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## PART 3

### APPENDICES

# APPENDIX A: NAVIGATIONAL STARS AND THE PLANETS

| Name | Pronunciation | Bayer name | Origin of name | Meaning of name | Distance* |
|---|---|---|---|---|---|
| Acamar | ā'ká·mär | θ Eridani | Arabic | another form of Achernar | 160 |
| Achernar | ā'kĕr·när | α Eridani | Arabic | end of the river (Eridanus) | 140 |
| Acrux | ā'krŭks | α Crucis | Modern | coined from Bayer name | 323 |
| Adhara | á·dā'rá | ϵ Canis Majoris | Arabic | the virgin(s) | 430 |
| Aldebaran | ăl dĕb'á·răn | α Tauri | Arabic | follower (of the Pleiades) | 65 |
| Alioth | ăl'ĭ·ŏth | ϵ Ursa Majoris | Arabic | another from of Capella | 83 |
| Alkaid | ăl·kād' | η Ursa Majoris | Arabic | leader of the daughters of the bier | 104 |
| Al Na'ir | ăl·nār' | α Gruis | Arabic | bright one (of the fish's tail) | 101 |
| Alnilam | ăl'nĭ·lăm | ϵ Orionis | Arabic | string of pearls | 1,344 |
| Alphard | ăl'färd | α Hydrae | Arabic | solitary star of the serpent | 177 |
| Alphecca | ăl·fĕk'á | α Corona Borealis | Arabic | feeble one (in the crown) | 75 |
| Alpheratz | ăl·fĕ'răts | α Andromeda | Arabic | the horse's navel | 97 |
| Altair | ăl·tār' | α Aquilae | Arabic | flying eagle or vulture | 16.7 |
| Alpha Phoenicis (Ankaa) | än'kä | α Phoenicis | Arabic | coined name | 85 |
| Antares | ăn·tā'rēz | α Scorpii | Greek | rival of Mars (in color) | 555 |
| Arcturus | ärk·tū'rŭs | α Bootis | Greek | the bear's guard | 37 |
| Atria | ăt'rĭ·á | α Trianguli Australis | Modern | coined from Bayer name | 391 |
| Avior | ā'vĭ·ôr | ϵ Carinae | Modern | coined name | 630 |
| Bellatrix | bĕ·lā'trĭks | γ Orionis | Latin | female warrior | 250 |
| Betelgeuse | bĕt'ĕljūz | α Orionis | Arabic | the arm pit (of Orion) | 300 |
| Canopus | ká·nōpŭs | α Carinae | Greek | city of ancient Egypt | 310 |
| Capella | ká·pĕl'á | α Aurigae | Latin | little she-goat | 43 |
| Deneb | dĕn'ĕb | α Cygni | Arabic | tail of the hen | 2,616 |
| Denebola | dĕ·n'ĕb'ȍ·lá | β Leonis | Arabic | tail of the lion | 36 |
| Diphda | dĭf'dá | β Ceti | Arabic | the second frog (Fomalhaut was once the first) | 96 |
| Dubhe | dŭb'ē | α Ursa Majoris | Arabic | the bear's back | 123 |
| Elnath | ĕl'năth | β Tauri | Arabic | one butting with horns | 130 |
| Eltanin | ĕl·tā'nĭn | γ Draconis | Arabic | head of the dragon | 154 |
| Enif | ĕn'ĭf | ϵ Pegasi | Arabic | nose of the horse | 688 |
| Fomalhaut | fō'mál·ôt | α Piscis Austrini | Arabic | mouth of the southern fish | 25 |
| Gacrux | gā'krŭks | γ Crucis | Modern | coined from Bayer name | 89 |
| Gienah | jē'ná | γ Covri | Arabic | right wing of the raven | 154 |
| Hadar | hă'där | β Centauri | Modern | leg of the centaur | 391 |
| Hamal | hăm'ál | α Arietis | Arabic | full-grown lamb | 66 |
| Kaus Australis | kôs ôs·trā'lĭs | ϵ Sagittarii | Arabic, Latin | southern part of the bow | 143 |
| Kochab | kō'kăb | β Ursa Minoris | Arabic | shortened form of "north star" (named when it was that) | 131 |
| Markab | mär'kăb | α Pegasi | Arabic | saddle (of Pegasus) | 133 |
| Menkar | mĕn'kär | α Ceti | Arabic | nose (of the whale) | 248 |
| Menkent | mĕn'kĕnt | θ Centauri | Modern | shoulder of the centaur | 59 |
| Miaplacidus | mī'á·plāsĭ·dŭs | β Carinae | Arabic, Latin | quiet or still waters | 113 |
| Mirfak | mĭr'făk | α Persei | Arabic | elbow of the Pleiades | 506 |
| Nunki | nŭn'kē | σ Sagittarii | Bab. | constellation of the holy city (Eridu) | 228 |
| Alpha Pavonis (Peacock) | pē'kŏk | α Pavonis | Modern | coined from English name of constellation | 179 |
| Polaris | pȍ·lā'rĭs | α Ursa Minoris | Latin | the pole (star) | 323 |
| Pollux | pŏl'ŭks | β Geminorum | Latin | Zeus' other twin son (Castor, α Geminorum, is first twin) | 33 |
| Procyon | prō'sĭ·ŏn | α Canis Min | Greek | before the dog (rising before the dog star, Sirius) | 11.5 |
| RasaIhague | rȧs'ăl·hā'gwē | α Ophiuchi | Arabic | head of the serpent charmer | 49 |
| Regulus | rĕg'ȕ·lŭs | α Leonis | Latin | the prince | 78 |
| Rigel | rī'jĕl | β Orionis | Arabic | foot (left foot of Orion) | 864 |
| Alpha Centauri (Rigil Kentaurus) | rījĭl kĕn·tô'rŭs | α Centauri | Arabic | foot of the centaur | 4.3 |
| Sabik | sā'bĭk | η Ophiuchi | Arabic | second winner or conqueror | 88 |
| Schedar | shĕd'ár | α Cassiopeiae | Arabic | the breast (of Cassiopeia) | 228 |
| Shaula | shô'lá | λ Scorpii | Arabic | cocked-up part of the scorpion's tail | 587 |
| Sirius | sĭr'ĭ·ŭs | α Canis Majoris | Greek | the scorching one (popularly, the dog star) | 8.6 |
| Spica | spī'kȧ | α Virginis | Latin | the ear of corn | 250 |
| Suhail | sōō·hāl' | λ Velorum | Arabic | shorted from of Al Suhail, one Arabic name for Conopus) | 545 |
| Vega | vē'gȧ | α Lyrae | Arabic | the falling eagle or vulture | 25 |
| Zubenelgenubi | zōō·bĕn'ĕl·jĕ·nū'bē | α Librae | Arabic | southern claw (of the scorpion) | 77 |

