 24	119 53
Great Wall…….	40 5	120 0
S. extr. of Coast…	38 40	121 11
Rock like a Junk…	38 56	122 49
Lindsay I. S. W. Pt.	36 26	126 28
Cape Basil, Basil bay	36 8	126 51

Japan Islands.

Asses Ears, S. one..	32 2	128 36
Nangasaki, mid. of City…………	32 44·8	129 52
C. Nomo………..	32 35	129 42
Horner Peak…….	31 9	130 28
C. Tschitschagoff, S. extr. of Japan I'ds	30 57	130 36
C. Cochrane…….	31 51	131 27
C. Misaki, W. Pt. Sikok Island….	33 18	132 17
Niphon S. Pt……	33 25	135 47
" N. E. C. Nambu.	41 23	141 30
" N. Pt………	41 32	140 50
C. Greig……….	41 9	140 8
Russian Promontory W. Pt………	39 52	139 38
Zach Mt………	35 25	132 20

Jesso.

C. Spanberg…….	44 35	145 0
N. extr. C. Soya….	45 31	141 51
C. Malespina……	43 42	141 18
Pyramid Rk. off the N. E. Pt…….	46 17	150 30

Kamtschatka.

Kronotsky pk 10.610 feet…………	54 45	160 33
Kluchevsky volcano 16.500 feet……	56 8	160 41
Behring Isl'd W. Pt.	55 17	165 46
" S. Pt.	54 21	166 44
Copper Isl'd, S. Pt..	54 33	168 11

N. W. Coast of N. America.

	N.	W.
C. Douglas E. Pt…	58 54	152 51
Mt St. Augustine sm	59 22	153 0
C. Elizabeth, E. Pt.	59 9	151 18
Montague Isl'd, Port Chambers, E. cove	60 16	146 50
" S. Point……..	59 46	147 30
Mt. St. Elias, 14.917 feet, seen 50 l. off.	60 17	140 52
Mt. Fairweather…	58 54	137 38
C. Fairweather….	58 51	137 50
C. Edgecumbe….	57 2	135 45

Russian America.

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Sitka Arsenal Light	57 2.9	135 17·2
C. Ommanney…..	56 9	134 34
C. Addington…..	55 27	133 48
C. Muzon………	54 43	132 42

N. W. Coast (Continued.)

Queen Charlotte's Is. Cape Henry….	52 52	132 25
" Pt. North……	54 20	133 11
" C. St. James, S. pt	51 55	131 2
Port Simpson. ….	54 33	130 18

Vancouver's Island.

Nootka So'nd friendly cove………	49 35	126 35·5
Esquimalt harbor, Islet entrance….	48 25·6	123 37·7
Port Discovery W. Head………..	48 5·5	122 54·5
Port Neah, S. W. Pt.	48 22·5	124 36·7
Gray's Harb. N. Hd.	47 0	124 7
Fort George…….	46 11·5	123 51
C. Perpetua…….	44 12	124 17
C. Mendocino……	40 29	124 32

Coast of California.

Mt. Bolbones, 3765 feet, 10 l. inland.	37 52·9	121 54·5
St. Francisco Fort S. side………	37 48·5	122 28·5
See also the Sea coasts of the United States for more particulars.		
Monterey Fort….	36 36·4	121 53
Pt. Conception….	34 31	120 30
San Juan………	32 53	117 44
St. Diego, Pt. Loma	32 38·8	117 14·7
C. Colnett, S. W. Pt.	30 59	116 15
Pt. St. Bartholomew N. Head…….	27 39·8	114 53·5
C. St. Lazaro Mount 1300 feet…….	24 47	112 16
C. Palmo………	23 22	109 17

Gulf of California.

Santa Cruz Island..	25 22	110 49
C. St. Gabriel……	28 35	112 46
C. Haro………..	27 50	110 54
Pt. Rosa………..	26 42	109 50

Mexico, West Coast.

Pt. Arbolado……	23 33	106 48
Mazatlan Custom H.	23 11·8	106 23·7
San Blas Arsenal..	21 32·5	105 15·5
Mt. St. Juan, 6220 ft 5 leagues inland.	21 27	104 56·5
Port Navidad sum. South Head…..	19 12	104 46
Colima Volcano 12-000 feet…….	19 25	103 33
Acapulco, Fort St. Diego………	16 50·8	99 52

Central America.

Libertad vill. fl. st..	13 30	89 17
Pt. Consequina Volcano, 3800 feet..	12 58	87 37
Volcan. Viejo 5562 ft	12 41	86 58
Port St. Juan S. bluff	11 15·2	85 53

Panama.

Bahia Honda Sentinel Isl'd at ent…	7 43·5	81 31
Pt. Mala………	7 25	80 2

NAMES OF PLACES.	LAT. N. ° ′	LON. W. ° ′
Panama, N. E. Bastion	8 56·9	79 31·2
C. Corrientes	5 33	77 29·5
Isl'd Gorgona, N. pt. 1296 feet	3 0	78 9

Peru.

	S.	W
C. Passado	0 21	80 32
C. St. Lorenzo	1 3	80 57
Guayaquil Arsenal.	2 12·4	79 52·7
Saddle of Payta, 1300 feet	5 12	81 10
Eten Hill 640 feet a mark	6 55	79 54
Mt. Sulivan 5000 ft. 17m. inland	7 17	79 21
Truxillo Ch., 1½m. inland	8 7·5	79 4·2
Guañape Hill, 700 ft	8 27	78 57
Mt. Division 3 pks. 1880 feet	9 11	78 38
Mt. Mongon summit, 3900 feet	9 38	78 22
Darwin pk., 5800 ft.	10 30	77 50
Pescador Isl'ds large one	11 47	77 20
Lima Bridge	12 3	77 6
Callao Arsenal fl. st.	12 4	77 13·7
San Lorenzo Island, 1284 ft., N. Pt. or C. St. Lorenzo	12 4	77 19
Chincha Isl'ds N. pt.	13 38	76 28
Mt. Quemado 2070 ft	14 20	76 11
Mt. Camana (like a fort)	16 37	72 45
Islay, port of Arequipa Custom H.	17 0	72 10·5
Morro of Sama, 3890 feet	17 59	70 56
Arica mole	18 28	70 24
Carrasco Mt. 5520 ft 4m. inland	20 58·5	70 10
Cobija Pk. 3330 feet	22 32	70 18
Mt. Mexillones 2560 feet, 3m. inland	23 6·5	70 35
Mt. Moreno 4160 ft.	23 28·5	70 38·5
Grande Pt. W. summit, 1572 feet	25 7	70 34
Port Caldera, W. hd.	27 3	70 56·2
Copiapo (landing pl.)	27 19·5	71 2
Herradura Point	28 6	71 16
Guasco port	28 27	71 19
Coquimbo Signal hill Mt. Edward's Ho.	29 54·2	71 19
Mt. Talinay, 2300 ft.	30 51	71 42
Valparaiso Lt. on N. W. Pt., fort St. Antonio	33 1·9	71 41·5
Aconcagua 23,200 ft. 25 leagues inland	32 38·5	70 1
Bell of Quillota 6200 ft. 7 leagues inl'nd	32 57·2	71 10·5
Talcahuano, Fort Galvez	36 42	73 10·2
Concepcion City mid	36 49·5	73 5·5
Paps of Bio Bio, 800 feet S. W. summit	36 48	73 15
Mocha Isl'd summit, 1250 feet	38 23	73 59
Valdivia City mid.	39 49	73 19
Chayapiran Volcano 8000 feet	42 48	72 34·7
Corcobado Volcano, 7500 feet	43 11·3	72 49
Chiloe Island, W. pt.	43 17	74 26

NAMES OF PLACES.	LAT. S. ° ′	LON. W. ° ′
Huafo Isl'd, N. W. Pt. 800 feet	43 36	74 49
C. Taytao, 3000 feet W. Point	45 53	75 8
C. Tres Montes 2000 feet Pt.	46 59	75 28
Port Otway, S. ent. summit	46 49·5	75 18·2
Dome of St. Paul's, 2284 feet	46 36	75 14
Port Sta. Barbara, W. Head	48 2	75 30
C. Montague W. cliff	49 7	75 37
C. Three Pts. 2000 ft	50 2	75 21
Diana Peak	52 8	74 48
Westminster Hall	52 37	74 24
C. Deseado	52 55·5	74 38
C. Noir, 600 ft. S. pt	54 30	73 6
C. Desolation Pks. pt	54 46	71 37
York Minster	55 25	70 5
Diego Ramirez Isl'd middle	56 25	68 44
Ildefonsa Isl'd 100 ft middle	55 52	69 19
False C. Horn	55 43	68 6
Orange Bay, Brunt Island	55 30·8	68 2
Cape Horn 500 feet	55 59	67 16

Islands in S. Pacific Ocean.

	S.	E.
Bishop and Clerk	55 15	158 56
Macquarrie Isl'd, N. Point	54 19	158 56
Campbell Isl'd, 1500 feet S. harbor, N. Head	52 34·4	169 12·7
Auckland Islands, S. Cape	50 56	166 7
" W. extreme	50 50	165 55
Mt. Eden, 1325 feet	50 35	166 10
Enderby Isl'd E. pt.	50 30	166 19
Penantipode Island, small	49 32	179 42
Bounty Islands	47 44	179 7
	S.	W.
Chatham Islands, S. Isle, like a Pyramid	44 20	176 4
Juan Fernandez Isl'd N. side Cumberland B. Fort	33 37·6	78 53
" S. Pt. Sta. Clara Island	33 45	79 2
St. Ambrose, vis. 10 leagues W. Pt.	26 21	80 10
Easter Island, N. E. Peak, 1323 feet	27 6	109 17
Pitcairn Island 2500 feet	25 3·6	130 8
Gambier's Isl'd, Mt. Duff	23 8	134 55
Encarnacion Island	24 45	136 40
St. Elmo	21 20	143 50
Aurora Isl'd 250 ft. N. Point	15 50	148 11
Otaheite Isl'd, vis. 12 l., Pt. Venus fl. st.	17 29·2	149 29
" Summit 7000 feet	17 39	149 30
" Papeta Harb. fl. st.	17 32·1	149 34
Eimeo Isl'd perforated Pk. 4041 feet	17 30	149 47
Marquesas E. extr. Ariadne Rk. 10 ft.	10 21	138 29
" Madalena Island 3700 feet S. Pt.	10 31	138 48

NAMES OF PLACES.	LAT. S. ° ′	LON. W. ° ′
St. Pedro Isl'd 1700 feet, E. Pt.	9 57	138 45
Sta. Christina 3000 f.	9 56	139 10
Hood Isl'd 1200 ft.	9 25	138 57
Washington Island, 2000 ft. S. Pt.	8 56	139 33
Nukahiva, 3600 feet.	8 55·3	140 6
Robert's Isl'd 2000 f.	8 0	140 48
Norfolk Island Mt. Pitt, 2000 ft.	28 58	167 46
Verraders Isl'd 2006 feet	15 54	173 48
Manua Isl'd, 2500 ft. summit	14 15	169 26
Apolima Isl'd 472 ft	13 49	172 3
Horne Isl'ds, 2500 ft	14 18	178 18
Pylslaart Isl'd 700 ft	23 34	176 4
Eoa Isl'd 600 ft. mid	21 24	174 57
Kao Isl'd Pyr, 5000 f	19 42	175 0
Tofoa Isl'd, 2800 ft.	19 45	175 3
Latte Isl'd, 1600 ft.	18 49	174 35
Lakamba Isl'd, 1200 ft. mid,	18 14	178 51
Niau I. seen 15 L. sm.	17 59	179 2

Fejee Islands.

Vanua Levou I. 2070 ft. E. or Unda p.	16 8	179 55
" Dana's Peak	16 46	178 49
Moala Isl'd, 1800 ft. S. Pt.	18 41	179 53
Mitre Isl'd, vis. 4 l.	11 55	170 9
Ticopia, vis. 10 leags	12 21	168 48

New Caledonia.

	S.	E.
New Caledonia, E. p	22 16	166 55
C. Colnett	20 29	164 44
" W. extr. Pt. Tonnerre	20 24	164 0

New Hebrides.

Tanna Isl'd, Cook's Pyramid	19 30·9	169 28·7
" Volcano, 4 m. inland	19 31	169 24
Sandwich Isl'd S. W. Pt.	17 45	168 9
Pentacote Isl'd S. pt.	15 59	168 19
Vanikoro Isl'd, sum. 3031 ft.	11 37	166 49
Volcano Isl'd sum.	10 23	165 49

Solomon Islands.

Guadalcanar Isl'd E. Pt.	9 50	160 54
" Mt. Lammas	9 50	160 20
Isabel Isl'd, S. Pt. C. Prieto	8 34	159 54
" M. Marescot, 3901 feet	8 14	159 38
Eddystone Rk. 1036 feet	8 18	156 31
Bongainville Isl'd Mt Balbi, 10.062 ft. 5 l. inland	5 56	154 29
N. Pt. C. l'Averdi	5 30	155 7
Bouka Isl'd, N. Pt.	5 1	154 40
" Summit	5 18	154 39
Garret Denys, 3200 ft. the highest of these Islands	3 4	152 34
Gardner's Isl'd, 2000 ft. N. Pt.	2 34	51 54

New Ireland.

