# LIFEBOAT SEXTANT

***INSTRUCTIONS FOR USE***
***IN FINDING***
***LATITUDE AND LONGITUDE***
***TOGETHER WITH***
***SIMPLE SAILING INSTRUCTIONS***

**U. S. Maritime Commission**

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**UNITED STATES NAVAL OBSERVATORY**
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## CHECK OFF LIST

In abandoning ship check on the following:

1. Your lifeboat should contain for navigation:

   *a.* Charts.
   *b.* Compass.
   *c.* This booklet and instrument (with accessories).
   *d.* Radio.

2. Is there any navigational equipment on the ship such as chronometers, watches, charts, sextants, etc., that you can still get?

3. Do you know the error of your watch? If so make a note of it but don't attempt to set it. Keep it wound. Keep it dry.

4. Do you know the date? If so mark it on the calendar (pp. 44–45).

5. Do you know your approximate position? If so make a note of it. (See part V.)

6. Read pages 2 and 3 before taking the sextant from the box.

# LIFEBOAT SEXTANT

## INTRODUCTION

The accompanying sextant is a device for measuring the altitude of the Sun (or star) to determine the position of the observer on land or sea. This instrument and this booklet are sufficient to determine the observer's latitude and, if the correct time is known, his longitude, with an accuracy of about 5 miles.

The booklet is so arranged that one with no previous training can concentrate on the simplest parts and do a fair job of navigating; other parts are sufficiently complete that one with previous training or with plenty of curiosity and time can navigate with all the power of the regular methods used on ships. There are eight parts:


I. Description and use of the sextant (p. 2).
II. Simple methods for determining position from the Sun (p. 12).
III. Simple methods for determining position from the stars (p. 22).
IV. Simple methods of determining direction (p. 25).
V. Simple sailing instructions (p. 27).
VI. General navigation methods (p. 33).
VII. Star identification (p. 39).
VIII. Tables, graph paper, plotting sheets.


*The beginner may omit part VI, and all of parts III and VII except the paragraphs dealing with Polaris.*

All the tables will serve for any year. Data are given for the Sun and stars but not the Moon and planets.

## Part I. DESCRIPTION AND USE OF THE SEXTANT

**1. Description.**—Read this page and the one opposite before taking the sextant from the box, then re-read it with the sextant in your hand, examining each part as you read.

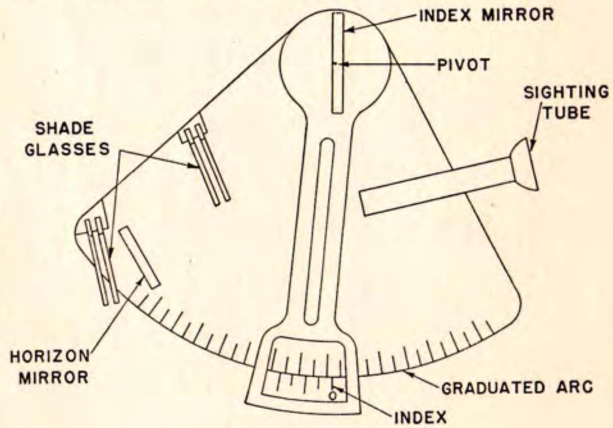
The instrument consists of a ribbed sheet or frame of plastic, to the front of which are attached:

(a) A movable *index arm* pivoted at one end to permit the index at the other end to slide along a graduated circular arc. Mounted on the index arm and over the pivot is a mirror called the *index mirror.*

(b) A mirror called the *horizon mirror* with the silver coating absent from half its surface.

(c) A sighting tube.

(d) Colored shade glasses.



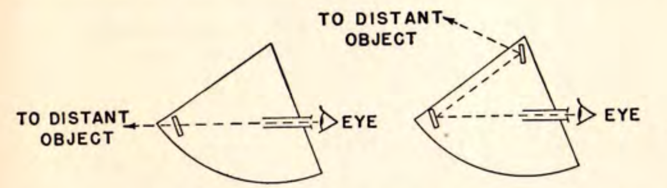




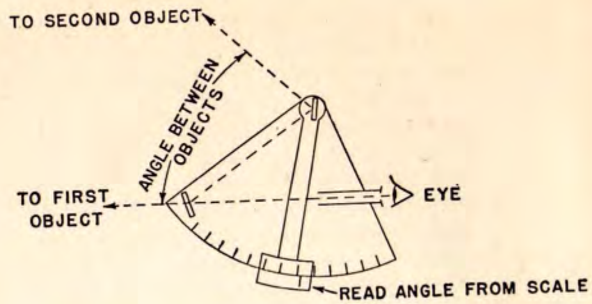

The sextant should be lifted only by the main framework or by the handle on the back; never by the index arm or the mirrors. The mirrors should not be touched except to clean them occasionally by gently rubbing the surface with a piece of cloth; the accuracy of the alignment of these mirrors determines the accuracy of the instrument.

The sighting tube is a hollow tube with a hole at the eye end.

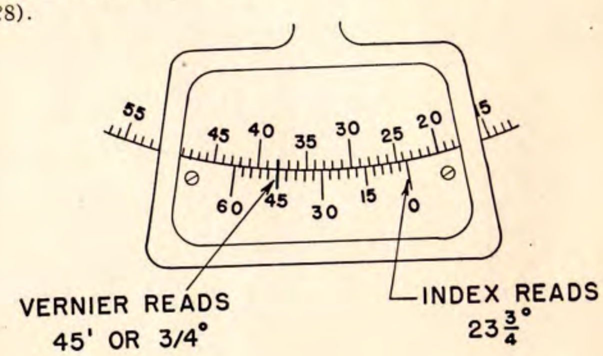
The horizon mirror is set directly in line with the sighting tube so that one can look through the tube into either the clear or the silvered half of the horizon mirror. By using the clear half it is possible to look through the tube and through the glass directly at a distant object. By looking through the tube into the silvered half one can see a reflection of the index mirror, and since the index mirror is itself silvered it is possible to see a distant object such as the Sun or a star reflected in it. The light from the object is reflected at the index mirror and again at the horizon mirror.




By properly directing the instrument and moving the index arm it is possible to look at two distant objects at the same time; one by direct vision through the clear portion of the horizon mirror and the other by reflection through the two mirrors. The instrument is so constructed that when this is done the angle between the two objects is indicated on the circular scale by the index. The index is the end mark on the index arm and is identified by the O.




The scale is graduated in degrees, and by noting the position of the index it is possible not only to read the whole degree but to estimate the reading to the nearest quarter degree or even to the nearest tenth. Care should always be exercised to make sure that the index line (with the zero) is used rather than one of the other lines parallel to it. In the following illustration the reading is seen to be 23¾ degrees (23¾°) or, estimating tenths, 23.8 degrees (23°.8).





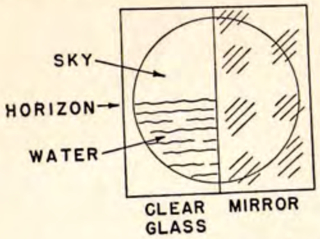

The beginner may wish to content himself with the nearest quarter degree or tenth estimated as above and to proceed with the other phases of the work; since a quarter of a degree is 15 minutes of arc or 15 nautical miles his position will be correct to about 8 miles if he reads the nearest quarter degree. In view of the other errors that the beginner is liable to make there is a great deal to be said for accepting this degree of accuracy on the first attempt. However, by the use of the *vernier* described in the next paragraph it is possible to read the angle to the nearest 0°.1 or 0°.05 with assurance.

The auxiliary marks on the index arm to the left of the index line and parallel to it constitute the vernier. These 20 auxiliary marks are spaced a little closer together than the divisions on the main scale (20 divisions on the vernier cover 19 on the scale); consequently in any position of the index arm one of them will be more nearly opposite a scale division than the others. To "read" the vernier it is only necessary to decide which division of the vernier is most nearly lined up with a division of the scale. In the preceding illustration the 15th division (counting from the index) is the one to be noted. Each division corresponds to 3 minutes of arc (3′) or 0°.05; consequently the 15th division corresponds to 45′ or 0°.75. Note that the lines marked 15, 30, 45 are the quarter degree marks. The exact reading for the setting in the illustration is 23°.75. *When the vernier is read it is advisable also to estimate the reading as in the previous paragraph to avoid gross errors.*

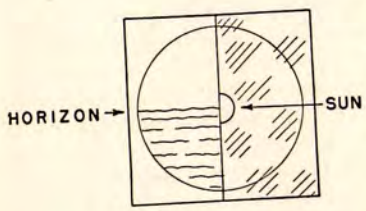
The shade glasses are mounted so they may be rotated into the line of sight when sighting at the Sun. There are two of them for cutting out glare in looking through the horizon glass and two more for use with the index glass.

**2. Observing the Altitude of the Sun.**—The most important use of the sextant is in observing the altitude of the Sun (its angular elevation above the horizon) for determining the observer's position at sea.

In this case the instrument is held vertically by the right hand and the observer sights through the sighting tube and the clear portion of the horizon mirror toward the distant horizon. He should face toward the Sun so the part of the horizon in the field of view is directly under the Sun. (If the glare on the water is troublesome one of the shade glasses behind the horizon mirror may be moved into the line of sight.)




The index arm is now rotated with the left hand until the glare of the Sun begins to be reflected into his eye. At this stage one of the shade glasses in front of the index mirror is turned into place and the index arm moved again. When the image of the Sun is finally brought into view it may be necessary to have both shade glasses in front of the index mirror.



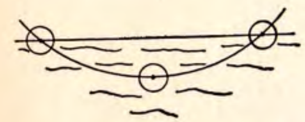

In making the final setting the instrument should be adjusted until the disk of the Sun and the horizon line are brought to the same height in the horizon mirror.

If the horizon is set opposite the middle of the Sun's disk as in the illustration the measured altitude is that of the center of the Sun, which is what is required for determination of position.

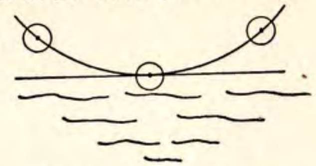
Navigators who have used a regular sextant with a telescope are accustomed to set the bottom edge of the Sun opposite the horizon. If this is done the observed altitude must be increased by 0°.25 to allow for the semidiameter of the Sun.



In observing the altitude of the Sun great care should be taken to hold the instrument vertical when the final adjustment is made. The tilt of the instrument may be tested by rotating it about the horizontal line through the sighting tube and the clear portion of the horizon mirror. If this rotation is performed while the index arm is fixed the Sun will appear to move away from the horizon as the instrument is tilted. The instrument should be swung back and forth and the index arm so adjusted that the horizon is even with the Sun's center at the lowest part of the arc.



INCORRECT SETTING



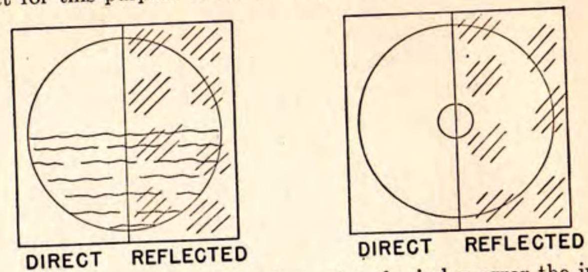
CORRECT SETTING

When satisfied with the setting of the instrument, read the time (if you have a timepiece) and then read the angle from the sextant. This angle gives you the altitude.

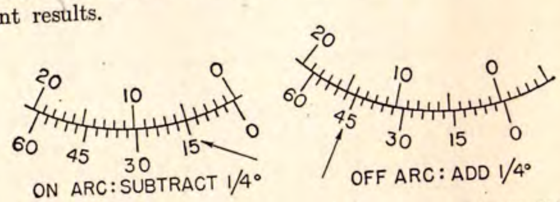
In the foregoing instructions it is assumed that the instrument is in perfect adjustment, which is usually not the case in practice. Instructions for adjusting the instrument will be given in a later paragraph; in the meantime the navigator may wish to use the instrument as it is and apply a correction for the most important error, *the index error*. Because of the importance of the index error and because the correction is easy to determine and apply most navigators determine it before and after each set of observations, though some prefer to adjust the instrument rather than to correct for the error.

The index error is the amount by which all measurements with a given instrument are either too large or too small. If the angles are too large the correction should be subtracted, and if too small the correction should be added.

The simplest way to determine the index error is to set the instrument so it should read zero and see what it does read. The sextant should read zero when the direct and reflected images of the same distant object are side by side; the most convenient object for this purpose is the horizon or the Sun.




With the instrument set to determine the index error the index will point exactly at zero, to the left of it (on the arc), or to the right of it (off the arc). If the index points exactly at zero no correction is applied. If the index is on the arc, the reading should be *subtracted* from altitudes measured with the instrument; if it is off the arc, the reading should be *added*. It is advisable to make this test several times and to take the average of the different results.

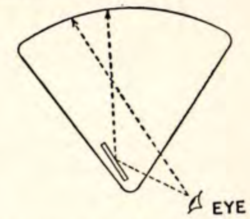



Note that in reading the vernier for index error, *on arc* readings are taken just as for ordinary angles. In the case of *off arc* readings it is necessary to count the marks from the left hand end of



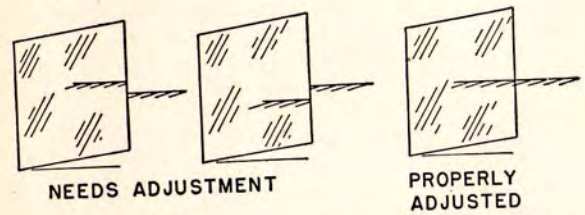
the vernier rather than from the right. For off arc readings it is particularly important to estimate the reading of the index before looking at the vernier.

**3. Adjusting the Sextant.**—When the instrument is in perfect adjustment the horizon mirror and the index mirror are each exactly perpendicular to the top of the frame of the instrument. On some sextants thumb screws are provided for making these adjustments; on others the mirrors are moulded rigidly to the frame and no adjustment is possible.

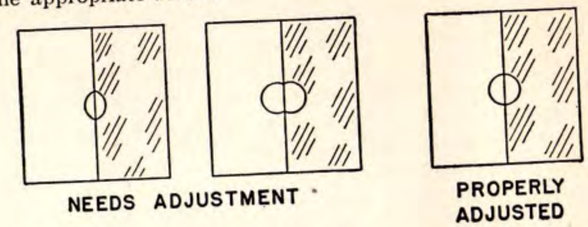



By holding the eye close to the index mirror and nearly level with the top of the instrument one can see the image of the graduated arc reflected in the index mirror and also by direct vision.

If the mirror is properly adjusted the portions of the arc seen by direct vision and by reflection will appear continuous and in line. If the line appears broken, the mirror should be adjusted by means of the thumbscrew directly in back of the mirror until the arc appears continuous.




The adjustment of the horizon mirror can be tested for perpendicularity after the index mirror has been adjusted. When looking at the direct and reflected images of the Sun as for determining index error the direct and reflected halves of the Sun should together form a circular disk. If not adjust by means of the appropriate screw.




If one wishes to eliminate the index error rather than correct each reading, set the index exactly on the zero scale division and sight at the horizon or the Sun as in determining index error. Adjust the appropriate screw until the images appear as in the illustration on page 8.

**4. Observing the Altitude of a Star.**—The altitude of a star can be measured in much the same manner as that of the Sun, but the observations are limited to the interval of twilight when both the horizon and the star can be seen. This period can be increased by practice and by the use of two special techniques.

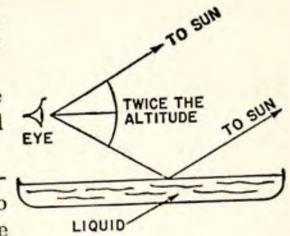
In looking at a faint star or at the horizon when it is faint the instrument should be moved up and down since faint objects moving through the field are more quickly perceived than fixed ones.

Also it must be remembered that the light which enters the eye directly through the clear portion of the horizon mirror undergoes fewer reflections than that through the index mirror and fainter objects can be seen. Consequently the sextant should be inverted and held in the left hand when necessary in order to use direct vision through the horizon glass on whichever is fainter, the star or the horizon. As darkness approaches the horizon will



be difficult to see and the sextant should be used in the normal way whereas as daylight approaches the star will be difficult and the sextant should be inverted.

**5. Miscellaneous.**—The lifeboat sextant can be used on land where the sea horizon is not visible. Instead of looking at the sea horizon one looks into a vessel or puddle of liquid at the reflected image of the Sun. Molasses or oil is good for the purpose but water will serve if sheltered from the wind.




The angle thus measured is twice the altitude of the Sun, hence it should be divided by two.

If the sextant should become damaged, every effort should be made to repair it. For example, if one of the mirrors is broken, any piece of plain glass will reflect enough light for measuring the altitude of the Sun.

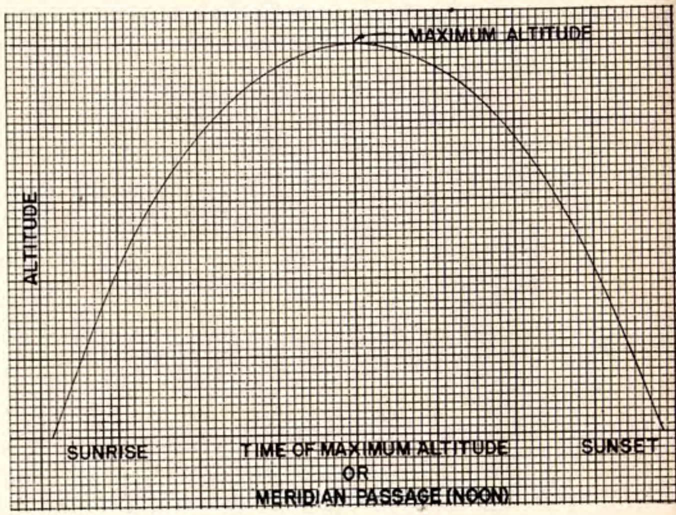
When the sextant is used at considerable height above the water a correction for dip should be subtracted from the measured altitude. The correction is as follows:

| *Height in Feet* | *Correction* |
|---|---|
| 0 | 0°00 |
| 10 | 0.05 |
| 37 | 0.10 |
| 85 | 0.15 |

This correction should be applied only to observations made with the sea horizon and not to those made by reflection from a liquid.

## Part II. SIMPLE METHODS FOR DETERMINING POSITION FROM THE SUN

**1. Altitude of the Sun.**—Part I of this book describes how the altitude of the Sun or its angle of elevation above the horizon can be measured with the sextant and how the time of the observation should be read from the watch; this part describes the method of computing the position of the observer from such observations. *If the correct time is not available, latitude only can be determined.*








The Sun rises each morning to the eastward and its altitude gradually increases from zero when it rises until it reaches its maximum value at midday. Then the altitude decreases until sunset when it is again zero.

At the instant of maximum altitude the Sun is said to be on the meridian, and it is either due north, due south, or straight overhead (in the zenith), depending on the latitude of the observer and the day of the year. The time of maximum altitude is called apparent noon or the time of meridian passage.

**2. Latitude from Noon Altitude.**—Since on any given day the maximum altitude depends only upon the latitude, it may be used to determine the latitude of an observer. On any given day there is one latitude on the Earth where the Sun will pass directly overhead or through the zenith at noon (i.e. maximum altitude 90°). In all latitudes north of this the Sun will pass to the south of the zenith, and in those south of it the Sun will pass to the north, and for each degree change of latitude the maximum altitude will change by one degree. The latitude of a place where the Sun is in the zenith at noon is equal to the declination of the Sun for that day. The declination of the Sun for each day of the year is given in table II.

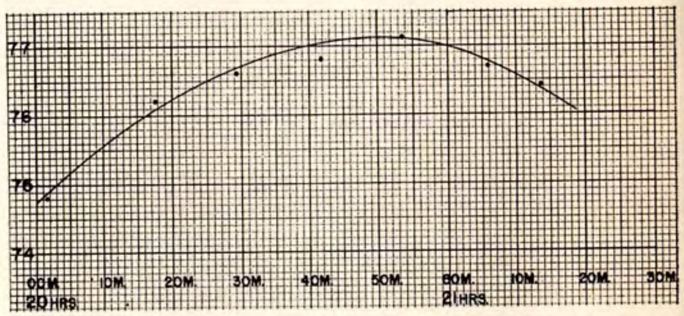
*Example:* On December 10, the declination of the Sun is S 22°.9 so an observer who measures the maximum altitude as 90° would know that he was in latitude S 22°.9. If he measured a maximum altitude of 85° with the Sun south of his zenith he would be 5° north of S 22°.9 or in latitude S 17°.9, and if the Sun was north he would be 5° south of S 22°.9 or S 27°.9.

To measure the meridian altitude accurately it is best to take a series of observations near the time of meridian passage and plot them on graph paper (pages 69–73). The maximum altitude can then be read from a smooth curve drawn through all the observations. This procedure will eliminate the danger of basing the result on a single or incorrect observation.

*Example:* On December 10, the following observations were made:

| *Time* | *Observed altitude* | |
|---|---|---|
| 20h01m6 | 74°8 | Sun South of Zenith |
| 20 17.5 | 76.2 | |
| 20 29.3 | 76.6 | |
| 20 41.8 | 76.8 | |
| 20 53.6 | 77.1 | |
| 21 05.9 | 76.7 | |
| 21 13.5 | 76.4 | |

The following plot shows the maximum altitude reached by the curve to be 77.1 degrees. The curve is so drawn as to have the same shape as the top portion of the one on page 12 and to pass as near as possible to all the points.




With the Sun *south* of the zenith and a maximum altitude of 77°1 the observer must be $90° - 77°1 = 12°9$ *north* of the point indicated by the declination of the Sun. The declination for December 10 is S 22°9 hence the latitude of the observer is 12°9 north of S 22°9 or S 10°0.

For determining the maximum altitude in this manner the watch need not be correct since its only purpose is in plotting the observations. If no timepiece is available the observations should be taken at regular intervals by estimation, and plotted at a convenient regular spacing on the graph paper.



It is sometimes difficult to decide whether the Sun is north or south of the zenith at the time of maximum altitude; in such cases the compass will usually settle the question. Further discussion of the direction of the Sun is given in part IV.

The declination of the Sun taken directly from table II as above may differ from the accurate value at the time of meridian passage by a few tenths of a degree ($0°1 = 6$ miles). The accurate value may be obtained by applying the correction from table III, according to the month and year and the longitude of the observer. A very rough estimate of the longitude will suffice.

The following additional examples of latitude determination illustrate the various cases that may arise.

*Examples of latitude from meridian altitude*

| | Sun south of zenith | | | Sun north of zenith | | |
|---|---|---|---|---|---|---|
| Year | 1944 | 1944 | 1945 | 1945 | 1944 | 1945 |
| Date | Jan. 5 | June 18 | Sept. 23 | Oct. 25 | Mar. 15 | Sept. 1 |
| Longitude | 70°W | 100°E | 170°W | 50°W | 10°E | 140°E |
| Greatest altitude | 75.4 | 58.2 | 32.6 | 54.3 | 69.1 | 28.0 |
| Declination | S 22.8 | N23.4 | N 0.1 | S 12.0 | S 2.3 | N 8.4 |
| Correction | N 0.1 | 0.0 | S 0.3 | S 0.2 | N 0.2 | N 0.1 |
| Corrected declination | S 22.7 | N23.4 | S 0.2 | S 12.2 | S 2.1 | N 8.5 |
| 90° minus altitude | 14.6 | 31.8 | 57.4 | 35.7 | 20.9 | 62.0 |
| Latitude | S 8.1 | N55.2 | N57.2 | S 47.9 | S 23.0 | S 53.5 |

The altitude used in this discussion is that of the center of the Sun (see p. 6) and it is assumed that the correction for index error has already been applied as prescribed on p. 8. The effect of refraction on meridian altitude is negligible except for altitudes less than 18°, which can be obtained only in high latitudes. The following quantities may be subtracted from the observed altitudes in such cases.

| *Altitude* | *Refraction* |
|---|---|
| 0° | 0:5 |
| 1 | 0.4 |
| 2 | 0.3 |
| 4 | 0.2 |
| 10 | 0.1 |
| 18 and above | 0.0 |

**3. Longitude and Time.**—An observer can determine his longitude by observing the Sun provided he knows the correct Greenwich Civil Time (GCT). The accuracy of the determination is limited by the uncertainty in the time; an error of one minute in the time will cause an error of a quarter of a degree in the longitude. *If the navigator does not have the correct time and has no radio to receive it he cannot determine his longitude;* he can only proceed to the correct latitude and then go east or west to his destination (see part V).

All navigational watches and chronometers used by the Navy, the Merchant Marine, and the Army and Navy Air Forces show GCT, and all times given in Army and Navy communications are expressed in GCT. It is reckoned from $0^h$ to $24^h$ rather than from $0^h$ to $12^h$ A.M., and $0^h$ to $12^h$ P.M.