**PLANETS**

| Name | Pronunciation | Origin of name | Meaning of name | Distance* |
|---|---|---|---|---|
| Mercury | mŭr'kȕ·rĭ | Latin | god of commerce and gain | 0.6 |
| Venus | vē'nŭs | Latin | goddess of love | 0.3 |
| Earth | ûrth | Mid. Eng. | — | — |
| Mars | märz | Latin | god of war | 0.5 |
| Jupiter | jōō'pĭ·tẽr | Latin | god of the heavens, identified with the Greek Zeus, chief of the Olympians s | 4.2 |
| Saturn | săt'ẽrn | Latin | god of seed-sowing | 8.5 |
| Uranus | ū'rá·nŭs | Greek | the personification of heaven | 18.8 |
| Neptune | nĕp'tūn | Latin | god of the sea | 29 |

Guide to pronunciations: fāte, ădd, finăl, lȧst, ábound, ärm; bē, ĕnd, camĕl, readẽr; īce, bĭt, anĭmal; ōver, pȍetic, hŏt, lôrd, mōōn; tūbe, ȕnite, tŭb, cirŭs, ûrn

*Distances for stars are in light-years (as measured in 2023). One light-year equals approximately 63,200 AU, or 5,880,000,000,000 miles.

Distances for planets are in AU from Earth. AU is the average distance of the Earth from the Sun, approximately 93,000,000 miles.