NAMES OF PLACES.	LAT. S. ° ′	LON. E. ° ′
New Ireland, E. Pt. C. St. Mary	4 2	153 18
" Cape St. George.	4 51	152 55

New Britain

N. Pt. C. Stephens..	4 12	152 0
S. E. Pt. C. Orford, S. E. extr.	5 24	152 4
Pt. Roebuck	6 15	150 33
C. Gloucester, 2 p'ks	5 28	148 23
Lotten Isl'd, above 3000 ft.	5 20	147 36
Volcano, above 4000 feet	5 32	148 17
Dischamps pk. 3 m. inland	5 5	151 28

N. Coast of New Guinea.

Cape Rodney	10 2	148 30
Cape King William 13000 ft.	6 16	147 40
Dampier Is'l 5000 ft.	4 40	145 58
Vulcan Isl'd, conical	4 6	145 1
Garnot Isl'd, conical	3 30	144 35
D'Urville Isl'd pk. near W. end	3 20·1	143 31·2
Mt. Julian, 2 l. inla'd	4 6	144 26
Eyries Mt. very high sum. 3 l. inland..	2 50	141 15
Cyclops Mt. vis. 20 l. E. sum	2 31	140 30
Lesson Isl'd, a high cone	2 7	139 27
Jobie Isl'd, vis. 20 l. E. Pt.	1 48	136 50
Arfak Mts. S. one, 9520 ft.	1 8.9	133 54
" N. one, 8610 feet	1 6·1	133 54
Bee-hive Mt.	0 44	133 25
Mt. Diceras, 8 m. inland	0 32	132 15

Galapagos Islands.

NAMES OF PLACES.	LAT. S. ° ′	LON. W. ° ′
Chatham Isl'd, 1650 ft. E. Pt. Mt. Pitt, 800 feet	0 44	89 20
" S. side watering-place	0 56·4	89 33·7
Charles Isl'd 1780 ft Post-Office on N. W. side, Daylight Pt.	1 15·4	90 31·7
Gardner Isl'd, 760 ft.	1°21	9 23
Albemarle Is. 3780 ft. Iguana Cove, S. W. side	0 59	91 32·5

Isl'ds in the N. Pacific Ocean.

	N.	W.
Redondo Rk. 85 ft.	0 14	91 40
Towers Isl'd, 211 ft. E. P.	0 21	90 0
Abingdon Isl'd S. pt. mid. 1930 ft.	0 34	90 49
Wenman Isl'd, 830 ft	1 23	91 54
Culpepper I. 550 ft.	1 40	92 4
Malpelo Island sum. 1200 ft.	4 0	81 32
Socorro Isl'd, 2000 ft S. E. Pt.	18 43	110 52
Benedicito Isl'd 1100 feet mid	19 20	110 35
Guadalupe Isl'ds, W. one, 3400 feet	28 54	118 20

Sandwich Islands.

Owhyhee Isl'd, S. pt.	19 5	155 49
" Mowna Roa Mt. 13.175 feet	19 28	155 38
" East Pt.	19 34	154 55
" West Pt.	19 42	156 6
Mowee Isl'd, E. Pt..	20 44	155 58
" W. sum. 6126 ft.	20 43	156 14

NAMES OF PLACES.	LAT. N. ° ′	LON. W. °
Morotoi Isl'd, E. Pt.	21 9	156 51
" W. Pt.	21 7	157 24
Woahoo Isl'd, E. Pt.	21 20	157 37
" S. or Diamond pt.	21 15	157 48
" Honoruru Fort..	21 18·2	157 55
" S. W. extreme..	21 17	158 7
" W. Pt.	21 36	158 15
" N. Pt.	21 43	157 58
Atoor Isl'd, E. Pt...	22 8	159 20
" Hanalae, B. Brit. Cons. E. side	22 14	159 32 7
" N. Pt.	22 16	159 31
Oneehow Island, E. Pt.	22 0	160 5
" S. Pt.	21 45	160 18
Necker Island, 300 feet	23 34	164 37
Rica de Oro Rk. or Lot's wife, 350 ft.	29 51	157 4
Volcanoes, 3 Sulph'r Islands	24 48	141 20
" N. Isl'd San Alessandro	25 14	141 18
" S. Isl'd, San Dionisio, 396 feet	24 22	141 28
Forfana Island	25 34	143 0
Rota Isl'd, 800 ft. E. Pt.	14 9	145 18
Assumption Island, 2026 ft.	19 41	145 27
Guam Isl'd, N. Pt..	13 39	144 53
Oalan Island, Mt. Crozer about 2000 feet	5 19	163 4·7
Mac Askill Islands, S. one	6 13	160 47
Pouinipet Isl'd sum. 2861 ft.	6 52	158 24
The highest land yet discovered is Mt. Erebus, which is 12.400 ft. above the sea, and is an active volcano in.	S. 77 38	E. 166 58

TABLE XL.

CONTAINING THE POSITIONS OF PLACES (OMITTED IN TABLE XXXIX.) ON THE COAST OF THE UNITED STATES OF AMERICA AND WEST INDIES, TAKEN FROM THE LATEST SURVEYS.

E. Coast of U. S. of America.

Maine.	Lat. N. ° ′	Lon. W. ° ′
Seal Island Lights.	44 29	67 06
Libby Island Light	44 34	67 23
Baker's Island Lt..	44 14	68 08
Petite Manan Is. Lt.	44 22	67 52
Isle au Haute.....	43 59	68 36
Cashes Ledge.. ..	42 56	68 51
Manegan Isl'd Lt..	43 45	69 17
Penmaguid Pt. Lt..	43 45	69 28
Bantam Ledge....	43 44	69 36
Seguin Island Lt...	43 42	69 44
Cape Small.......	43 41	69 50
Cape Elizabeth Lt..	43 34	70 11
Wood Island Light	43 28	70 19
Goat Island Light.	43 21	70 25
Cape Neddeck	43 10	70 36
Boone Island Light	43 7	70 28
New Hampshire.		
White Island Light	42 58	70 38
Portsm'th Outer Lt.	43 04	70 41
Great Boar's Head.	42 55	70 47
Massachusetts.		
Newburyport Light on Plumb. Isl'd..	42 49	70 49
Annis Squam Lt...	42 40	70 41
Cape Ann	42 39	70 35
Gloucester Hr. Lt.	42 35	70 39
Baker's Island Lt..	42 32	70 47
Nahant, east pt. of Boston Harbor..	42 25	70 54
Scituate Har. Light	42 12	70 43
Brant Point.......	42 05	70 38
Gurnet Pt. Lt., ent. to Plymouth....	42 00	70 36
Beach Pt. Lt., ent. to Barnstable Bay .	41 44	70 16
Race Point Light..	42 04	70 15
Nausette Light....	41 52	69 57
Chatham Hr. Light	41 40	69 57
Great Point Light.	41 24	70 03
Sankaty Hd. Light.	41 17	69 57
Smith's Point.....	41 18	70 17
Cape Poge Light..	41 25	70 27
No Man's Land....	41 15	70 49
Gay Head Light...	41 21	70 50
Cuttyhunk Isl. Lt..	41 25	70 57
Sangkornet Point..	41 27	71 11
Nantucket Shoals.		
McBlair's Shoal ...	41 24	69 48
Old South Shoal...	41 04	69 51
Davis' Sho. Lt. Ship	40 57	69 51
George's Shoals.		
S. E. Point.......	41 33	67 39
W. Point.........	41 42	67 59
N. E. Point.......	41 48	67 47
North Shoal......	41 53	67 43
Third Shoal......	41 51	67 26
East Shoal.......	41 47	67 19
Rhode Island.		
Brenton's Reef....	41 26	71 21
Beaver Tail Point.	41 27	71 24
Watch Hill Pt. Lt.	41 18	71 51
Block Isl. S. E. Pt..	41 09	71 33
New York and Connecticut.		
Montauk Pt. Light.	41 04	71 51
Fire Island Light..	40 38	73 13

New Jersey and Pennsylvania.	Lat. N. ° ′	Lon. W. ° ′
Barnegat Light ...	39 46	74 6
Little Egg Hr., or Tucker's Isl. Lt..	39 30	74 17
Chincoteague Lt...	37 55	75 21
Carolina and Georgia.		
Currituck Inlet....	36 23	75 55
Boddy's Isl'd Light	35 47	75 32
Ocracock Light ...	35 7	75 58
Doboy Bar	31 20	81 22
Amelia Isl'd Light.	30 40	81 36
Florida.		
St. John's Light...	30 20	81 33
Carysfort Rf. Lt. Sh.	25 13	80 13
Sand Key Lt. Bea.	24 27	81 52
Cape Romano.....	25 51	81 56
Carlos Bay Ent...	26 32	82 15
Tampa Bay Ent. Lt.	27 35	82 47
Dog Island Light..	29 46	84 48
Cape St. Blas Lt..	29 40	85 28
Islands in the West Indies.		
Barbadoes N. Pt...	13 19	59 45
Martinico S. E. Pt.	14 30	60 50
Mariegalanta S. Pt.	15 52	61 24
Saintes Isl'd W. Pt.	15 52	61 45
Guadaloupe, Petite Terre Light.....	16 10	61 7
St. Austatia, N. Pt.	17 32	63 5
Saba, W. Pt.......	17 39	63 19
Aves or Bird Island, N. Pt..........	15 41	63 37
Berbuda, N. end ..	17 43	61 52
St. Bartholom's, N.	17 54	62 48
St. Martin's, S. E. Pt.	18 5	63 5
Anguilla Custom H.	18 13	63 4
Dog & Prickly Pear	18 17	63 17
Sombrero	18 36	63 28
Virgin Gorda, E. Pt.	18 30	64 14
Santa Cruz, E. end.	17 45	64 34
Frenchman's Cap. .	18 14	64 52
Sail Rock.........	18 16	65 8
Crab Isl., E. end...	18 7	65 18
Porto Rico, Saint Juan Lt	18 29	66 7
Pt. Brugen, or N. W. Pt..........	18 32	67 8
Cape Roxo........	17 56	67 10
Monico Island.....	18 9	67 56
Zecheo Island.....	18 24	67 28
St. Domingo Island.		
Saona Isl., E. Pt...	18 12	68 31
Beata Island......	17 37	71 32
Altovela..........	17 28	71 40
Cape Jaqnemel....	18 13	72 33
Isle a Vache, E. end.	18 6	73 31
Navassa Isl., Mid..	18 25	75 3
Jeremie	18 40	74 5
C. Nichola, Mole ..	19 49	73 27
Tortuga, E. Pt....	20 1	72 36
Port Paix.........	19 56	72 46
Pt. Picolet........	19 47	72 12
Grange Pt........	19 56	71 42
Port de Plata.....	19 46	70 46
Old Cape Francois.	19 42	69 55
Cape Samana	19 18	69 6
Cape Raphael.....	19 3	68 50

Jamaica.	Lat. N. ° ′	Lon. W. ° ′
Morant Pt. Lt.....	17 56	76 11
Portland Pt.......	17 44	77 10
S. Negril.........	18 16	78 25
Morant Keys......	17 26	75 57
Portlan Rock......	17 7	77 27
Pedra Shoals, N. Pt.	17 40	78 54
South Rocks, above water..........	16 50	78 20
Camanbrack, E. Pt.	19 45	79 42
Swan Isl., E. Pt...	17 25	83 50
Cuba.		
Trinidad..........	21 43	80 6
Jardines, S. E. Key.	21 40	81 12
Cape Antonia Lt...	21 51	84 57
Pt. Hyecos Lt.....	23 11	81 9
French Cay, N. Pt.	22 50	79 30
Neuvitas Lt.......	21 40	77 15
Pt. de Mulas......	21 10	75 55
Bara[illegible]o............	20 21	74 30
Cape Maize........	20 15	74 7
Cumberland Hr...	19 55	75 15
St. Jaco de Cuba Lt.	19 57	76 2
Turks and Caicos Islands.		
Baho de Navidad..	20 13	68 52
Silver Key Bank,		
——S. W. end	20 18	69 58
——N. end.......	20 55	69 52
——N. E. end	20 35	69 18
Square Handkerc'f,		
——S. W. end....	20 52	70 55
——N. E. end....	21 9	70 25
Grand Turk Lt....	21 31	71 5
Salt Key.........	21 19	71 10
Sand Key.........	21 14	71 11
Philips' Reef......	21 43	71 20
N. W. Caycos	21 52	72 16
West Caycos......	21 37	72 27
South Caycos	21 3	71 45
Bahamas.		
Gt. Inagua, S. W. end............	20 55	73 39
Hogsties, E. end...	21 40	73 51
Mayaguana, E. end.	22 23	72 42
——S. W. end....	22 21	73 9
French Key, E. Pt.	22 35	73 28
Aclin's Isl., N.E. end	22 45	73 50
Bird Rock, N. W. end of Crooked Is.	22 51	74 22
Miraporvos, S.E end	22 00	74 28
Castle Isl.........	22 7	74 20
Atwood's Keys, E. end...........	23 6	73 37
Watling's Isl., N. E. Pt.............	24 7	74 25
Conception Isl., S. Pt............	23 47	75 8
Long Isl., N. Pt ...	23 42	75 18
Eluethera Isl'd, S. Pt.,—Ship Chan'l	24 37	76 9
Harbor Isl., N. end.	25 35	76 45
Gt. Abaco, N. E. Pt. (keys off.)...	26 38	76 50
Mantanilla Reef...	27 31	79 8
Memory Rock.....	26 55	79 3
Gt. Bahama, S. E. Pt.	26 28	78 40
Stirrup Keys......	25 50	77 55
Berry Isl., E.	25 28	77 42
Orange Keys N. end	24 56	79 9