Lifeboats equipped with two-way radio may obtain the correct time by contacting ships or shore stations. Time signals in code are broadcast by many countries; the various wavelengths, codes and times are given in Radio Aids to Navigation (H.O. 205).

The code used by American naval stations is as follows. During the last five minutes of the hour there is a signal for each second except the 29th second of each minute and except during the last ten seconds of each minute when only those indicated by dashes in the following table are sent:



| Minute | Second | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 55 | — | | — | — | — | — | | | | | — |
| 56 | — | — | | — | — | — | | | | | — |
| 57 | — | — | — | | — | — | | | | | — |
| 58 | — | — | — | — | | — | | | | | — |
| 59 | — | | | | | | | | | | —— |

The dash for 60 of each minute refers to the beginning of the next minute, and the long dash at $59^m$ $60^s$ is the beginning of the next hour ($00^m$ $00^s$). The following schedule lists the *present* (June 1944) frequencies and hours of GCT; the long dash is $00^m$ $00^s$ of the hour given.

| Station | Kilocycles | Hours of GCT |
|---|---|---|
| NSS, Maryland | 122, 4390, 9425, 12630 | 4, 10, 16, 22 |
| NPG, California | 115 | 0, 17, 20 |
| | 115, 9250, 12540 | 3, 8, 15 |
| NPM, Hawaii | 9090, 14390, 17370 | 4, 16, 20 |
| NBA, Canal Zone | 148, 5515, 11080 | 5 |
| | 148, 2170, 5515, 11080 | 17 |

Changes in schedule are listed in the Hydrographic Bulletin.

On ships at sea zone time is frequently used. Zone time differs by the nearest whole number of hours from GCT depending upon the longitude of the nearest full hour meridian. Clocks near the 15°W meridian are one hour slower than GCT, and clocks near the 15°E meridian are one hour faster.

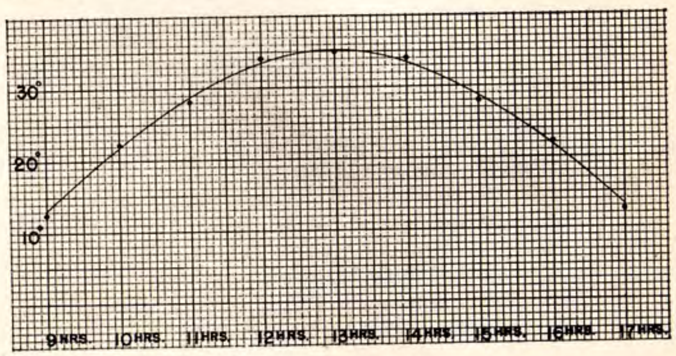
Standard time in the United States is based on zone time: Eastern, Central, Mountain and Pacific being 5, 6, 7, 8 hours slower than GCT. War time in each of these zones is one hour more advanced than the corresponding standard time.

If you know the error of your watch within a few minutes but do not know the correct hour you can still use it if you have a reasonable idea of your longitude. Proceed to determine the longitude as described below and remember that an error of one hour in the GCT will give a longitude wrong by 15° which can then be corrected. If you are still uncertain of the hour you can perhaps make use of the fact that you are in one of two possible longitudes separated by 15°.

**4. Longitude from Equal Altitudes before and after Noon.**—The longitude of an observer can be computed from the GCT of meridian passage or greatest altitude of the Sun.

Since the top of the altitude curve (see illustration on p. 12) is rather flat and the observations are subject to errors of several tenths of a degree it is impossible to determine accurately the time of meridian passage from this part of the daily altitude curve. It can best be determined from the steep part of the curve several hours before or after meridian passage.

At equal times before and after meridian passage the altitude of the Sun is the same. Hence the time of meridian passage may be accurately determined as the average of two times, one before apparent noon and one after, when the Sun had the same altitude. This is illustrated by the following typical altitude curve.



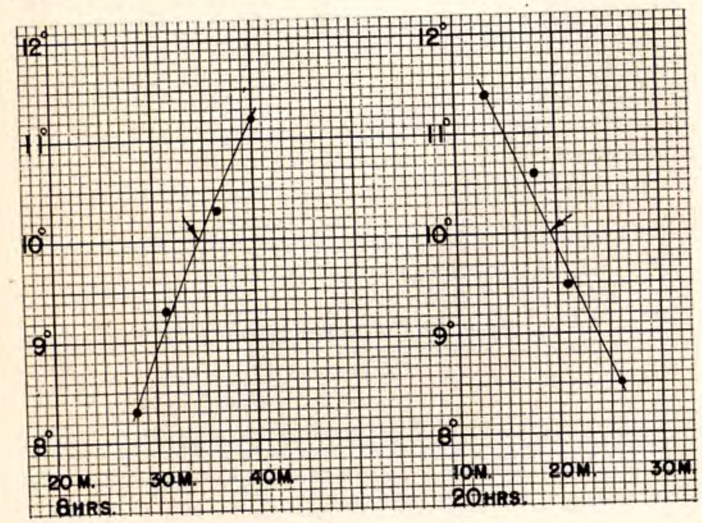



Examination of the top of the curve shows that maximum altitude occurred near 13 hours. The following more accurate determinations are read from the steep parts of the curve.

| *Altitude* | *Forenoon* | *Afternoon* | *Average* |
|---|---|---|---|
| 15° | $9^h12^m$ | $16^h46^m$ | $12^h59^m$ |
| 20 | 9 47 | 16 13 | 13 00 |
| 30 | 11 15 | 14 47 | 13 01 |

The times of sunrise and sunset can obviously be used for the same purpose, the time of meridian passage being the average of the two.

In plotting observations to determine the times of equal altitude the entire curve need not be plotted, and a larger scale may be used to obtain greater accuracy.



*Example:* Determine the GCT of meridian passage from the following observations:

| *GCT* | *Altitude* | *GCT* | *Altitude* |
|---|---|---|---|
| $8^h27^m.9$ | $8°.3$ | $20^h13^m.2$ | $11°.4$ |
| 31.1 | 9.3 | 17.9 | 10.6 |
| 36.6 | 10.3 | 21.3 | 9.5 |
| 39.9 | 11.2 | 25.9 | 8.5 |

Inspection of the graphs shows that the Sun's altitude was 10° at $8^h34^m.5$ and again at $20^h19^m.5$. The average is $14^h27^m.0$ which is the GCT of meridian passage in the observer's longitude.

The west longitude of a place where the Sun is on the meridian is equal to the Greenwich hour angle (GHA) of the Sun at that instant. This quantity which is measured westward from 0° to 360° can be computed for any instant. Table IV gives its value for $0^h$ of each day of the year. The value from this table is to be corrected according to table V for the hours, minutes and tenths of GCT. Be sure to take the correction for the hours from the Sun column in table V.

*Example:* The time of meridian passage found in the previous example was $14^h27^m.0$. Assuming this observation made on September 10, 1944 what is the longitude?

| | |
|---|---|
| Sun's GHA from table IV for September 10.......... | 180°.7 |
| Correction for 14 hours (table V).................. | 210.0 |
| Correction for 27.0 minutes (table V)............... | 6.8 |
| GHA at time of local meridian passage (sum)...... | 397.5 |
| Subtract ......................................... | 360 |
| | 37.5 |

The longitude of the observer is therefore 37°.5 W.

West longitudes greater than 180° may be converted to east longitudes by subtracting from 360°.



It is also possible to use equal altitudes taken on an afternoon and on the following morning.

If the observer moves east or west between equal altitude observations the longitude will be that of the midpoint of his track. Motion north or south will introduce an error which may amount to half the change in latitude.

As in § 2 the altitude is that of the Sun's center corrected for index error. No correction for refraction need be applied since its effect is eliminated by observing east and west of the meridian.

## Part III. SIMPLE METHODS FOR DETERMINING POSITION FROM THE STARS

**1. Introduction.**—The observation of the altitude of a star (part I, § 4) is usually more difficult for the beginner than that of the Sun but the calculations are easier, and the results are valuable. The method of determining latitude from Polaris (§ 3) is particularly simple and effective, but the methods given in § 2 and § 4, especially the latter, suffer from the fact that the stars may not be observable at the time required. For this reason the general methods of part VI are superior in these cases.

Stars may be identified by the methods given in part VII, and Polaris is especially easy to find.

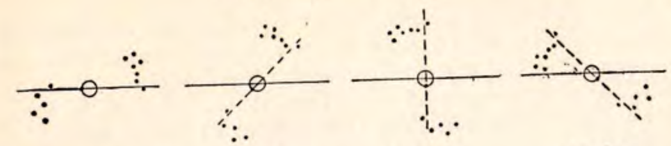
**2. Latitude by Meridian Altitude.**—The method of determining latitude from a measured meridian altitude of the Sun described in part II § 2 can be applied directly to any star that can be identified. The declination of a star does not change as does that of the Sun; the declinations of several navigational stars are given in table VII.

**3. Latitude from Altitude of Polaris.**—In latitudes north of about 10°N, Polaris gives a very simple method of determining latitude. With an error of one degree or less, the altitude of Polaris is equal to the latitude of the observer.

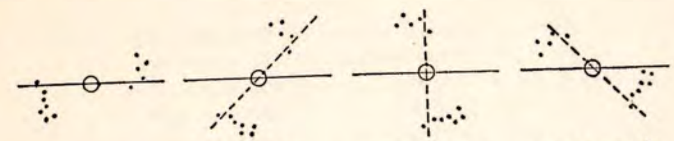
The observed altitude of Polaris may be corrected to give the accurate latitude by applying a correction which depends only upon the appearance of the Dipper and Cassiopeia. As explained in part VII the star groups near Polaris revolve about the pole in a counterclockwise direction. The correction to the altitude of Polaris depends only upon this rotation, and the correction for any given position can be determined from the following figures.







NO CORRECTION ADD 0.°8 ADD 1.°0 ADD 0.°7



NO CORRECTION SUBTRACT 0.°8 SUBTRACT 1.°0 SUBTRACT 0.°7

The figures are drawn for angles of 0°, 45° and 90° between the vertical and the line through Cassiopeia and the Dipper. For intermediate positions the angle may be estimated and the correction taken from the following table.

| *Angle* | *Correction* | *Angle* | *Correction* |
|---|---|---|---|
| 0° | 1.°0 | 50° | 0.°6 |
| 10 | 1.0 | 60 | 0.5 |
| 20 | 0.9 | 70 | 0.3 |
| 30 | 0.9 | 80 | 0.2 |
| 40 | 0.8 | 90 | 0.0 |

Note that the correction changes very slowly near the time when the correction is greatest, and hence an error in estimation of the position has little effect at this time.

**4. Longitude from Equal Altitudes.**—Longitude may be determined by observing equal altitudes east and west of the meridian for any known star in the manner prescribed for the Sun in Part II, § 4. The problem is to find one where both altitudes may be observed.

The calculation is similar to that for the Sun, the longitude being equal to the GHA of the star at the time of meridian passage. The GHA of a particular star is obtained by adding the GHA ♈ for the time of observation to the SHA of the Star; the GHA ♈ is obtained from tables V and VI and the SHA from table VII. The values of the GHA ♈ in table VI are for $0^h$ GCT in 1944. To obtain the values in other years they must be corrected as follows:

| *Year* | *January-February* | *March-December* |
|---|---|---|
| 1944 | No correction | No correction |
| 1945 | Add 0°8 | Subtract 0°2 |
| 1946 | Add 0°5 | Subtract 0°5 |
| 1947 | Add 0°2 | Subtract 0°8 |

The corrections for 1944, 1945, 1946 and 1947 may be used for 1948, 1949, 1950 and 1951 respectively.

*Example:* Find the GHA of Sirius at $6^h45^m.3$ GCT on January 16, 1944

| | |
|---|---|
| GHA ♈ (table VI) | 114°3 |
| Correction for year | 0.0 |
| Correction for $6^h$ (table V) | 90.2 |
| Correction for $45^m.3$ (table V) | 11.3 |
| GHA ♈ (sum) | 215°8 |
| SHA Sirius (table VII) | 259.3 |
| | 475.1 |
| | 360 |
| GHA Sirius | 115°1 |

## Part IV. SIMPLE METHODS OF DETERMINING DIRECTION

The direction of true north may easily be obtained by observing the bearing of the Sun or a star. The identification of stars for this purpose is explained in part VII.

Rough orientation may be obtained just by watching the motions of the stars without identifying any particular one. It need only be remembered that stars which are rising are in the eastern half of the sky and those which are setting are in the western. Those due east rise fastest and those due west set fastest while those due north or south move horizontally.

In northern latitudes Polaris (North Star) is extremely useful since it indicates north directly and is easily identified. Polaris is visible north of about 10°N, and gives a good determination of direction except in high latitudes where it is nearly overhead.

As already explained in part II the Sun rises in an easterly direction, crosses the meridian at noon due north, due south or in the zenith, depending upon the latitude, and sets in a westerly direction. About March 21 and September 21 the Sun rises due east and sets due west. From March till September it rises north of east and sets north of west, and from September till March it rises south of east and sets south of west.

In latitudes where the Sun does not pass too near the zenith, (see part II § 1) some use can be made of the fact that at apparent noon when the Sun's altitude is greatest the Sun is either due north or due south. In all cases where the Sun is more than 30° from the zenith at noon it will be south of an observer in northern latitudes and north of an observer in southern latitudes.

Table VIII A gives the bearing, from the north, of the Sun when rising or setting. Take the value from the table for the month and the latitude.

*Example:* On May 10 in latitude 30°N the Sun rises 70° east of north (20° north of east) and sets 70° west of north (20° north of west).

The bearing when rising is measured in the same manner as the courses on the Pilot Chart and on the plotting sheet (part V); the bearing when setting may be converted by subtracting from 360°. In the above example these bearings are thus 70° when rising and 360° − 70° = 290° when setting.

Table VIII B gives the bearing, when rising or setting, of any object whose declination is known; it may be used for stars or for the Sun when greater accuracy than that given in table VIII A is desired.

*Example 1:* The declination of Sirius (taken to the nearest degree from table VII) is 17°S. Hence in latitude 10°S Sirius rises 107° east of north (17° south of east) and sets 107° west of north.

*Example 2:* On May 10 the declination of the Sun (nearest degree from table II) is 18°N. Hence in latitude 30°N the bearing of the Sun from table VIII B is 69°.

It must be remembered that stars cannot usually be seen on the horizon, and in rising or setting they change somewhat in bearing, especially in high latitude. In the northern hemisphere the shift is toward the south in rising and toward the north in setting, and in the southern hemisphere the reverse is true.

Methods of obtaining bearings at times other than those of rising or setting are given in part VI.

## Part V. SIMPLE SAILING INSTRUCTIONS

**1. Dead Reckoning.**—In addition to determining your position it is necessary to decide where you want to go, to start in the proper direction, and to keep track of your progress. This process which is known as dead reckoning should be begun at once.

Write down the best estimate of the time, date and place of the accident, and try to keep track of all subsequent motion whether due to wind, current, or rowing. This dead reckoning may be kept on the pilot chart, in this book, or in a special log book.

There are several pilot charts in the lifeboat, for the different oceans and seasons of the year. Select the proper chart and plot your position on it as best you can (see § 3).

Motion through the water can be determined by timing the drift of bits of paper or other material as they float past. If no timepiece is available a simple pendulum consisting of a small heavy object on the end of a string will do. A pendulum 10 inches long makes a complete oscillation from one end to the other and back in one second. A boat moving 100 feet in a minute will travel one nautical mile in an hour. If no other scale is available, the graph paper on pages 69–73 which is graduated in inches will serve.

The direction of motion may be determined by the compass or directly from the Sun or a star. The method of obtaining direction by means of the Sun and stars is explained in part IV. Even if a compass is available it should be checked by the Sun and stars.

Knowing the direction and speed of the boat the position on the chart at the end of any given time may be plotted on the chart. From the point of departure mark on the chart an arrow indicating the direction of motion and lay off distances traveled in any given interval of time.

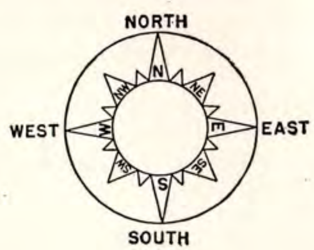
**2. The Compass.**—Three principal types of compass are in common use: the pocket type with a needle mounted on a pivot, *the mariner's with a floating card,* and the dial type.

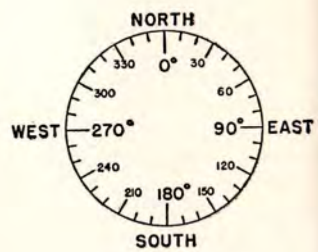
The pocket compass is held in the hand and turned until the north point marked on the card is underneath the north end of the needle. In this position all the directions marked on the card are correct.

In the mariner's compass the floating card is fastened to the needle so that the card automatically assumes the proper orientation, and direction may be read from the card just as with the pocket type. In addition, there is an index line marked on the bowl for reading headings. If the compass is so mounted in the boat that the line through this mark and the center of the compass is exactly parallel to the axis of the boat, the heading of the boat will be that shown by the index.

In the dial type compass there is no card but only a scale and index. The scale reading shown by the index is the direction in which the compass is pointed, and if the compass is properly orientated in the boat it is the direction in which the boat is headed.

Compass readings are given in terms of north, east, south and west, and also in terms of angles from 0° to 360°, as shown in the illustration.






The compass needle points toward magnetic north rather than true north, but the variation for a particular location given on the pilot chart may be applied to give true north. A variation of 10°W means that the needle points 10° west of true north.

In addition to the variation, the compass is affected by errors due to any iron that may be near it. For this reason if the compass or the iron is movable they should be kept apart, and once having been properly located neither should be moved unnecessarily. While there are tricks for eliminating the remaining error such as fastening the compass to an oar and holding it out of the boat, or compensating and adjusting, the safest general rule is to leave it alone and determine the error by comparison with the Sun or a star. On a given heading of the boat the error should remain fairly constant and it can be accurately determined by repeated use at each opportunity of the methods of part IV.

**3. The Pilot Chart.**—The pilot chart not only shows land areas, winds and currents, compass variation, latitude and longitude, etc., but it is so designed (Mercator type) that all the necessary operations of dead reckoning may be done very simply on it. In order to save wear on the chart, however, it is advisable to use the plotting sheets (see § 4) for most of the work and to transfer only the final results to the chart itself.

Latitude and longitude are shown on the chart by means of horizontal and vertical lines, with latitude scales along the right and left hand edges and longitude scales on the top and bottom. The latitude and longitude of any point on the chart may be read by means of these scales. The lines are drawn across the chart at five-degree intervals and intermediate values are determined by comparing the distance of the point from the nearest 5° line with the scale at the edge of the chart. The distance may be transferred by means of the dividers in the sextant box, or by means of marks on a sheet of paper.

The distance between two points on the chart may be measured by means of the latitude scale. In any latitude a difference in latitude of 1′ is equal to a distance of one nautical mile (6080 ft.). Be sure to use the part of the scale in the latitude where the plotting is being done as the scale varies with the latitude. Note that 1° of longitude corresponds to a shorter distance than 1° of latitude, except at the equator, and should not be used in scaling distances.

Directions may be plotted on the chart by means of the circular scale printed on the chart. The bearing marked on the circular scale may be transferred to another part of the chart by means of parallel rulers or by making appropriate marks on a blank page of this book.

The vertical lines on the chart run true north and south and the horizontal ones east and west, east being to the right.

To the drift with respect to the water must be added that due to currents of the water. The direction of flow of the principal ocean currents is shown on the pilot charts by the small black arrows. The rate of flow (drift) varies with the season, the position of the Moon, etc., but a general idea of the magnitude may be obtained from the following examples. The South Equatorial current in the Atlantic has a speed of 0.6 knots (nautical miles per hour) near Africa, which increases to 2 or even 2.5 near South America. The North Atlantic current which starts near the Cape Verde Islands averages 0.7 knots. The Gulf Stream starting in the Gulf of Mexico has a maximum of 2.2 knots between Key West and Havana, 3.5 off Fowey Rocks, and about 2 off Cape Hatteras. The Japan Stream has a speed of 2 or 3 knots near Japan.

In setting your course toward shore examine the pilot chart carefully to determine the probable wind and ocean currents. Remember that a current of only 1 knot will carry you 24 nautical miles in a day, and the nearest land may not be the easiest to reach.

When longitude cannot be determined the navigator should proceed to the latitude of his destination and try to strike this



parallel of latitude sufficiently far to the east or west that there is no doubt whether it is east or west of him. He can then proceed due east or west, taking latitude observations as he goes along, until he reaches his destination.

An improvised sail in favorable winds and a sea anchor or drag in unfavorable ones will enable one to make the best use of wind and current.

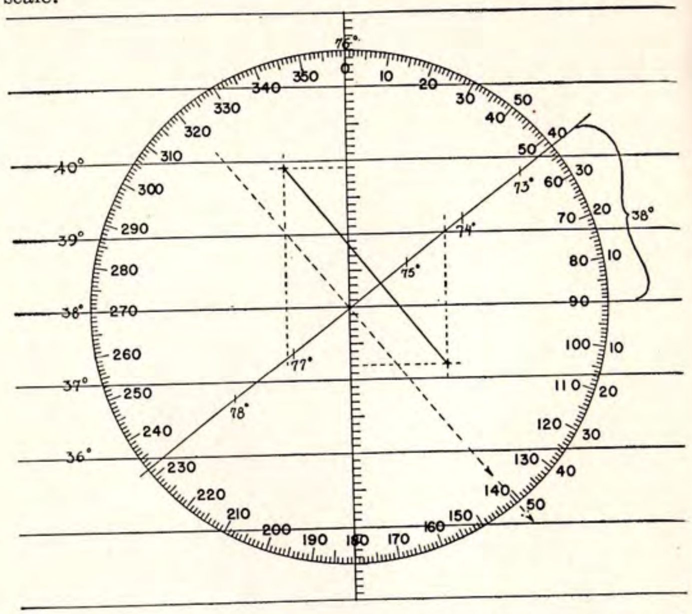
The pilot chart indicates the prevailing winds in various places by means of arrows. These are explained on the chart. In the Beaufort scale, wind speed is indicated by the number of feathers.

| *Symbol* | *Speed in nautical miles per hour* |
|---|---|
| | 1– 3 |
| | 4– 6 |
| | 7–10 |
| | 11–16 |
| | 17–21 |
| | 22–27 |

**4. Use of the Plotting Sheet.**—The plotting sheets in the back of this book may be made up to represent a small portion of the pilot chart and can be used in the same manner for plotting courses, distances, etc. These sheets have a constant latitude scale and have provision for obtaining the proper foreshortened longitude scale so they may be used for any latitude. The foreshortened longitude scale is easily established by laying off distances (using the latitude scale, 1° = ½ inch) along a line inclined to the horizontal by an angle equal to the average latitude of the area being plotted. The meridians of longitude may then be drawn parallel to the central one or plotting may be done by scaling on the inclined line.

*Example:* Construct a plotting sheet centered at latitude 38°N and longitude 76° W. Plot the points 39°.9 N, 77°.1 W, and 37°.2 N, 74°.3 W, and find the course and distance between them.

The line through the center of the diagram making an angle of 38° with the horizontal is drawn. After the two points have been plotted the dotted line is drawn through the center of the circle parallel to the line connecting the two points, and the course is read from the circular scale where the dotted line crosses it. The distance between the two points is measured with the latitude scale.

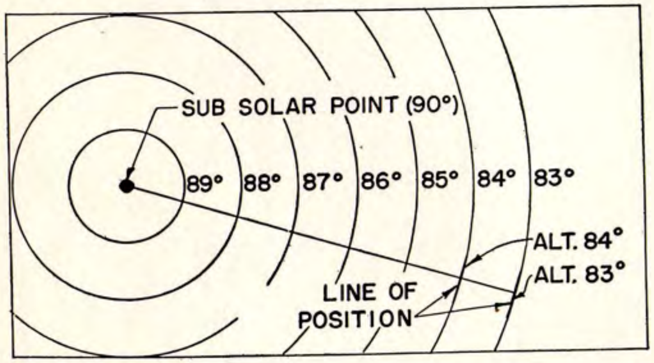


The distance between the two points is 3°.5 or 3.5 x 60=210 nautical miles, and the bearing of the second point from the first is 141°. Thus by traveling 210 miles on a course of 141° one could go from 39°.9 N, 77°.1 W, to 37°.2 N, 74°.3 W. The course on the return trip would be 321°.

## Part VI. GENERAL NAVIGATION METHODS

**1. Line of Position.**—The methods given in parts II-V were designed for those with no technical background; the methods outlined in this part are an abridgment of the conventional methods, and are designed for those with previous navigational experience or for those who are somewhat academically inclined. These methods permit the speedy reduction of an observation taken at any time.