# APPENDIX B

## CONVERSION OF COMPASS POINTS TO DEGREES

| Conversion of Compass Points to Degrees | | | | | |
|---|---|---|---|---|---|
| | Points | Angular measure | | Points | Angular measure |
| NORTH TO EAST | | | SOUTH TO WEST | | |
| North | 0 | 0° 00′ 00″ | South | 16 | 180° 00′ 00″ |
| N1/4E | 1/4 | 2° 48′ 45″ | S1/4W | 16 1/4 | 182° 48′ 45″ |
| N1/2E | 1/2 | 5° 37′ 30″ | S1/2W | 16 1/2 | 185° 37′ 30″ |
| N3/4E | 3/4 | 8° 26′ 15″ | S3/4W | 16 3/4 | 188° 26′ 15″ |
| N by E | 1 | 11° 15′ 00″ | S by W | 17 | 191° 15′ 00″ |
| N by E1/4E | 1 1/4 | 14° 03′ 45″ | S by W1/4W | 17 1/4 | 194° 03′ 45″ |
| N by E1/2E | 1 1/2 | 16° 52′ 30″ | S by W1/2W | 17 1/2 | 196° 52′ 30″ |
| N by E3/4E | 1 3/4 | 19° 41′ 15″ | S by W3/4W | 17 3/4 | 199° 41′ 15″ |
| NNE | 2 | 22° 30′ 00″ | SSW | 18 | 202° 30′ 00″ |
| NNE1/4E | 2 1/4 | 25° 18′ 45″ | SSW1/4W | 18 1/4 | 205° 18′ 45″ |
| NNE1/2E | 2 1/2 | 28° 07′ 30″ | SSW1/2W | 18 1/2 | 208° 07′ 30″ |
| NNE3/4E | 2 3/4 | 30° 56′ 15″ | SSW3/4W | 18 3/4 | 210° 56′ 15″ |
| NE by N | 3 | 33° 45′ 00″ | SW by S | 19 | 213° 45′ 00″ |
| NE3/4N | 3 1/4 | 36° 33′ 45″ | SW3/4S | 19 1/4 | 216° 33′ 45″ |
| NE1/2N | 3 1/2 | 39° 22′ 30″ | SW1/2S | 19 1/2 | 219° 22′ 30″ |
| NE1/4N | 3 3/4 | 42° 11′ 15″ | SW1/4S | 19 3/4 | 222° 11′ 15″ |
| NE | 4 | 45° 00′ 00″ | SW | 20 | 225° 00′ 00″ |
| NE1/4E | 4 1/4 | 47° 48′ 45″ | SW1/4W | 20 1/4 | 227° 48′ 45″ |
| NE1/2E | 4 1/2 | 50° 37′ 30″ | SW1/2W | 20 1/2 | 230° 37′ 30″ |
| NE3/4E | 4 3/4 | 53° 26′ 15″ | SW3/4W | 20 3/4 | 233° 26′ 15″ |
| NE by E | 5 | 56° 15′ 00″ | SW by W | 21 | 236° 15′ 00″ |
| NE by E1/4E | 5 1/4 | 59° 03′ 45″ | SW by W1/4W | 21 1/4 | 239° 03′ 45″ |
| NE by E1/2E | 5 1/2 | 61° 52′ 30″ | SW by W1/2W | 21 1/2 | 241° 52′ 30″ |
| NE by E3/4E | 5 3/4 | 64° 41′ 15″ | SW by W3/4W | 21 3/4 | 244° 41′ 15″ |
| ENE | 6 | 67° 30′ 00″ | WSW | 22 | 247° 30′ 00″ |
| ENE1/4E | 6 1/4 | 70° 18′ 45″ | WSW1/4W | 22 1/4 | 250° 18′ 45″ |
| ENE1/2E | 6 1/2 | 73° 07′ 30″ | WSW1/2W | 22 1/2 | 235° 07′ 30″ |
| ENE3/4E | 6 3/4 | 75° 56′ 15″ | WSW3/4W | 22 3/4 | 255° 56′ 15″ |
| E by N | 7 | 78° 45′ 00″ | W by S | 23 | 258° 45′ 00″ |
| E3/4N | 7 1/4 | 81° 33′ 45″ | W3/4S | 23 1/4 | 261° 33′ 45″ |

| Conversion of Compass Points to Degrees | | | | | |
|---|---|---|---|---|---|
| E1/2N | 7 1/2 | 84° 22′ 30″ | W1/2S | 23 1/2 | 264° 22 30″ |
| E1/4N | 7 3/4 | 87° 11′ 15″ | W1/4S | 23 3/4 | 267° 11′ 15″ |
| EAST TO SOUTH | | | WEST TO NORTH | | |
| East | 8 | 90° 00′ 00″ | West | 24 | 270° 00′ 00″ |
| E1/4S | 8 1/4 | 92° 48′ 45″ | W1/4N | 24 1/4 | 272° 48′ 45″ |
| E1/2S | 8 1/2 | 95° 37′ 30″ | W1/2N | 24 1/2 | 275° 37′ 30″ |
| E3/4S | 8 3/4 | 98° 26′ 15″ | W3/4N | 24 3/4 | 278° 26′ 15″ |
| E by S | 9 | 101° 15′ 00″ | W by N | 25 | 281° 15′ 00″ |
| ESE3/4E | 9 1/4 | 104° 03′ 45″ | WNW3/4W | 25 1/4 | 284° 03′ 45″ |
| ESE1/2E | 9 1/2 | 106° 52′ 30″ | WNW1/2W | 25 1/2 | 286° 52′ 30″ |
| ESE1/4E | 9 3/4 | 109° 41′ 15″ | WNW1/4W | 25 3/4 | 289° 41′ 15″ |
| ESE | 10 | 112° 30′ 00″ | WNW | 26 | 292° 30′ 00″ |
| SE by E3/4E | 10 1/4 | 115° 18′ 45″ | NW by W3/4W | 26 1/4 | 295° 18′ 45″ |
| SE by E1/2E | 10 1/2 | 118° 07′ 30″ | NW by W1/2W | 26 1/2 | 298° 07′ 30″ |
| SE by E1/4E | 10 3/4 | 120° 56′ 15″ | NW by W1/4W | 26 3/4 | 300° 56′ 15″ |
| SE by E | 11 | 123° 45′ 00″ | NW by W | 27 | 303° 45′ 00″ |
| SE3/4E | 11 1/4 | 126° 33′ 45″ | NW3/4W | 27 1/4 | 306° 33′ 45″ |
| SE1/2E | 11 1/2 | 129° 22′ 30″ | NW1/2W | 27 1/2 | 309° 22′ 30″ |
| SE1/4E | 11 3/4 | 132° 11′ 15″ | NW1/4W | 27 3/4 | 312° 11′ 15″ |
| SE | 12 | 135° 00′ 00″ | NW | 28 | 315° 00′ 00″ |
| SE1/4S | 12 1/4 | 137° 48′ 45″ | NW1/4N | 28 1/4 | 317° 48′ 45″ |
| SE1/2S | 12 1/2 | 140° 37′ 30″ | NW1/2N | 28 1/2 | 320° 37′ 30″ |
| SE3/4S | 12 3/4 | 143° 26′ 15″ | NW3/4N | 28 3/4 | 323° 26′ 15″ |
| SE by S | 13 | 146° 15′ 00″ | NW by N | 29 | 326° 15′ 00″ |
| SSE3/4E | 13 1/4 | 149° 03′ 45″ | NNW3/4W | 29 1/4 | 329° 03′ 45″ |
| SSE1/2E | 13 1/2 | 151° 52′ 30″ | NNW1/2W | 29 1/2 | 331° 52′ 30″ |
| SSE1/4E | 13 3/4 | 154° 41′ 15″ | NNW1/4W | 29 3/4 | 334° 41′ 15″ |
| SSE | 14 | 157° 30′ 00″ | NNW | 30 | 337° 30′ 00″ |
| S by E3/4E | 14 1/4 | 160° 18′ 45″ | N by W3/4W | 30 1/4 | 340° 18′ 45″ |
| S by E1/2E | 14 1/2 | 163° 07′ 30″ | N by W1/2W | 30 1/2 | 343° 07′ 30″ |
| S by E1/4E | 14 3/4 | 165° 56′ 15″ | N by W1/4W | 30 3/4 | 345° 56′ 15″ |
| S by E | 15 | 168° 45′ 00″ | N by W | 31 | 348° 45′ 00″ |
| S3/4E | 15 1/4 | 171° 33′ 45″ | N3/4W | 31 1/4 | 351° 33′ 45″ |
| S1/2E | 15 1/2 | 174° 22′ 30″ | N1/2W | 31 1/2 | 354° 22′ 30″ |
| S1/4E | 15 3/4 | 177° 11′ 15″ | N1/4W | 31 3/4 | 357° 11′ 15″ |
| South | 16 | 180° 00′ 00 | North | 32 | 360° 00′ 00 |