	Lat. N. ° ′	Lon. W. ° ′		Lat. N. ° ′	Lon. W. ° ′		Lat. N. ° ′	Lon. W. ° ′
Ridding Rocks, S..	25 12	79 10	Isl. Contoy, N. Pt..	21 32	86 51	Little Curacoa	12 2	68 38
			Isl. Cozumel, N. Pt.	20 35	86 44	Buen Ayre, N. Pt..	12 19	68 31
Mexico.			—— South Pt.....	21 15	87 00	P. Rosa Light.....	12 2	68 17
Pasa de Cabello...	28 20	96 22	N. Triangle.......	18 46	87 20	Bird Island, E	11 57	67 32
Brazo de Santiago.	26 6	97 12	—— South end....	18 23	87 20	—— Western end .	12 00	67 46
St. Fernando River,			Mauger Key Light.	17 36	87 46	Laguira..........	10 37	66 56
ent	25 20	97 30	Turneff Reef, S. Pt.	17 10	88 00	Cape Codera......	10 36	66 3
River Tampico, ent.	22 15	97 48	Half Moon Key Lt.	17 12	87 34	Orchilla Isl., W. end.	11 50	66 14
Cape Rojo........	21 35	97 20	Glover's Reef, N.Pt.	16 55	87 45	Blanco Island, N ..	11 55	64 37
Tamiagua Bar.....	21 13	97 17	Cape Three Points.	15 58	88 38	Los Hermanos, S. Pt.	11 42	64 29
Boca de Lima.....	20 30	96 57	Utilla Isl., E. Pt...	16 7	86 53	Tortuga Salada, E.		
Alvarado Bar.....	18 47	95 43	Rattan Isl., E. Pt..	16 27	86 12	Point	10 53	65 15
Pt. Morillos.......	18 38	94 54	—— West Point...	16 17	86 38	Margarita, E. end..	11 00	63 50
Barilla...........	18 10	94 32	Barburet Island...	16 26	86 9	—— W. end	10 58	64 28
River St. Ann.....	18 11	93 51	Cape Camaron....	16 00	85 3	Testigos Isl., mid..	11 23	93 10
Isl. Carmen, W. Pt.	18 38	91 48				Dragon's Mouth—		
Isl. Real, W. Pt..	18 52	91 22	*New Granada.*			Point Pera	10 44	61 58
			Port Sabanilla, ent.	11 1	75 1	Serpant's Mouth,—		
Yucatan.			—— Hacha	11 33	72 56	Point Yeacos....	10 4	61 58
Pt. Piedras.......	21 11	90 10	Cape La Vela.....	12 10	72 14			
Bocos Del Rio La-			Pt. Galinas.......	12 25	71 44	*Guiana.*		
gartos..........	21 36	88 14	Isl. Oruba, N. W. Pt.	12 36	70 12	Mouth of Essequibo	7 00	58 18
Los Arcos........	20 13	91 59	—— S. E. Point...	12 24	70 1	— Leauwan Isl..		
Bajo Nuevo.......	21 50	92 6	Cape St. Roman...	12 11	70 7	Cape Nassau......	7 36	58 56
Isl. Arenas.......	22 8	91 25	Curaco Isl., N. Pt..	12 21	69 10	Pt. Baja	9 25	60 43
Mugeres Isl., S. Pt..	21 18	86 45	St. Ann's Bay.....	12 6	68 54			

NEW TIME TABLES

WHICH FURNISH THE SHORTEST METHOD OF FINDING THE TIME AT SHIP (AND THENCE THE LONGITUDE BY CHRONOMETER), AT ABOUT 8 O'CLOCK IN THE MORNING, OR 4 O'CLOCK IN THE AFTERNOON.

By James H. Brownlow, *Teacher of Practical Navigation and Nautical Astronomy*, 92 *Madison Street, New York.*

EXPLANATION AND USE OF THE TABLES.

Table A, in Two Parts.

The first part contains the True Altitude of the Sun's centre, at the instant it is 8 hours, A. M., or 4 hours, P. M., apparent time, when the Latitude and Declination are of the same name. The second part contains the same, when the Latitude and Declination are of different names. These tables are entered with the *degree* of Declination at the top, and the *degree* of Latitude at the side, and the angle of meeting gives the True Altitude required. If there are *miles* of Latitude and Declination, two proportions are necessary, which may be made either mentally, or by the aid of Table B.

Table B,

For finding the proportion of Altitude for the miles of Latitude and Declination, as follows: Enter this table with the difference of Altitude for 1° of Latitude at the top, and the miles of Latitude at the side, and the angle of meeting gives the proportion of Altitude required, in miles and tenths, which must be added to the Altitude taken from Table A, if the Altitude was increasing with the Latitude; or subtracted, if decreasing. Again, enter this table with the difference of Altitude for 1° of Declination at the top, and the miles of Declination at the side, and take out the proportion of Altitude, to be added to the Altitude taken from Table A, if it was increasing with the Declination, or subtracted if decreasing, will give the true Altitude of the Sun's centre, from which *subtract* the joint correction for Semidiameter, Dip, &c., (which is usually taken at 10′) to obtain the Observed Altitude of the Sun's lower limb: now set the Quadrant to this Altitude, and when the Sun arrives at it, note the time by Chronometer, to which apply the error, if any, and you have the Mean Time at Greenwich, and Apparent Time at Ship, which is either 8 hours, A. M., or 4 hours P. M. To the Apparent Time at Ship apply the Equation of Time, which will give the Mean Time at Ship, the difference between which and the Mean Time at Greenwich is the Longitude in time, turned into space at the rate of 15° to the hour, or 1′ to 4 seconds of time.

EXAMPLE.

September 10th, 1857, in Latitude 30° 29′ N., and Longitude by D. R. 60° W., the height of the eye being 18 feet, required the Altitude at which to set my Quadrant, so as to observe the Altitude of the Sun's lower limb at 8 o'clock in the morning, Apparent Time, and by noting the time by Chronometer, find the Longitude.

The Sun's Declination on September 10th, is 4° 52′ N., and Latitude 30° 29′ N., being of the same name, I enter first part of Table A with 4° of Declination and 30° of Latitude, which gives the Altitude 27° 50′, and under the *same degree of Declination*, but opposite 31° of Latitude, the Altitude is 27° 37′, which gives the Difference of Altitude for 1° of Latitude to be 13′ *decreasing*. Again, entering Table A, with 5° of Declination and 30° of Latitude, gives the Altitude 28° 21′, which gives the Difference of Altitude for 1° of Declination to be 31′ *increasing*. Now enter Table B, with 13′ at top, and 29′ of Latitude at the side, and take out the proportion of Altitude for 29′ of Latitude, which is 6′ 3 tenths, to be *subtracted* from Altitude 27° 50′. Again enter Table B, with 31′ at top, and 52′ of Declination at the side, and take out the proportion of Altitude for 52′ of Declination, which is 26′ 9 tenths, to be *added* to Altitude 27° 50′. As the greater of these two proportions is additive, and the lesser one subtractive, take the difference between them, which is 20′ 6 tenths (or 21′), and add it to 27° 50′, will give the true

Altitude of the Sun's centre 28° 11′, from which *subtract* 10′ for Semidiameter, Dip, &c., gives the Observed Altitude of the Sun's lower limb 28° 1′, to which I set my Quadrant, and when the Sun arrives at that Altitude, note the time by Chronometer; which suppose to be 11hrs. 58m. 10sec., A. M., Mean Time at Greenwich, the Longitude is found as follows.

Apparent Time at Ship................	8h.	00m.	00sec., A. M.	
Equation of Time, to subtract..........		3	10	
Mean Time at Ship....................	7	56	50	A. M.
Mean Time at Greenwich..............	11	58	10	A. M.
Longitude in Time.....................	4	1	20	in degrees 60° 20′ W.

Remark.—As the above method of setting the Quadrant to the Altitude, and waiting until the Sun arrives to that Altitude, may be considered somewhat inconvenient, Table C has been constructed to obviate that necessity.

Table C, in Two Parts.

The first part of this table is used when the Latitude and Declination are of the same name; the second part, when they are of different names. They are entered with the Declination at top, and Latitude at the side, and the angle of meeting gives the time (in seconds and hundredth parts of a second) corresponding to a change of the Sun's Altitude of *one* mile at 8hrs., A. M., or 4hrs., P. M. The Declination is given only for every other degree, as the change for 1° is small, and the proportion for the intermediate degree of Declination, or for miles of Latitude and Declination, can be made either mentally or by Table B, in the same manner as the proportion of Altitude is found for miles of Lat. and Dec.

By Table C, then, we obtain the time corresponding to a change of Altitude of *one* mile at 8hrs., A. M., or 4hrs., P. M. Now, if we observe the Sun's Altitude within a few minutes of those times, say within 10 minutes of them, either before or after, note the time by Chronometer; and, after correcting the Observed Altitude, as usual to obtain the True Altitude, take the difference in miles between it and the Altitude taken from Table A, and multiply this difference of Altitudes by the time corresponding to one mile, taken from Table C, and we have the time either before or after 8hrs., A. M., or 4hrs., P. M., according as the Altitude observed is greater or less than the Altitude taken from Table A. In the morning, if the Altitude observed (after correcting it) is greater than the *one* taken from Table A, the time corresponding to the difference of Altitude must be added to 8hrs.; but if the Altitude observed be less, the time must be subtracted from 8hrs. In the afternoon, if the Altitude observed be greater than the one from Table A, the time must be subtracted from 4hrs.; but if the Altitude observed be less, the time must be added to 4hrs

Suppose, in the preceding example, the Sun's Altitude had been observed a few minutes after 8 o'clock to be 30° 1′, and the time by Chronometer 12hrs. 7m. 39sec., A. M., the work to find the Longitude would be as follows:

Sun's Obs. Alt..................	30° 1′
Corr. for Semid., Dip, &c, to add..	10
True Alt. by Observation........	30 11
True Alt., from Table A........	28 11
Diff. of Alts.................. ..	2° or 120 miles.

The time corresponding to a change of Alt. of one mile, at 8hrs., from Table C...... 4.74
Difference of Altitude............. 120

60)568.~~80~~(9m. 28s
540
28

Note.—If the difference of Altitude does not exceed 50 or 60 miles, it is enough, to take out the time from Table C for the nearest degree of Declination and Latitude.

Note.—Multiply the 4sec. and 74 hundredths by 120 miles, cut off the two right hand figures, and the remaining figures are seconds.

Time for Diff. of Alts.................		9m.	28sec.	
App. Time from Table A............	8h.	0	00	A. M.
App Time at Ship.................	8	9	28	A. M
Equation of Time, subt............		3	10	
Mean Time at Ship........	8	6	18	A. M.
Mean Time at Greenwich...........	12	7	39	A. M.
Longitude in Time................	4	1	21	or 60° 20′ W.

Remark.—When the Ship is on the Equator, and the Sun is also on the Equator, that is, when his Declination is 0, the Sun rises and sets vertically. In this case, the Sun's change of Altitude is uniformly 1 mile in 4 seconds of time, throughout the entire day. But, under any other circumstances, the time corresponding to a change of the Sun's Altitude of 1 mile, is more than 4 seconds.

When the Lat. and Dec. are under 3°, the time from Table C may be assumed the same for 2hrs.
" " " " 10° " " " " " " 1 hr.
" " " " 20° " " " " " " 40 minutes.
When the Lat. is under " 30° " " " " " " 15 "
" " " " 50° " " " " " " 10 "
" " " " 60° " " " " " " 7 "

TABLE A.—Part I.

This Table shows the True Altitude of the Sun's Centre at the instant it is 8 o'Clock in the Morning, or 4 o'Clock in the Afternoon, Apparent Time, for more readily finding the Longitude by Chronometer.

DECLINATION AND LATITUDE OF THE SAME NAME.