At any instant there is one point on the earth called the subsolar point where the Sun is in the zenith (altitude 90°); the latitude and longitude of this point are equal to the declination and GHA of the Sun. Concentric with this point are a series




of small circles on the earth containing those places where the altitude is 89°, 88°, etc. Except for the first few of these circles near 90° the radius of a circle is very great and a portion of a circle plotted on a navigator's chart appears as a straight line.

The navigator refers to a portion of one of these circles of equal altitudes as a line of position. The lines of position are obviously at right angles to the direction to the subsolar point, and in going from one line of position to another, the altitude increases toward the Sun.

Thus at any given GCT in any small region of the navigator's chart there will be a series of parallel lines of position corresponding to different altitudes of the Sun and all at right angles to the line toward the Sun. Lines separated by 60 nautical miles on the chart will correspond to altitudes differing by one degree, increasing toward the Sun. When any one such line has been drawn and the altitude for it determined, the line for any other altitude differing from it by a small amount can be laid down with the aid of the distance scale of the chart.

In order to determine one line of position in a given neighborhood at a given time it is necessary only to compute the altitude and direction (azimuth) of the Sun as seen from a chosen point in the neighborhood at the given time. The line toward the Sun through the chosen point is then drawn on the chart according to the computed azimuth and the line of position drawn through the same point at right angles to it. The computed altitude corresponds to the line of position so determined.

The customary method of determining the line of position from an observed time and altitude (obtained as described in part I) is as follows. The navigator assumes a latitude and longitude and computes the altitude and azimuth for that position at the time of observation. He then draws on the chart the line through the assumed position in the direction of the observed object by means of the computed azimuth. The line of position through the assumed position is at right angles to the azimuth line and the altitude is the computed altitude; the line of position through the observer's actual location is parallel to that through the assumed position, and at a distance from it equal to the difference between the observed and computed altitude.



**2. Use of the Tables.**—The first step in the computation of the altitude and azimuth is to take the declination and GHA from tables II and IV for the Sun or VI and VII for a star (see part III § 4). The data given in tables II, IV and VI are for $0^h$ GCT in 1944. To obtain the values for $0^h$ GCT in any other year interpolate as follows:

| *Year* | *January-February* | *March-December* |
|---|---|---|
| 1944 | tabular value | tabular value |
| 1945 | ¾ day later | ¼ day earlier |
| 1946 | ½ day later | ½ day earlier |
| 1947 | ¼ day later | ¾ day earlier |

The values for 1944, 1945, 1946 and 1947 may be used for 1948, 1949, 1950 and 1951 respectively. Correction for the hours and minutes of GCT is accomplished with the aid of table V. From the GHA is then subtracted the west longitude (0° to 360°) to give the local hour angle (LHA).

Knowing the assumed latitude, the declination, and the LHA, the altitude and azimuth are taken from table IX. This table gives the altitude and azimuth of a celestial body for each 5° of latitude, declination, and LHA. The values for a given latitude are on one page: those for latitude and declination both north or both south (Same), and those for latitude north and declination south or latitude south and declination north (Contrary). Refraction is included in the table so no correction should be used.

The calculation is facilitated by taking the assumed latitude as the nearest 5° parallel, and the longitude so that the LHA is a multiple of 5°. It is then necessary to interpolate the altitude and azimuth for the declination only.

The azimuth given in table IX is measured from the elevated pole toward the east or west according to whether the body is east or west of the meridian. True azimuth from north through 360° is obtained as follows:

Lat. North, LHA West, 360°—tabular azimuth.
Lat. North, LHA East, tabular azimuth.
Lat. South, LHA West, 180°+tabular azimuth.
Lat. South, LHA East, 180°—tabular azimuth.

Latitude zero should be treated as *North* in applying these rules.

*Example:* On August 3, 1945 at $19^h\ 30^m.0$ GCT the altitude of the Sun was observed to be 53°.6 in approximate latitude 39°N, longitude 75° W. Find the line of position.

The data from tables II and IV are:

| | *Declination* | *GHA* |
|---|---|---|
| Aug. 3 | N17°.6 | 178°.5 |
| Aug. 4 | N17°.3 | 178.5 |
| Aug. 3½ (¼ da. earlier than $19^h$) | N17.4 | 178.5 |
| Correction for $19^h$ (table V) | | 285.0 |
| Correction for $30^m0$ (table V) | | 7.5 |
| Sum | | 471.0 |
| | | 360 |
| | | 111.0 |
| Assumed latitude and longitude | N40.0 | W76.0 |
| LHA (difference) | | W35°. |

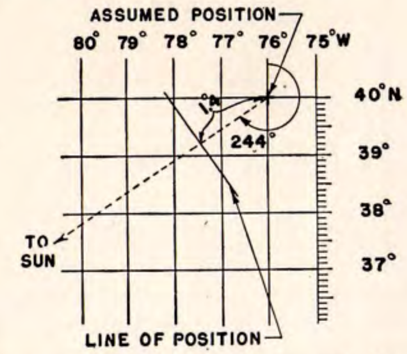
(Note that the assumed longitude is the nearest value to 75° which makes LHA an integral multiple of 5°.)

From table IX for latitude 40° (Same) and LHA 35°:

| | *Altitude* | *Azimuth* |
|---|---|---|
| Declination 15° | 50°.6 | 119° |
| Declination 20° | 54.0 | 113 |
| Declination 17.4 (by interpolation) | 52.2 | 116 |
| Observed altitude | 53.6 | |
| Difference in altitude | 1.4 | |
| 360°—Az. (Lat. North, LHA West) | | 244 |

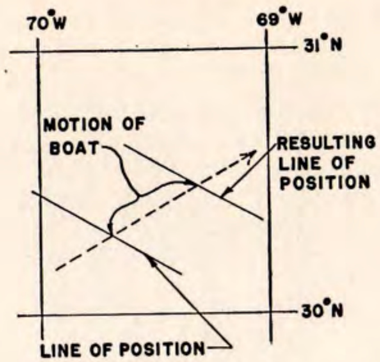


The line of position as determined from the observation therefore crosses the 244° azimuth line 1°.4 toward the Sun from the assumed position N 40°, W 76°.




**3. Intersection of Lines of Position.**—The line of position so obtained from an observation tells the navigator that he is somewhere on that line, but does not tell him where on the line. If he can determine a second line, from a second observation, which intersects the first at a favorable angle he can then fix his position at the intersection of the two lines. The second observation can be that of a different object or of the same object after it has had time to change its bearing by a sufficient amount to give a good intersection.

The observer will usually be moving during the time between the first and second observations and it is necessary to allow for this motion by means of dead reckoning (see part V). It is obvious that by traveling a given distance in a given direction from any point on the line of position already laid down on the chart one will arrive at a point on a new line of position parallel to the old.




The intersection of this new line of position and the line of position from the second observation is the position of the observer at the time of the second observation.

Increased accuracy in the reduction of a particular observation may be obtained by separate reductions for four assumed positions, for the 5° parallels north and south of the estimated position and for the 5° hour angles east and west. It should be remembered however that the key to accurate determination of position consists of taking many observations of many different objects, hence the advantage of using stars.

In some columns of table IX low altitudes were omitted for lack of space. These columns may be extended by estimation for emergency use. Altitudes up to 90° are given although high altitudes should in general be avoided; they are difficult to observe properly and the circle of position is not well represented by a straight line.

One familiar with this part of the book will have no difficulty computing the bearing or azimuth of the Sun or a star for any time for the purpose described in part IV. He will also recognize the angle between the meridian and the line through Cassiopeia and the dipper used in part III as the LHA of Polaris.

## Part VII. STAR IDENTIFICATION

The star chart on pages 40, 41 will enable you to identify stars for the uses described in parts III, IV and VI. This chart shows the stars as they appear in the sky, and should be held overhead in comparing with the sky.

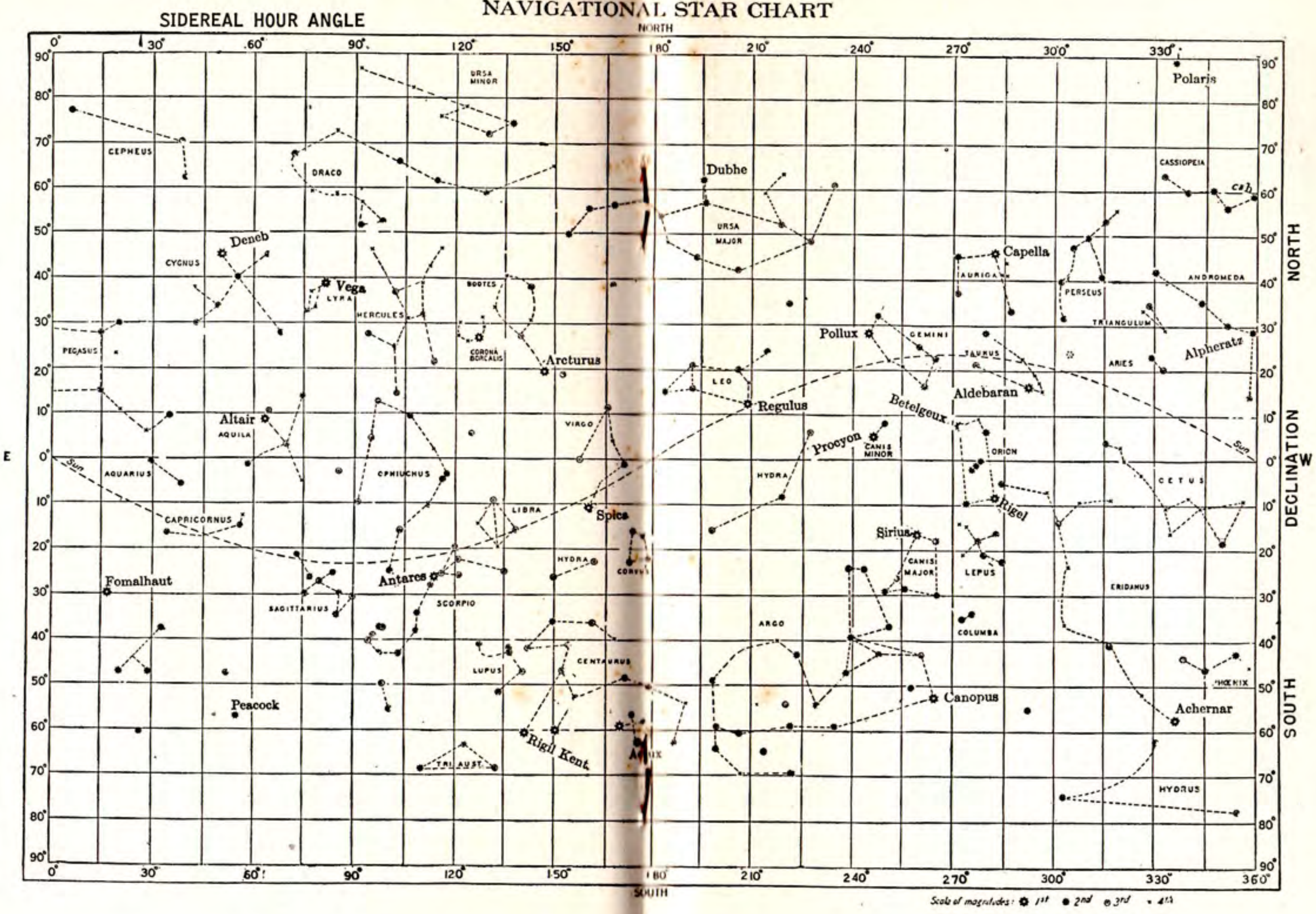
The network of vertical and horizontal lines on the chart indicates declination and sidereal hour angle (SHA). Declination on the sky corresponds exactly to latitude on the earth. In any given latitude a star that passes directly overhead or through the zenith must have the declination equal to the latitude. Thus in 40°N latitude the stars Deneb, Vega, and Capella will pass approximately through the zenith, and Arcturus with declination 20°N will pass about 20° south of the zenith.

Stars on the right-hand half of the chart are visible in general from September-March, and those on the left from March-September.

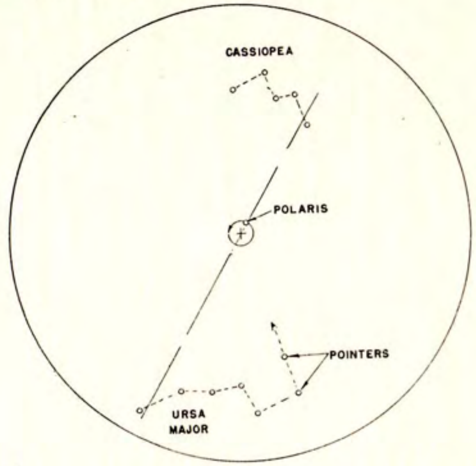
The brightness or magnitude of each star is indicated by the symbol according to the scale of magnitudes at the bottom of the chart; the brightest stars are called first magnitude. The names of the stars in table VII and of the principal star groups or constellations are printed on the chart.

Stars in the sky may be identified by comparison with the chart, brightness and conspicuous configurations making the identification possible. The configurations on the star chart appear much as they do on the sky except for those with high declination where the map is badly distorted. In the northern hemisphere Ursa Major (the big dipper) and Cassiopeia are prominent groups

# NAVIGATIONAL STAR CHART



whose relative positions are badly distorted on the chart. They are shown in the following sketch:




These stars are seen the year around (in northern latitude) and during the course of any one night they rotate about Polaris in much the same manner as the hour hand of a clock, but in the other direction, making a complete revolution in slightly less than 24 hours.

Ursa Major and Cassiopeia are useful in locating Polaris. The two stars in the bowl of the dipper are called Pointers because they point to Polaris.

The beginner may sometimes be confused by the planets in comparing the chart with the sky. These objects are brighter than most stars and move about. They are always near the dotted curved line on the chart and cause no confusion in other parts of the chart.

## Part VIII

## TABLES
## GRAPH PAPER
## PLOTTING SHEETS

TABLE I.—*Calendar.*

## 1944

**JANUARY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | 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 | 29 |
| 30 | 31 | -- | -- | -- | -- | -- |

**FEBRUARY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | 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 | 29 | -- | -- | -- | -- |

**MARCH**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | 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 | 29 | 30 | 31 | -- |

**APRIL**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | 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 | 29 |
| 30 | -- | -- | -- | -- | -- | -- |

**MAY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | 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 | 29 | 30 | 31 | -- | -- | -- |

**JUNE**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | 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 | 29 | 30 | -- |

**JULY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | 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 | 29 |
| 30 | 31 | -- | -- | -- | -- | -- |

**AUGUST**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | 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 | 29 | 30 | 31 | -- | -- |

**SEPTEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | 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 | 29 | 30 |

**OCTOBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| 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 |
| 29 | 30 | 31 | -- | -- | -- | -- |

**NOVEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | 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 | 29 | 30 | -- | -- |

**DECEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | 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 | 29 | 30 |
| 31 | -- | -- | -- | -- | -- | -- |

## 1945

**JANUARY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | 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 | 29 | 30 | 31 | -- | -- | -- |

**FEBRUARY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | 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 | -- | -- | -- |

**MARCH**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | 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 | 29 | 30 | 31 |

**APRIL**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| 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 |
| 29 | 30 | -- | -- | -- | -- | -- |

**MAY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | 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 | 29 | 30 | 31 | -- | -- |

**JUNE**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | 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 | 29 | 30 |

**JULY**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| 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 |
| 29 | 30 | 31 | -- | -- | -- | -- |

**AUGUST**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | 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 | 29 | 30 | 31 | -- |

**SEPTEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | 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 | 29 |
| 30 | -- | -- | -- | -- | -- | -- |

**OCTOBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | 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 | 29 | 30 | 31 | -- | -- | -- |

**NOVEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | 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 | 29 | 30 | -- |

**DECEMBER**

| S. | M. | T. | W. | T. | F. | S. |
|---|---|---|---|---|---|---|
| -- | -- | -- | -- | -- | -- | 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 | 29 |
| 30 | 31 | -- | -- | -- | -- | -- |



TABLE I.—*Calendar, 1945–1955.*

| Month | Month Begins on | | | | | | | | | | | No. of Days |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1945 | 1946 | 1947 | 1948 | 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | |
| January | Mon. | Tue. | Wed. | Thu. | Sat. | Sun. | Mon. | Tue. | Thu. | Fri. | Sat. | 31 |
| February | Thu. | Fri. | Sat. | *Sun. | Tue. | Wed. | Thu. | *Fri. | Sun. | Mon. | Tue. | 28, 29* |
| March | Thu. | Fri. | Sat. | Mon. | Tue. | Wed. | Thu. | Sat. | Sun. | Mon. | Tue. | 31 |
| April | Sun. | Mon. | Tue. | Thu. | Fri. | Sat. | Sun. | Tue. | Wed. | Thu. | Fri. | 30 |
| May | Tue. | Wed. | Thu. | Sat. | Sun. | Mon. | Tue. | Thu. | Fri. | Sat. | Sun. | 31 |
| June | Fri. | Sat. | Sun. | Tue. | Wed. | Thu. | Fri. | Sun. | Mon. | Tue. | Wed. | 30 |
| July | Sun. | Mon. | Tue. | Thu. | Fri. | Sat. | Sun. | Tue. | Wed. | Thu. | Fri. | 31 |
| August | Wed. | Thu. | Fri. | Sun. | Mon. | Tue. | Wed. | Fri. | Sat. | Sun. | Mon. | 31 |
| September | Sat. | Sun. | Mon. | Wed. | Thu. | Fri. | Sat. | Mon. | Tue. | Wed. | Thu. | 30 |
| October | Mon. | Tue. | Wed. | Fri. | Sat. | Sun. | Mon. | Wed. | Thu. | Fri. | Sat. | 31 |
| November | Thu. | Fri. | Sat. | Mon. | Tue. | Wed. | Thu. | Sat. | Sun. | Mon. | Tue. | 30 |
| December | Sat. | Sun. | Mon. | Wed. | Thu. | Fri. | Sat. | Mon. | Tue. | Wed. | Thu. | 31 |

**Sun.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| 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 |
| 29 | 30 | 31 | | | | |

**Mon.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | 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 |
| 23 | 29 | 30 | 31 | | | |

**Tue.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | 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 | 29 | 30 | 31 | | |

**Wed.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | 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 | 29 | 30 | 31 | |

**Thu.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | 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 | 29 | 30 | 31 |

**Fri.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | | 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 | 29 | 30 |
| 31 | | | | | | |

**Sat.**

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | | | 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 | 29 |
| 30 | 31 | | | | | |

To obtain a calendar for any month from 1945–1955:

1. Find the day of the week on which the desired month begins (from top table).
2. Select the month which begins on that day. (From 7 calendars).
3. Mark out excess days (if any) at the end of the month.

Example: April 1946 begins on Monday and has 30 days; use the second calendar and mark out the 31st.

TABLE II.—*Declination of the Sun.*

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | S 23°1 | S 17°5 | S 7°7 | N 4°4 | N15°0 | N22°0 | N23°1 | N18°1 | N 8°4 | S 3°1 | S 14°3 | S 21°8 |
| 2 | 23.0 | 17.2 | 7.3 | 4.8 | 15.3 | 22.1 | 23.1 | 17.9 | 8.1 | 3.4 | 14.6 | 21.9 |
| 3 | 22.9 | 16.9 | 6.9 | 5.2 | 15.6 | 22.3 | 23.0 | 17.6 | 7.7 | 3.8 | 15.0 | 22.1 |
| 4 | 22.9 | 16.6 | 6.6 | 5.6 | 15.9 | 22.4 | 22.9 | 17.3 | 7.3 | 4.2 | 15.3 | 22.2 |
| 5 | 22.8 | 16.3 | 6.2 | 5.9 | 16.2 | 22.5 | 22.8 | 17.1 | 7.0 | 4.6 | 15.6 | 22.3 |
| 6 | S 22.7 | S 16.0 | S 5.8 | N 6.3 | N16.4 | N22.6 | N22.7 | N16.8 | N 6.6 | S 5.0 | S 15.9 | S 22.5 |
| 7 | 22.5 | 15.7 | 5.4 | 6.7 | 16.7 | 22.7 | 22.6 | 16.5 | 6.2 | 5.4 | 16.2 | 22.6 |
| 8 | 22.4 | 15.4 | 5.0 | 7.1 | 17.0 | 22.8 | 22.5 | 16.3 | 5.8 | 5.7 | 16.5 | 22.7 |
| 9 | 22.3 | 15.1 | 4.6 | 7.4 | 17.3 | 22.9 | 22.4 | 16.0 | 5.5 | 6.1 | 16.8 | 22.8 |
| 10 | 22.2 | 14.8 | 4.2 | 7.8 | 17.5 | 23.0 | 22.3 | 15.7 | 5.1 | 6.5 | 17.1 | 22.9 |
| 11 | S 22.0 | S 14.5 | S 3.8 | N 8.2 | N17.8 | N23.1 | N22.2 | N15.4 | N 4.7 | S 6.9 | S 17.3 | S 23.0 |
| 12 | 21.9 | 14.1 | 3.5 | 8.6 | 18.0 | 23.1 | 22.0 | 15.1 | 4.3 | 7.3 | 17.6 | 23.1 |
| 13 | 21.7 | 13.8 | 3.1 | 8.9 | 18.3 | 23.2 | 21.9 | 14.8 | 3.9 | 7.6 | 17.9 | 23.1 |
| 14 | 21.5 | 13.5 | 2.7 | 9.3 | 18.5 | 23.2 | 21.7 | 14.5 | 3.6 | 8.0 | 18.1 | 23.2 |
| 15 | 21.4 | 13.1 | 2.3 | 9.6 | 18.8 | 23.3 | 21.6 | 14.2 | 3.2 | 8.4 | 18.4 | 23.3 |
| 16 | S 21.2 | S 12.8 | S 1.9 | N10.0 | N19.0 | N23.3 | N21.4 | N13.9 | N 2.8 | S 8.8 | S 18.7 | S 23.3 |
| 17 | 21.0 | 12.4 | 1.5 | 10.4 | 19.2 | 23.4 | 21.3 | 13.5 | 2.4 | 9.1 | 18.9 | 23.3 |
| 18 | 20.8 | 12.1 | 1.1 | 10.7 | 19.5 | 23.4 | 21.1 | 13.2 | 2.0 | 9.5 | 19.1 | 23.4 |
| 19 | 20.6 | 11.7 | 0.7 | 11.1 | 19.7 | 23.4 | 20.9 | 12.9 | 1.6 | 9.9 | 19.4 | 23.4 |
| 20 | 20.4 | 11.4 | S 0.3 | 11.4 | 19.9 | 23.4 | 20.7 | 12.6 | 1.2 | 10.2 | 19.6 | 23.4 |
| 21 | S 20.2 | S 11.0 | N 0.1 | N11.7 | N20.1 | N23.4 | N20.5 | N12.2 | N 0.8 | S 10.6 | S 19.8 | S 23.4 |
| 22 | 20.0 | 10.7 | 0.5 | 12.1 | 20.3 | 23.4 | 20.4 | 11.9 | 0.5 | 10.9 | 20.1 | 23.4 |
| 23 | 19.8 | 10.3 | 0.9 | 12.4 | 20.5 | 23.4 | 20.2 | 11.6 | N 0.1 | 11.3 | 20.3 | 23.4 |
| 24 | 19.5 | 9.9 | 1.3 | 12.7 | 20.7 | 23.4 | 20.0 | 11.2 | S 0.3 | 11.6 | 20.5 | 23.4 |
| 25 | 19.3 | 9.6 | 1.7 | 13.1 | 20.9 | 23.4 | 19.7 | 10.9 | 0.7 | 12.0 | 20.7 | 23.4 |
| 26 | S 19.0 | S 9.2 | N 2.1 | N13.4 | N21.1 | N23.4 | N19.5 | N10.5 | S 1.1 | S 12.3 | S 20.9 | S 23.4 |
| 27 | 18.8 | 8.8 | 2.5 | 13.7 | 21.2 | 23.3 | 19.3 | 10.2 | 1.5 | 12.7 | 21.1 | 23.3 |
| 28 | 18.5 | 8.5 | 2.9 | 14.0 | 21.4 | 23.3 | 19.1 | 9.8 | 1.9 | 13.0 | 21.3 | 23.3 |
| 29 | 18.3 | S 8.1 | 3.2 | 14.4 | 21.6 | 23.3 | 18.8 | 9.5 | 2.3 | 13.3 | 21.4 | 23.3 |
| 30 | 18.0 | ------ | 3.6 | N14.7 | 21.7 | N23.2 | 18.6 | 9.1 | S 2.7 | 13.7 | S 21.6 | 23.2 |
| 31 | S 17.7 | ------ | N 4.0 | ------ | N21.9 | ------ | N18.4 | N 8.8 | ------ | S 14.0 | ------ | S 23.1 |