# APPENDIX C

# MISCELLANEOUS DATA

## UNIT CONVERSION

Use the conversion tables that appear on the following pages to convert between different systems of units. Conversions followed by an asterisk * are exact relationships.

## MISCELLANEOUS DATA

### Area

| | |
|---|---|
| 1 square inch | = 6.4516 square centimeters* |
| 1 square foot | = 144 square inches* |
| | = 0.09290304 square meter* |
| | = 0.000022957 acre |
| 1 square yard | = 9 square feet* |
| | = 0.83612736 square meter |
| 1 square (statute) mile | = 27,878,400 square feet* |
| | = 640 acres* |
| | = 2.589988110336 square kilometers* |
| 1 square centimeter | = 0.1550003 square inch |
| | = 0.00107639 square foot |
| 1 square meter | = 10.76391 square feet |
| | = 1.19599005 square yards |
| 1 square kilometer | = 247.1053815 acres |
| | = 0.38610216 square statute mile |
| | = 0.29155335 square nautical mile |

### Astronomy

| | |
|---|---|
| 1 mean solar unit | = 1.00273791 sidereal units |
| 1 sidereal unit | = 0.99726957 mean solar units |
| 1 microsecond | = 0.000001 second* |
| 1 second | = 1,000,000 microseconds* |
| | = 0.01666667 minute |
| | = 0.00027778 hour |
| | = 0.00001157 day |
| 1 minute | = 60 seconds* |
| | = 0.01666667 hour |
| | = 0.00069444 day |
| 1 hour | = 3,600 seconds* |
| | = 60 minutes* |
| | = 0.04166667 day |
| 1 mean solar day | = $24^h03^m56^s.55536$ of mean sidereal time |
| | = 1 rotation of Earth with respect to Sun (mean)* |
| | = 1.00273791 rotations of Earth with respect to vernal equinox (mean) |
| | = 1.0027378118868 rotations of Earth with respect to stars (mean) |
| 1 mean sidereal day | = $23^h56^m04^s09054$ of mean solar time |
| 1 sidereal month | = 27.321661 days |
| | = $27^d07^h43^m11^s.5$ |
| 1 synodical month | = 29.530588 days |
| | = $29^d12^h44^m02^s.8$ |