Lat.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°
°	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '	° '
0	30 0	30 0	29 59	29 57	29 55	29 52	29 49	29 45	29 41	29 36	29 30	29 24	29 17
1	30 0	30 1	30 1	30 1	30 0	29 58	29 56	29 53	29 50	29 46	29 42	29 37	29 31
2	29 59	30 1	30 2	30 3	30 4	30 3	30 2	30 1	29 59	29 56	29 53	29 49	29 44
3	29 57	30 1	30 3	30 5	30 7	30 8	30 8	30 8	30 7	30 5	30 3	30 1	29 57
4	29 55	30 0	30 4	30 7	30 10	30 12	30 13	30 14	30 14	30 14	30 13	30 12	30 10
5	29 52	29 58	30 3	30 8	30 12	30 15	30 18	30 20	30 21	30 22	30 23	30 22	30 21
6	29 49	29 56	30 2	30 8	30 13	30 18	30 22	30 25	30 28	30 30	30 31	30 32	30 32
7	29 45	29 53	30 1	30 8	30 14	30 20	30 25	30 30	30 34	30 37	30 39	30 41	30 43
8	29 41	29 50	29 59	30 7	30 14	30 21	30 28	30 34	30 39	30 43	30 47	30 50	30 53
9	29 36	29 46	29 56	30 5	30 14	30 22	30 30	30 37	30 43	30 49	30 54	30 58	31 2
10	29 30	29 42	29 53	30 3	30 13	30 23	30 31	30 39	30 47	30 54	31 0	31 6	31 11
11	29 24	29 37	29 49	30 1	30 12	30 22	30 32	30 41	30 50	30 58	31 6	31 13	31 19
12	29 17	29 31	29 44	29 57	30 10	30 21	30 32	30 43	30 53	31 2	31 11	31 19	31 26
13	29 9	29 25	29 39	29 53	30 7	30 20	30 32	30 44	30 55	31 5	31 15	31 25	31 33
14	29 1	29 18	29 33	29 49	30 3	30 17	30 31	30 44	30 56	31 8	31 19	31 30	31 39
15	28 53	29 10	29 27	29 43	29 59	30 15	30 29	30 43	30 57	31 10	31 22	31 34	31 45
16	28 44	29 2	29 20	29 38	29 55	30 11	30 27	30 42	30 57	31 11	31 25	31 38	31 50
17	28 34	28 54	29 13	29 31	29 50	30 7	30 24	30 41	30 57	31 12	31 27	31 41	31 54
18	28 24	28 44	29 5	29 25	29 44	30 3	30 21	30 38	30 55	31 12	31 28	31 43	31 58
19	28 13	28 35	28 56	29 17	29 37	29 57	30 17	30 35	30 54	31 11	31 28	31 45	32 1
20	28 1	28 24	28 47	29 9	29 31	29 52	30 12	30 32	30 51	21 10	31 28	31 46	32 3
21	27 50	28 14	28 37	29 0	29 23	29 45	30 7	30 28	30 48	21 8	31 28	31 47	32 5
22	27 37	28 2	28 27	28 51	29 15	29 38	30 1	30 23	30 45	31 6	31 26	31 46	32 6
23	27 24	27 50	28 16	28 41	29 6	29 31	29 54	30 18	30 40	31 3	31 24	31 46	32 6
24	27 11	27 38	28 5	28 31	28 57	29 22	29 47	30 12	30 36	30 59	81 22	31 44	32 6
25	26 57	27 25	27 53	28 20	28 47	29 14	29 40	30 5	30 30	30 55	31 19	31 42	32 5
26	26 42	27 12	27 40	28 9	28 37	29 4	29 31	29 58	30 24	30 50	31 15	31 89	32 3
27	26 27	26 58	27 27	27 57	28 26	28 54	29 22	29 50	30 17	30 44	31 10	31 36	32 1
28	26 12	26 43	27 14	27 44	28 14	28 44	29 13	29 42	30 10	30 38	31 5	31 32	31 58
29	25 56	26 28	27 0	27 31	28 2	28 33	29 3	29 33	30 2	30 31	30 59	31 27	31 54
30	25 40	26 13	26 45	27 18	27 50	28 21	28 53	29 23	29 54	30 23	30 53	31 22	31 50
31	25 23	25 57	26 30	27 4	27 37	28 9	28 41	29 13	29 45	30 15	30 46	31 16	31 46
32	25 5	25 40	26 15	26 49	27 23	27 57	28 30	29 3	29 35	30 7	30 38	31 9	31 40
33	24 48	25.23	25 59	26 34	27 9	27 43	28 18	28 51	29 25	29 58	30 30	31 2	31 34
34	24 29	25 6	25 42	26 19	26 54	27 30	28 5	28 39	29 14	29 48	30 21	30 54	31 27
35	24 11	24 48	25 26	26 3	26 39	27 16	27 52	28 27	29 2	29 37	30 12	30 46	31 19
36	23 52	24 30	25 9	25 46	26 24	27 1	27 38	28 14	28 50	29 26	30 2	30 37	31 11
37	23 32	24 11	24 50	25 29	26 7	26 46	27 23	28 1	28 38	29 15	29 51	30 27	31 3
38	23 12	23 52	24 32	25 12	25 51	26 30	27 9	27 47	28 25	29 3	29 40	30 17	30 53
39	22 52	23 33	24 13	24 54	25 34	26 14	26 53	27 32	28 11	28 50	29 28	30 6	30 44
40	22 31	23 13	23 54	24 35	25 16	25 57	26 37	27 17	27 57	28 37	29 16	29 55	30 33
41	22 10	22 53	23 35	24 17	24 58	25 40	26 21	27 2	27 43	28 23	29 3	29 43	30 22
42	21 49	22 32	23 15	23 58	24 40	25 22	26 4	26 46	27 27	28 9	28 49	29 30	30 10
43	21 27	22 11	22 55	23 38	24 21	25 4	25 47	26 30	27 12	27 54	28 35	29 17	29 58
44	21 5	21 49	22 34	23 18	24 2	24 46	25 29	26 13	26 56	27 38	28 21	29 3	29 45
45	20 42	21 28	22 13	22 58	23 42	24 27	25 11	25 55	26 39	27 23	28 6	28 49	29 32
46	20 19	21 5	21 51	22 37	23 22	24 7	24 52	25 37	26 22	27 6	27 50	28 34	29 18
47	19 56	20 43	21 29	22 16	23 2	23 48	24 33	25 19	26 4	26 49	27 34	28 19	29 3
48	19 33	20 20	21 7	21 54	22 41	23 27	24 14	25 0	25 46	26 32	27 18	28 3	28 48
49	19 9	19 57	20 45	21 32	22 20	23 7	23 54	24 41	25 28	26 14	27 0	28 47	28 32
50	18 45	19 33	20 22	21 10	21 58	22 46	23 34	24 21	25 9	25 56	26 43	27 30	28 16
51	18 20	19 9	19 58	20 47	21 36	22 24	23 13	24 1	24 49	25 37	26 25	27 12	28 0
52	17 56	18 45	19 35	20 24	21 14	22 3	22 52	23 41	24 29	25 18	26 6	26 54	27 42
53	17 31	18 21	19 11	20 1	20 51	21 41	22 30	23 20	24 9	24 58	25 47	26 36	27 25
54	17 5	17 56	18 47	19 37	20 28	21 18	22 8	22 58	23 48	24 38	25 28	26 17	27 7
55	16 40	17 31	18 22	19 13	20 4	20 55	21 46	22 37	23 27	24 18	25 8	25 58	26 48
56	16 14	17 6	17 58	18 49	19 41	20 32	21 23	22 15	23 6	23 57	244 7	25 38	26 29
57	15 48	16 40	17 33	18 25	19 17	20 9	21 0	21 52	22 44	23 35	24 27	25 18	26 9
58	15 22	16 15	17 7	18 0	18 52	19 45	20 37	21 30	22 22	23 14	24 6	24 57	25 49
59	14 55	15 49	16 42	17 35	18 28	19 21	20 14	21 6	21 59	22 51	23 44	24 36	25 28
60	14 29	15 22	16 16	17 9	18 3	18 56	19 50	20 43	21 36	22 29	23 22	24 15	25 8

This Table shows the True Altitude of the Sun's Centre at the instant it is 8 o'Clock in the Morning, or 4 o'Clock in the Afternoon, Apparent Time, for more readily finding the Longitude by Chronometer.

DECLINATION AND LATITUDE OF THE SAME NAME.

Lat.	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°
°	° ′		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	′	° ′
0	29 9	29 1	28 53	28 44	28 34	28 24	28 13	28 1	27 50	27 37	27 24	27 11
1	29 25	29 18	29 10	29 2	28 54	28 44	28 35	28 24	28 14	28 2	27 50	27 38
2	29 39	29 33	29 27	29 20	29 13	29 5	28 56	28 47	28 37	28 27	28 16	28 5
3	29 53	29 49	29 43	29 38	29 31	29 25	29 17	29 9	29 0	28 51	28 41	28 31
4	30 7	30 3	29 59	29 55	29 50	29 44	29 37	29 31	29 23	29 15	29 6	28 57
5	30 20	30 17	30 15	30 11	30 7	30 3	29 57	29 52	29 45	29 38	29 31	29 22
6	30 32	30 31	30 29	30 27	30 24	30 21	30 17	30 12	30 7	30 1	29 54	29 47
7	30 44	30 44	30 43	30 42	30 41	30 38	30 35	30 32	30 28	30 23	30 18	30 12
8	30 55	30 56	30 57	30 57	30 57	30 55	30 55	30 51	30 48	30 45	30 40	30 36
9	31 5	31 8	30 10	31 11	31 12	31 12	31 11	31 10	31 8	31 6	31 3	30 59
10	31 15	31 19	31 22	31 25	31 27	31 28	31 28	31 28	31 28	31 26	31 24	31 22
11	31 25	31 30	31 34	31 38	31 41	31 43	31 45	31 46	31 47	31 46	31 46	31 44
12	31 33	31 39	31 45	31 50	31 54	31 58	32 1	32 3	32 5	32 6	32 6	32 6
13	31 41	31 49	31 55	32 2	32 7	32 12	32 16	32 20	32 22	32 25	32 26	32 27
14	31 49	31 57	32 5	32 13	32 19	32 25	32 31	32 35	32 39	32 43	32 46	32 48
15	31 55	32 5	32 14	32 23	32 31	32 38	32 45	32 51	32 56	33 0	33 4	33 7
16	32 2	32 13	32 23	32 33	32 42	32 50	32 58	33 5	33 12	33 17	33 23	33 27
17	32 7	32 19	32 31	32 42	32 52	33 2	33 11	33 19	33 27	33 34	33 40	33 46
18	32 12	32 25	32 38	32 50	33 2	33 13	33 23	33 32	33 41	33 50	33 57	34 4
19	32 16	32 31	32 45	32 58	33 11	33 23	33 34	33 45	33 55	34 5	34 13	34 21
20	32 20	32 35	32 51	33 5	33 19	33 32	33 45	33 57	34 8	34 19	34 29	34 38
21	32 22	32 39	32 56	33 12	33 27	33 41	33 55	34 8	34 21	34 33	34 44	34 54
22	32 25	32 43	33 0	33 17	33 34	33 50	34 5	34 19	34 33	34 46	34 58	35 10
23	32 26	32 46	33 4	33 23	33 40	33 57	34 13	34 29	34 44	34 58	35 12	35 24
24	32 27	32 48	33 7	33 27	33 46	34 4	34 21	34 38	34 54	35 10	35 24	35 39
25	32 27	32 49	33 10	33 31	33 51	34 10	34 29	34 47	35 4	35 21	35 37	35 52
26	32 27	32 50	33 12	33 34	33 55	34 15	34 35	34 54	35 13	35 31	35 48	36 5
27	32 26	32 50	33 13	33 36	33 58	34 20	34 41	35 1	35 21	35 40	35 59	36 16
28	32 24	32 49	33 14	33 38	34 1	34 24	34 46	35 8	35 29	35 49	36 9	36 28
29	32 21	32 48	33 13	33 39	34 3	34 27	34 51	35 13	35 35	35 57	36 18	36 38
30	32 18	32 46	33 12	33 39	34 5	34 30	34 54	35 18	35 42	36 4	36 26	36 48
31	32 14	32 43	33 11	33 38	34 5	34 32	34 57	35 22	35 47	36 11	36 34	36 57
32	32 10	32 40	33 9	33 37	34 5	34 33	34 59	35 26	35 51	36 16	36 41	37 5
33	32 5	32 35	33 6	33 35	34 4	34 33	35 1	35 28	35 55	36 21	36 47	37 12
34	31 59	32 31	33 2	33 33	34 3	34 33	35 2	35 30	35 58	36 26	36 52	37 19
35	31 53	32 25	32 58	33 29	34 1	34 32	35 2	35 31	36 1	36 29	36 57	37 24
36	31 46	32 19	32 53	33 26	33 58	34 30	35 1	35 32	36 2	36 32	37 1	37 29
37	31 38	32 13	32 47	33 21	33 54	34 27	35 0	35 32	36 3	36 34	37 4	37 34
38	31 29	32 5	32 41	33 16	33 50	34 24	34 58	35 30	36 3	36 35	37 6	37 37
39	31 21	31 57	32 34	33 10	33 45	34 20	34 55	35 29	36 2	36 35	37 8	37 40
40	31 11	31 49	32 26	33 3	33 39	34 15	34 51	35 26	36 1	36 35	37 8	37 41
41	31 1	31 40	32 18	32 56	33 33	34 10	34 47	35 23	35 58	36 34	37 8	37 42
42	30 50	31 30	32 9	32 48	33 26	34 4	34 42	35 19	35 55	36 32	37 7	37 42
43	30 39	31 19	31 59	32 39	33 18	33 57	34 36	35 14	35 51	36 29	37 5	37 42
44	30 27	31 8	31 49	32 30	33 10	33 50	34 29	35 8	35 47	36 25	37 3	37 40
45	30 14	30 56	31 38	32 20	33 1	33 42	34 22	35 2	35 41	36 21	37 0	37 38
46	30 1	30 44	31 27	32 9	32 51	33 33	34 14	34 55	35 36	36 16	36 56	37 35
47	29 47	30 31	31 15	31 58	32 41	33 23	34 6	34 47	35 29	36 10	36 51	37 31
48	29 33	30 18	31 2	31 46	32 30	33 13	33 56	34 39	35 21	36 3	36 45	37 27
49	29 18	30 3	30 49	31 33	32 18	33 2	33 46	34 30	35 13	35 56	36 39	37 21
50	29 3	29 49	30 35	31 20	32 6	32 51	33 36	34 20	35 4	35 48	36 31	37 15
51	28 47	29 34	30 20	31 7	31 53	32 39	33 24	34 10	34 55	35 39	36 23	37 7
52	28 30	29 18	30 5	30 52	31 39	32 26	33 12	33 58	34 44	35 30	36 15	37 0
53	28 13	29 1	29 50	30 37	31 25	32 12	33 0	33 46	34 33	35 19	36 5	36 51
54	27 56	28 45	29 33	30 22	31 10	31 58	32 46	33 34	34 21	35 8	35 55	36 42
55	27 38	28 27	29 17	30 6	30 55	31 44	32 32	33 21	34 9	34 57	35 44	36 32
56	27 19	28 9	28 59	29 49	30 39	31 28	32 18	33 7	33 56	34 44	35 33	36 21
57	27 0	27 51	28 42	29 32	30 22	31 13	32 2	32 52	33 42	34 31	35 20	36 9
58	26 41	27 32	28 23	29 14	30 5	30 56	31 47	32 37	33 27	34 17	35 7	35 57
59	26 21	27 13	28 4	28 56	29 48	30 39	31 30	32 21	33 12	34 3	34 53	35 44
60	26 0	26 53	27 45	28 37	29 29	30 21	31 13	32 5	32 56	33 48	34 39	35 30

TABLE A.—PART II.

This Table shows the True Altitude of the Sun's Centre at the instant it is 8 o'Clock in the Morning, or 4 o'Clock in the Afternoon, Apparent Time, for more readily finding the Longitude by Chronometer.

DECLINATION AND LATITUDE OF DIFFERENT NAMES.