TABLE III.—*Correction to Sun's Declination at Time of Meridian Passage.*

| Date | Longitude | | | | | Date | Longitude | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 180W | 90W | 0 | 90E | 180E | | 180W | 90W | 0 | 90E | 180E |
| 1944 | | | | | | 1946 | | | | | |
| Jan. | N0°2 | N0°1 | N0°1 | 0°0 | 0°0 | Jan. | N0.3 | N0.2 | N0.2 | N0.1 | N0.1 |
| Feb. | N0.3 | N0.2 | N0.2 | N0.1 | 0.0 | Feb. | N0.5 | N0.4 | N0.3 | N0.2 | N0.2 |
| Mar. | N0.4 | N0.3 | N0.2 | N0.1 | 0.0 | Mar. | N0.2 | N0.1 | 0.0 | S 0.1 | S 0.2 |
| Apr. | N0.3 | N0.2 | N0.2 | N0.1 | 0.0 | Apr. | N0.1 | N0.1 | 0.0 | S 0.1 | S 0.1 |
| May | N0.2 | N0.1 | N0.1 | N0.1 | 0.0 | May | N0.1 | N0.1 | 0.0 | S 0.1 | S 0.1 |
| June | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | June | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| July | S 0.2 | S 0.1 | S 0.1 | 0.0 | 0.0 | July | S 0.1 | 0.0 | 0.0 | 0.0 | N0.1 |
| Aug. | S 0.3 | S 0.2 | S 0.2 | S 0.1 | 0.0 | Aug. | S 0.2 | S 0.1 | 0.0 | N0.1 | N0.2 |
| Sept. | S 0.4 | S 0.3 | S 0.2 | S 0.1 | 0.0 | Sept. | S 0.2 | S 0.1 | 0.0 | N0.1 | N0.2 |
| Oct. | S 0.3 | S 0.2 | S 0.2 | S 0.1 | 0.0 | Oct. | S 0.2 | S 0.1 | 0.0 | N0.1 | N0.2 |
| Nov. | S 0.2 | S 0.1 | S 0.1 | S 0.1 | 0.0 | Nov. | S 0.1 | S 0.1 | 0.0 | N0.1 | N0.1 |
| Dec. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Dec. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1945 | | | | | | 1947 | | | | | |
| Jan. | N0°3 | N0°3 | N0°2 | N0°2 | N0°1 | Jan. | N0.2 | N0.2 | N0.1 | N0.1 | 0.0 |
| Feb. | N0.6 | N0.5 | N0.4 | N0.3 | N0.2 | Feb. | N0.4 | N0.3 | N0.2 | N0.2 | N0.1 |
| Mar. | N0.3 | N0.2 | N0.1 | 0.0 | S 0.1 | Mar. | N0.1 | 0.0 | S 0.1 | S 0.2 | S 0.3 |
| Apr. | N0.2 | N0.1 | N0.1 | 0.0 | S 0.1 | Apr. | N0.1 | 0.0 | S 0.1 | S 0.1 | S 0.2 |
| May | N0.1 | N0.1 | N0.1 | 0.0 | S 0.1 | May | N0.1 | 0.0 | S 0.1 | S 0.1 | S 0.1 |
| June | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | June | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| July | S 0.1 | S 0.1 | 0.0 | 0.0 | 0.0 | July | 0.0 | 0.0 | 0.0 | N0.1 | N0.1 |
| Aug. | S 0.2 | S 0.2 | S 0.1 | 0.0 | N0.1 | Aug. | S 0.1 | 0.0 | N0.1 | N0.2 | N0.2 |
| Sept. | S 0.3 | S 0.2 | S 0.1 | 0.0 | N0.1 | Sept. | S 0.1 | 0.0 | N0.1 | N0.2 | N0.3 |
| Oct. | S 0.2 | S 0.2 | S 0.1 | 0.0 | N0.1 | Oct. | S 0.1 | 0.0 | N0.1 | N0.2 | N0.2 |
| Nov. | S 0.1 | S 0.1 | S 0.1 | 0.0 | N0.1 | Nov. | S 0.1 | 0.0 | N0.1 | N0.1 | N0.1 |
| Dec. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Dec. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

The quantities in this table for 1944, 1945, 1946, 1947 will serve also for 1948, 1949, 1950, 1951 respectively.

TABLE IV.—*GHA of the Sun.*

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 179°3 | 176°6 | 176°9 | 179°0 | 180°7 | 180°6 | 179°1 | 178°4 | 180°0 | 182°5 | 184°1 | 182°8 |
| 2 | 179.1 | 176.6 | 176.9 | 179.1 | 180.8 | 180.6 | 179.1 | 178.5 | 180.1 | 182.6 | 184.1 | 182.7 |
| 3 | 179.0 | 176.6 | 177.0 | 179.1 | 180.8 | 180.5 | 179.0 | 178.5 | 180.1 | 182.7 | 184.1 | 182.6 |
| 4 | 178.9 | 176.5 | 177.0 | 179.2 | 180.8 | 180.5 | 179.0 | 178.5 | 180.2 | 182.8 | 184.1 | 182.5 |
| 5 | 178.8 | 176.5 | 177.1 | 179.3 | 180.8 | 180.4 | 178.9 | 178.5 | 180.3 | 182.9 | 184.1 | 182.4 |
| 6 | 178.7 | 176.5 | 177.1 | 179.4 | 180.9 | 180.4 | 178.9 | 178.5 | 180.4 | 182.9 | 184.1 | 182.3 |
| 7 | 178.6 | 176.5 | 177.2 | 179.4 | 180.9 | 180.4 | 178.8 | 178.6 | 180.5 | 183.0 | 184.1 | 182.2 |
| 8 | 178.4 | 176.4 | 177.2 | 179.5 | 180.9 | 180.3 | 178.8 | 178.6 | 180.6 | 183.1 | 184.1 | 182.1 |
| 9 | 178.3 | 176.4 | 177.3 | 179.6 | 180.9 | 180.3 | 178.8 | 178.6 | 180.6 | 183.1 | 184.0 | 182.0 |
| 10 | 178.2 | 176.4 | 177.4 | 179.6 | 180.9 | 180.2 | 178.7 | 178.7 | 180.7 | 183.2 | 184.0 | 181.8 |
| 11 | 178.1 | 176.4 | 177.4 | 179.7 | 180.9 | 180.2 | 178.7 | 178.7 | 180.8 | 183.3 | 184.0 | 181.7 |
| 12 | 178.0 | 176.4 | 177.5 | 179.8 | 180.9 | 180.1 | 178.7 | 178.8 | 180.9 | 183.3 | 184.0 | 181.6 |
| 13 | 177.9 | 176.4 | 177.6 | 179.8 | 180.9 | 180.1 | 178.6 | 178.8 | 181.0 | 183.4 | 183.9 | 181.5 |
| 14 | 177.8 | 176.4 | 177.6 | 179.9 | 180.9 | 180.0 | 178.6 | 178.8 | 181.1 | 183.5 | 183.9 | 181.4 |
| 15 | 177.7 | 176.4 | 177.7 | 180.0 | 180.9 | 180.0 | 178.6 | 178.9 | 181.2 | 183.5 | 183.9 | 181.3 |
| 16 | 177.7 | 176.4 | 177.8 | 180.0 | 180.9 | 179.9 | 178.5 | 178.9 | 181.3 | 183.6 | 183.8 | 181.1 |
| 17 | 177.6 | 176.4 | 177.9 | 180.1 | 180.9 | 179.8 | 178.5 | 179.0 | 181.3 | 183.6 | 183.8 | 181.0 |
| 18 | 177.5 | 176.5 | 177.9 | 180.1 | 180.9 | 179.8 | 178.5 | 179.0 | 181.4 | 183.7 | 183.7 | 180.9 |
| 19 | 177.4 | 176.5 | 178.0 | 180.2 | 180.9 | 179.7 | 178.5 | 179.1 | 181.5 | 183.7 | 183.7 | 180.8 |
| 20 | 177.3 | 176.5 | 178.1 | 180.3 | 180.9 | 179.7 | 178.5 | 179.1 | 181.6 | 183.8 | 183.6 | 180.6 |
| 21 | 177.2 | 176.5 | 178.2 | 180.3 | 180.9 | 179.6 | 178.4 | 179.2 | 181.7 | 183.8 | 183.5 | 180.5 |
| 22 | 177.2 | 176.6 | 178.2 | 180.4 | 180.9 | 179.6 | 178.4 | 179.3 | 181.8 | 183.9 | 183.5 | 180.4 |
| 23 | 177.1 | 176.6 | 178.3 | 180.4 | 180.9 | 179.5 | 178.4 | 179.3 | 181.9 | 183.9 | 183.4 | 180.3 |
| 24 | 177.0 | 176.6 | 178.4 | 180.5 | 180.8 | 179.5 | 178.4 | 179.4 | 182.0 | 183.9 | 183.3 | 180.1 |
| 25 | 177.0 | 176.7 | 178.5 | 180.5 | 180.8 | 179.4 | 178.4 | 179.5 | 182.0 | 184.0 | 183.3 | 180.0 |
| 26 | 176.9 | 176.7 | 178.5 | 180.5 | 180.8 | 179.4 | 178.4 | 179.5 | 182.1 | 184.0 | 183.2 | 179.9 |
| 27 | 176.9 | 176.7 | 178.6 | 180.6 | 180.8 | 179.3 | 178.4 | 179.6 | 182.2 | 184.0 | 183.1 | 179.8 |
| 28 | 176.8 | 176.8 | 178.7 | 180.6 | 180.7 | 179.3 | 178.4 | 179.7 | 182.3 | 184.0 | 183.0 | 179.6 |
| 29 | 176.8 | 176.8 | 178.8 | 180.7 | 180.7 | 179.2 | 178.4 | 179.7 | 182.4 | 184.0 | 182.9 | 179.5 |
| 30 | 176.7 | ------ | 178.8 | 180.7 | 180.7 | 179.2 | 178.4 | 179.8 | 182.5 | 184.1 | 182.9 | 179.4 |
| 31 | 176.7 | ------ | 178.9 | ------ | 180.6 | ------ | 178.4 | 179.9 | ------ | 184.1 | ------ | 179.3 |



TABLE V.—*Correction of GHA.*

| Sun | | Sun or ♈ | | | | ♈ | |
|---|---|---|---|---|---|---|---|
| Hours of GCT | Correction | Minutes of GCT | Correction | Minutes of GCT | Correction | Hours of GCT | Correction |
| 1 | 15°0 | 1 | 0°3 | 31 | 7°8 | 1 | 15°0 |
| 2 | 30.0 | 2 | 0.5 | 32 | 8.0 | 2 | 30.1 |
| 3 | 45.0 | 3 | 0.8 | 33 | 8.3 | 3 | 45.1 |
| 4 | 60.0 | 4 | 1.0 | 34 | 8.5 | 4 | 60.2 |
| 5 | 75.0 | 5 | 1.3 | 35 | 8.8 | 5 | 75.2 |
| 6 | 90.0 | 6 | 1.5 | 36 | 9.0 | 6 | 90.2 |
| 7 | 105.0 | 7 | 1.8 | 37 | 9.3 | 7 | 105.3 |
| 8 | 120.0 | 8 | 2.0 | 38 | 9.5 | 8 | 120.3 |
| 9 | 135.0 | 9 | 2.3 | 39 | 9.8 | 9 | 135.4 |
| 10 | 150.0 | 10 | 2.5 | 40 | 10.0 | 10 | 150.4 |
| 11 | 165.0 | 11 | 2.8 | 41 | 10.3 | 11 | 165.5 |
| 12 | 180.0 | 12 | 3.0 | 42 | 10.5 | 12 | 180.5 |
| 13 | 195.0 | 13 | 3.3 | 43 | 10.8 | 13 | 195.5 |
| 14 | 210.0 | 14 | 3.5 | 44 | 11.0 | 14 | 210.6 |
| 15 | 225.0 | 15 | 3.8 | 45 | 11.3 | 15 | 225.6 |
| 16 | 240.0 | 16 | 4.0 | 46 | 11.5 | 16 | 240.7 |
| 17 | 255.0 | 17 | 4.3 | 47 | 11.8 | 17 | 255.7 |
| 18 | 270.0 | 18 | 4.5 | 48 | 12.0 | 18 | 270.7 |
| 19 | 285.0 | 19 | 4.8 | 49 | 12.3 | 19 | 285.8 |
| 20 | 300.0 | 20 | 5.0 | 50 | 12.5 | 20 | 300.8 |
| 21 | 315.0 | 21 | 5.3 | 51 | 12.8 | 21 | 315.9 |
| 22 | 330.0 | 22 | 5.5 | 52 | 13.0 | 22 | 330.9 |
| 23 | 345.0 | 23 | 5.8 | 53 | 13.3 | 23 | 345.9 |
| 24 | 360.0 | 24 | 6.0 | 54 | 13.5 | 24 | 361.0 |
| | | 25 | 6.3 | 55 | 13.8 | | |
| | | 26 | 6.5 | 56 | 14.0 | | |
| | | 27 | 6.8 | 57 | 14.3 | | |
| | | 28 | 7.0 | 58 | 14.5 | | |
| | | 29 | 7.3 | 59 | 14.8 | | |
| | | 30 | 7.5 | 60 | 15.0 | | |

## TABLE VI.—*GHA* ♈.

| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 99°.5 | 130°.1 | 158°.7 | 189°.2 | 218°.8 | 249°.4 | 278°.9 | 309°.5 | 340°.0 | 9°.6 | 40°.2 | 69°.7 |
| 2 | 100.5 | 131.1 | 159.7 | 190.2 | 219.8 | 250.3 | 279.9 | 310.5 | 341.0 | 10.6 | 41.1 | 70.7 |
| 3 | 101.5 | 132.1 | 160.7 | 191.2 | 220.8 | 251.3 | 280.9 | 311.5 | 342.0 | 11.6 | 42.1 | 71.7 |
| 4 | 102.5 | 133.1 | 161.6 | 192.2 | 221.8 | 252.3 | 281.9 | 312.4 | 343.0 | 12.6 | 43.1 | 72.7 |
| 5 | 103.5 | 134.0 | 162.6 | 193.2 | 222.7 | 253.3 | 282.9 | 313.4 | 344.0 | 13.6 | 44.1 | 73.7 |
| 6 | 104.5 | 135.0 | 163.6 | 194.2 | 223.7 | 254.3 | 283.9 | 314.4 | 345.0 | 14.5 | 45.1 | 74.7 |
| 7 | 105.5 | 136.0 | 164.6 | 195.1 | 224.7 | 255.3 | 284.8 | 315.4 | 346.0 | 15.5 | 46.1 | 75.6 |
| 8 | 106.4 | 137.0 | 165.6 | 196.1 | 225.7 | 256.3 | 285.8 | 316.4 | 346.9 | 16.5 | 47.1 | 76.6 |
| 9 | 107.4 | 138.0 | 166.6 | 197.1 | 226.7 | 257.2 | 286.8 | 317.4 | 347.9 | 17.5 | 48.0 | 77.6 |
| 10 | 108.4 | 139.0 | 167.6 | 198.1 | 227.7 | 258.2 | 287.8 | 318.4 | 348.9 | 18.5 | 49.0 | 78.6 |
| 11 | 109.4 | 140.0 | 168.5 | 199.1 | 228.7 | 259.2 | 288.8 | 319.3 | 349.9 | 19.5 | 50.0 | 79.6 |
| 12 | 110.4 | 140.9 | 169.5 | 200.1 | 229.6 | 260.2 | 289.8 | 320.3 | 350.9 | 20.5 | 51.0 | 80.6 |
| 13 | 111.4 | 141.9 | 170.5 | 201.1 | 230.6 | 261.2 | 290.8 | 321.3 | 351.9 | 21.4 | 52.0 | 81.6 |
| 14 | 112.4 | 142.9 | 171.5 | 202.0 | 231.6 | 262.2 | 291.7 | 322.3 | 352.9 | 22.4 | 53.0 | 82.5 |
| 15 | 113.3 | 143.9 | 172.5 | 203.0 | 232.6 | 263.2 | 292.7 | 323.3 | 353.8 | 23.4 | 54.0 | 83.5 |
| 16 | 114.3 | 144.9 | 173.5 | 204.0 | 233.6 | 264.1 | 293.7 | 324.3 | 354.8 | 24.4 | 54.9 | 84.5 |
| 17 | 115.3 | 145.9 | 174.5 | 205.0 | 234.6 | 265.1 | 294.7 | 325.3 | 355.8 | 25.4 | 55.9 | 85.5 |
| 18 | 116.3 | 146.9 | 175.4 | 206.0 | 235.6 | 266.1 | 295.7 | 326.2 | 356.8 | 26.4 | 56.9 | 86.5 |
| 19 | 117.3 | 147.8 | 176.4 | 207.0 | 236.5 | 267.1 | 296.7 | 327.2 | 357.8 | 27.3 | 57.9 | 87.5 |
| 20 | 118.3 | 148.8 | 177.4 | 208.0 | 237.5 | 268.1 | 297.7 | 328.2 | 358.8 | 28.3 | 58.9 | 88.5 |
| 21 | 119.3 | 149.8 | 178.4 | 208.9 | 238.5 | 269.1 | 298.6 | 329.2 | 359.8 | 29.3 | 59.9 | 89.4 |
| 22 | 120.2 | 150.8 | 179.4 | 209.9 | 239.5 | 270.1 | 299.6 | 330.2 | 0.7 | 30.3 | 60.9 | 90.4 |
| 23 | 121.2 | 151.8 | 180.4 | 210.9 | 240.5 | 271.0 | 300.6 | 331.2 | 1.7 | 31.3 | 61.8 | 91.4 |
| 24 | 122.2 | 152.8 | 181.4 | 211.9 | 241.5 | 272.0 | 301.6 | 332.2 | 2.7 | 32.3 | 62.8 | 92.4 |
| 25 | 123.2 | 153.8 | 182.3 | 212.9 | 242.5 | 273.0 | 302.6 | 333.1 | 3.7 | 33.3 | 63.8 | 93.4 |
| 26 | 124.2 | 154.7 | 183.3 | 213.9 | 243.4 | 274.0 | 303.6 | 334.1 | 4.7 | 34.2 | 64.8 | 94.4 |
| 27 | 125.2 | 155.7 | 184.3 | 214.9 | 244.4 | 275.0 | 304.6 | 335.1 | 5.7 | 35.2 | 65.8 | 95.4 |
| 28 | 126.2 | 156.7 | 185.3 | 215.8 | 245.4 | 276.0 | 305.5 | 336.1 | 6.7 | 36.2 | 66.8 | 96.3 |
| 29 | 127.1 | 157.7 | 186.3 | 216.8 | 246.4 | 277.0 | 306.5 | 337.1 | 7.6 | 37.2 | 67.8 | 97.3 |
| 30 | 128.1 | ------ | 187.3 | 217.8 | 247.4 | 277.9 | 307.5 | 338.1 | 8.6 | 38.2 | 68.7 | 98.3 |
| 31 | 129.1 | ------ | 188.2 | ------ | 248.4 | ------ | 308.5 | 339.1 | ------ | 39.2 | ------ | 99.3 |



## TABLE VII.—*Stars.*

| Name | Magnitude | Declination | SHA |
|---|---|---|---|
| Achernar | 0.6 | S 57°.5 | 336°.1 |
| Acrux | 1.1 | S 62.8 | 174.1 |
| Aldebaran | 1.1 | N 16.4 | 291.8 |
| Alpheratz | 2.2 | N 28.8 | 358.6 |
| Altair | 0.9 | N 8.7 | 63.0 |
| Antares | 1.2 | S 26.3 | 113.5 |
| Arcturus | 0.2 | N 19.5 | 146.7 |
| Betelgeux | 0.1–1.2 | N 7.4 | 272.0 |
| Canopus | —0.9 | S 52.7 | 264.3 |
| Capella | 0.2 | N 45.9 | 281.9 |
| Caph | 2.4 | N 58.8 | 358.5 |
| Deneb | 1.3 | N 45.1 | 50.1 |
| Dubhe | 2.0 | N 62.0 | 194.9 |
| Fomalhaut | 1.3 | S 29.9 | 16.4 |
| Peacock | 2.1 | S 56.9 | 54.7 |
| Polaris | 2.1 | N 89.0 | 333.7 |
| Pollux | 1.2 | N 28.2 | 244.5 |
| Procyon | 0.5 | N 5.4 | 245.9 |
| Regulus | 1.3 | N 12.2 | 208.7 |
| Rigel | 0.3 | S 8.3 | 282.0 |
| Rigil Kent | 0.3 | S 60.6 | 141.1 |
| Sirius | —1.6 | S 16.6 | 259.3 |
| Spica | 1.2 | S 10.9 | 159.4 |
| Vega | 0.1 | N 38.7 | 81.2 |

## TABLE VIII.—*Bearing from North when Rising or Setting.*

### A. SUN.

| Latitude | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N70° | ----- | 130° | 100° | 60° | 20° | ----- | ----- | 50° | 80° | 120° | 160° | ----- |
| 60 | 140° | 120 | 90 | 70 | 50 | 40° | 40° | 60 | 80 | 110 | 130 | 140° |
| 50 | 120 | 110 | 90 | 70 | 60 | 50 | 60 | 70 | 90 | 100 | 120 | 130 |
| 40 | 120 | 110 | 90 | 80 | 70 | 60 | 60 | 70 | 90 | 100 | 110 | 120 |
| 30 | 110 | 110 | 90 | 80 | 70 | 60 | 60 | 70 | 90 | 100 | 110 | 120 |
| 20 | 110 | 100 | 90 | 80 | 70 | 70 | 70 | 80 | 90 | 100 | 110 | 110 |
| N10 | 110 | 100 | 90 | 80 | 70 | 70 | 70 | 80 | 90 | 100 | 110 | 110 |
| 0 | 110 | 100 | 90 | 80 | 70 | 70 | 70 | 80 | 90 | 100 | 110 | 110 |
| S 10 | 110 | 100 | 90 | 80 | 70 | 70 | 70 | 80 | 90 | 100 | 110 | 110 |
| 20 | 110 | 100 | 90 | 80 | 70 | 70 | 70 | 80 | 90 | 100 | 110 | 110 |
| 30 | 110 | 110 | 90 | 80 | 70 | 60 | 60 | 70 | 90 | 100 | 110 | 120 |
| 40 | 120 | 110 | 90 | 80 | 70 | 60 | 60 | 70 | 90 | 100 | 110 | 120 |
| S 50 | 120 | 110 | 90 | 70 | 60 | 50 | 60 | 70 | 90 | 100 | 120 | 130 |