| | |
|---|---|
| 1 tropical (ordinary) year | = 31,556,925.975 seconds<br>= 525,948.766 minutes<br>= 8,765.8128 hours<br>= $365^{d}.24219879 – 0^{d}.0000000614(t–1900)$,<br>where *t* = the year (date)<br>= $365^{d}05^{h}48^{m}46^{s}$ (–) $0^{s}.0053(t–1900)$ |
| 1 sidereal year | = $365^{d}.25636042 + 0.0000000011(t–1900)$,<br>where *t* = the year (date)<br>= $365^{d}06^{h}09^{m}09^{s}.5$ (+) $0^{s}.0001(t–1900)$ |
| 1 calendar year (common) | = 31,536,000 seconds*<br>= 525,600 minutes*<br>= 8,760 hours*<br>= 365 days* |
| 1 calendar year (leap) | = 31,622,400 seconds*<br>= 527,040 minutes*<br>= 8,784 hours*<br>= 366 days |
| 1 light-year | = 9,460,000,000,000 kilometers<br>= 5,880,000,000,000 statute miles<br>= 5,110,000,000,000 nautical miles<br>= 63,240 astronomical units<br>= 0.3066 parsecs |
| 1 parsec | = 30,860,000,000,000 kilometers<br>= 19,170,000,000,000 statute miles<br>= 16,660,000,000,000 nautical miles<br>= 206,300 astronomical units<br>= 3.262 light years |
| 1 astronomical unit | = 149,600,000 kilometers<br>= 92,960,000 statute miles<br>= 80,780,000 nautical miles<br>= $499^{s}.012$ light-time<br>= mean distance, Earth to Sun |
| Mean distance, Earth to Moon | = 384,400 kilometers<br>= 238,855 statute miles<br>= 207,559 nautical miles |
| Mean distance, Earth to Sun | = 149,600,000 kilometers<br>= 92,957,000 statute miles<br>= 80,780,000 nautical miles<br>= 1 astronomical unit |
| Sun's diameter | = 1,392,000 kilometers<br>= 865,000 statute miles<br>= 752,000 nautical miles |
| Sun's mass | = 1,987,000,000,000,000,000,000,000,000,000,000 grams<br>= 2,200,000,000,000,000,000,000,000,000 short tons<br>= 2,000,000,000,000,000,000,000,000,000 long tons |
| Speed of Sun relative to neighboring stars | = 19.4 kilometers per second<br>= 12.1 statute miles per second<br>= 10.5 nautical miles per second |
| Orbital speed of Earth | = 29.8 kilometers per second<br>= 18.5 statute miles per second<br>= 16.1 nautical miles per second |
| Obliquity of the ecliptic | = $23°27'08''.26 – 0''.4684\ (t–1900)$,<br>where *t* = the year (date) |
| General precession of the equinoxes | = $50''.2564 + 0''.000222\ (t–1900)$, per year,<br>where *t* = the year (date) |
| Precession of the equinoxes in right ascension | = $46''.0850 + 0''.000279\ (t–1900)$, per year,<br>where *t* = the year (date) |
| Precession of the equinoxes in declination | = $20''.0468 – 0''.000085\ (t–1900)$, per year,<br>where *t* = the year (date) |

| | |
|---|---|
| Magnitude ratio | = 2.512 |
| | = $\sqrt[5]{100}$* |

## Charts

| | |
|---|---|
| Nautical miles per inch | = reciprocal of natural scale 72,913.39 |
| Statute miles per inch | = reciprocal of natural scale 63,360* |
| Inches per nautical mile | = 72,913.39 natural scale |
| Inches per statute mile | = 63,360 natural scale* |
| Natural scale | = 1:72,913.39 nautical miles per inch |
| | = 1:63,360 statute miles per inch* |

## Earth

| | |
|---|---|
| Acceleration due to gravity (standard) | = 980.665 centimeters per second per second |
| | = 32.1740 feet per second per second |
| Mass-ratio—Sun/Earth | = 332,958 |
| Mass-ratio—Sun/(Earth & Moon) | = 328,912 |
| Mass-ratio—Earth/Moon | = 81.30 |
| Mean density | = 5.517 grams per cubic centimeter |
| Velocity of escape | = 6.94 statute miles per second |
| Curvature of surface | = 0.8 foot per nautical mile |

*World Geodetic System (WGS) Ellipsoid of 1984*

| | |
|---|---|
| Equatorial radius (a) | = 6,378,137 meters |
| | = 3,443.918 nautical miles |
| Polar radius (b) | = 6,356,752.314 meters |
| | = 3432.372 nautical miles |
| Mean radius (2a + b)/3 | = 6,371,008.770 meters |
| | = 3440.069 nautical miles |
| Flattening or ellipticity (f = 1 – b/a) | = 1/298.257223563 |
| | = 0.003352811 |
| Eccentricity ($e = (2f - f^2)^{1/2}$) | = 0.081819191 |
| Eccentricity squared ($e^2$) | = 0.006694380 |