Lat.	0°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	11°	12°
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	30 0	30 0	29 59	29 57	29 55	29 52	29 49	29 45	29 41	29 36	29 30	29 24	29 17
1	30 0	29 58	29 56	29 53	29 50	29 46	29 42	29 36	29 31	29 25	29 18	29 10	29 2
2	29 59	29 56	29 53	29 49	29 44	29 39	29 34	29 27	29 20	29 13	29 5	28 56	28 47
3	29 57	29 53	29 49	29 44	29 38	29 32	29 25	29 17	29 9	29 1	28 51	28 42	28 31
4	29 55	29 50	29 44	29 38	29 31	29 24	29 16	29 7	28 58	28 48	28 38	28 27	28 15
5	29 52	29 46	29 39	29 32	29 24	29 15	29 6	28 56	28 46	28 35	28 23	28 11	27 59
6	29 49	29 42	29 34	29 25	29 16	29 6	28 55	28 44	28 33	28 21	28 8	27 55	27 41
7	29 45	29 36	29 27	29 17	29 7	28 56	28 44	28 32	28 20	28 6	27 53	27 38	27 24
8	29 41	29 31	29 20	29 9	28 58	28 46	28 33	28 20	28 6	27 51	27 37	27 21	27 5
9	29 36	29 25	29 13	29 1	28 48	28 35	28 21	28 6	27 51	27 36	27 20	27 3	26 47
10	29 30	29 18	29 5	28 51	28 38	28 23	28 8	27 53	27 37	27 20	27 3	26 45	26 27
11	29 24	29 10	28 56	28 42	28 27	28 11	27 55	27 38	27 21	27 3	26 45	26 27	26 8
12	29 17	29 2	28 47	28 31	28 15	27 59	27 41	27 24	27 5	26 47	26 27	26 8	25 48
13	29 9	28 54	28 37	28 21	28 3	27 45	27 27	27 8	26 49	26 29	26 9	25 48	25 27
14	29 1	28 45	28 27	28 9	27 51	27 32	27 12	26 53	26 32	26 11	25 50	25 28	25 6
15	28 53	28 35	28 16	27 57	27 38	27 18	26 57	26 36	26 15	25 53	25 31	25 8	24 45
16	28 44	28 24	28 5	27 45	27 24	27 3	26 41	26 19	25 57	25 34	25 11	24 47	24 23
17	28 34	28 14	27 53	27 32	27 10	26 48	26 25	26 2	25 39	25 15	24 51	24 26	24 1
18	28 24	28 2	27 40	27 18	26 55	26 32	26 9	25 45	25 20	24 55	24 30	24 4	23 38
19	28 13	27 50	27 28	27 4	26 40	26 16	25 51	25 26	25 1	24 35	24 9	23 42	23 15
20	28 1	27 38	27 14	26 50	26 25	26 0	25 34	25 8	24 41	24 14	23 47	23 19	22 52
21	27 50	27 25	27 0	26 35	26 9	25 42	25 16	24 49	24 21	23 53	23 25	22 57	22 28
22	27 37	27 12	26 46	26 19	25 52	25 25	24 57	24 29	24 1	23 32	23 3	22 33	22 4
23	27 24	26 58	26 31	26 3	25 35	25 7	24 38	24 9	23 40	23 10	22 40	22 10	21 39
24	27 11	26 43	26 15	25 47	25 18	24 49	24 19	23 49	23 19	22 48	22 17	21 46	21 14
25	26 57	26 28	25 59	25 30	25 0	24 30	23 59	23 28	22 57	22 25	21 53	21 21	20 49
26	26 42	26 13	25 43	25 12	24 41	24 10	23 39	23 7	22 35	22 3	21 30	20 57	20 24
27	26 27	25 57	25 26	24 54	24 23	23 51	23 18	22 46	22 13	21 39	21 6	20 32	19 58
28	26 12	25 40	25 8	24 36	24 3	23 30	22 57	22 24	21 50	21 16	20 41	20 6	19 32
29	25 56	25 23	24 51	24 17	23 44	23 10	22 36	22 1	21 27	20 52	20 16	19 41	19 5
30	25 40	25 6	24 32	23 58	23 24	22 49	22 14	21 39	21 3	20 27	19 51	19 15	18 38
31	25 23	24 48	24 13	23 39	23 3	22 28	21 52	21 16	20 39	20 3	19 26	18 48	18 11
32	25 5	24 30	23 55	23 19	22 42	22 6	21 29	20 52	20 15	19 38	19 0	18 22	17 44
33	24 48	24 12	23 35	22 58	22 21	21 44	21 6	20 29	19 51	19 12	18 34	17 55	17 16
34	24 29	23 52	23 15	22 37	22 0	21 22	20 43	20 5	19 26	18 47	18 8	17 28	16 49
35	24 11	23 33	22 55	22 16	21 38	20 59	20 20	19 40	19 1	18 21	17 41	17 1	16 20
36	23 52	23 13	22 34	21 55	21 15	20 36	19 56	19 16	18 35	17 55	17 14	16 33	15 52
37	23 32	22 53	22 13	21 33	20 53	20 12	19 32	18 51	18 10	17 28	16 47	16 5	15 24
38	23 12	22 32	21 51	21 11	20 30	19 48	19 7	18 25	17 44	17 2	16 20	15 37	14 55
39	22 52	22 11	21 30	20 48	20 6	19 24	18 42	18 0	17 17	16 35	15 52	15 9	14 26
40	22 31	21 50	21 7	20 25	19 43	19 0	18 17	17 34	16 51	16 8	15 24	14 41	13 57
41	22 10	21 28	20 45	20 2	19 19	18 35	17 52	17 8	16 24	15 40	14 56	14 12	13 27
42	21 49	21 6	20 22	19 38	18 54	18 10	17 26	16 42	15 57	15 12	14 28	13 43	12 58
43	21 27	20 43	19 59	19 14	18 30	17 45	17 0	16 15	15 30	14 45	13 59	13 14	12 28
44	21 5	20 20	19 35	18 50	18 5	17 19	16 34	15 48	15 2	14 17	13 30	12 44	11 58
45	20 42	19 57	19 11	18 26	17 40	16 54	16 7	15 21	14 35	13 48	13 2	12 15	11 28
46	20 19	19 33	18 47	18 1	17 14	16 27	15 41	14 54	14 7	13 20	12 32	11 45	10 58
47	19 56	19 10	18 23	17 36	16 48	16 1	15 14	14 26	13 39	12 51	12 3	11 15	10 27
48	19 33	18 45	17 58	17 10	16 22	15 35	14 47	13 59	13 10	12 22	11 34	10 45	9 57
49	19 9	18 21	17 33	16 45	15 56	15 8	14 19	13 31	12 42	11 53	11 4	10 15	9 26
50	18 45	17 56	17 8	16 19	15 30	14 41	13 52	13 2	12 13	11 24	10 34	9 45	8 55
51	18 20	17 31	16 42	15 53	15 3	14 14	13 24	12 34	11 44	10 54	10 4	9 14	8 24
52	17 56	17 6	16 16	15 26	14 36	13 46	12 56	12 6	11 15	10 25	9 34	8 44	7 53
53	17 31	16 41	15 50	15 0	14 9	13 18	12 28	11 37	10 46	9 55	9 4	8 13	7 22
54	17 5	16 15	15 24	14 33	13 42	12 51	11 59	11 8	10 17	9 25	8 34	7 42	6 51
55	16 40	15 49	14 57	14 6	13 14	12 22	11 31	10 39	9 47	8 55	8 4	7 12	6 20
56	16 14	15 22	14 30	13 38	12 46	11 54	11 2	10 10	9 18	8 25	7 33	6 41	5 48
57	15 48	14 56	14 3	13 11	12 18	11 26	10 33	9 41	8 48	7 55	7 2	6 9	5 17
58	15 22	14 29	13 36	12 43	11 50	10 57	10 4	9 11	8 18	7 25	6 32	5 38	4 45
59	14 55	14 2	13 9	12 15	11 22	10 29	9 35	8 42	7 48	6 54	6 1	5 7	4 14
60	14 29	13 35	12 41	11 47	10 54	10 0	9 6	8 12	7 18	6 24	5 30	4 36	3 42

This Table shows the True Altitude of the Sun's Centre at the instant it is 8 o'Clock in the Morning, or 4 o'Clock in the Afternoon, Apparent Time, for more readily finding the Longitude by Chronometer.

DECLINATION AND LATITUDE OF DIFFERENT NAMES.

Lat.	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°	23°	24°
°	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
0	29 9	29 1	28 53	28 44	28 34	28 24	28 13	28 1	27 50	27 37	27 24	27 11
1	28 54	28 45	28 35	28 24	28 14	28 2	27 50	27 38	27 25	27 12	26 58	26 43
2	28 37	28 27	28 16	28 5	27 53	27 40	27 28	27 14	27 0	26 46	26 31	26 15
3	28 21	28 9	27 57	27 45	27 32	27 18	27 4	26 50	26 35	26 19	26 3	25 47
4	28 3	27 51	27 38	27 24	27 10	26 55	26 40	26 25	26 9	25 52	25 35	25 18
5	27 45	27 32	27 18	27 3	26 48	26 32	26 16	26 0	25 42	25 25	25 7	24 49
6	27 27	27 12	26 57	26 41	26 25	26 9	25 51	25 34	25 16	24 57	24 38	24 19
7	27 8	26 53	26 36	26 19	26 2	25 45	25 26	25 8	24 49	24 29	24 9	23 49
8	26 49	26 32	26 15	25 57	25 39	25 20	25 1	24 41	24 21	24 1	23 40	23 19
9	26 29	26 11	25 53	25 34	25 15	24 55	24 35	24 14	23 53	23 32	23 10	22 48
10	26 9	25 50	25 31	25 11	24 51	24 30	24 9	23 47	23 25	23 3	22 40	22 17
11	25 48	25 28	25 8	24 47	24 26	24 4	23 42	23 19	22 57	22 33	22 10	21 46
12	25 27	25 6	24 45	24 23	24 1	23 38	23 15	22 52	22 28	22 4	21 39	21 14
13	25 6	24 44	24 21	23 58	23 35	23 12	22 48	22 23	21 59	21 33	21 8	20 42
14	24 44	24 21	23 57	23 33	23 9	22 45	22 20	21 55	21 29	21 3	20 37	20 10
15	24 21	23 57	23 33	23 8	22 43	22 17	21 52	21 26	20 59	20 32	20 5	19 38
16	23 58	23 33	23 8	22 42	22 16	21 50	21 23	20 56	20 29	20 1	19 33	19 5
17	23 35	23 9	22 43	22 16	21 50	21 22	20 55	20 27	19 59	19 30	19 1	18 32
18	23 12	22 45	22 17	21 50	21 22	20 54	20 26	19 57	19 28	18 58	18 29	17 59
19	22 48	22 20	21 52	21 23	20 55	20 26	19 56	19 27	18 57	18 27	17 56	17 26
20	22 23	21 55	21 26	20 56	20 27	19 57	19 27	18 56	18 26	17 55	17 23	16 52
21	21 59	21 29	20 59	20 29	19 59	19 28	18 57	18 26	17 54	17 22	16 50	16 18
22	21 33	21 3	20 32	20 1	19 30	18 58	18 27	17 55	17 22	16 50	16 17	15 44
23	21 8	20 37	20 5	19 33	19 1	18 29	17 56	17 23	16 50	16 17	15 43	15 10
24	20 42	20 10	19 38	19 5	18 32	17 59	17 26	16 52	16 18	15 44	15 10	14 35
25	20 16	19 43	19 10	18 37	18 3	17 29	16 55	16 20	15 46	15 11	14 36	14 1
26	19 50	19 16	18 42	18 8	17 33	16 58	16 23	15 48	15 13	14 37	14 2	13 26
27	19 23	18 49	18 14	17 39	17 3	16 28	15 52	15 16	14 40	14 4	13 27	12 51
28	18 56	18 21	17 45	17 9	16 33	15 57	15 21	14 44	14 7	13 30	12 53	12 16
29	18 29	17 53	17 16	16 40	16 3	15 26	14 49	14 11	13 34	12 56	12 18	11 40
30	18 2	17 25	16 47	16 10	15 32	14 55	14 17	13 39	13 0	12 22	11 44	11 5
31	17 34	16 56	16 18	15 40	15 2	14 23	13 45	13 6	12 27	11 48	11 8	10 29
32	17 6	16 27	15 49	15 10	14 31	13 51	13 12	12 33	11 53	11 13	10 34	9 54
33	16 37	15 58	15 19	14 39	13 59	13 20	12 40	12 0	11 19	10 39	9 58	9 18
34	16 9	15 29	14 49	14 9	13 28	12 48	12 7	11 26	10 45	10 4	9 23	8 42
35	15 40	14 59	14 19	13 38	12 57	12 15	11 34	10 53	10 11	9 29	8 48	8 6
36	15 11	14 30	13 48	13 7	12 25	11 43	11 1	10 19	9 37	8 55	8 12	7 30
37	14 42	14 0	13 18	12 35	11 53	11 10	10 28	9 45	9 2	8 20	7 37	6 54
38	14 12	13 30	12 47	12 4	11 21	10 38	9 55	9 11	8 28	7 44	7 1	6 17
39	13 43	12 59	12 16	11 32	10 49	10 5	9 21	8 37	7 53	7 9	6 25	5 41
40	13 13	12 29	11 45	11 1	10 16	9 32	8 48	8 3	7 19	6 34	5 49	5 5
41	12 43	11 58	11 14	10 29	9 44	8 59	8 14	7 29	6 44	5 59	5 13	4 28
42	12 13	11 28	10 42	9 57	9 11	8 26	7 40	6 55	6 9	5 23	4 37	3 52
43	11 42	10 57	10 11	9 25	8 39	7 53	7 6	6 20	5 34	4 48	4 1	3 15
44	11 12	10 25	9 39	8 52	8 6	7 19	6 32	5 46	4 59	4 12	3 25	2 38
45	10 41	9 54	9 7	8 20	7 33	6 46	5 58	5 11	4 24	3 36	2 49	2 2
46	10 10	9 23	8 35	7 48	7 0	6 12	5 24	4 37	3 49	3 1	2 13	1 25
47	9 39	8 51	8 3	7 15	6 27	5 39	4 50	4 2	3 14	2 25	1 37	0 48
48	9 8	8 20	7 31	6 42	5 54	5 5	4 16	3 27	2 38	1 49	1 1	0 12
49	8 37	7 48	6 59	6 10	5 20	4 31	3 42	2 52	2 3	1 14	0 24	
50	8 6	7 16	6 26	5 37	4 47	3 57	3 7	2 18	1 28	0 38		
51	7 34	6 44	5 54	5 4	4 14	3 23	2 33	1 43	0 52	0 2		
52	7 3	6 12	5 22	4 31	3 40	2 49	1 59	1 8	0 17			
53	6 31	5 40	4 49	3 58	3 7	2 15	1 24	0 33				
54	5 59	5 8	4 16	3 25	2 33	1 41	0 50					
55	5 28	4 36	3 44	2 52	2 0	1 7	0 15					
56	4 56	4 3	3 11	2 18	1 26	0 33						
57	4 24	3 31	2 38	1 45	0 52							
58	3 52	2 59	2 5	1 12	0 19							
59	3 20	2 26	1 32	0 39								
60	2 48	1 54	1 0	0 6								

TABLE B.—Sexagesimal Proportional Table

For finding the proportion of Altitude for Miles of Latitude and Declination, to be applied to the Altitude taken from Table A.