### B. STARS OR SUN.

| Decl. / Lat. | S 50° | S 40° | S 30° | S 20° | S 10° | 0° | N10° | N20° | N30° | N40° | N50° |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N70° | ------ | ------ | ------ | 180° | 121° | 90° | 59° | 0° | ------ | ------ | ------ |
| 60 | ------ | ------ | 180° | 133 | 110 | 90 | 70 | 47 | 0° | ------ | ------ |
| 50 | ------ | 180° | 141 | 122 | 106 | 90 | 74 | 58 | 39 | 0° | ------ |
| 40 | 180° | 147 | 131 | 117 | 103 | 90 | 77 | 63 | 49 | 33 | 0° |
| 30 | 152 | 138 | 125 | 113 | 102 | 90 | 78 | 67 | 55 | 42 | 28 |
| 20 | 145 | 133 | 122 | 111 | 101 | 90 | 79 | 69 | 58 | 47 | 35 |
| N10 | 141 | 131 | 121 | 110 | 100 | 90 | 80 | 70 | 59 | 49 | 39 |
| 0 | 140 | 130 | 120 | 110 | 100 | 90 | 80 | 70 | 60 | 50 | 40 |
| S 10 | 141 | 131 | 121 | 110 | 100 | 90 | 80 | 70 | 59 | 49 | 39 |
| 20 | 145 | 133 | 122 | 111 | 101 | 90 | 79 | 69 | 58 | 47 | 35 |
| 30 | 152 | 138 | 125 | 113 | 102 | 90 | 78 | 67 | 55 | 42 | 28 |
| 40 | 180 | 147 | 131 | 117 | 103 | 90 | 77 | 63 | 49 | 33 | 0 |
| S 50 | ------ | 180 | 141 | 122 | 106 | 90 | 74 | 58 | 39 | 0 | ------ |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | **90.0** | -- | **85.0** | 0 | **80.0** | 0 | **75.0** | 0 | **70.0** | 0 | **65.0** | 0 | **60.0** | 0 |
| | 5 | **85.0** | 90 | **82.9** | 45 | **78.8** | 26 | **74.2** | 18 | **69.4** | 14 | **64.6** | 11 | **59.6** | 9 |
| | 10 | **80.0** | 90 | **78.8** | 63 | **75.9** | 45 | **72.0** | 33 | **67.7** | 26 | **63.2** | 20 | **58.5** | 17 |
| | 15 | **75.0** | 90 | **74.2** | 71 | **72.0** | 56 | **68.9** | 44 | **65.2** | 35 | **61.1** | 29 | **56.8** | 24 |
| | 20 | **70.0** | 90 | **69.4** | 76 | **67.7** | 63 | **65.2** | 52 | **62.0** | 43 | **58.4** | 36 | **54.5** | 31 |
| | 25 | **65.0** | 90 | **64.5** | 78 | **63.2** | 67 | **61.1** | 58 | **58.4** | 49 | **55.2** | 42 | **51.7** | 36 |
| | 30 | **60.0** | 90 | **59.6** | 80 | **58.5** | 71 | **56.8** | 62 | **54.5** | 54 | **51.7** | 47 | **48.6** | 41 |
| | 35 | **55.0** | 90 | **54.7** | 81 | **53.8** | 73 | **52.3** | 65 | **50.4** | 58 | **48.0** | 51 | **45.2** | 45 |
| | 40 | **50.0** | 90 | **49.8** | 82 | **49.0** | 75 | **47.7** | 67 | **46.1** | 60 | **44.0** | 54 | **41.6** | 48 |
| | 45 | **45.0** | 90 | **44.8** | 83 | **44.2** | 76 | **43.1** | 69 | **41.7** | 63 | **39.9** | 57 | **37.8** | 51 |
| | 50 | **40.0** | 90 | **39.8** | 83 | **39.3** | 77 | **38.4** | 71 | **37.2** | 65 | **35.7** | 59 | **33.9** | 53 |
| | 55 | **35.0** | 90 | **34.9** | 84 | **34.4** | 78 | **33.7** | 72 | **32.6** | 66 | **31.4** | 60 | **29.8** | 55 |
| | 60 | **30.0** | 90 | **29.9** | 84 | **29.5** | 78 | **28.9** | 73 | **28.1** | 67 | **27.0** | 62 | **25.7** | 56 |
| | 65 | **25.0** | 90 | **24.9** | 84 | **24.6** | 79 | **24.1** | 74 | **23.4** | 68 | **22.6** | 63 | **21.5** | 58 |
| | 70 | **20.0** | 90 | **20.0** | 85 | **19.7** | 79 | **19.3** | 74 | **18.8** | 69 | **18.1** | 64 | **17.3** | 58 |
| | 75 | **15.0** | 90 | **15.0** | 85 | **14.8** | 80 | **14.6** | 74 | **14.2** | 69 | **13.6** | 64 | **13.0** | 59 |
| | 80 | **10.1** | 90 | **10.0** | 85 | **9.9** | 80 | **9.8** | 75 | **9.5** | 70 | **9.2** | 65 | **8.8** | 60 |
| | 85 | **5.2** | 90 | **5.1** | 85 | **5.1** | 80 | **5.0** | 75 | **4.9** | 70 | **4.7** | 65 | **4.5** | 60 |
| CONTRARY | 0 | **90.0** | -- | **85.0** | 180 | **80.0** | 180 | **75.0** | 180 | **70.0** | 180 | **65.0** | 180 | **60.0** | 180 |
| | 5 | **85.0** | 90 | **82.9** | 135 | **78.8** | 154 | **74.2** | 162 | **69.4** | 166 | **64.6** | 169 | **59.6** | 171 |
| | 10 | **80.0** | 90 | **78.8** | 117 | **75.9** | 135 | **72.0** | 147 | **67.7** | 155 | **63.2** | 160 | **58.5** | 163 |
| | 15 | **75.0** | 90 | **74.2** | 109 | **72.0** | 124 | **68.9** | 136 | **65.2** | 145 | **61.1** | 151 | **56.8** | 156 |
| | 20 | **70.0** | 90 | **69.4** | 104 | **67.7** | 117 | **65.2** | 128 | **62.0** | 137 | **58.4** | 144 | **54.5** | 149 |
| | 25 | **65.0** | 90 | **64.5** | 102 | **63.2** | 113 | **61.1** | 122 | **58.4** | 131 | **55.2** | 138 | **51.7** | 144 |
| | 30 | **60.0** | 90 | **59.6** | 100 | **58.5** | 109 | **56.8** | 118 | **54.5** | 126 | **51.7** | 133 | **48.6** | 139 |
| | 35 | **55.0** | 90 | **54.7** | 99 | **53.8** | 107 | **52.3** | 115 | **50.4** | 122 | **48.0** | 129 | **45.2** | 135 |
| | 40 | **50.0** | 90 | **49.8** | 98 | **49.0** | 105 | **47.7** | 113 | **46.1** | 120 | **44.0** | 126 | **41.6** | 132 |
| | 45 | **45.0** | 90 | **44.8** | 97 | **44.2** | 104 | **43.1** | 111 | **41.7** | 117 | **39.9** | 123 | **37.8** | 129 |
| | 50 | **40.0** | 90 | **39.8** | 97 | **39.3** | 103 | **38.4** | 109 | **37.2** | 115 | **35.7** | 121 | **33.9** | 127 |
| | 55 | **35.0** | 90 | **34.9** | 96 | **34.4** | 102 | **33.7** | 108 | **32.6** | 114 | **31.4** | 120 | **29.8** | 125 |
| | 60 | **30.0** | 90 | **29.9** | 96 | **29.5** | 102 | **28.9** | 107 | **28.1** | 113 | **27.0** | 118 | **25.7** | 124 |
| | 65 | **25.0** | 90 | **24.9** | 96 | **24.6** | 101 | **24.1** | 106 | **23.4** | 112 | **22.6** | 117 | **21.5** | 122 |
| | 70 | **20.0** | 90 | **20.0** | 95 | **19.7** | 101 | **19.3** | 106 | **18.8** | 111 | **18.1** | 116 | **17.3** | 122 |
| | 75 | **15.0** | 90 | **15.0** | 95 | **14.8** | 100 | **14.6** | 106 | **14.2** | 111 | **13.6** | 116 | **13.0** | 121 |
| | 80 | **10.1** | 90 | **10.0** | 95 | **9.9** | 100 | **9.8** | 105 | **9.5** | 110 | **9.2** | 115 | **8.8** | 120 |
| | 85 | **5.2** | 90 | **5.1** | 95 | **5.1** | 100 | **5.0** | 105 | **4.9** | 110 | **4.7** | 115 | **4.5** | 120 |

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | **85.0** | 180 | **90.0** | --- | **85.0** | 0 | **80.0** | 0 | **75.0** | 0 | **70.0** | 0 | **65.0** | 0 |
| | 5 | **82.9** | 135 | **85.0** | 90 | **83.0** | 44 | **78.9** | 26 | **74.2** | 18 | **69.4** | 13 | **64.6** | 10 |
| | 10 | **78.8** | 116 | **80.0** | 90 | **78.9** | 63 | **76.0** | 44 | **72.1** | 32 | **67.8** | 25 | **63.3** | 20 |
| | 15 | **74.2** | 108 | **75.1** | 89 | **74.3** | 70 | **72.2** | 55 | **69.1** | 43 | **65.4** | 34 | **61.3** | 28 |
| | 20 | **69.4** | 104 | **70.1** | 89 | **69.6** | 75 | **67.9** | 62 | **65.4** | 51 | **62.3** | 42 | **58.7** | 35 |
| | 25 | **64.6** | 101 | **65.1** | 89 | **64.7** | 77 | **63.5** | 66 | **61.4** | 56 | **58.8** | 48 | **55.7** | 40 |
| | 30 | **59.6** | 99 | **60.1** | 89 | **59.9** | 79 | **58.9** | 69 | **57.2** | 60 | **55.0** | 52 | **52.3** | 45 |
| | 35 | **54.7** | 97 | **55.2** | 88 | **55.0** | 80 | **54.2** | 71 | **52.8** | 63 | **51.0** | 56 | **48.6** | 49 |
| | 40 | **49.8** | 96 | **50.2** | 88 | **50.1** | 80 | **49.5** | 73 | **48.3** | 65 | **46.8** | 58 | **44.8** | 52 |
| | 45 | **44.8** | 95 | **45.2** | 88 | **45.2** | 81 | **44.7** | 74 | **43.8** | 67 | **42.5** | 60 | **40.8** | 54 |
| | 50 | **39.8** | 94 | **40.2** | 88 | **40.2** | 81 | **39.9** | 75 | **39.2** | 68 | **38.1** | 62 | **36.8** | 56 |
| | 55 | **34.9** | 94 | **35.3** | 87 | **35.3** | 81 | **35.1** | 75 | **34.5** | 69 | **33.7** | 63 | **32.6** | 57 |
| | 60 | **29.9** | 93 | **30.3** | 87 | **30.4** | 81 | **30.3** | 76 | **29.9** | 70 | **29.3** | 64 | **28.4** | 58 |
| | 65 | **24.9** | 92 | **25.3** | 87 | **25.5** | 81 | **25.5** | 76 | **25.2** | 70 | **24.8** | 65 | **24.1** | 59 |
| | 70 | **20.0** | 92 | **20.4** | 86 | **20.6** | 81 | **20.6** | 76 | **20.5** | 70 | **20.3** | 65 | **19.8** | 60 |
| | 75 | **15.0** | 91 | **15.4** | 86 | **15.7** | 81 | **15.8** | 76 | **15.9** | 71 | **15.8** | 65 | **15.5** | 60 |
| | 80 | **10.0** | 91 | **10.4** | 86 | **10.8** | 81 | **11.0** | 76 | **11.2** | 71 | **11.2** | 66 | **11.2** | 60 |
| | 85 | **5.1** | 90 | **5.6** | 85 | **5.9** | 80 | **6.3** | 75 | **6.5** | 70 | **6.8** | 65 | **7.0** | 60 |
| CONTRARY | 0 | **85.0** | 180 | **80.0** | 180 | **75.0** | 180 | **70.0** | 180 | **65.0** | 180 | **60.0** | 180 | **55.0** | 180 |
| | 5 | **82.9** | 135 | **78.8** | 153 | **74.2** | 162 | **69.4** | 166 | **64.5** | 169 | **59.6** | 171 | **54.7** | 172 |
| | 10 | **78.8** | 116 | **75.9** | 135 | **72.0** | 146 | **67.7** | 154 | **63.2** | 159 | **58.5** | 162 | **53.7** | 165 |
| | 15 | **74.2** | 108 | **72.0** | 124 | **68.8** | 135 | **65.1** | 144 | **61.0** | 150 | **56.7** | 155 | **52.2** | 159 |
| | 20 | **69.4** | 104 | **67.7** | 116 | **65.1** | 127 | **61.9** | 136 | **58.2** | 142 | **54.3** | 148 | **50.1** | 152 |
| | 25 | **64.6** | 101 | **63.1** | 112 | **60.9** | 121 | **58.2** | 129 | **55.0** | 136 | **51.4** | 142 | **47.6** | 147 |
| | 30 | **59.6** | 99 | **58.4** | 108 | **56.6** | 117 | **54.2** | 124 | **51.4** | 131 | **48.2** | 137 | **44.7** | 142 |
| | 35 | **54.7** | 97 | **53.7** | 106 | **52.1** | 113 | **50.0** | 120 | **47.5** | 127 | **44.7** | 133 | **41.6** | 138 |
| | 40 | **49.8** | 96 | **48.8** | 104 | **47.4** | 111 | **45.6** | 117 | **43.4** | 124 | **40.9** | 130 | **38.1** | 135 |
| | 45 | **44.8** | 95 | **44.0** | 102 | **42.8** | 109 | **41.2** | 115 | **39.2** | 121 | **37.0** | 127 | **34.5** | 132 |
| | 50 | **39.8** | 94 | **39.1** | 101 | **38.0** | 107 | **36.6** | 113 | **34.9** | 119 | **33.0** | 124 | **30.8** | 130 |
| | 55 | **34.9** | 94 | **34.2** | 100 | **33.2** | 105 | **32.0** | 111 | **30.5** | 117 | **28.8** | 122 | **26.9** | 127 |
| | 60 | **29.9** | 93 | **29.3** | 99 | **28.4** | 104 | **27.3** | 110 | **26.0** | 115 | **24.5** | 120 | **22.9** | 126 |
| | 65 | **24.9** | 92 | **24.4** | 98 | **23.6** | 103 | **22.6** | 108 | **21.5** | 114 | **20.2** | 119 | **18.8** | 124 |
| | 70 | **20.0** | 92 | **19.4** | 97 | **18.7** | 102 | **17.9** | 108 | **16.9** | 113 | **15.8** | 118 | **14.6** | 123 |
| | 75 | **15.0** | 91 | **14.5** | 96 | **13.9** | 102 | **13.2** | 107 | **12.4** | 112 | **11.4** | 117 | **10.4** | 122 |
| | 80 | **10.0** | 91 | **9.6** | 96 | **9.0** | 101 | **8.4** | 106 | **7.8** | 111 | **7.0** | 116 | **6.2** | 121 |
| | 85 | **5.1** | 90 | **4.7** | 95 | **4.2** | 100 | **3.7** | 105 | **3.2** | 110 | **2.7** | 115 | **2.1** | 120 |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | **80.0** | 180 | **85.0** | 180 | **90.0** | --- | **85.0** | 0 | **80.0** | 0 | **75.0** | 0 | **70.0** | 0 |
| | 5 | **78.8** | 153 | **83.0** | 135 | **85.1** | 90 | **83.0** | 44 | **78.9** | 25 | **74.3** | 17 | **69.5** | 12 |
| | 10 | **75.9** | 135 | **78.9** | 116 | **80.2** | 89 | **79.0** | 62 | **76.1** | 43 | **72.2** | 31 | **67.9** | 24 |
| | 15 | **72.0** | 123 | **74.3** | 108 | **75.2** | 89 | **74.5** | 70 | **72.4** | 54 | **69.3** | 42 | **65.6** | 33 |
| | 20 | **67.7** | 116 | **69.6** | 103 | **70.3** | 88 | **69.9** | 74 | **68.3** | 60 | **65.8** | 49 | **62.7** | 40 |
| | 25 | **63.2** | 110 | **64.7** | 100 | **65.4** | 88 | **65.1** | 76 | **63.9** | 65 | **61.9** | 54 | **59.3** | 46 |
| | 30 | **58.5** | 107 | **59.9** | 97 | **60.5** | 87 | **60.3** | 77 | **59.4** | 67 | **57.8** | 58 | **55.6** | 50 |
| | 35 | **53.8** | 104 | **55.0** | 96 | **55.6** | 87 | **55.5** | 78 | **54.8** | 69 | **53.6** | 61 | **51.8** | 53 |
| | 40 | **49.0** | 102 | **50.1** | 94 | **50.6** | 86 | **50.7** | 78 | **50.2** | 71 | **49.2** | 63 | **47.8** | 56 |
| | 45 | **44.2** | 100 | **45.2** | 93 | **45.7** | 86 | **45.9** | 79 | **45.6** | 72 | **44.8** | 65 | **43.6** | 58 |
| | 50 | **39.3** | 98 | **40.2** | 92 | **40.8** | 85 | **41.0** | 79 | **40.9** | 72 | **40.3** | 66 | **39.4** | 59 |
| | 55 | **34.4** | 97 | **35.3** | 91 | **35.9** | 85 | **36.2** | 79 | **36.2** | 72 | **35.9** | 66 | **35.2** | 60 |
| | 60 | **29.5** | 96 | **30.4** | 90 | **31.0** | 84 | **31.4** | 78 | **31.5** | 73 | **31.3** | 67 | **30.9** | 61 |
| | 65 | **24.6** | 95 | **25.5** | 89 | **26.1** | 84 | **26.6** | 78 | **26.8** | 72 | **26.8** | 67 | **26.6** | 61 |
| | 70 | **19.7** | 94 | **20.6** | 88 | **21.3** | 83 | **21.8** | 78 | **22.1** | 72 | **22.3** | 67 | **22.3** | 62 |
| | 75 | **14.8** | 93 | **15.7** | 88 | **16.4** | 82 | **17.0** | 77 | **17.5** | 72 | **17.8** | 67 | **18.0** | 62 |
| | 80 | **9.9** | 92 | **10.8** | 87 | **11.5** | 82 | **12.2** | 77 | **12.8** | 72 | **13.3** | 66 | **13.7** | 61 |
| | 85 | **5.1** | 91 | **5.9** | 86 | **6.7** | 81 | **7.5** | 76 | **8.2** | 71 | **8.8** | 66 | **9.4** | 61 |
| CONTRARY | 0 | **80.0** | 180 | **75.0** | 180 | **70.0** | 180 | **65.0** | 180 | **60.0** | 180 | **55.0** | 180 | **50.0** | 180 |
| | 5 | **78.8** | 153 | **74.2** | 161 | **69.4** | 166 | **64.5** | 169 | **59.6** | 171 | **54.7** | 172 | **49.7** | 173 |
| | 10 | **75.9** | 135 | **72.0** | 146 | **67.7** | 153 | **63.1** | 158 | **58.4** | 162 | **53.7** | 165 | **48.9** | 167 |
| | 15 | **72.0** | 123 | **68.8** | 134 | **65.1** | 143 | **60.9** | 149 | **56.6** | 154 | **52.1** | 158 | **47.5** | 161 |
| | 20 | **67.7** | 116 | **65.1** | 126 | **61.8** | 135 | **58.1** | 141 | **54.1** | 147 | **50.0** | 151 | **45.6** | 155 |
| | 25 | **63.2** | 110 | **60.9** | 120 | **58.1** | 128 | **54.8** | 135 | **51.2** | 141 | **47.4** | 146 | **43.3** | 150 |
| | 30 | **58.5** | 107 | **56.6** | 115 | **54.1** | 123 | **51.2** | 130 | **47.9** | 136 | **44.4** | 141 | **40.7** | 145 |
| | 35 | **53.8** | 104 | **52.1** | 112 | **49.9** | 119 | **47.3** | 125 | **44.3** | 131 | **41.1** | 136 | **37.7** | 141 |
| | 40 | **49.0** | 102 | **47.4** | 109 | **45.5** | 116 | **43.2** | 122 | **40.5** | 127 | **37.6** | 133 | **34.5** | 138 |
| | 45 | **44.2** | 100 | **42.8** | 106 | **41.0** | 113 | **38.9** | 119 | **36.5** | 124 | **33.9** | 130 | **31.1** | 134 |
| | 50 | **39.3** | 98 | **38.0** | 104 | **36.4** | 110 | **34.5** | 116 | **32.4** | 122 | **30.1** | 127 | **27.5** | 132 |
| | 55 | **34.4** | 97 | **33.2** | 103 | **31.8** | 108 | **30.1** | 114 | **28.2** | 119 | **26.0** | 124 | **23.8** | 129 |
| | 60 | **29.5** | 96 | **28.4** | 101 | **27.1** | 107 | **25.5** | 112 | **23.8** | 117 | **21.9** | 122 | **19.9** | 127 |
| | 65 | **24.6** | 95 | **23.6** | 100 | **22.4** | 105 | **21.0** | 110 | **19.4** | 116 | **17.7** | 120 | **15.9** | 125 |
| | 70 | **19.7** | 94 | **18.7** | 99 | **17.6** | 104 | **16.4** | 109 | **15.0** | 114 | **13.5** | 119 | **11.9** | 124 |
| | 75 | **14.8** | 93 | **13.9** | 98 | **12.8** | 103 | **11.7** | 108 | **10.5** | 113 | **9.2** | 118 | **7.8** | 122 |
| | 80 | **9.9** | 92 | **9.0** | 97 | **8.1** | 102 | **7.0** | 107 | **6.0** | 112 | **5.0** | 116 | **3.8** | 121 |
| | 85 | **5.1** | 91 | **4.2** | 96 | **3.3** | 101 | **2.5** | 105 | ---- | --- | ---- | --- | ---- | --- |