## Length

| | |
|---|---|
| 1 inch | = 25.4 millimeters* |
| | = 2.54 centimeters* |
| 1 foot (U.S.) | = 12 inches* |
| | = 1 British foot |
| | = $^1/_3$ yard* |
| | = 0.3048 meter* |
| | = $^1/_6$ fathom* |
| 1 foot (U.S. Survey) | = 0.30480061 meter |
| 1 yard | = 36 inches* |
| | = 3 feet* |
| | = 0.9144 meter* |
| 1 fathom | = 6 feet* |
| | = 2 yards* |
| | = 1.8288 meters* |
| 1 cable | = 720 feet* |
| | = 240 yards* |
| | = 219.4560 meters* |
| 1 cable (British) | = 0.1 nautical mile |
| 1 statute mile | = 5,280 feet* |
| | = 1,760 yards* |
| | = 1,609.344 meters* |
| | = 1.609344 kilometers* |
| | = 0.86897624 nautical mile |
| 1 nautical mile | = 6,076.11548556 feet |
| | = 2,025.37182852 yards |
| | = 1,852 meters* |

| | |
|---|---|
| | = 1.852 kilometers* |
| | = 1.150779448 statute miles |
| 1 meter | = 100 centimeters* |
| | = 39.370079 inches |
| | = 3.28083990 feet |
| | = 1.09361330 yards |
| | = 0.54680665 fathom |
| | = 0.00062137 statute mile |
| | = 0.00053996 nautical mile |
| 1 kilometer | = 3,280.83990 feet |
| | = 1,093.61330 yards |
| | = 1,000 meters* |
| | = 0.62137119 statute mile |
| | = 0.53995680 nautical mile |

## Mass

| | |
|---|---|
| 1 ounce | = 437.5 grains* |
| | = 28.349523125 grams* |
| | = 0.0625 pound* |
| | = 0.028349523125 kilogram* |
| 1 pound | = 7,000 grains* |
| | = 16 ounces* |
| | = 0.45359237 kilogram* |
| 1 short ton | = 2,000 pounds* |
| | = 907.18474 kilograms* |
| | = 0.90718474 metric ton* |
| | = 0.8928571 long ton |
| 1 long ton | = 2,240 pounds* |
| | = 1,016.0469088 kilograms* |
| | = 1.12 short tons* |
| | = 1.0160469088 metric tons* |
| 1 kilogram | = 2.204623 pounds |
| | = 0.00110231 short ton |
| | = 0.0009842065 long ton |
| 1 metric ton | = 2,204.623 pounds |
| | = 1,000 kilograms* |
| | = 1.102311 short tons |
| | = 0.9842065 long ton |

## Mathematics

| | |
|---|---|
| $\pi$ | = 3.141592653589793238462643383279502884197 1 |
| $\pi^2$ | = 9.8696044011 |
| $\sqrt{\pi}$ | = 1.7724538509 |
| Base of Naperian logarithms (e) | = 2.718281828459 |
| Modulus of common logarithms ($\log_{10}e$) | = 0.4342944819032518 |
| 1 radian | = 206,264.″80625 |
| | = 3,437′.7467707849 |
| | = 57°.2957795131 |
| | = 57°17′44″.80625 |
| 1 circle | = 1,296,000″* |
| | = 21,600′* |
| | = 360°* |
| | = 2π radians* |
| 180° | = π radians* |
| 1° | = 3600″* |
| | = 60′* |
| | = 0.01745329251994329576 66 radian |
| 1′ | = 60″* |
| | = 0.000290888208665721596 radian |
| 1″ | = 0.0000048481368110953599 33 radian |
| Sine of 1′ | = 0.000290888204563424 60 |
| Sine of 1″ | = 0.0000048481368110763 7 |

## Meteorology

Atmosphere (dry air)

| | | |
|---|---|---|
| Nitrogen | = 78.08% | 99.99% |
| Oxygen | = 20.95% | |
| Argon | = 0.93% | |
| Carbon dioxide | = 0.03% | |
| Neon | = 0.0018% | |
| Helium | = 0.000524% | |
| Krypton | = 0.0001% | |
| Hydrogen | = 0.00005% | |
| Xenon | = 0.0000087% | |
| Ozone | = 0 to 0.000007% (increasing with altitude) | |
| Radon | = 0.000000000000000006% (decreasing with altitude) | |

| | |
|---|---|
| Standard atmospheric pressure at sea level | = 1,013.250 dynes per square centimeter |
| | = 1,033.227 grams per square centimeter |
| | = 1,033.227 centimeters of water |
| | = 1,013.250 hectopascals (millibars)* |
| | = 760 millimeters of mercury |
| | = 76 centimeters of mercury |
| | = 33.8985 feet of water |
| | = 29.92126 inches of mercury |
| | = 14.6960 pounds per square inch |
| | = 1.033227 kilograms per square centimeter |
| | = 1.013250 bars* |
| Absolute zero | = (–)273.16°C |
| | = (–)459.69°F |