Miles of Lat. or Decli.	DIFFERENCE OF ALTITUDE FOR 1° OF LATITUDE OR DECLINATION.													
	1′	3′	5′	7′	9′	11′	13′	15′	17′	19′	21′	23′	25′	27′
′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.5
2	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.7	0.8	0.8	0.9
3	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4
4	0.1	0.2	0.3	0.5	0.6	0.7	0.9	1.0	1.1	1.3	1.4	1.5	1.7	1.8
5	0.1	0.3	0.4	0.6	0.8	0.9	1.1	1.3	1.4	1.6	1.8	1·9	2.1	2·3
6	0.1	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1	2.3	2.5	2.7
7	0.1	0.4	0.6	0.8	1.1	1.3	1.5	1.8	2.0	2.2	2.5	2.7	2.9	3.2
8	0.1	0.4	0.7	0.9	1.2	1.5	1.7	2.0	2.3	2.5	2.8	3.1	3.3	3.6
9	0.2	0.5	0.8	1.1	1.4	1.7	2.0	2.3	2.6	2.9	3.2	3.5	3.8	4.1
10	0.2	0.5	0.8	1.2	1.5	1.8	2.2	2.5	2.8	3.2	3.5	3.8	4.2	4.5
11	0.2	0.6	0.9	1.3	1.7	2.0	2.4	2.8	3.1	3.5	3.9	4.2	4.6	5.0
12	0.2	0.6	1.0	1.4	1.8	2.2	2.6	3.0	3.4	3.8	4.2	4.6	5.0	5.4
13	0.2	0.7	1.1	1.5	2.0	2.4	2.8	3.3	3.7	4.1	4.6	5.0	5.4	5.9
14	0.2	0.7	1.2	1.6	2.1	2.6	3.0	3.5	4.0	4.4	4.9	5.4	5.8	6.3
15	0.3	0.8	1.3	1.8	2.3	2.8	3.3	3.8	4.3	4.8	5.3	5.8	6.3	6.8
16	0.3	0.8	1.3	1.9	2.4	2.9	3.5	4.0	4.5	5.1	5.6	6.1	6.7	7.2
17	0.3	0.9	1.4	2.0	2.6	3.1	3.7	4.3	4.8	5.4	6.0	6.5	7.1	7.7
18	0.3	0.9	1.5	2.1	2.7	3.3	3.9	4.5	5.1	5.7	6.3	6.9	7.5	8.1
19	0.3	1.0	1.6	2.2	2.9	3.5	4.1	4.8	5.4	6.0	6.7	7.3	7.9	8.6
20	0.3	1.0	1.7	2.3	3.0	3.7	4.3	5.0	5.7	6.3	7.0	7.7	8.3	9.0
21	0.4	1.1	1.8	2.5	3.2	3.9	4.6	5.3	6.0	6.7	7.4	8.1	8.8	9.5
22	0.4	1.1	1.8	2.6	3.3	4.0	4.8	5.5	6.2	7.0	7.7	8.4	9.2	9.9
23	0.4	1.2	1.9	2.7	3.5	4.2	5.0	5.8	6.5	7.3	8.1	8.8	9.6	10.4
24	0.4	1.2	2.0	2.8	3.6	4.4	5.2	6.0	6.8	7.6	8.4	9.2	10.0	10.8
25	0.4	1.3	2.1	2.9	3.8	4.6	5.4	6.3	7.1	7.9	8.8	9.6	10.4	11.3
26	0.4	1.3	2.2	3.0	3.9	4.8	5.6	6.5	7.4	8.2	9.1	10.0	10.8	11.7
27	0.5	1.4	2.3	3.2	4.1	5.0	5.9	6.8	7.7	8.6	9.5	10.4	11.3	12.2
28	0.5	1.4	2.3	3.3	4.2	5.1	6.1	7.0	7.9	8.9	9.8	10.7	11.7	12.6
29	0.5	1.5	2.4	3.4	4.4	5.3	6.3	7.3	8.2	9.2	10.2	11.1	12.1	13.1
30	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5
31	0.5	1.6	2.6	3.6	4.7	5.7	6.7	7.8	8.8	9.8	10.9	11.9	12.9	14.0
32	0.5	1.6	2.7	3.7	4.8	5.9	6.9	8.0	9.1	10.1	11.2	12.3	13.3	14.4
33	0.6	1.7	2.8	3.9	5.0	6.1	7.2	8.3	9.4	10.5	11.6	12.7	13.8	14.9
34	0.6	1.7	2.8	4.0	5.1	6.2	7.4	8.5	9.6	10.8	11.9	13.0	14.2	15.3
35	0.6	1.8	2.9	4.1	5.3	6.4	7.6	8.8	9.9	11.1	12.3	13.4	14.6	15.8
36	0.6	1.8	3.0	4.2	5.4	6.6	7.8	9.0	10.2	11.4	12.6	13.8	15.0	16.2
37	0.6	1.9	3.1	4.3	5.6	6.8	8.0	9.3	10.5	11.7	13.0	14.2	15.4	16.7
38	0.6	1.9	3.2	4.4	5.7	7.0	8.2	9.5	10.8	12.0	13.3	14.6	15.8	17.1
39	0.7	2.0	3.3	4.6	5.9	7.2	8.5	9.8	11.1	12.4	13.7	15.0	16.3	17.6
40	0.7	2.0	3.3	4.7	6.0	7.3	8.7	10.0	11.3	12.7	14.0	15.3	16.7	18.0
41	0.7	2.1	3.4	4.8	6.2	7.5	8.9	10.3	11.6	13.0	14.4	15.7	17.1	18.5
42	0.7	2.1	3.5	4.9	6.3	7.7	9.1	10.5	11.9	13.3	14.7	16.1	17.5	18.9
43	0.7	2.2	3.6	5.0	6.5	7.9	9.3	10.8	12.2	13.6	15.1	16.5	17.9	19.4
44	0.7	2.2	3.7	5.1	6.6	8.1	9.5	11.0	12.5	13.9	15.4	16.9	18.3	19.8
45	0.8	2.3	3.8	5.3	6.8	8.3	9.8	11.3	12.8	14.3	15.8	17.3	18.8	20.3
46	0.8	2.3	3.8	5.4	6.9	8.4	10.0	11.5	13.0	14.6	16.1	17.6	19.2	20.7
47	0.8	2.4	3.9	5.5	7.1	8.6	10.2	11.8	13.3	14.9	16.5	18.0	19.6	21.2
48	0.8	2.4	4.0	5.6	7.2	8.8	10.4	12.0	13.6	15.2	16.8	18.4	20.0	21.6
49	0.8	2.5	4.1	5.7	7.4	9.0	10.6	12.3	13.9	15.5	17.2	18.8	20.4	22.1
50	0.8	2.5	4.2	5.8	7.5	9.2	10.8	12.5	14.2	15.8	17.5	19.2	20.8	22.5
51	0.9	2.6	4.3	6.0	7.7	9.4	11.1	12.8	14.5	16.2	17.9	19.6	21.3	23.0
52	0.9	2.6	4.3	6.1	7.8	9.5	11.3	13.0	14.7	16.5	18.2	19.9	21.7	23.4
53	0.9	2.7	4.4	6.2	9.0	9.7	11.5	13.3	15.0	16.8	18.6	20.3	22.1	23.9
54	0.9	2.7	4.5	6.3	9.1	9.9	11.7	13.5	15.3	17.1	18.9	20.7	22.5	24.3
55	0.9	2.8	4.6	6.4	9.3	10.1	11.9	13.8	15.6	17.4	19.3	21.1	22.9	24.8
56	0.9	2.8	4.7	6.5	9.4	10.3	12.1	14.0	15.9	17.7	19.6	21.5	23.3	25.2
57	1.0	2.9	4.8	6.7	9.6	10.5	12.4	14.3	16.2	18.1	20.0	21.9	23.8	25.7
58	1.0	2.9	4.8	6.8	9.7	10.6	12.6	14.5	16.4	18.4	20.3	22.2	24.2	26.1
59	1.0	3.0	4.9	6.9	9.9	10.8	12.8	14.8	16.7	18.7	20.7	22.6	24.6	26.6
60	1.0	3.0	5.0	7.0	9.0	11.0	13.0	15.0	17.0	19.0	21.0	23.0	25.0	27.0

For finding the proportion of Altitude for Miles of Latitude and Declination, to be applied to the Altitude taken from Table A.

Miles of Lat. or Decli.	DIFFERENCE OF ALTITUDE FOR 1° OF LATITUDE OR DECLINATION. 29′	31′	33′	35′	37′	39′	41′	43′	45′	47′	49′	51′	53′	55′
′	′	′	′	′	′	′	′	′	′	′	′	′	′	′
1	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9
2	1.0	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8
3	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
4	1.9	2.1	2.2	2.3	2.5	2.6	2.7	2.9	3.0	3.1	3.3	3.4	3.5	3.7
5	2.4	2.6	2.8	2.9	3.1	3.3	3.4	3.6	3.8	3.9	4.1	4.3	4.4	4.6
6	2.9	3.1	3.3	3.5	3.7	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.5
7	3.4	3.6	3.9	4.1	4.3	4.6	4.8	5.0	5.3	5.5	5.7	6.0	6.2	6.4
8	3.9	4.1	4.4	4.7	4.9	5.2	5.5	5.7	6.0	6.3	6.5	6.8	7.1	7.3
9	4.4	4.7	5.0	5.3	5.6	5.9	6.2	6.5	6.8	7.1	7.4	7.7	8.0	8.3
10	4.8	5.2	5.5	5.8	6.2	6.5	6.8	7.2	7.5	7.8	8.2	8.5	8.8	9.2
11	5.3	5.7	6.1	6.4	6.8	7.2	7.5	7.9	8.3	8.6	9.0	9.4	9.7	10.1
12	5.8	6.2	6.6	7.0	7.4	7.8	8.2	8.6	9.0	9.4	9.8	10.2	10.6	11.0
13	6.3	6.7	7.2	7.6	8.0	8.5	8.9	9.3	9.8	10.2	10.6	11.1	11.5	11.9
14	6.8	7.2	7.7	8.2	8.6	9.1	9.6	10.0	10.5	11.0	11.4	11.9	12.4	12.8
15	7.3	7.8	8.3	8.8	9.3	9.8	10.3	10.8	11.3	11.8	12.3	12.8	13.3	13.8
16	7.7	8.3	8.8	9.3	9.9	10.4	10.9	11.5	12.0	12.5	13.1	13.6	14.1	14.7
17	8.2	8.8	9.4	9.9	10.5	11.1	11.6	12.2	12.8	13.3	13.9	14.5	15.0	15.6
18	8.7	9.3	9.9	10.5	11.1	11.7	12.3	12.9	13.5	14.1	14.7	15.3	15.9	16.5
19	9.2	9.8	10.5	11.1	11.7	12.4	13.0	13.6	14.3	14.9	15.5	16.2	16.8	17.4
20	9.7	10.3	11.0	11.7	12.3	13.0	13.7	14.3	15.0	15.7	16.3	17.0	17.7	18.3
21	10.2	10.9	11.6	12.3	13.0	13.7	14.4	15.1	15.8	16.5	17.2	17.9	18.6	19.3
22	10.6	11.4	12.1	12.8	13.6	14.3	15.0	15.8	16.5	17.2	18.0	18.7	19.4	20.2
23	11.1	11.9	12.7	13.4	14.2	15.0	15.7	16.5	17.3	18.0	18.8	19.6	20.3	21.1
24	11.6	12.4	13.2	14.0	14.8	15.6	16.4	17.2	18.0	18.8	19.6	20.4	21.2	22.0
25	12.1	12.9	13.8	14.6	15.4	16.3	17.1	17.9	18.8	19.6	20.4	21.3	22.1	22.9
26	12.6	13.4	14.3	15.2	16.0	16.9	17.8	18.6	19.5	20.4	21.2	22.1	23.0	23.8
27	13.1	14.0	14.9	15.8	16.7	17.6	18.5	19.4	20.3	21.2	22.1	23.0	23.9	24.8
28	13.5	14.5	15.4	16.3	17.3	18.2	19.1	20.1	21.0	21.9	22.9	23.8	24.7	25.7
29	14.0	15.0	16.0	16.9	17.9	18.9	19.8	20.8	21.8	22.7	23.7	24.7	25.6	26.6
30	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5
31	15.0	16.0	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3	25.3	26.4	27.4	28.4
32	15.5	16.5	17.6	18.7	19.7	20.8	21.9	22.9	24.0	25.1	26.1	27.2	28.3	29.3
33	16.0	17.1	18.2	19.3	20.4	21.5	22.6	23.7	24.8	25.9	27.0	28.1	29.2	30.3
34	16.4	17.6	18.7	19.8	21.0	22.1	23.2	24.4	25.5	26.6	27.8	28.9	30.0	31.2
35	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.4	28.6	29.8	30.9	32.1
36	17.4	18.6	19.8	21.0	22.2	23.4	24.6	25.8	27.0	28.2	29.4	30.6	31.8	33.0
37	17.9	19.1	20.4	21.6	22.8	24.1	25.3	26.5	27.8	29.0	30.2	31.5	32.7	33.9
38	18.4	19.6	20.9	22.2	23.4	24.7	26.0	27.2	28.5	29.8	31.0	32.3	33.6	34.8
39	18.9	20.2	21.5	22.8	24.1	25.4	26.7	28.0	29.3	30.6	31.9	33.2	34.5	35.8
40	19.3	20.7	22.0	23.3	24.7	26.0	27.3	28.7	30.0	31.3	32.7	34.0	35.3	36.7
41	19.8	21.2	22.6	23.9	25.3	26.7	28.0	29.4	30.8	32.1	33.5	34.9	36.2	37.6
42	20.3	21.7	23.1	24.5	25.9	27.3	28.7	30.1	31.5	32.9	34.3	35.7	37.1	38.5
43	20.8	22.2	23.7	25.1	26.5	28.0	29.4	30.8	32.3	33.7	35.1	36.6	38.0	39.4
44	21.3	22.7	24.2	25.7	27.1	28.6	30.1	31.5	33.0	34.5	35.9	37.4	38.9	40.3
45	21.8	23.3	24.8	26.3	27.8	29.3	30.8	32.3	33.8	35.3	36.8	38.3	39.8	41.3
46	22.2	23.8	25.3	26.8	28.4	29.9	31.4	33.0	34.5	36.0	37.6	39.1	40.6	42.2
47	22.7	24.3	25.9	27.4	29.0	30.6	32.1	33.7	35.3	36.8	38.4	40.0	41.5	43.1
48	23.2	24.8	26.4	28.0	29.6	31.2	32.8	34.4	36.0	37.6	39.2	40.8	42.4	44.0
49	23.7	25.3	27.0	28.6	30.2	31.9	33.5	35.1	36.8	38.4	40.0	41.7	43.3	44.9
50	24.2	25.8	27.5	29.2	30.8	32.5	34.2	35.8	37.5	39.2	40.8	42.5	44.2	45.8
51	24.7	26.4	28.1	29.8	31.5	33.2	34.9	36.6	38.3	40.0	41.7	43.4	45.1	46.8
52	25.1	26.9	28.6	30.3	32.1	33.8	35.5	37.3	39.0	40.7	42.5	44.2	45.9	47.7
53	25.6	27.4	29.2	30.9	32.7	34.5	36.2	38.0	39.8	41.5	43.3	45.1	46.8	48.6
54	26.1	27.9	29.7	31.5	33.5	35.1	36.9	38.7	40.5	42.3	44.1	45.9	47.7	49.5
55	26.6	28.4	30.3	32.1	33.9	35.8	37.6	39.4	41.3	43.1	44.9	46.8	48.6	50.4
56	27.1	28.9	30.8	32.7	34.5	36.4	38.3	40.1	42.0	43.9	45.7	47.6	49.5	51.3
57	27.6	29.5	31.4	33.3	35.2	37.1	39.0	40.9	42.8	44.7	46.6	48.5	50.4	52.3
58	28.0	30.0	31.9	33.8	35.8	37.7	39.6	41.6	43.5	45.4	47.4	49.3	51.2	53.2
59	28.5	30.5	32.5	34.4	36.4	38.4	40.3	42.3	44.3	46.2	48.2	50.2	52.1	54.1
60	29.0	31.0	33.0	35.0	37.0	39.0	41.0	43.0	45.0	47.0	49.0	51.0	53.0	55.0