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 75.0 | 180 | 80.0 | 180 | 85.0 | 180 | 90.0 | --- | 85.0 | 0 | 80.0 | 0 | 75.0 | 0 |
| | 5 | 74.2 | 161 | 78.9 | 153 | 83.0 | 135 | 85.2 | 89 | 83.1 | 43 | 79.0 | 24 | 74.3 | 16 |
| | 10 | 72.0 | 146 | 76.0 | 134 | 79.0 | 116 | 80.3 | 89 | 79.2 | 61 | 76.3 | 42 | 72.4 | 30 |
| | 15 | 68.9 | 134 | 72.2 | 123 | 74.5 | 107 | 75.5 | 88 | 74.9 | 69 | 72.8 | 52 | 69.6 | 40 |
| | 20 | 65.2 | 125 | 68.0 | 115 | 69.9 | 102 | 70.7 | 87 | 70.3 | 72 | 68.8 | 59 | 66.3 | 47 |
| | 25 | 61.1 | 119 | 63.5 | 110 | 65.1 | 99 | 65.9 | 87 | 65.7 | 75 | 64.5 | 63 | 62.6 | 53 |
| | 30 | 56.8 | 114 | 58.9 | 106 | 60.3 | 96 | 61.1 | 86 | 61.0 | 76 | 60.2 | 66 | 58.6 | 56 |
| | 35 | 52.3 | 110 | 54.2 | 103 | 55.5 | 94 | 56.2 | 85 | 56.3 | 76 | 55.8 | 67 | 54.6 | 59 |
| | 40 | 47.7 | 107 | 49.5 | 100 | 50.7 | 92 | 51.4 | 85 | 51.6 | 77 | 51.3 | 69 | 50.4 | 61 |
| | 45 | 43.1 | 105 | 44.7 | 98 | 45.9 | 91 | 46.6 | 84 | 46.9 | 77 | 46.8 | 69 | 46.2 | 62 |
| | 50 | 38.4 | 102 | 39.9 | 96 | 41.0 | 90 | 41.8 | 83 | 42.2 | 76 | 42.3 | 70 | 41.9 | 63 |
| | 55 | 33.7 | 100 | 35.1 | 94 | 36.2 | 88 | 37.0 | 82 | 37.6 | 76 | 37.7 | 70 | 37.6 | 64 |
| | 60 | 28.9 | 98 | 30.3 | 93 | 31.4 | 87 | 32.3 | 82 | 32.9 | 76 | 33.2 | 70 | 33.2 | 64 |
| | 65 | 24.1 | 97 | 25.5 | 92 | 26.6 | 86 | 27.5 | 81 | 28.2 | 75 | 28.7 | 69 | 28.9 | 64 |
| | 70 | 19.3 | 95 | 20.6 | 90 | 21.8 | 85 | 22.8 | 80 | 23.6 | 74 | 24.2 | 69 | 24.6 | 64 |
| | 75 | 14.6 | 94 | 15.8 | 89 | 17.0 | 84 | 18.0 | 79 | 18.9 | 74 | 19.7 | 68 | 20.3 | 63 |
| | 80 | 9.8 | 93 | 11.0 | 88 | 12.2 | 83 | 13.3 | 78 | 14.3 | 73 | 15.2 | 68 | 16.0 | 62 |
| | 85 | 5.0 | 91 | 6.3 | 86 | 7.5 | 82 | 8.6 | 77 | 9.8 | 72 | 10.8 | 67 | 11.8 | 62 |
| | 90 | ---- | --- | ---- | --- | ---- | --- | 4.0 | 75 | 5.2 | 71 | 6.5 | 66 | 7.6 | 61 |
| CONTRARY | 0 | 75.0 | 180 | 70.0 | 180 | 65.0 | 180 | 60.0 | 180 | 55.0 | 180 | 50.0 | 180 | 45.0 | 180 |
| | 5 | 74.2 | 161 | 69.4 | 166 | 64.5 | 168 | 59.6 | 170 | 54.7 | 172 | 49.7 | 173 | 44.8 | 174 |
| | 10 | 72.0 | 146 | 67.7 | 153 | 63.1 | 158 | 58.4 | 161 | 53.7 | 164 | 48.8 | 166 | 44.0 | 168 |
| | 15 | 68.9 | 134 | 65.1 | 142 | 60.9 | 148 | 56.6 | 153 | 52.0 | 157 | 47.4 | 160 | 42.8 | 162 |
| | 20 | 65.2 | 125 | 61.9 | 134 | 58.1 | 140 | 54.1 | 146 | 49.9 | 150 | 45.5 | 154 | 41.1 | 157 |
| | 25 | 61.1 | 119 | 58.2 | 127 | 54.8 | 134 | 51.2 | 139 | 47.3 | 144 | 43.2 | 148 | 39.0 | 152 |
| | 30 | 56.8 | 114 | 54.2 | 122 | 51.2 | 128 | 47.8 | 134 | 44.3 | 139 | 40.5 | 143 | 36.5 | 147 |
| | 35 | 52.3 | 110 | 50.0 | 117 | 47.3 | 124 | 44.2 | 129 | 40.9 | 134 | 37.5 | 139 | 33.8 | 143 |
| | 40 | 47.7 | 107 | 45.6 | 114 | 43.2 | 120 | 40.4 | 125 | 37.4 | 131 | 34.2 | 135 | 30.8 | 140 |
| | 45 | 43.1 | 105 | 41.2 | 111 | 38.9 | 117 | 36.4 | 122 | 33.6 | 127 | 30.7 | 132 | 27.6 | 136 |
| | 50 | 38.4 | 102 | 36.6 | 108 | 34.5 | 114 | 32.2 | 119 | 29.7 | 124 | 27.0 | 129 | 24.1 | 133 |
| | 55 | 33.7 | 100 | 32.0 | 106 | 30.1 | 111 | 27.9 | 116 | 25.6 | 121 | 23.2 | 126 | 20.6 | 131 |
| | 60 | 28.9 | 98 | 27.3 | 104 | 25.5 | 109 | 23.6 | 114 | 21.5 | 119 | 19.2 | 124 | 16.8 | 128 |
| | 65 | 24.1 | 97 | 22.6 | 102 | 21.0 | 107 | 19.2 | 112 | 17.2 | 117 | 15.2 | 122 | 13.0 | 126 |
| | 70 | 19.3 | 95 | 17.9 | 100 | 16.3 | 105 | 14.7 | 110 | 12.9 | 115 | 11.0 | 120 | 9.1 | 124 |
| | 75 | 14.6 | 94 | 13.2 | 99 | 11.7 | 104 | 10.2 | 109 | 8.5 | 113 | 6.9 | 118 | 5.2 | 123 |
| | 80 | 9.8 | 93 | 8.4 | 97 | 7.0 | 102 | 5.6 | 107 | 4.1 | 112 | ---- | --- | ---- | --- |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 70.0 | 180 | 75.0 | 180 | 80.0 | 180 | 85.0 | 180 | 90.0 | --- | 85.0 | 0 | 80.0 | 0 |
| | 5 | 69.4 | 166 | 74.2 | 161 | 78.9 | 154 | 83.1 | 136 | 85.3 | 89 | 83.2 | 42 | 79.0 | 23 |
| | 10 | 67.7 | 153 | 72.1 | 146 | 76.1 | 135 | 79.2 | 116 | 80.6 | 88 | 79.5 | 60 | 76.5 | 40 |
| | 15 | 65.2 | 142 | 69.1 | 134 | 72.4 | 122 | 74.9 | 107 | 75.9 | 87 | 75.3 | 67 | 73.2 | 51 |
| | 20 | 62.0 | 133 | 65.4 | 125 | 68.3 | 114 | 70.3 | 102 | 71.2 | 87 | 70.9 | 71 | 69.4 | 57 |
| | 25 | 58.4 | 126 | 61.4 | 118 | 63.9 | 109 | 65.7 | 98 | 66.5 | 86 | 66.4 | 73 | 65.3 | 61 |
| | 30 | 54.5 | 121 | 57.2 | 113 | 59.4 | 105 | 61.0 | 95 | 61.9 | 85 | 61.9 | 74 | 61.2 | 64 |
| | 35 | 50.4 | 116 | 52.8 | 109 | 54.8 | 101 | 56.3 | 93 | 57.2 | 84 | 57.4 | 75 | 56.9 | 65 |
| | 40 | 46.1 | 112 | 48.3 | 106 | 50.2 | 99 | 51.6 | 91 | 52.5 | 83 | 52.9 | 75 | 52.6 | 66 |
| | 45 | 41.7 | 109 | 43.8 | 103 | 45.6 | 96 | 46.9 | 89 | 47.9 | 82 | 48.3 | 74 | 48.3 | 67 |
| | 50 | 37.2 | 106 | 39.2 | 100 | 40.9 | 94 | 42.2 | 88 | 43.2 | 81 | 43.8 | 74 | 44.0 | 67 |
| | 55 | 32.6 | 103 | 34.6 | 98 | 36.2 | 92 | 37.6 | 86 | 38.6 | 80 | 39.3 | 74 | 39.7 | 67 |
| | 60 | 28.1 | 101 | 29.9 | 96 | 31.5 | 90 | 32.9 | 85 | 34.0 | 79 | 34.8 | 73 | 35.3 | 67 |
| | 65 | 23.4 | 99 | 25.2 | 94 | 26.8 | 89 | 28.2 | 83 | 29.4 | 78 | 30.3 | 72 | 31.0 | 66 |
| | 70 | 18.8 | 97 | 20.5 | 92 | 22.1 | 87 | 23.6 | 82 | 24.8 | 77 | 25.9 | 71 | 26.7 | 66 |
| | 75 | 14.2 | 95 | 15.8 | 90 | 17.4 | 85 | 18.9 | 80 | 20.3 | 75 | 21.4 | 70 | 22.5 | 65 |
| | 80 | 9.5 | 93 | 11.2 | 89 | 12.8 | 84 | 14.3 | 79 | 15.7 | 74 | 17.1 | 69 | 18.2 | 64 |
| | 85 | 4.9 | 92 | 6.5 | 87 | 8.2 | 82 | 9.8 | 77 | 11.3 | 73 | 12.7 | 68 | 14.1 | 63 |
| | 90 | ---- | --- | 2.0 | 85 | 3.6 | 81 | 5.2 | 76 | 6.9 | 71 | 8.4 | 66 | 9.9 | 62 |
| CONTRARY | 0 | 70.0 | 180 | 65.0 | 180 | 60.0 | 180 | 55.0 | 180 | 50.0 | 180 | 45.0 | 180 | 40.0 | 180 |
| | 5 | 69.4 | 166 | 64.5 | 168 | 59.6 | 170 | 54.7 | 172 | 49.7 | 173 | 44.8 | 174 | 39.8 | 174 |
| | 10 | 67.7 | 153 | 63.1 | 157 | 58.4 | 161 | 53.7 | 164 | 48.8 | 166 | 44.0 | 167 | 39.1 | 169 |
| | 15 | 65.2 | 142 | 61.0 | 148 | 56.6 | 152 | 52.0 | 156 | 47.4 | 159 | 42.7 | 161 | 38.0 | 164 |
| | 20 | 62.0 | 133 | 58.2 | 140 | 54.1 | 145 | 49.9 | 149 | 45.5 | 153 | 41.0 | 156 | 36.4 | 158 |
| | 25 | 58.4 | 126 | 55.0 | 133 | 51.2 | 138 | 47.3 | 143 | 43.1 | 147 | 38.9 | 151 | 34.5 | 154 |
| | 30 | 54.5 | 121 | 51.4 | 127 | 47.9 | 133 | 44.3 | 138 | 40.4 | 142 | 36.4 | 146 | 32.3 | 149 |
| | 35 | 50.4 | 116 | 47.5 | 122 | 44.3 | 128 | 40.9 | 133 | 37.4 | 137 | 33.6 | 141 | 29.7 | 145 |
| | 40 | 46.1 | 112 | 43.4 | 118 | 40.5 | 124 | 37.4 | 129 | 34.0 | 133 | 30.6 | 137 | 26.9 | 141 |
| | 45 | 41.7 | 109 | 39.2 | 115 | 36.5 | 120 | 33.6 | 125 | 30.5 | 130 | 27.3 | 134 | 23.9 | 138 |
| | 50 | 37.2 | 106 | 34.9 | 112 | 32.4 | 117 | 29.7 | 122 | 26.8 | 126 | 23.8 | 131 | 20.7 | 135 |
| | 55 | 32.6 | 103 | 30.5 | 109 | 28.2 | 114 | 25.6 | 119 | 23.0 | 123 | 20.2 | 128 | 17.3 | 132 |
| | 60 | 28.1 | 101 | 26.0 | 106 | 23.8 | 111 | 21.5 | 116 | 19.0 | 121 | 16.4 | 125 | 13.7 | 130 |
| | 65 | 23.4 | 99 | 21.5 | 104 | 19.4 | 109 | 17.2 | 114 | 14.9 | 118 | 12.5 | 123 | 10.1 | 127 |
| | 70 | 18.8 | 97 | 16.9 | 102 | 15.0 | 107 | 12.9 | 111 | 10.7 | 116 | 8.6 | 121 | 6.3 | 125 |
| | 75 | 14.2 | 95 | 12.4 | 100 | 10.5 | 105 | 8.5 | 109 | 6.5 | 114 | 4.5 | 119 | ---- | --- |
| | 80 | 9.5 | 93 | 7.7 | 98 | 6.0 | 103 | 4.1 | 108 | ---- | --- | ---- | --- | ---- | --- |

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 65.0 | 180 | 70.0 | 180 | 75.0 | 180 | 80.0 | 180 | 85.0 | 180 | 90.0 | --- | 85.0 | 0 |
| | 5 | 64.6 | 168 | 69.4 | 166 | 74.3 | 162 | 79.0 | 154 | 83.2 | 136 | 85.5 | 89 | 83.3 | 40 |
| | 10 | 63.2 | 157 | 67.8 | 153 | 72.3 | 146 | 76.3 | 135 | 79.5 | 116 | 80.9 | 88 | 79.8 | 58 |
| | 15 | 61.1 | 148 | 65.4 | 142 | 69.3 | 134 | 72.8 | 123 | 75.3 | 107 | 76.4 | 87 | 75.8 | 66 |
| | 20 | 58.4 | 139 | 62.3 | 133 | 65.8 | 125 | 68.8 | 114 | 70.9 | 101 | 71.9 | 86 | 71.6 | 70 |
| | 25 | 55.2 | 132 | 58.8 | 126 | 61.9 | 118 | 64.5 | 108 | 66.4 | 97 | 67.4 | 85 | 67.3 | 72 |
| | 30 | 51.7 | 126 | 55.0 | 120 | 57.8 | 112 | 60.2 | 104 | 61.9 | 94 | 62.9 | 84 | 63.0 | 72 |
| | 35 | 48.0 | 121 | 51.0 | 115 | 53.6 | 108 | 55.8 | 100 | 57.4 | 92 | 58.4 | 82 | 58.7 | 73 |
| | 40 | 44.0 | 117 | 46.8 | 111 | 49.2 | 104 | 51.3 | 97 | 52.9 | 89 | 53.9 | 81 | 54.4 | 73 |
| | 45 | 39.9 | 113 | 42.5 | 107 | 44.8 | 101 | 46.8 | 95 | 48.3 | 87 | 49.4 | 80 | 50.0 | 72 |
| | 50 | 35.7 | 110 | 38.1 | 104 | 40.3 | 98 | 42.3 | 92 | 43.8 | 86 | 45.0 | 79 | 45.7 | 72 |
| | 55 | 31.4 | 106 | 33.7 | 101 | 35.9 | 96 | 37.7 | 90 | 39.3 | 84 | 40.5 | 78 | 41.4 | 71 |
| | 60 | 27.0 | 104 | 29.3 | 99 | 31.3 | 93 | 33.2 | 88 | 34.8 | 82 | 36.1 | 76 | 37.2 | 70 |
| | 65 | 22.6 | 101 | 24.8 | 96 | 26.8 | 91 | 28.7 | 86 | 30.3 | 81 | 31.7 | 75 | 32.9 | 69 |
| | 70 | 18.1 | 99 | 20.3 | 94 | 22.3 | 89 | 24.2 | 84 | 25.9 | 79 | 27.4 | 74 | 28.7 | 68 |
| | 75 | 13.6 | 96 | 15.8 | 92 | 17.8 | 87 | 19.7 | 82 | 21.4 | 77 | 23.1 | 72 | 24.5 | 67 |
| | 80 | 9.2 | 94 | 11.2 | 90 | 13.3 | 85 | 15.2 | 80 | 17.1 | 75 | 18.8 | 70 | 20.4 | 65 |
| | 85 | 4.7 | 92 | 6.8 | 88 | 8.8 | 83 | 10.8 | 78 | 12.7 | 74 | 14.5 | 69 | 16.3 | 64 |
| | 90 | ---- | --- | ---- | --- | 4.4 | 81 | 6.4 | 76 | 8.4 | 72 | 10.4 | 67 | 12.3 | 62 |
| CONTRARY | 0 | 65.0 | 180 | 60.0 | 180 | 55.0 | 180 | 50.0 | 180 | 45.0 | 180 | 40.0 | 180 | 35.0 | 180 |
| | 5 | 64.6 | 168 | 59.6 | 170 | 54.7 | 171 | 49.7 | 173 | 44.8 | 173 | 39.8 | 174 | 34.8 | 175 |
| | 10 | 63.2 | 157 | 58.5 | 161 | 53.7 | 163 | 48.8 | 165 | 44.0 | 167 | 39.1 | 168 | 34.2 | 170 |
| | 15 | 61.1 | 148 | 56.7 | 152 | 52.1 | 156 | 47.4 | 158 | 42.7 | 161 | 38.0 | 163 | 33.2 | 164 |
| | 20 | 58.4 | 139 | 54.3 | 144 | 50.0 | 148 | 45.5 | 152 | 41.0 | 155 | 36.4 | 157 | 31.8 | 160 |
| | 25 | 55.2 | 132 | 51.4 | 138 | 47.4 | 142 | 43.2 | 146 | 38.9 | 149 | 34.5 | 152 | 30.0 | 155 |
| | 30 | 51.7 | 126 | 48.2 | 132 | 44.4 | 136 | 40.5 | 141 | 36.4 | 144 | 32.2 | 148 | 28.0 | 151 |
| | 35 | 48.0 | 121 | 44.7 | 127 | 41.2 | 131 | 37.5 | 136 | 33.6 | 140 | 29.7 | 143 | 25.6 | 147 |
| | 40 | 44.0 | 117 | 40.9 | 122 | 37.6 | 127 | 34.2 | 131 | 30.6 | 135 | 26.8 | 139 | 23.0 | 143 |
| | 45 | 39.9 | 113 | 37.0 | 118 | 33.9 | 123 | 30.7 | 127 | 27.3 | 132 | 23.8 | 136 | 20.1 | 139 |
| | 50 | 35.7 | 110 | 33.0 | 115 | 30.1 | 119 | 27.0 | 124 | 23.8 | 128 | 20.5 | 132 | 17.1 | 136 |
| | 55 | 31.4 | 106 | 28.8 | 111 | 26.0 | 116 | 23.1 | 121 | 20.2 | 125 | 17.1 | 129 | 13.9 | 133 |
| | 60 | 27.0 | 104 | 24.5 | 109 | 21.9 | 113 | 19.2 | 118 | 16.4 | 122 | 13.5 | 126 | 10.5 | 130 |
| | 65 | 22.6 | 101 | 20.2 | 106 | 17.7 | 110 | 15.1 | 115 | 12.5 | 119 | 9.8 | 124 | 7.0 | 128 |
| | 70 | 18.1 | 99 | 15.8 | 103 | 13.5 | 108 | 11.0 | 112 | 8.6 | 117 | 6.0 | 121 | 3.5 | 125 |
| | 75 | 13.6 | 96 | 11.4 | 101 | 9.2 | 106 | 6.9 | 110 | 4.5 | 114 | ---- | --- | ---- | --- |
| | 80 | 9.2 | 94 | 7.0 | 99 | 4.8 | 103 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 60.0 | 180 | 65.0 | 180 | 70.0 | 180 | 75.0 | 180 | 80.0 | 180 | 85.0 | 180 | 90.0 | --- |
| | 5 | 59.6 | 170 | 64.6 | 168 | 69.5 | 166 | 74.3 | 162 | 79.0 | 155 | 83.3 | 137 | 85.7 | 89 |
| | 10 | 58.5 | 161 | 63.3 | 157 | 67.9 | 153 | 72.4 | 146 | 76.5 | 136 | 79.8 | 117 | 81.3 | 88 |
| | 15 | 56.8 | 152 | 61.3 | 148 | 65.6 | 142 | 69.6 | 134 | 73.2 | 123 | 75.8 | 107 | 77.0 | 86 |
| | 20 | 54.5 | 144 | 58.7 | 139 | 62.7 | 133 | 66.3 | 125 | 69.4 | 114 | 71.6 | 101 | 72.7 | 85 |
| | 25 | 51.7 | 137 | 55.7 | 132 | 59.3 | 125 | 62.6 | 118 | 65.3 | 108 | 67.3 | 97 | 68.4 | 84 |
| | 30 | 48.6 | 131 | 52.3 | 126 | 55.6 | 119 | 58.6 | 112 | 61.2 | 103 | 63.0 | 93 | 64.1 | 82 |
| | 35 | 45.2 | 126 | 48.6 | 120 | 51.8 | 114 | 54.6 | 107 | 56.9 | 99 | 58.7 | 91 | 59.8 | 81 |
| | 40 | 41.6 | 121 | 44.8 | 116 | 47.8 | 110 | 50.4 | 103 | 52.6 | 96 | 54.4 | 88 | 55.6 | 80 |
| | 45 | 37.8 | 117 | 40.8 | 111 | 43.6 | 106 | 46.2 | 100 | 48.3 | 93 | 50.0 | 86 | 51.3 | 78 |
| | 50 | 33.9 | 113 | 36.8 | 108 | 39.4 | 102 | 41.9 | 97 | 44.0 | 90 | 45.7 | 84 | 47.1 | 77 |
| | 55 | 29.8 | 109 | 32.6 | 104 | 35.2 | 99 | 37.6 | 94 | 39.7 | 88 | 41.4 | 82 | 42.9 | 75 |
| | 60 | 25.7 | 106 | 28.4 | 101 | 30.9 | 96 | 33.2 | 91 | 35.3 | 86 | 37.2 | 80 | 38.7 | 74 |
| | 65 | 21.5 | 103 | 24.1 | 99 | 26.6 | 94 | 28.9 | 89 | 31.0 | 83 | 32.9 | 78 | 34.6 | 72 |
| | 70 | 17.3 | 100 | 19.8 | 96 | 22.3 | 91 | 24.6 | 86 | 26.7 | 81 | 28.7 | 76 | 30.5 | 71 |
| | 75 | 13.0 | 98 | 15.5 | 93 | 18.0 | 89 | 20.3 | 84 | 22.5 | 79 | 24.5 | 74 | 26.4 | 69 |
| | 80 | 8.8 | 95 | 11.2 | 91 | 13.7 | 86 | 16.0 | 82 | 18.2 | 77 | 20.4 | 72 | 22.4 | 67 |
| | 85 | 4.5 | 92 | 7.0 | 88 | 9.4 | 84 | 11.8 | 79 | 14.1 | 75 | 16.3 | 70 | 18.4 | 65 |
| | 90 | ---- | --- | 2.7 | 86 | 5.1 | 81 | 7.6 | 77 | 9.9 | 72 | 12.3 | 68 | 14.5 | 63 |
| CONTRARY | 0 | 60.0 | 180 | 55.0 | 180 | 50.0 | 180 | 45.0 | 180 | 40.0 | 180 | 35.0 | 180 | 30.0 | 180 |
| | 5 | 59.6 | 170 | 54.7 | 171 | 49.7 | 172 | 44.8 | 173 | 39.8 | 174 | 34.8 | 174 | 29.8 | 175 |
| | 10 | 58.5 | 161 | 53.7 | 163 | 48.9 | 165 | 44.0 | 167 | 39.1 | 168 | 34.2 | 169 | 29.3 | 170 |
| | 15 | 56.8 | 152 | 52.2 | 155 | 47.5 | 158 | 42.8 | 160 | 38.0 | 162 | 33.2 | 164 | 28.4 | 165 |
| | 20 | 54.5 | 144 | 50.1 | 148 | 45.6 | 151 | 41.1 | 154 | 36.4 | 156 | 31.8 | 159 | 27.1 | 161 |
| | 25 | 51.7 | 137 | 47.6 | 141 | 43.3 | 145 | 39.0 | 148 | 34.5 | 151 | 30.0 | 154 | 25.5 | 156 |
| | 30 | 48.6 | 131 | 44.7 | 136 | 40.7 | 140 | 36.5 | 143 | 32.3 | 146 | 28.0 | 149 | 23.6 | 152 |
| | 35 | 45.2 | 126 | 41.6 | 130 | 37.7 | 134 | 33.8 | 138 | 29.7 | 142 | 25.6 | 145 | 21.4 | 148 |
| | 40 | 41.6 | 121 | 38.1 | 126 | 34.5 | 130 | 30.8 | 134 | 26.9 | 137 | 23.0 | 141 | 19.0 | 144 |
| | 45 | 37.8 | 117 | 34.5 | 121 | 31.1 | 126 | 27.6 | 130 | 23.9 | 133 | 20.1 | 137 | 16.3 | 140 |
| | 50 | 33.9 | 113 | 30.8 | 117 | 27.5 | 122 | 24.1 | 126 | 20.7 | 130 | 17.1 | 133 | 13.5 | 137 |
| | 55 | 29.8 | 109 | 26.9 | 114 | 23.8 | 118 | 20.6 | 122 | 17.3 | 126 | 13.9 | 130 | 10.5 | 134 |
| | 60 | 25.7 | 106 | 22.9 | 111 | 19.9 | 115 | 16.8 | 119 | 13.7 | 123 | 10.5 | 127 | 7.3 | 131 |
| | 65 | 21.5 | 103 | 18.8 | 108 | 15.9 | 112 | 13.0 | 116 | 10.1 | 120 | 7.0 | 124 | 4.0 | 128 |
| | 70 | 17.3 | 100 | 14.6 | 105 | 11.9 | 109 | 9.1 | 113 | 6.3 | 117 | 3.5 | 122 | ---- | --- |
| | 75 | 13.0 | 98 | 10.5 | 102 | 7.8 | 106 | 5.2 | 111 | 2.6 | 115 | ---- | --- | ---- | --- |