## Pressure

| | |
|---|---|
| 1 dyne per square centimeter | = 0.001 hectopascal (millibar)* |
| | = 0.000001 bar* |
| 1 gram per square centimeter | = 1 centimeter of water |
| | = 0.980665 hectopascal (millibar)* |
| | = 0.07355592 centimeter of mercury |
| | = 0.0289590 inch of mercury |
| | = 0.0142233 pound per square inch |
| | = 0.001 kilogram per square centimeter* |
| | = 0.000967841 atmosphere |
| 1 hectopascal (millibar) | = 1,000 dynes per square centimeter* |
| | = 1.01971621 grams per square centimeter |
| | = 0.7500617 millimeter of mercury |
| | = 0.03345526 foot of water |
| | = 0.02952998 inch of mercury |
| | = 0.01450377 pound per square inch |
| | = 0.001 bar* |
| | = 0.00098692 atmosphere |
| 1 millimeter of mercury | = 1.35951 grams per square centimeter |
| | = 1.3332237 hectopascals (millibars) |
| | = 0.1 centimeter of mercury* |
| | = 0.04460334 foot of water |
| | = 0.039370079 inch of mercury |
| | = 0.01933677 pound per square inch |
| | = 0.001315790 atmosphere |
| 1 centimeter of mercury | = 10 millimeters of mercury* |
| 1 inch of mercury | = 34.53155 grams per square centimeter |
| | = 33.86389 hectopascals (millibars) |
| | = 25.4 millimeters of mercury* |
| | = 1.132925 feet of water |
| | = 0.4911541 pound per square inch |
| | = 0.03342106 atmosphere |
| 1 centimeter of water | = 1 gram per square centimeter |
| | = 0.001 kilogram per square centimeter |
| 1 foot of water | = 30.48000 grams per square centimeter |
| | = 29.89067 hectopascals (millibars) |
| | = 2.241985 centimeters of mercury |
| | = 0.882671 inch of mercury |
| | = 0.4335275 pound per square inch |
| | = 0.02949980 atmosphere |

| | |
|---|---|
| 1 pound per square inch | = 68,947.57 dynes per square centimeter |
| | = 70.30696 grams per square centimeter |
| | = 70.30696 centimeters of water |
| | = 68.94757 hectopascals (millibars) |
| | = 51.71493 millimeters of mercury |
| | = 5.171493 centimeters of mercury |
| | = 2.306659 feet of water |
| | = 2.036021 inches of mercury |
| | = 0.07030696 kilogram per square centimeter |
| | = 0.06894757 bar |
| | = 0.06804596 atmosphere |
| 1 kilogram per square centimeter | = 1,000 grams per square centimeter* |
| | = 1,000 centimeters of water |
| 1 bar | = 1,000,000 dynes per square centimeter* |
| | = 1,000 hectopascals (millibars)* |

## Speed

| | |
|---|---|
| 1 foot per minute | = 0.01666667 foot per second |
| | = 0.00508 meter per second* |
| 1 yard per minute | = 3 feet per minute* |
| | = 0.05 foot per second* |
| | = 0.03409091 statute mile per hour |
| | = 0.02962419 knot |
| | = 0.01524 meter per second* |
| 1 foot per second | = 60 feet per minute* |
| | = 20 yards per minute* |
| | = 1.09728 kilometers per hour* |
| | = 0.68181818 statute mile per hour |
| | = 0.59248380 knot |
| | = 0.3048 meter per second* |
| 1 statute mile per hour | = 88 feet per minute* |
| | = 29.33333333 yards per minute |
| | = 1.609344 kilometers per hour* |
| | = 1.46666667 feet per second |
| | = 0.86897624 knot |
| | = 0.44704 meter per second* |
| 1 knot | = 101.26859143 feet per minute |
| | = 33.75619714 yards per minute |
| | = 1.852 kilometers per hour* |
| | = 1.68780986 feet per second |
| | = 1.15077945 statute miles per hour |
| | = 0.51444444 meter per second |
| 1 kilometer per hour | = 0.62137119 statute mile per hour |
| | = 0.53995680 knot |
| 1 meter per second | = 196.85039340 feet per minute |
| | = 65.6167978 yards per minute |
| | = 3.6 kilometers per hour* |
| | = 3.28083990 feet per second |
| | = 2.23693632 statute miles per hour |
| | = 1.94384449 knots |
| Light in vacuum | = 299,792.5 kilometers per second |
| | = 186,282 statute miles per second |
| | = 161,875 nautical miles per second |
| | = 983.570 feet per microsecond |
| Light in air | = 299,708 kilometers per second |
| | = 186,230 statute miles per second |
| | = 161,829 nautical miles per second |
| | = 983.294 feet per microsecond |
| Sound in dry air at 59°F or 15°C and standard sea level pressure | = 1,116.45 feet per second |
| | = 761.22 statute miles per hour |
| | = 661.48 knots |
| | = 340.29 meters per second |

| | |
|---|---|
| Sound in 3.485 percent saltwater at 60°F _ _ _ | = 4,945.37 feet per second |
| | = 3,371.85 statute miles per hour |
| | = 2,930.05 knots |
| | = 1,507.35 meters per second |