TABLE C.—First Part.

The Time (in seconds and hundredth parts of seconds) corresponding to a change of the Sun's Altitude of 1 mile, at 8 o'clock, A. M., or 4 o'clock, P. M., and which may be assumed the same for 20 minutes; that is, 10 minutes either before or after 8, A. M., or 4, P. M. (See Remark at bottom of page 247.)

DECLINATION AND LATITUDE OF THE SAME NAME.

Lat.	0°	2°	4°	6°	8°	10°	12°	14°	16°	18°	20°	22°	24°
°	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
0	4.00	4.00	4.01	4.03	4.05	4.08	4.12	4.16	4.22	4.28	4.34	4.42	4.50
1	.00	.00	.01	.03	.05	.08	.11	.15	.21	.27	.33	.40	.48
2	.00	.00	.01	.02	.04	.07	.10	.14	.18	.25	.31	.38	.46
3	.00	.01	.01	.02	.04	.06	.10	.14	.18	.24	.30	.38	.45
4	.01	.01	.01	.02	.04	.06	.09	.13	.17	.23	.29	.35	.44
5	4.02	4.02	4.02	4.03	4.04	4.06	4.09	4.13	4.17	4.22	4.28	4.34	4.43
6	.03	.02	.02	.03	.04	.06	.09	.12	.16	.21	.27	.34	.42
7	.04	.03	.03	.04	.05	.06	.09	.12	.16	.21	.27	.33	.41
8	.05	.04	.04	.04	.05	.07	.09	.12	.16	.20	.26	.32	.40
9	.07	.06	.05	.05	.06	.08	.10	.12	.16	.20	.26	.32	.39
10	4.08	4.07	4.06	4.06	4.07	4.08	4.10	4.13	4.17	4.21	4.26	4.32	4.38
11	.10	.08	.07	.07	.08	.09	.11	.13	.17	.21	.26	.32	.38
12	.12	.10	.09	.09	.09	.10	.12	.14	.18	.22	.26	.32	.38
13	.14	.12	.11	.10	.10	.11	.13	.15	.18	.22	.26	.32	.38
14	.16	.14	.13	.12	.12	.13	.14	.16	.19	.23	.27	.32	.38
15	4.19	4.17	4.15	4.14	4.14	4.15	4.16	4.18	4.20	4.24	4.28	4.32	4.38
16	.22	.19	.17	.16	.16	.17	.18	.19	.22	.25	.29	.33	.39
17	.25	.22	.20	.18	.18	.19	.20	.21	.24	.27	.30	.34	.40
18	.28	.25	.23	.21	.20	.21	.22	.23	.25	.28	.31	.35	.41
19	.31	.28	.26	.24	.23	.23	.24	.25	.27	.30	.33	.36	.42
20	4.34	4.31	4.29	4.27	4.26	4.26	4.26	4.27	4.29	4.31	4.34	4.38	4.43
21	.38	.34	.32	.30	.29	.29	.29	.30	.31	.33	.36	.40	.44
22	.42	.38	.35	.34	.32	.32	.32	.32	.33	.35	.38	.42	.46
23	.46	.42	.39	.37	.36	.35	.35	.35	.36	.38	.40	.44	.48
24	.50	.46	.44	.42	.40	.38	.38	.38	.39	.41	.43	.46	.50
25	4.55	4.51	4.48	4.46	4.44	4.42	4.42	4.42	4.42	4.44	4.46	4.48	4.52
26	.60	.56	.52	.50	.48	.46	.46	.46	.46	.47	.49	.51	.55
27	.65	.61	.57	.54	.52	.50	.50	.50	.50	.50	.52	.54	.58
28	.70	.66	.62	.59	.57	.55	.54	.54	.54	.54	.55	.57	.61
29	.75	.71	.67	.64	.62	.60	.58	.58	.58	.58	.59	.61	.64
30	4.81	4.77	4.73	4.69	4.67	4.65	4.63	4.63	4.63	4.63	4.63	4.65	4.68
31	.87	.83	.79	.75	.72	.70	.68	.68	.68	.68	.68	.70	.72
32	.93	.89	.85	.81	.78	.76	.74	.73	.73	.73	.73	.74	.76
33	5.00	.95	.91	.87	.84	.82	.80	.78	.78	.78	.78	.78	.80
34	.07	5.02	.98	.94	.90	.88	.86	.84	.83	.83	.83	.84	.85
35	5.14	5.09	5.05	5.01	4.97	.95	4.93	4.91	4.90	4.89	4.89	4.89	4.90
36	.22	.17	.13	.09	5.05	5.02	5.00	.98	.96	.95	.95	.95	.96
37	.30	.25	.21	.17	.13	.10	.07	5.05	5.03	5.01	5.01	5.01	5.02
38	.39	.33	.29	.25	.21	.18	.14	.12	.10	.08	.08	.08	.08
39	.48	.42	.38	.34	.30	.26	.22	.20	.18	.16	.15	.15	.15
40	5.58	5.52	5.47	5.43	5.39	5.35	5.31	5.28	5.26	5.24	5.23	5.23	5.23
41	.68	.62	.57	.52	.48	.44	.40	.37	.35	.33	.31	.30	.30
42	.78	.72	.67	.62	.58	.54	.50	.46	.44	.42	.40	.38	.38
43	.89	.83	.77	.72	.68	.64	.60	.56	.53	.51	.49	.47	.47
44	6.00	.94	.88	.83	.78	.74	.70	.66	.63	.61	.59	.58	.56
45	6.12	6.06	6.00	5.94	5.89	5.85	5.81	5.77	5.74	5.71	5.69	5.67	5.66
46	.25	.18	.12	6.06	6.01	.97	.93	.89	.86	.82	.80	.78	.77
47	.38	.31	.25	.19	.14	6.10	6.06	6.02	.98	.94	.92	.90	.88
48	.52	.45	.39	.33	.27	.23	.19	.15	6.11	6.07	6.05	6.03	6.01
49	.66	.60	.54	.48	.42	.36	.32	.28	.24	.21	.18	.15	.13
50	6.81	6.75	6.69	6.63	6.59	6.51	6.46	6.42	6.38	6.34	6.32	6.29	6.27
51	.97	.91	.85	.79	.73	.67	.61	.57	.53	.49	.47	.44	.42
52	7.14	7.08	7.02	.96	.90	.84	.78	.73	.69	.65	.63	.60	.58
53	.33	.26	.20	7.14	7.08	7.02	.96	.91	.87	.83	.80	.76	.74
54	.53	.45	.39	.33	.27	.22	7.15	7.10	7.06	7.02	.98	.94	.91
55	7.74	7.66	7.59	7.53	7.47	7.41	7.35	7.29	7.25	7.21	7.17	7.13	7.09
56	.96	.88	.81	.74	.68	.62	.56	.50	.45	.41	.37	.33	.29
57	8.19	8.11	8.04	.98	.92	.86	.80	.74	.18	.62	.58	.54	.50
58	.44	.36	.28	8.22	8.16	8.10	8.14	.98	.92	.86	.81	.77	.73
59	.70	.62	.54	.47	.41	.35	.29	8.23	8.17	8.11	8.06	8.02	.98
60	.98	.90	.82	.75	.69	.63	.57	.51	.45	.38	.33	.29	8.25

The Time (in seconds and hundredth parts of seconds) corresponding to a change of the Sun's Altitude of 1 mile, at 8 o'clock, A. M., or 4 o'clock, P. M., and which may be assumed the same for 20 minutes; that is, 10 minutes either before or after 8, A. M., or 4, P. M. (See Remark at bottom of page 247).

DECLINATION AND LATITUDE OF DIFFERENT NAMES.