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 55.0 | 180 | 60.0 | 180 | 65.0 | 180 | 70.0 | 180 | 75.0 | 180 | 80.0 | 180 | 85.0 | 180 |
| | 5 | 54.7 | 171 | 59.7 | 170 | 64.6 | 168 | 69.5 | 166 | 74.4 | 162 | 79.1 | 155 | 83.5 | 138 |
| | 10 | 53.8 | 163 | 58.6 | 161 | 63.4 | 158 | 68.1 | 153 | 72.6 | 147 | 76.8 | 136 | 80.2 | 118 |
| | 15 | 52.3 | 155 | 57.0 | 152 | 61.5 | 148 | 65.9 | 142 | 70.0 | 135 | 73.6 | 124 | 76.4 | 107 |
| | 20 | 50.4 | 148 | 54.8 | 144 | 59.1 | 139 | 63.1 | 133 | 66.9 | 125 | 70.1 | 115 | 72.4 | 101 |
| | 25 | 48.0 | 141 | 52.2 | 137 | 56.2 | 132 | 59.9 | 125 | 63.4 | 118 | 66.2 | 108 | 68.4 | 96 |
| | 30 | 45.2 | 135 | 49.2 | 130 | 53.0 | 125 | 56.5 | 119 | 59.6 | 112 | 62.3 | 103 | 64.3 | 93 |
| | 35 | 42.2 | 129 | 45.9 | 125 | 49.5 | 120 | 52.8 | 114 | 55.8 | 107 | 58.3 | 99 | 60.2 | 90 |
| | 40 | 38.9 | 124 | 42.5 | 120 | 45.9 | 115 | 49.0 | 109 | 51.8 | 102 | 54.2 | 95 | 56.1 | 87 |
| | 45 | 35.4 | 120 | 38.8 | 115 | 42.1 | 110 | 45.1 | 105 | 47.8 | 99 | 50.1 | 92 | 52.1 | 85 |
| | 50 | 31.8 | 116 | 35.1 | 111 | 38.2 | 106 | 41.1 | 101 | 43.7 | 95 | 46.0 | 89 | 48.0 | 82 |
| | 55 | 28.1 | 112 | 31.2 | 107 | 34.2 | 103 | 37.0 | 98 | 39.6 | 92 | 41.9 | 86 | 43.9 | 80 |
| | 60 | 24.2 | 108 | 27.3 | 104 | 30.2 | 99 | 33.0 | 94 | 35.6 | 89 | 37.9 | 84 | 39.9 | 78 |
| | 65 | 20.3 | 105 | 23.3 | 101 | 26.2 | 96 | 28.9 | 91 | 31.4 | 86 | 33.8 | 81 | 36.0 | 76 |
| | 70 | 16.3 | 102 | 19.2 | 98 | 22.1 | 93 | 24.8 | 89 | 27.4 | 84 | 29.8 | 79 | 32.0 | 74 |
| | 75 | 12.3 | 99 | 15.2 | 95 | 18.0 | 90 | 20.7 | 86 | 23.3 | 81 | 25.8 | 76 | 28.1 | 71 |
| | 80 | 8.2 | 96 | 11.1 | 92 | 13.9 | 87 | 16.6 | 83 | 19.3 | 79 | 21.8 | 74 | 24.3 | 69 |
| | 85 | 4.1 | 93 | 7.0 | 89 | 9.8 | 85 | 12.6 | 80 | 15.3 | 76 | 17.9 | 72 | 20.5 | 67 |
| | 90 | ---- | --- | 2.9 | 86 | 5.7 | 82 | 8.5 | 78 | 11.4 | 73 | 14.1 | 69 | 16.7 | 65 |
| CONTRARY | 0 | 55.0 | 180 | 50.0 | 180 | 45.0 | 180 | 40.0 | 180 | 35.0 | 180 | 30.0 | 180 | 25.0 | 180 |
| | 5 | 54.7 | 171 | 49.7 | 172 | 44.8 | 173 | 39.8 | 174 | 34.8 | 174 | 29.8 | 175 | 24.9 | 175 |
| | 10 | 53.8 | 163 | 48.9 | 165 | 44.0 | 166 | 39.1 | 168 | 34.2 | 169 | 29.3 | 170 | 24.4 | 170 |
| | 15 | 52.3 | 155 | 47.6 | 158 | 42.8 | 160 | 38.0 | 162 | 33.2 | 163 | 28.4 | 165 | 23.5 | 166 |
| | 20 | 50.4 | 148 | 45.8 | 151 | 41.2 | 153 | 36.5 | 156 | 31.8 | 158 | 27.1 | 160 | 22.4 | 161 |
| | 25 | 48.0 | 141 | 43.6 | 144 | 39.2 | 148 | 34.7 | 150 | 30.1 | 153 | 25.5 | 155 | 20.9 | 157 |
| | 30 | 45.2 | 135 | 41.1 | 139 | 36.8 | 142 | 32.5 | 145 | 28.1 | 148 | 23.6 | 150 | 19.2 | 153 |
| | 35 | 42.2 | 129 | 38.2 | 133 | 34.2 | 137 | 30.0 | 140 | 25.8 | 143 | 21.5 | 146 | 17.2 | 149 |
| | 40 | 38.9 | 124 | 35.1 | 128 | 31.2 | 132 | 27.3 | 136 | 23.2 | 139 | 19.1 | 142 | 14.9 | 145 |
| | 45 | 35.4 | 120 | 31.8 | 124 | 28.1 | 128 | 24.3 | 131 | 20.4 | 135 | 16.5 | 138 | 12.5 | 141 |
| | 50 | 31.8 | 116 | 28.4 | 120 | 24.8 | 124 | 21.1 | 128 | 17.4 | 131 | 13.6 | 134 | 9.8 | 138 |
| | 55 | 28.1 | 112 | 24.8 | 116 | 21.3 | 120 | 17.8 | 124 | 14.2 | 127 | 10.6 | 131 | 7.0 | 134 |
| | 60 | 24.2 | 108 | 21.0 | 112 | 17.7 | 116 | 14.4 | 120 | 10.9 | 124 | 7.4 | 128 | 4.1 | 131 |
| | 65 | 20.3 | 105 | 17.2 | 109 | 14.0 | 113 | 10.8 | 117 | 7.6 | 121 | 4.3 | 125 | ---- | --- |
| | 70 | 16.3 | 102 | 13.3 | 106 | 10.2 | 110 | 7.2 | 114 | 4.1 | 118 | ---- | --- | ---- | --- |
| | 75 | 12.3 | 99 | 9.4 | 103 | 6.4 | 107 | 3.4 | 111 | ---- | --- | ---- | --- | ---- | --- |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 50.0 | 180 | 55.0 | 180 | 60.0 | 180 | 65.0 | 180 | 70.0 | 180 | 75.0 | 180 | 80.0 | 180 |
| | 5 | 49.8 | 172 | 54.7 | 171 | 59.7 | 170 | 64.6 | 169 | 69.6 | 166 | 74.4 | 163 | 79.2 | 156 |
| | 10 | 49.0 | 165 | 53.9 | 163 | 58.7 | 161 | 63.5 | 158 | 68.2 | 154 | 72.8 | 148 | 77.1 | 138 |
| | 15 | 47.7 | 157 | 52.5 | 155 | 57.2 | 152 | 61.8 | 148 | 66.2 | 143 | 70.4 | 136 | 74.2 | 125 |
| | 20 | 46.0 | 150 | 50.7 | 148 | 55.2 | 144 | 59.5 | 139 | 63.7 | 134 | 67.5 | 126 | 70.9 | 115 |
| | 25 | 44.0 | 144 | 48.4 | 141 | 52.7 | 137 | 56.8 | 132 | 60.7 | 126 | 64.3 | 118 | 67.3 | 108 |
| | 30 | 41.6 | 138 | 45.8 | 134 | 49.9 | 130 | 53.8 | 125 | 57.5 | 119 | 60.8 | 112 | 63.6 | 103 |
| | 35 | 38.9 | 133 | 43.0 | 129 | 46.9 | 124 | 50.6 | 119 | 54.0 | 113 | 57.2 | 106 | 59.9 | 98 |
| | 40 | 36.0 | 127 | 39.9 | 124 | 43.6 | 119 | 47.2 | 114 | 50.5 | 108 | 53.5 | 102 | 56.1 | 94 |
| | 45 | 32.8 | 123 | 36.6 | 119 | 40.2 | 114 | 43.6 | 109 | 46.8 | 104 | 49.7 | 98 | 52.2 | 91 |
| | 50 | 29.5 | 118 | 33.2 | 114 | 36.6 | 110 | 40.0 | 105 | 43.0 | 100 | 45.9 | 94 | 48.4 | 88 |
| | 55 | 26.1 | 114 | 29.6 | 110 | 33.0 | 106 | 36.2 | 101 | 39.3 | 96 | 42.1 | 91 | 44.6 | 85 |
| | 60 | 22.6 | 110 | 26.0 | 106 | 29.3 | 102 | 32.5 | 98 | 35.5 | 93 | 38.3 | 88 | 40.8 | 82 |
| | 65 | 18.9 | 107 | 22.3 | 103 | 25.5 | 99 | 28.6 | 94 | 31.6 | 90 | 34.4 | 85 | 37.0 | 79 |
| | 70 | 15.2 | 103 | 18.5 | 99 | 21.7 | 95 | 24.8 | 91 | 27.8 | 86 | 30.6 | 82 | 33.3 | 77 |
| | 75 | 11.5 | 100 | 14.7 | 96 | 17.9 | 92 | 21.0 | 88 | 24.0 | 83 | 26.9 | 79 | 29.6 | 74 |
| | 80 | 7.8 | 97 | 10.9 | 93 | 14.1 | 89 | 17.2 | 85 | 20.2 | 80 | 23.1 | 76 | 25.9 | 71 |
| | 85 | 4.0 | 93 | 7.1 | 90 | 10.3 | 85 | 13.4 | 81 | 16.5 | 77 | 19.4 | 73 | 22.3 | 69 |
| | 90 | ---- | --- | 3.4 | 88 | 6.5 | 82 | 9.6 | 78 | 12.8 | 74 | 15.8 | 70 | 18.8 | 66 |
| | 95 | ---- | --- | ---- | --- | ---- | --- | 6.0 | 75 | 9.1 | 72 | 12.2 | 67 | 15.3 | 63 |
| CONTRARY | 0 | 50.0 | 180 | 45.0 | 180 | 40.0 | 180 | 35.0 | 180 | 30.0 | 180 | 25.0 | 180 | 20.0 | 180 |
| | 5 | 49.8 | 172 | 44.8 | 173 | 39.8 | 174 | 34.8 | 174 | 29.9 | 175 | 24.9 | 175 | 19.9 | 175 |
| | 10 | 49.0 | 165 | 44.1 | 166 | 39.2 | 167 | 34.2 | 168 | 29.3 | 169 | 24.4 | 170 | 19.4 | 171 |
| | 15 | 47.7 | 157 | 43.0 | 159 | 38.1 | 161 | 33.3 | 163 | 28.4 | 164 | 23.6 | 165 | 18.7 | 166 |
| | 20 | 46.0 | 150 | 41.4 | 153 | 36.7 | 155 | 32.0 | 157 | 27.2 | 159 | 22.4 | 160 | 17.6 | 162 |
| | 25 | 44.0 | 144 | 39.5 | 147 | 34.9 | 150 | 30.3 | 152 | 25.6 | 154 | 21.0 | 156 | 16.3 | 158 |
| | 30 | 41.6 | 138 | 37.2 | 141 | 32.8 | 144 | 28.4 | 147 | 23.8 | 149 | 19.3 | 151 | 14.7 | 153 |
| | 35 | 38.9 | 133 | 34.7 | 136 | 30.5 | 139 | 26.1 | 142 | 21.7 | 145 | 17.3 | 147 | 12.9 | 149 |
| | 40 | 36.0 | 127 | 31.9 | 131 | 27.8 | 134 | 23.6 | 137 | 19.4 | 140 | 15.1 | 143 | 10.8 | 146 |
| | 45 | 32.8 | 123 | 29.0 | 126 | 25.0 | 130 | 21.0 | 133 | 16.9 | 136 | 12.7 | 139 | 8.6 | 142 |
| | 50 | 29.5 | 118 | 25.8 | 122 | 22.0 | 126 | 18.0 | 129 | 14.1 | 132 | 10.1 | 135 | 6.2 | 138 |
| | 55 | 26.1 | 114 | 22.5 | 118 | 18.8 | 122 | 15.0 | 125 | 11.2 | 128 | 7.4 | 131 | ---- | --- |
| | 60 | 22.6 | 110 | 19.0 | 114 | 15.5 | 118 | 11.8 | 121 | 8.2 | 124 | 4.5 | 128 | ---- | --- |
| | 65 | 18.9 | 107 | 15.5 | 110 | 12.0 | 114 | 8.5 | 117 | 5.0 | 121 | ---- | --- | ---- | --- |
| | 70 | 15.2 | 103 | 11.9 | 107 | 8.5 | 110 | 5.1 | 114 | ---- | --- | ---- | --- | ---- | --- |

Same

| Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0° | **45.0** | 180 | **50.0** | 180 | **55.0** | 180 | **60.0** | 180 | **65.0** | 180 | **70.0** | 180 | **75.0** | 180 |
| 5 | **44.8** | 173 | **49.8** | 172 | **54.8** | 171 | **59.7** | 170 | **64.7** | 169 | **69.6** | 167 | **74.5** | 164 |
| 10 | **44.2** | 166 | **49.1** | 165 | **54.0** | 163 | **58.8** | 161 | **63.7** | 158 | **68.4** | 155 | **73.1** | 149 |
| 15 | **43.1** | 159 | **47.9** | 157 | **52.7** | 155 | **57.4** | 152 | **62.1** | 149 | **66.6** | 144 | **70.9** | 137 |
| 20 | **41.7** | 153 | **46.4** | 150 | **51.0** | 148 | **55.6** | 144 | **60.0** | 140 | **64.3** | 134 | **68.3** | 127 |
| 25 | **39.9** | 147 | **44.5** | 144 | **49.0** | 141 | **53.3** | 137 | **57.6** | 132 | **61.6** | 126 | **65.3** | 119 |
| 30 | **37.8** | 141 | **42.2** | 138 | **46.6** | 134 | **50.8** | 130 | **54.8** | 125 | **58.6** | 119 | **62.1** | 112 |
| 35 | **35.4** | 135 | **39.7** | 132 | **43.9** | 128 | **48.0** | 124 | **51.8** | 119 | **55.5** | 114 | **58.8** | 107 |
| 40 | **32.8** | 130 | **37.0** | 127 | **41.0** | 123 | **45.0** | 119 | **48.7** | 114 | **52.2** | 108 | **55.4** | 102 |
| 45 | **30.0** | 125 | **34.1** | 122 | **38.0** | 118 | **41.8** | 114 | **45.4** | 109 | **48.8** | 104 | **51.9** | 97 |
| 50 | **27.1** | 121 | **31.0** | 117 | **34.8** | 113 | **38.5** | 109 | **42.0** | 104 | **45.3** | 99 | **48.4** | 94 |
| 55 | **24.0** | 116 | **27.8** | 113 | **31.5** | 109 | **35.1** | 105 | **38.6** | 100 | **41.8** | 95 | **44.8** | 90 |
| 60 | **20.7** | 112 | **24.5** | 109 | **28.1** | 105 | **31.7** | 101 | **35.1** | 96 | **38.3** | 92 | **41.3** | 86 |
| 65 | **17.4** | 108 | **21.1** | 105 | **24.7** | 101 | **28.2** | 97 | **31.5** | 93 | **34.8** | 88 | **37.8** | 83 |
| 70 | **14.1** | 104 | **17.7** | 101 | **21.2** | 97 | **24.7** | 93 | **28.0** | 89 | **31.2** | 85 | **34.3** | 80 |
| 75 | **10.6** | 101 | **14.2** | 97 | **17.7** | 93 | **21.1** | 90 | **24.5** | 86 | **27.7** | 81 | **30.8** | 77 |
| 80 | **7.2** | 97 | **10.7** | 94 | **14.2** | 90 | **17.6** | 86 | **21.0** | 82 | **24.3** | 78 | **27.4** | 74 |
| 85 | **3.7** | 94 | **7.2** | 90 | **10.7** | 86 | **14.1** | 83 | **17.5** | 79 | **20.8** | 75 | **24.1** | 71 |
| 90 | ---- | --- | **3.7** | 87 | **7.2** | 83 | **10.6** | 79 | **14.1** | 76 | **17.4** | 72 | **20.8** | 68 |
| 95 | ---- | --- | ---- | --- | **3.8** | 79 | **7.2** | 76 | **10.7** | 72 | **14.1** | 69 | **17.5** | 65 |

Contrary

| LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **45.0** | 180 | **40.0** | 180 | **35.0** | 180 | **30.0** | 180 | **25.0** | 180 | **20.0** | 180 | **15.1** | 180 |
| 5 | **44.8** | 173 | **39.8** | 174 | **34.8** | 174 | **29.9** | 174 | **24.9** | 175 | **19.9** | 175 | **14.9** | 176 |
| 10 | **44.2** | 166 | **39.2** | 167 | **34.3** | 168 | **29.3** | 169 | **24.4** | 170 | **19.5** | 170 | **14.5** | 171 |
| 15 | **43.1** | 159 | **38.3** | 161 | **33.4** | 162 | **28.5** | 163 | **23.6** | 165 | **18.7** | 166 | **13.8** | 167 |
| 20 | **41.7** | 153 | **36.9** | 155 | **32.1** | 157 | **27.3** | 158 | **22.5** | 160 | **17.7** | 161 | **12.9** | 162 |
| 25 | **39.9** | 147 | **35.3** | 149 | **30.6** | 151 | **25.9** | 153 | **21.2** | 155 | **16.4** | 156 | **11.7** | 158 |
| 30 | **37.8** | 141 | **33.3** | 143 | **28.7** | 146 | **24.1** | 148 | **19.5** | 150 | **14.9** | 152 | **10.3** | 154 |
| 35 | **35.4** | 135 | **31.1** | 138 | **26.6** | 141 | **22.2** | 143 | **17.7** | 146 | **13.2** | 148 | **8.6** | 150 |
| 40 | **32.8** | 130 | **28.6** | 133 | **24.3** | 136 | **19.9** | 139 | **15.6** | 141 | **11.2** | 144 | **6.8** | 146 |
| 45 | **30.0** | 125 | **25.9** | 128 | **21.7** | 131 | **17.5** | 134 | **13.2** | 137 | **9.0** | 140 | **4.7** | 142 |
| 50 | **27.1** | 121 | **23.1** | 124 | **19.0** | 127 | **14.9** | 130 | **10.8** | 133 | **6.6** | 136 | ---- | --- |
| 55 | **24.0** | 116 | **20.1** | 120 | **16.1** | 123 | **12.1** | 126 | **8.1** | 129 | **4.1** | 131 | ---- | --- |
| 60 | **20.7** | 112 | **16.9** | 116 | **13.1** | 119 | **9.2** | 122 | **5.3** | 125 | ---- | --- | ---- | --- |
| 65 | **17.4** | 108 | **13.7** | 112 | **10.0** | 115 | **6.2** | 118 | ---- | --- | ---- | --- | ---- | --- |
| 70 | **14.1** | 104 | **10.4** | 108 | **6.8** | 111 | **3.2** | 115 | ---- | --- | ---- | --- | ---- | --- |



Same

| Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 0° | **40.0** | 180 | **45.0** | 180 | **50.0** | 180 | **55.0** | 180 | **60.0** | 180 | **65.0** | 180 | **70.0** | 180 |
| 5 | **39.8** | 173 | **44.8** | 173 | **49.8** | 172 | **54.8** | 172 | **59.8** | 171 | **64.7** | 169 | **69.6** | 168 |
| 10 | **39.3** | 167 | **44.2** | 166 | **49.2** | 165 | **54.1** | 163 | **59.0** | 162 | **63.8** | 159 | **68.6** | 156 |
| 15 | **38.4** | 161 | **43.3** | 159 | **48.1** | 158 | **53.0** | 155 | **57.7** | 153 | **62.4** | 150 | **67.0** | 145 |
| 20 | **37.2** | 155 | **42.0** | 153 | **46.7** | 151 | **51.4** | 148 | **56.1** | 145 | **60.6** | 141 | **65.0** | 136 |
| 25 | **35.7** | 149 | **40.3** | 146 | **45.0** | 144 | **49.6** | 141 | **54.1** | 137 | **58.4** | 133 | **62.6** | 127 |
| 30 | **33.9** | 143 | **38.4** | 141 | **43.0** | 138 | **47.4** | 134 | **51.7** | 131 | **55.9** | 126 | **59.9** | 120 |
| 35 | **31.8** | 138 | **36.3** | 135 | **40.7** | 132 | **45.0** | 128 | **49.2** | 124 | **53.2** | 120 | **57.1** | 114 |
| 40 | **29.5** | 132 | **33.9** | 130 | **38.2** | 126 | **42.4** | 123 | **46.5** | 119 | **50.4** | 114 | **54.1** | 109 |
| 45 | **27.1** | 127 | **31.3** | 124 | **35.5** | 121 | **39.6** | 118 | **43.6** | 114 | **47.4** | 109 | **51.0** | 104 |
| 50 | **24.4** | 123 | **28.6** | 120 | **32.7** | 116 | **36.7** | 113 | **40.6** | 109 | **44.3** | 104 | **47.8** | 99 |
| 55 | **21.7** | 118 | **25.8** | 115 | **29.8** | 112 | **33.7** | 108 | **37.5** | 104 | **41.2** | 100 | **44.6** | 95 |
| 60 | **18.8** | 114 | **22.8** | 111 | **26.7** | 107 | **30.6** | 104 | **34.4** | 100 | **38.0** | 95 | **41.4** | 91 |
| 65 | **15.8** | 110 | **19.8** | 106 | **23.7** | 103 | **27.5** | 99 | **31.2** | 96 | **34.8** | 92 | **38.2** | 87 |
| 70 | **12.8** | 106 | **16.7** | 102 | **20.5** | 99 | **24.3** | 95 | **28.0** | 92 | **31.6** | 88 | **35.0** | 83 |
| 75 | **9.7** | 102 | **13.5** | 98 | **17.3** | 95 | **21.1** | 92 | **24.8** | 88 | **28.4** | 84 | **31.8** | 80 |
| 80 | **6.5** | 98 | **10.3** | 94 | **14.1** | 91 | **17.9** | 88 | **21.6** | 84 | **25.2** | 80 | **28.7** | 76 |
| 85 | **3.4** | 94 | **7.2** | 91 | **10.9** | 87 | **14.7** | 84 | **18.4** | 80 | **22.0** | 77 | **25.6** | 73 |
| 90 | ---- | --- | **4.0** | 87 | **7.8** | 84 | **11.5** | 80 | **15.2** | 77 | **18.9** | 73 | **22.6** | 70 |
| 95 | ---- | --- | ---- | --- | **4.6** | 80 | **8.4** | 76 | **12.2** | 73 | **15.9** | 70 | **19.6** | 66 |
| 100 | ---- | --- | ---- | --- | ---- | --- | **5.3** | 73 | **9.1** | 70 | **12.9** | 66 | **16.7** | 63 |