Lat.	1°	3°	5°	7°	9°	11°	13°	15°	17°	19°	21°	23°	24°
°	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
1	4.00	4.01	4.03	4.05	4.08	4.11	4.15	4.20	4.26	4.32	4.39	4.47	4.52
2	.00	.02	.04	.06	.09	.12	.16	.22	.28	.34	.41	.49	.54
3	.01	.03	.05	.07	.10	.13	.18	.24	.30	.36	.43	.51	.56
4	.02	.04	.06	.08	.11	.14	.19	.26	.32	.38	.45	.54	.59
5	.03	.05	.07	.09	.12	.16	.21	.28	.34	.40	.47	.56	61
6	4.04	4.06	4.08	4.11	4.14	4.18	4.23	4.30	4.36	4.42	4.50	4.59	4.64
7	.05	.07	.09	.13	.16	.20	.25	.32	.38	.44	.52	.61	.66
8	.06	.08	.11	.15	.18	.22	.27	.34	.40	.47	.55	.64	.69
9	.08	.10	.12	.16	.20	.24	.29	.36	.42	.50	.58	.67	.72
10	.09	.11	.14	.18	.22	.26	.32	.38	.45	.53	.61	.70	.75
11	4.11	4.13	4.16	4.20	4.24	4.29	4.35	4.41	4.48	4.56	4.64	4.74	4.79
12	.13	.15	.18	.22	.26	.32	.38	.44	.51	.59	.67	.77	.82
13	.15	.18	.21	.25	.29	.35	.41	.47	.54	.62	.70	.80	.85
14	.17	.21	.24	.28	.33	.39	.45	.51	.58	.66	.74	.84	.89
15	.20	.24	.28	.32	.36	.41	.47	.54	.61	.69	.78	.87	.93
16	4.23	4.37	4.31	4.35	4.39	4.44	4.50	4.57	4.65	4.73	4.82	4.92	4.97
17	.26	.30	.34	.38	.42	.48	.54	.61	.69	.77	.86	.96	5.01
18	.29	.33	.37	.41	.46	.52	.58	.65	.73	.81	.90	5.00	.05
19	.32	.36	.40	.44	.50	.56	.62	.69	.77	.85	.95	.05	.10
20	.35	.39	.43	.48	.54	.60	.66	.74	.82	.90	5.00	.10	.15
21	4.39	4.43	4.47	4.52	4.58	4.64	4.70	4.78	4.86	4.95	5.05	5.15	5.20
22	.43	.47	.51	.56	.62	.69	.75	83	.91	5.00	.10	.20	.25
23	.47	.51	.56	.61	.67	.74	.80	.88	.96	.05	.15	.25	.30
24	.52	.56	.61	.66	.72	.79	.85	.93	5.01	.10	.20	.30	.36
25	.57	.61	.66	.71	.77	.84	.91	4.99	.07	.16	.26	.36	.42
26	4.62	4.66	4.71	4.76	4.82	4.89	4.97	5.05	5.13	5.22	5.32	5.42	5.48
27	.67	.71	.76	.82	.88	.95	5.03	.11	.19	.28	.38	.48	.54
28	.72	.76	.81	.87	.94	5.01	.09	.17	.25	.34	.44	.54	.60
29	.77	.82	.87	.93	5.00	.07	.15	.23	.31	.41	.51	.61	.67
30	.83	.88	.93	.99	.07	.14	.22	.30	.38	.48	.58	.68	.74
31	4.89	4.95	5.00	5.06	5.14	5.21	5.29	5.37	5.45	5.55	5.65	5.75	5.81
32	.96	5.02	.07	.13	.21	.28	.36	.44	.52	.62	.72	.82	.88
33	5.03	.09	.14	.20	.28	.35	.43	.51	.59	.69	.79	.90	.96
34	.10	.16	.21	.27	.35	.42	.50	.58	.67	.77	.87	.98	6.04
35	.17	.24	.29	.35	.43	.50	.58	.66	.75	.85	.95	6.07	.13
36	5.25	5.32	5.37	5.43	5.51	5.58	5.66	5.74	5.83	5.93	6.03	6.15	6.22
37	.33	.40	.45	.52	.60	.67	.75	.83	.92	6.02	.12	.24	.31
38	.42	.48	.54	.61	.69	.76	.84	.92	6.01	.11	.21	.33	.40
39	.51	.57	.63	.70	.78	.85	.93	6.02	.11	.21	.31	.43	.49
40	.61	.67	.73	.80	.88	.95	6.03	.12	.21	.31	.41	.53	.59
41	5.71	5.77	5.83	5.90	5.98	6.05	6.13	6.23	6.32	6.42	6.52	6.63	6.69
42	.81	.87	.93	6.01	6.09	.16	.24	.34	.43	.53	.63	.74	.80
43	.92	.98	6.04	.12	.20	.27	.35	.45	.54	.64	.74	.85	.91
44	6.03	6.09	.16	.23	.31	.39	.47	.57	.66	.76	.86	.97	7.03
45	.15	.22	.29	.37	.45	.53	.61	.71	.88	.93	.98	7.09	.15
46	6.28	6.35	6.42	6.50	6.58	6.66	6.74	6.84					
47	.41	.48	.55	.63	.71	.79	.87	7.97					
48	.55	.62	.69	.77	.85	.93	7.01	.11					
49	.69	.76	.83	.91	.99	7.07	.15	.25					
50	.84	.91	.99	7.07	7.15	.23							
51	7.00	7.07	7.15	7.23	7.31	7.39							
52	.17	.24	.32	.40	.49	.57							
53	.36	.43	.51	.59	.68	.76							
54	.56	.63	.71	.79	.87	.95							
55	.77	.84	.92	8.00									
56	7.99	8.06	8.14	8.22									
57	8.22	.30	.38	.46									
58	.47	.55	.63	.71									
59	.73	.81	.89	97									
60	.01	.09	.18	.25									

EXTRACTS FROM NAUTICAL ALMANAC, FOR 1854.

TO WORK EXAMPLES OF LATITUDE BY THE MOON, ON PAGES 102, 103.

Date.	Semid. Noon.	Semid. Mid.	Hor. Par. Noon.	Hor. Par. Mid.	Declination. Noon.	Declination. Mid.	Equation Of Time.	Meridian. Passage.
		′ ″		′ ″		° ′		h. m.
July 11		16 0		60 0	° ′	21 21 S.	— 5 m.	13 58
" 12					19 9 S.			14 56
April 23		′ ″		′ ″				21 59
" 24		16 0		57 0		0 51 S.		22 43
" 25					2 2 N.		+ 2 m.	
	′ ″		′ ″					
April 4	15 0		54 0		26 0 N.	26 13 N.	— 3 m.	5 30
" 5								6 21
April 1	15 0		55 0		18 46 N.	20 36 N.	— 4 m.	3 3
" 2								3 51
April 12		16 0		59 0		4 25 S.		11 53
" 13					7 27 S.		— 1 m.	12 42

FROM LARGE NAUTICAL ALMANAC.

TO WORK SAME EXAMPLES AS ABOVE.

Date.	Semid. Noon.	Semid. Mid.	Hor. Par. Noon.	Hor. Par. Mid.	Declination.	Diff. 10 m.	Equation of Time.	Meridian, Passage.
					At 19 h.			
		′ ″		′ ″	° ′ ″	″	m. s.	h. m.
July 11	′ ″	16 37	′ ″	60 51	20 6 34 S.	112	— 5 7	13 58
" 12	16 32		60 32					14 56
					At 17 h.			
								h. m.
April 23								21 59
" 24		15 31		56 50	0 21 16 N.	145	+ 1 57	22 43
" 25	15 27		56 35					
					At 7 h.			
April 4	14 49	14 49	54 15	54 15	26 9 52 N.	9	— 3 6	5 30
" 5								6 21
					At 7 h.			
April 1	15 2	14 58	55 3	54 50	19 52 23 N.	91	— 4 0	3 4
" 2								3 51
					At 18 h.			
April 12		16 0		58 36	4 40 12 S.	152	— 0 50	11 54
" 13	16 5		58 54					12 43

TO WORK EXAMPLES OF LATITUDE BY PLANETS, ON PAGE 105.

Date.	Names.	Meridian Passage.	Declination.	Equation.
		h. m.	° ′	m.
January 1	Venus.	3 15	13 5 S.	— 4
" 2	"		12 40 S.	
June 6	Mars.	6 2	7 25 N.	+ 2
" 7	"		7 13 N.	
April 13	Jupiter.	18 24	21 7 S.	— 1
" 14	"		21 6 S.	
February 1	Saturn.	6 46	17 4 N.	
" 2	"		17 4 N.	— 14

TO WORK EXAMPLES OF LATITUDE BY STARS, PAGES 107, 108.

Date.	Names.	Meridian Passage.	Declination.
		h. m.	° ′
February 27	Aldebaran	5 48	16 13 N.
February 28	Antares	17 36	26 6 S.
March 21	Sirius	6 34	16 31 S.
March 26	Vega	18 12	38 39 N.
May 1	Vega	15 59	38 39 N.
June 21	Cross-Foot Star	6 21	62 17 S.
April 1	Castor	6 43	32 12 N.

TO WORK LATITUDE BY POLAR STAR, PAGE 109.

Date.	Meridian Passage.	Right Ascension.	Declination.	Equation.
	h. m.	h. m.	° ′	
July 1	18 26		88 32 N.	
July 20	17 9		88 32 N.	
January 20		20 9		
February 10		21 36		m. — 15

TO WORK EXAMPLES OF TIME BY MOON, PAGE 133.

Date.	Semi-Diam.	Hor. Par.	Right Ascension. Noon.	Right Ascension. Mid.	Declination. Noon.	Declination. Mid.	Equation of Time.	Dif. 1 h.	Sun's Right Ascension.	Dif. 1 h.
	′	′	h. m. s.	h. m. s.	° ′	° ′	m. s.		h. m. s.	s.
Mar. 10	15	55	8 12 21	8 38 26	24 14 N.	23 4 N.	10 31.55	.665	23 21 53	9.

TO WORK EXAMPLES OF TIME BY PLANETS, PAGE 135

Date.	Right Ascen.	Declination.	Equation.	Diff. 1 h.	Sun's R. A.	Diff. 1 h.
	h. m. s.	° ′	m. s.	s.	h. m. s.	s.
April 6	22 27 28	6 7 S.	2 30.50	.725	1 0 18	9
" 7	22 29 44					
December 5	19 57 13	21 15 S.	9 12.43	1.049	16 46 36	11
" 6	19 58 4					

TO WORK EXAMPLES OF TIME BY STARS, ON PAGE 137.

Date.	Right Ascen.	Declination.	Equation.	Diff. 1 h.	Sun's R. A.	Diff. 1 h.
	h. m. s.	° ′	m. s.		h. m. s.	s.
February 9	6 38 43	16 31 S.	14 31.61	.39	21 31 34	10
May 12	16 20 24	26 6 S.	3 52.34	.53	h. m. s. 3 15 50	10

The following are a few from among the many recommendations of the work received by the Publishers :—

New York, *April* 5, 1856.

Mr. Shaw,—*Dear Sir,*—Having used the new treatise on the Practice of Navigation at Sea, by Captain William Thoms, during ten passages across the Atlantic, I am of opinion that it is the most clear, simple, and practical work on the subject I have yet seen, containing all that is requisite to the navigator, without being encumbered with pages of useless matter.

For the learner I consider it most especially desirable, for everything necessary for finding a ship's place on the Ocean is so simply and clearly explained, and illustrated by diagrams, that it must clear the mist and doubts that so often hang over him.

I am fully of opinion that this work will, in time, be duly appreciated, and generally adopted by our sea-faring community. Very respectfully,

P. E. Le Fevre, *Master Steamship Ariel.*

New York, *December* 26, 1855.

Mr. R. L. Shaw,—*Dear Sir,*—Captain Eldridge, of the Steamship Pacific, in conversation with me, after having used Thoms' Practical Navigation, said : "The book recommends itself, publish it, it is sure to go."

Jas. H. Brownlow, *Teacher of Navigation.*

New York, *April* 5, 1856.

Mr. Shaw,—*Dear Sir,*—Having used the work on Navigation published by Captain William Thoms, I can cheerfully recommend it to all those interested in navigation, in being the most simple and easy method of calculations. Yours,

Thos. D. Ewan, *Master of Steamship Southerner.*

Mr. R. L. Shaw,—I have used Thoms' Navigator for several voyages, and prefer it to any other I have had before, and recommend it to all classes of navigators, being more explicit, and best adapted to the general practice of navigation at sea.

J. Westervelt, *Master of Schooner Pearl.*

New York, *March* 12, 1856.

New York, *April* 7, 1856.

Mr. R. L. Shaw,—*Dear Sir,*—I have used Thoms' Navigation for three voyages and prefer it to any others I have seen.

John Hardy, *Master of Schooner D. Davidson.*

OPINION OF THE WORK,

From Men of Experience.

We, the undersigned, Captains of Ships, and others, having examined the Manuscript of a new Treatise on the Practice of Navigation, and Nautical Astronomy, by Capt. Wm. Thoms, are of opinion that it is the most simple and practical work on the subject we have yet seen, especially for the learner, who will be greatly assisted in obtaining a knowledge of the Science by the numerous Diagrams which illustrate the subject, and is particularly adapted for Seamen, as it treats on those subjects only which have reference to the Ship's Place on the Ocean, (or Navigation proper.) Many new problems have also been introduced, which will be found of much practical value to many Captains of Ships, who may not have had an opportunity of previously becoming acquainted with them.

We are therefore of opinion, that if the work is published in its present style, it will be duly appreciated by our seafaring community, and would in time be extensively used by them throughout this large maritime country.

Names.	Vessels Attached to.	Names.	Vessels Attached to.
S. McKAY,	Great Republic.	J. WILSON COMBY,	Calhoun.
THOMAS DIXON,	Fidelia.	WILLIAM HOWARD,	Lucy Watts.
EDWARD MURRAY,	Balance.	VICTOR VIEROUS,	H. T. L.
WM. BRAGDON,	Blon.	CHARLES LIDBECK,	Abrasia.
JOHN T. FRENCH,	Cornelia.	WILLIAM DALY,	Gazelle.
JOHN STRAKER,	Telegraph.	JAMES NEWBERY,	Jasper.
J. H. CASWELL,	S. Austin.	THOMAS McLEAVY,	Mary Morris.
ISAAC LYNCH,	S. B. Strong.	C. FERD. BROWN,	E. Bulkley.
WILLIAM P. JONES,	Kensington.	G. DOUGHTY,	Anstiss.
GUNDER KRABEL,	*Chief Mate.*	JOS. G. WOODSIDE,	Contest.
FRANCIS PATTERSON,	"	FRED. WIELMANN,	Vulture.
JOHN W HOLMES,	R. DeWolfe.	JOSEPH D. HUGHES,	Uranus.
CHAS. ANDERSON,	Mar. Vineyard.	EDWARD MOORE,	Augusta.
JAMES SAFFORD,	Helene.	RUFUS BROWN,	Mongolia.
JOHN KIRKPATRICK,	*Mate.*	B. F. TAYLOR,	Anna Tift.
AND. ARMSTRONG,	Cora Linn,	LEWIS E. JACKSON,	Hollander.
C. E. LUCAS,	*Mate.*	WM. L. KEMPTON,	St. Joseph.
A. B. CLAUSSE,	Sword Fish.	B. FRANCIS,	Cataract.
RICHARD LLOYD,	*Gloucester, Mass.*	ZACHEUS KEMPTON,	Horatio.
A. P. FOSTER,	Adela Swift.	J. H. ROGERS,	S. B. Strong.
JAMES W. TAYLOR,	D. B. Warner.	WILLIAM LYDDON,	J. N. Cooper.
J. W. JEROLOMON,	Alexander Law.	CHAS. E. MERRY,	Skylark.
ALF. B. LOWBER,	S. S. Ericsson.	G. RICE,	B. N. Hawkins.
JOHN R. CAVARLY,	Am. Eagle.	J. R. McDOUGALL,	John Stroud.
JOSEPH C. DOWD,	Wm. Rathbone.	JOSHUA E. SMITH,	Ann Elizabeth.
RICH'D. B. MORSE,	George Rayner.	M. NICHOLAS,	*Unattached.*
HENRY W. DODGE,	T. & P. Woodward.	JOHN MOONEY,	Governor Brown
W. R. FOREMAN,	Ohio.	PETER WIXEN,	North Wind.
MARTIN ALLEN,	Rapid.	EDWARD ABEEL,	Isaac Wright.
PET. BORGESTONE,	H. W. Moncure.	CHAS. ANDERSON,	Statira Moir.