Contrary

| LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | **40.0** | 180 | **35.0** | 180 | **30.0** | 180 | **25.0** | 180 | **20.0** | 180 | **15.1** | 180 | **10.1** | 180 |
| 5 | **39.8** | 173 | **34.9** | 174 | **29.9** | 174 | **24.9** | 175 | **19.9** | 175 | **14.9** | 175 | **10.0** | 176 |
| 10 | **39.3** | 167 | **34.4** | 168 | **29.4** | 169 | **24.4** | 169 | **19.5** | 170 | **14.6** | 171 | **9.6** | 171 |
| 15 | **38.4** | 161 | **33.5** | 162 | **28.6** | 163 | **23.7** | 164 | **18.8** | 165 | **13.9** | 166 | **9.0** | 167 |
| 20 | **37.2** | 155 | **32.4** | 156 | **27.5** | 158 | **22.7** | 159 | **17.8** | 160 | **13.0** | 161 | **8.1** | 163 |
| 25 | **35.7** | 149 | **30.9** | 151 | **26.2** | 152 | **21.4** | 154 | **16.6** | 156 | **11.9** | 157 | **7.1** | 158 |
| 30 | **33.9** | 143 | **29.2** | 145 | **24.6** | 147 | **19.9** | 149 | **15.2** | 151 | **10.5** | 153 | **5.8** | 154 |
| 35 | **31.8** | 138 | **27.3** | 140 | **22.7** | 142 | **18.1** | 144 | **13.5** | 146 | **8.9** | 148 | ---- | --- |
| 40 | **29.5** | 132 | **25.1** | 135 | **20.6** | 137 | **16.2** | 140 | **11.7** | 142 | **7.2** | 144 | ---- | --- |
| 45 | **27.1** | 127 | **22.7** | 130 | **18.4** | 133 | **14.0** | 135 | **9.6** | 138 | **5.2** | 140 | ---- | --- |
| 50 | **24.4** | 123 | **20.2** | 126 | **16.0** | 128 | **11.7** | 131 | **7.4** | 134 | ---- | --- | ---- | --- |
| 55 | **21.7** | 118 | **17.5** | 121 | **13.4** | 124 | **9.2** | 127 | **5.0** | 129 | ---- | --- | ---- | --- |
| 60 | **18.8** | 114 | **14.8** | 117 | **10.7** | 120 | **6.6** | 123 | ---- | --- | ---- | --- | ---- | --- |
| 65 | **15.8** | 110 | **11.9** | 113 | **7.9** | 116 | **3.8** | 119 | ---- | --- | ---- | --- | ---- | --- |
| 70 | **12.8** | 106 | **8.9** | 109 | **5.0** | 112 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | **35.0** | 180 | **40.0** | 180 | **45.0** | 180 | **50.0** | 180 | **55.0** | 180 | **60.0** | 180 | **65.0** | 180 |
| | 5 | **34.9** | 174 | **39.9** | 174 | **44.8** | 173 | **49.8** | 173 | **54.8** | 172 | **59.8** | 171 | **64.8** | 170 |
| | 10 | **34.4** | 168 | **39.4** | 167 | **44.3** | 166 | **49.3** | 165 | **54.2** | 164 | **59.1** | 162 | **64.0** | 160 |
| | 15 | **33.7** | 162 | **38.6** | 161 | **43.5** | 159 | **48.4** | 158 | **53.2** | 156 | **58.0** | 154 | **62.8** | 151 |
| | 20 | **32.6** | 156 | **37.5** | 155 | **42.3** | 153 | **47.1** | 151 | **51.9** | 149 | **56.6** | 146 | **61.2** | 142 |
| | 25 | **31.4** | 150 | **36.1** | 149 | **40.9** | 147 | **45.6** | 144 | **50.3** | 142 | **54.8** | 138 | **59.3** | 134 |
| | 30 | **29.8** | 145 | **34.5** | 143 | **39.2** | 141 | **43.8** | 138 | **48.3** | 135 | **52.8** | 131 | **57.1** | 127 |
| | 35 | **28.1** | 139 | **32.7** | 137 | **37.3** | 135 | **41.8** | 132 | **46.2** | 129 | **50.6** | 125 | **54.8** | 121 |
| | 40 | **26.1** | 134 | **30.6** | 132 | **35.1** | 129 | **39.6** | 126 | **43.9** | 123 | **48.1** | 119 | **52.2** | 115 |
| | 45 | **24.0** | 129 | **28.4** | 127 | **32.8** | 124 | **37.2** | 121 | **41.4** | 118 | **45.6** | 114 | **49.6** | 109 |
| | 50 | **21.7** | 124 | **26.1** | 122 | **30.4** | 119 | **34.6** | 116 | **38.8** | 113 | **42.9** | 109 | **46.8** | 104 |
| | 55 | **19.3** | 120 | **23.6** | 117 | **27.8** | 114 | **32.0** | 111 | **36.1** | 108 | **40.1** | 104 | **44.0** | 100 |
| | 60 | **16.7** | 115 | **21.0** | 113 | **25.2** | 110 | **29.3** | 106 | **33.4** | 103 | **37.3** | 99 | **41.2** | 95 |
| | 65 | **14.1** | 111 | **18.3** | 108 | **22.4** | 105 | **26.5** | 102 | **30.6** | 99 | **34.5** | 95 | **38.3** | 91 |
| | 70 | **11.4** | 107 | **15.5** | 104 | **19.6** | 101 | **23.7** | 98 | **27.7** | 94 | **31.6** | 91 | **35.4** | 87 |
| | 75 | **8.6** | 102 | **12.8** | 100 | **16.8** | 97 | **20.9** | 93 | **24.9** | 90 | **28.8** | 87 | **32.6** | 83 |
| | 80 | **5.9** | 98 | **9.9** | 95 | **14.0** | 92 | **18.0** | 89 | **22.0** | 86 | **25.9** | 83 | **29.8** | 79 |
| | 85 | **3.0** | 94 | **7.1** | 91 | **11.1** | 88 | **15.1** | 85 | **19.1** | 82 | **23.1** | 79 | **27.0** | 75 |
| | 90 | ---- | --- | **4.3** | 87 | **8.3** | 84 | **12.3** | 81 | **16.3** | 78 | **20.3** | 75 | **24.2** | 72 |
| | 95 | ---- | --- | ---- | --- | **5.5** | 80 | **9.5** | 77 | **13.6** | 74 | **17.6** | 71 | **21.5** | 68 |
| | 100 | ---- | --- | ---- | --- | ---- | --- | **6.8** | 73 | **10.8** | 70 | **14.9** | 67 | **18.9** | 64 |
| CONTRARY | 0 | **35.0** | 180 | **30.0** | 180 | **25.0** | 180 | **20.0** | 180 | **15.1** | 180 | **10.1** | 180 | **5.2** | 180 |
| | 5 | **34.9** | 174 | **29.9** | 174 | **24.9** | 175 | **19.9** | 175 | **15.0** | 175 | **10.0** | 175 | ---- | --- |
| | 10 | **34.4** | 168 | **29.5** | 169 | **24.5** | 169 | **19.5** | 170 | **14.6** | 170 | **9.6** | 171 | ---- | --- |
| | 15 | **33.7** | 162 | **28.8** | 163 | **23.8** | 164 | **18.9** | 165 | **14.0** | 165 | **9.1** | 166 | ---- | --- |
| | 20 | **32.6** | 156 | **27.8** | 157 | **22.9** | 159 | **18.0** | 160 | **13.2** | 161 | **8.3** | 162 | ---- | --- |
| | 25 | **31.4** | 150 | **26.6** | 152 | **21.7** | 153 | **16.9** | 155 | **12.1** | 156 | **7.3** | 157 | ---- | --- |
| | 30 | **29.8** | 145 | **25.1** | 147 | **20.3** | 148 | **15.6** | 150 | **10.9** | 151 | **6.1** | 153 | ---- | --- |
| | 35 | **28.1** | 139 | **23.4** | 142 | **18.7** | 143 | **14.1** | 145 | **9.4** | 147 | ---- | --- | ---- | --- |
| | 40 | **26.1** | 134 | **21.5** | 137 | **16.9** | 139 | **12.4** | 141 | **7.7** | 142 | ---- | --- | ---- | --- |
| | 45 | **24.0** | 129 | **19.5** | 132 | **15.0** | 134 | **10.5** | 136 | **6.0** | 138 | ---- | --- | ---- | --- |
| | 50 | **21.7** | 124 | **17.3** | 127 | **12.8** | 129 | **8.4** | 132 | **4.0** | 134 | ---- | --- | ---- | --- |
| | 55 | **19.3** | 120 | **14.9** | 122 | **10.6** | 125 | **6.2** | 127 | ---- | --- | ---- | --- | ---- | --- |
| | 60 | **16.7** | 115 | **12.5** | 118 | **8.2** | 121 | **3.9** | 123 | ---- | --- | ---- | --- | ---- | --- |
| | 65 | **14.1** | 111 | **9.9** | 114 | **5.7** | 116 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 70 | **11.4** | 107 | **7.3** | 109 | **3.2** | 112 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | **30.0** | 180 | **35.0** | 180 | **40.0** | 180 | **45.0** | 180 | **50.0** | 180 | **55.0** | 180 | **60.0** | 180 |
| | 5 | **29.9** | 174 | **34.9** | 174 | **39.9** | 174 | **44.9** | 173 | **49.9** | 173 | **54.8** | 172 | **59.8** | 171 |
| | 10 | **29.5** | 168 | **34.5** | 168 | **39.5** | 167 | **44.4** | 166 | **49.4** | 165 | **54.3** | 164 | **59.3** | 163 |
| | 15 | **28.9** | 163 | **33.8** | 162 | **38.8** | 161 | **43.7** | 160 | **48.6** | 158 | **53.5** | 157 | **58.4** | 155 |
| | 20 | **28.1** | 157 | **33.0** | 156 | **37.8** | 155 | **42.7** | 153 | **47.6** | 152 | **52.4** | 150 | **57.1** | 147 |
| | 25 | **27.0** | 152 | **31.8** | 150 | **36.7** | 149 | **41.5** | 147 | **46.3** | 145 | **51.0** | 143 | **55.7** | 140 |
| | 30 | **25.7** | 146 | **30.5** | 145 | **35.3** | 143 | **40.0** | 141 | **44.7** | 139 | **49.3** | 136 | **53.9** | 133 |
| | 35 | **24.2** | 141 | **28.9** | 139 | **33.7** | 137 | **38.3** | 135 | **43.0** | 133 | **47.5** | 130 | **52.0** | 126 |
| | 40 | **22.6** | 136 | **27.2** | 134 | **31.9** | 132 | **36.5** | 129 | **41.0** | 127 | **45.5** | 124 | **49.9** | 120 |
| | 45 | **20.7** | 131 | **25.4** | 129 | **29.9** | 127 | **34.5** | 124 | **39.0** | 121 | **43.4** | 118 | **47.7** | 115 |
| | 50 | **18.8** | 126 | **23.3** | 124 | **27.9** | 121 | **32.3** | 119 | **36.8** | 116 | **41.1** | 113 | **45.4** | 109 |
| | 55 | **16.7** | 121 | **21.2** | 119 | **25.7** | 117 | **30.1** | 114 | **34.5** | 111 | **38.8** | 108 | **43.0** | 104 |
| | 60 | **14.5** | 117 | **19.0** | 114 | **23.4** | 112 | **27.8** | 109 | **32.1** | 106 | **36.4** | 103 | **40.5** | 100 |
| | 65 | **12.3** | 112 | **16.7** | 110 | **21.1** | 107 | **25.4** | 104 | **29.7** | 101 | **33.9** | 98 | **38.0** | 95 |
| | 70 | **9.9** | 108 | **14.3** | 105 | **18.6** | 102 | **23.0** | 100 | **27.2** | 97 | **31.4** | 94 | **35.6** | 90 |
| | 75 | **7.6** | 103 | **11.9** | 101 | **16.2** | 98 | **20.5** | 95 | **24.7** | 92 | **28.9** | 89 | **33.1** | 86 |
| | 80 | **5.1** | 99 | **9.4** | 96 | **13.7** | 94 | **18.0** | 91 | **22.2** | 88 | **26.4** | 85 | **30.6** | 82 |
| | 85 | ---- | --- | **7.0** | 92 | **11.2** | 89 | **15.5** | 87 | **19.7** | 84 | **24.0** | 81 | **28.1** | 78 |
| | 90 | ---- | --- | **4.5** | 88 | **8.8** | 85 | **13.0** | 82 | **17.3** | 80 | **21.5** | 77 | **25.7** | 74 |
| | 95 | ---- | --- | ---- | --- | **6.3** | 81 | **10.6** | 78 | **14.9** | 76 | **19.1** | 73 | **23.3** | 70 |
| | 100 | ---- | --- | ---- | --- | ---- | --- | **8.2** | 74 | **12.5** | 71 | **16.8** | 69 | **21.0** | 66 |
| CONTRARY | 0 | **30.0** | 180 | **25.0** | 180 | **20.0** | 180 | **15.1** | 180 | **10.1** | 180 | **5.2** | 180 | ---- | --- |
| | 5 | **29.9** | 174 | **24.9** | 175 | **19.9** | 175 | **15.0** | 175 | **10.0** | 175 | ---- | --- | ---- | --- |
| | 10 | **29.5** | 168 | **24.6** | 169 | **19.6** | 170 | **14.6** | 170 | **9.7** | 170 | ---- | --- | ---- | --- |
| | 15 | **28.9** | 163 | **24.0** | 164 | **19.0** | 164 | **14.1** | 165 | **9.2** | 166 | ---- | --- | ---- | --- |
| | 20 | **28.1** | 157 | **23.2** | 158 | **18.2** | 159 | **13.4** | 160 | **8.5** | 161 | ---- | --- | ---- | --- |
| | 25 | **27.0** | 152 | **22.1** | 153 | **17.3** | 154 | **12.4** | 155 | **7.6** | 156 | ---- | --- | ---- | --- |
| | 30 | **25.7** | 146 | **20.9** | 148 | **16.1** | 149 | **11.3** | 151 | **6.5** | 152 | ---- | --- | --- | --- |
| | 35 | **24.2** | 141 | **19.5** | 143 | **14.7** | 144 | **10.0** | 146 | **5.2** | 147 | ---- | --- | ---- | --- |
| | 40 | **22.6** | 136 | **17.9** | 138 | **13.2** | 139 | **8.5** | 141 | ---- | --- | ---- | --- | ---- | --- |
| | 45 | **20.7** | 131 | **16.1** | 133 | **11.5** | 135 | **6.9** | 137 | ---- | --- | ---- | --- | ---- | --- |
| | 50 | **18.8** | 126 | **14.2** | 128 | **9.7** | 130 | **5.1** | 132 | ---- | --- | ---- | --- | ---- | --- |
| | 55 | **16.7** | 121 | **12.2** | 123 | **7.7** | 126 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 60 | **14.5** | 117 | **10.1** | 119 | **5.6** | 121 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 65 | **12.3** | 112 | **7.9** | 114 | **3.6** | 116 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 70 | **9.9** | 108 | **5.6** | 110 | ---- | --- | ---- | --- | ---- | --- | ---- | --- | ---- | --- |

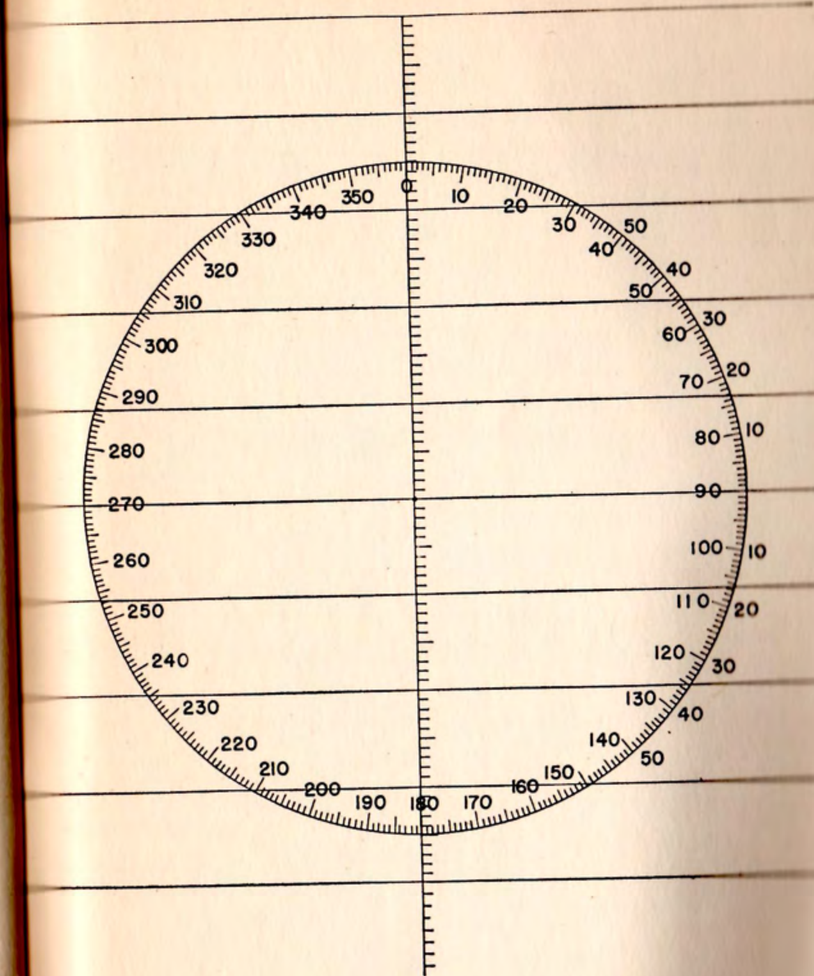
## TABLE IX.—*Altitude and Azimuth.*—**Lat. 65°**

| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 25.0 | 180 | 30.0 | 180 | 35.0 | 180 | 40.0 | 180 | 45.0 | 180 | 50.0 | 180 | 55.0 | 180 |
| | 5 | 24.9 | 174 | 29.9 | 174 | 34.9 | 174 | 39.9 | 174 | 44.9 | 173 | 49.9 | 173 | 54.9 | 172 |
| | 10 | 24.6 | 169 | 29.6 | 169 | 34.6 | 168 | 39.6 | 167 | 44.5 | 167 | 49.5 | 166 | 54.5 | 165 |
| | 15 | 24.1 | 164 | 29.1 | 163 | 34.0 | 162 | 39.0 | 161 | 43.9 | 160 | 48.9 | 159 | 53.8 | 158 |
| | 20 | 23.4 | 158 | 28.4 | 157 | 33.3 | 156 | 38.2 | 155 | 43.1 | 154 | 48.0 | 152 | 52.9 | 151 |
| | 25 | 22.6 | 153 | 27.5 | 152 | 32.3 | 150 | 37.2 | 149 | 42.1 | 148 | 46.9 | 146 | 51.7 | 144 |
| | 30 | 21.5 | 148 | 26.4 | 146 | 31.2 | 145 | 36.0 | 143 | 40.9 | 142 | 45.6 | 140 | 50.4 | 137 |
| | 35 | 20.3 | 142 | 25.1 | 141 | 29.9 | 139 | 34.7 | 138 | 39.5 | 136 | 44.2 | 134 | 48.9 | 131 |
| | 40 | 18.9 | 137 | 23.7 | 136 | 28.5 | 134 | 33.2 | 132 | 37.9 | 130 | 42.6 | 128 | 47.2 | 125 |
| | 45 | 17.4 | 132 | 22.2 | 130 | 26.9 | 129 | 31.6 | 127 | 36.2 | 125 | 40.9 | 122 | 45.4 | 119 |
| | 50 | 15.8 | 127 | 20.5 | 125 | 25.2 | 124 | 29.8 | 121 | 34.4 | 119 | 39.0 | 117 | 43.5 | 114 |
| | 55 | 14.1 | 122 | 18.7 | 121 | 23.4 | 119 | 28.0 | 116 | 32.6 | 114 | 37.1 | 112 | 41.6 | 109 |
| | 60 | 12.3 | 118 | 16.9 | 116 | 21.5 | 114 | 26.1 | 111 | 30.6 | 109 | 35.1 | 106 | 39.5 | 104 |
| | 65 | 10.4 | 113 | 15.0 | 111 | 19.5 | 109 | 24.1 | 107 | 28.6 | 104 | 33.0 | 102 | 37.5 | 99 |
| | 70 | 8.4 | 108 | 13.0 | 106 | 17.5 | 104 | 22.0 | 102 | 26.5 | 99 | 31.0 | 97 | 35.4 | 94 |
| | 75 | 6.4 | 104 | 10.9 | 102 | 15.4 | 99 | 19.9 | 97 | 24.4 | 95 | 28.9 | 92 | 33.3 | 89 |
| | 80 | 4.4 | 99 | 8.9 | 97 | 13.4 | 95 | 17.8 | 93 | 22.3 | 90 | 26.7 | 88 | 31.1 | 85 |
| | 85 | ---- | --- | 6.8 | 92 | 11.3 | 90 | 15.7 | 88 | 20.2 | 86 | 24.6 | 83 | 29.0 | 81 |
| | 90 | ---- | --- | 4.7 | 88 | 9.2 | 86 | 13.6 | 84 | 18.1 | 81 | 22.6 | 79 | 27.0 | 76 |
| | 95 | ---- | --- | ---- | --- | 7.1 | 81 | 11.6 | 79 | 16.0 | 77 | 20.5 | 75 | 25.0 | 72 |
| | 100 | ---- | --- | ---- | --- | 5.0 | 77 | 9.5 | 75 | 14.0 | 72 | 18.5 | 70 | 23.0 | 68 |
| | 105 | ---- | --- | ---- | --- | ---- | --- | 7.5 | 70 | 12.0 | 68 | 16.5 | 66 | 21.1 | 64 |
| | 110 | ---- | --- | ---- | --- | ---- | --- | 5.6 | 66 | 10.1 | 64 | 14.7 | 62 | 19.2 | 60 |
| CONTRARY | 0 | 25.0 | 180 | 20.0 | 180 | 15.1 | 180 | 10.1 | 180 | 5.2 | 180 | ---- | --- | ---- | --- |
| | 5 | 24.9 | 174 | 19.9 | 175 | 15.0 | 175 | 10.0 | 175 | 5.1 | 175 | ---- | --- | ---- | --- |
| | 10 | 24.6 | 169 | 19.7 | 169 | 14.7 | 170 | 9.7 | 170 | 4.8 | 171 | ---- | --- | ---- | --- |
| | 15 | 24.1 | 164 | 19.2 | 164 | 14.2 | 165 | 9.3 | 165 | 4.4 | 166 | ---- | --- | ---- | --- |
| | 20 | 23.4 | 158 | 18.5 | 159 | 13.6 | 160 | 8.7 | 160 | ---- | --- | ---- | --- | ---- | --- |
| | 25 | 22.6 | 153 | 17.7 | 154 | 12.8 | 155 | 7.9 | 156 | ---- | --- | ---- | --- | ---- | --- |
| | 30 | 21.5 | 148 | 16.6 | 149 | 11.8 | 150 | 7.0 | 151 | ---- | --- | ---- | --- | ---- | --- |
| | 35 | 20.3 | 142 | 15.5 | 144 | 10.7 | 145 | 5.9 | 146 | ---- | --- | ---- | --- | ---- | --- |
| | 40 | 18.9 | 137 | 14.2 | 139 | 9.4 | 140 | 4.7 | 141 | ---- | --- | ---- | --- | ---- | --- |
| | 45 | 17.4 | 132 | 12.7 | 134 | 8.0 | 135 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 50 | 15.8 | 127 | 11.1 | 129 | 6.5 | 131 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 55 | 14.1 | 122 | 9.4 | 124 | 4.8 | 126 | ---- | -- | ---- | --- | ---- | --- | ---- | --- |
| | 60 | 12.3 | 118 | 7.7 | 120 | ---- | --- | ---- | -- | ---- | --- | ---- | --- | ---- | --- |

## TABLE IX.—*Altitude and Azimuth.*—**Lat. 70°**



| | Dec. | 0° | | 5° | | 10° | | 15° | | 20° | | 25° | | 30° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LHA | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. | Alt. | Az. |
| | | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| SAME | 0° | 20.0 | 180 | 25.0 | 180 | 30.0 | 180 | 35.0 | 180 | 40.0 | 180 | 45.0 | 180 | 50.0 | 180 |
| | 5 | 20.0 | 175 | 25.0 | 174 | 29.9 | 174 | 34.9 | 174 | 39.9 | 174 | 44.9 | 174 | 49.9 | 173 |
| | 10 | 19.7 | 169 | 24.7 | 169 | 29.7 | 169 | 34.7 | 168 | 39.7 | 168 | 44.6 | 167 | 49.6 | 167 |
| | 15 | 19.3 | 164 | 24.3 | 164 | 29.3 | 163 | 34.2 | 162 | 39.2 | 162 | 44.2 | 161 | 49.1 | 160 |
| | 20 | 18.8 | 159 | 23.8 | 158 | 28.7 | 157 | 33.7 | 157 | 38.6 | 156 | 43.5 | 155 | 48.4 | 154 |
| | 25 | 18.1 | 154 | 23.0 | 153 | 28.0 | 152 | 32.9 | 151 | 37.8 | 150 | 42.7 | 149 | 47.6 | 147 |
| | 30 | 17.3 | 148 | 22.2 | 148 | 27.1 | 146 | 32.0 | 145 | 36.9 | 144 | 41.7 | 143 | 46.6 | 141 |
| | 35 | 16.3 | 143 | 21.2 | 142 | 26.1 | 141 | 31.0 | 140 | 35.8 | 138 | 40.6 | 137 | 45.5 | 135 |
| | 40 | 15.3 | 138 | 20.1 | 137 | 25.0 | 136 | 29.8 | 134 | 34.6 | 133 | 39.4 | 131 | 44.2 | 129 |
| | 45 | 14.1 | 133 | 18.9 | 132 | 23.7 | 130 | 28.5 | 129 | 33.3 | 127 | 38.1 | 126 | 42.8 | 123 |
| | 50 | 12.8 | 128 | 17.6 | 127 | 22.4 | 125 | 27.1 | 124 | 31.9 | 122 | 36.6 | 120 | 41.3 | 118 |
| | 55 | 11.4 | 123 | 16.2 | 122 | 20.9 | 120 | 25.7 | 119 | 30.4 | 117 | 35.1 | 115 | 39.8 | 113 |
| | 60 | 9.9 | 118 | 14.7 | 117 | 19.4 | 115 | 24.2 | 114 | 28.9 | 112 | 33.5 | 110 | 38.2 | 108 |
| | 65 | 8.4 | 114 | 13.1 | 112 | 17.8 | 110 | 22.5 | 109 | 27.2 | 107 | 31.9 | 105 | 36.5 | 102 |
| | 70 | 6.9 | 109 | 11.5 | 107 | 16.2 | 106 | 20.9 | 104 | 25.6 | 102 | 30.2 | 100 | 34.9 | 98 |
| | 75 | 5.2 | 104 | 9.9 | 102 | 14.6 | 101 | 19.2 | 99 | 23.9 | 97 | 28.5 | 95 | 33.2 | 93 |
| | 80 | ---- | --- | 8.2 | 98 | 12.9 | 96 | 17.6 | 94 | 22.2 | 92 | 26.8 | 90 | 31.5 | 88 |
| | 85 | ---- | --- | 6.5 | 93 | 11.2 | 91 | 15.8 | 89 | 20.5 | 88 | 25.1 | 86 | 29.7 | 83 |
| | 90 | ---- | --- | ---- | --- | 9.5 | 86 | 14.1 | 85 | 18.8 | 83 | 23.4 | 81 | 28.1 | 79 |
| | 95 | ---- | --- | ---- | --- | 7.8 | 82 | 12.5 | 80 | 17.1 | 78 | 21.8 | 76 | 26.4 | 74 |
| | 100 | ---- | --- | ---- | --- | 6.2 | 77 | 10.8 | 76 | 15.5 | 74 | 20.1 | 72 | 24.8 | 70 |
| | 105 | ---- | --- | ---- | --- | ---- | --- | 9.2 | 71 | 13.8 | 69 | 18.5 | 67 | 23.2 | 66 |
| | 110 | ---- | --- | ---- | --- | ---- | --- | 7.6 | 66 | 12.3 | 65 | 17.0 | 63 | 21.7 | 61 |
| | 115 | ---- | --- | ---- | --- | ---- | --- | 6.1 | 62 | 10.8 | 60 | 15.5 | 58 | 20.2 | 57 |
| | 120 | ---- | --- | ---- | --- | ---- | --- | ---- | --- | 9.3 | 56 | 14.1 | 54 | 18.8 | 52 |
| CONTRARY | 0 | 20.0 | 180 | 15.1 | 180 | 10.1 | 180 | 5.2 | 180 | ---- | --- | ---- | --- | ---- | --- |
| | 5 | 20.0 | 175 | 15.0 | 175 | 10.0 | 175 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 10 | 19.7 | 169 | 14.8 | 170 | 9.8 | 170 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 15 | 19.3 | 164 | 14.4 | 165 | 9.4 | 165 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 20 | 18.8 | 159 | 13.9 | 160 | 8.9 | 160 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 25 | 18.1 | 154 | 13.2 | 154 | 8.3 | 155 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 30 | 17.3 | 148 | 12.4 | 149 | 7.5 | 150 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 35 | 16.3 | 143 | 11.5 | 144 | 6.6 | 145 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 40 | 15.3 | 138 | 10.4 | 139 | 5.6 | 140 | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 45 | 14.1 | 133 | 9.3 | 134 | ---- | --- | ---- | --- | ---- | --- | ---- | --- | ---- | --- |
| | 50 | 12.8 | 128 | 8.0 | 130 | ---- | --- | ---- | --- | ---- | --- | ---- | --- | ---- | --- |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