## Volume

| | |
|---|---|
| 1 cubic inch | = 16.387064 cubic centimeters* |
| | = 0.016387064 liter* |
| | = 0.004329004 gallon |
| 1 cubic foot | = 1,728 cubic inches* |
| | = 28.316846592 liters* |
| | = 7.480519 U.S. gallons |
| | = 6.228822 imperial (British) gallons |
| | = 0.028316846592 cubic meter* |
| 1 cubic yard | = 46,656 cubic inches* |
| | = 764.554857984 liters* |
| | = 201.974026 U.S. gallons |
| | = 168.1782 imperial (British) gallons |
| | = 27 cubic feet* |
| | = 0.764554857984 cubic meter* |
| 1 milliliter | = 0.06102374 cubic inch |
| | = 0.0002641721 U.S. gallon |
| | = 0.00021997 imperial (British) gallon |
| 1 cubic meter | = 264.172035 U.S. gallons |
| | = 219.96878 imperial (British) gallons |
| | = 35.31467 cubic feet |
| | = 1.307951 cubic yards |
| 1 quart (U.S.) | = 57.75 cubic inches* |
| | = 32 fluid ounces* |
| | = 2 pints* |
| | = 0.9463529 liter |
| | = 0.25 gallon* |
| 1 gallon (U.S.) | = 3,785.412 milliliters |
| | = 231 cubic inches* |
| | = 0.1336806 cubic foot |
| | = 4 quarts* |
| | = 3.785412 liters |
| | = 0.8326725 imperial (British) gallon |
| 1 liter | = 1,000 milliliters |
| | = 61.02374 cubic inches |
| | = 1.056688 quarts |
| | = 0.2641721 gallon |
| 1 register ton | = 100 cubic feet* |
| | = 2.8316846592 cubic meters* |
| 1 measurement ton | = 40 cubic feet* |
| | = 1 freight ton* |
| 1 freight ton | = 40 cubic feet* |
| | = 1 measurement ton* |

## Volume-Mass

| | |
|---|---|
| 1 cubic foot of seawater | = 64 pounds |
| 1 cubic foot of freshwater | = 62.428 pounds at temperature of maximum density (4°C = 39°.2F) |
| 1 cubic foot of ice | = 56 pounds |
| 1 displacement ton | = 35 cubic feet of seawater* |
| | = 1 long ton |

**Prefixes to Form Decimal Multiples and Sub-Multiples of International System of Units (SI)**

| Multiplying factor | | Prefix | Symbol |
|---:|---|---|---|
| 1 000 000 000 000 | $= 10^{12}$ | tera | T |
| 1 000 000 000 | $= 10^{9}$ | giga | G |
| 1 000 000 | $= 10^{6}$ | mega | M |
| 1 000 | $= 10^{3}$ | kilo | k |
| 100 | $= 10^{2}$ | hecto | h |
| 10 | $= 10^{1}$ | deka | da |
| 0. 1 | $= 10^{-1}$ | deci | d |
| 0. 01 | $= 10^{-2}$ | centi | c |
| 0. 001 | $= 10^{-3}$ | milli | m |
| 0. 000 001 | $= 10^{-6}$ | micro | µ |
| 0. 000 000 001 | $= 10^{-9}$ | nano | n |
| 0. 000 000 000 001 | $= 10^{-12}$ | pico | p |
| 0. 000 000 000 000 001 | $= 10^{-15}$ | femto | f |
| 0. 000 000 000 000 000 001 | $= 10^{-18}$ | atto | a |

## NGA MARITIME SAFETY INFORMATION NAUTICAL CALCULATORS

**NGA's Maritime Safety Office website** offers a variety of online Nautical Calculators for public use. These calculators solve many of the equations and conversions typically associated with marine navigation. See Figure C1.

*Figure C1. Link to NGA Nautical Calculators. https://msi.nga.mil/Calc*

**List of NGA Maritime Safety information Nautical Calculators** https://msi.nga.mil

| **Celestial Navigation Calculators** |
|---|
| Compass Error from Amplitudes Observed on the Visible Horizon |
| Altitude Correction for Air Temperature |
| Table of Offsets |
| Latitude and Longitude Factors |
| Altitude Corrections for Atmospheric Pressure |
| Altitude Factors & Change of Altitude |

**List of NGA Maritime Safety information Nautical Calculators** https://msi.nga.mil

| |
|---|
| Pub 229 |
| Compass Error from Amplitudes observed on the Celestial Horizon |
| **Conversion Calculators** |
| Chart Scales and Conversions for Nautical and Statute Miles |
| Conversions for Meters, Feet and Fathoms |
| **Distance Calculators** |
| Length of a Degree of Latitude and Longitude |
| Speed for Measured Mile and Speed, Time and Distance |
| Distance of an Object by Two Bearings |
| Distance of the Horizon |
| Distance by Vertical Angle Measured Between Sea Horizon and Top of Object Beyond Sea Horizon |
| Traverse Table |
| Geographic Range |
| Distance by Vertical Angle Measured Between Waterline at Object and Top of Object |
| Dip of Sea Short of the Horizon |
| Distance by Vertical Angle Measured Between Waterline at Object and Sea Horizon Beyond Object |
| Meridional Parts |
| **Log and Trig Calculators** |
| Logarithmic and Trigonometric Functions |
| **Sailings Calculators** |
| Great Circle Sailing |
| Mercator NGA Sailing |
| **Time Zones Calculators** |
| Time Zones, Zone Descriptions and Suffixes |
| **Weather Data Calculators** |
| Direction and Speed of True Wind |
| Correction of Barometer Reading for Height Above Sea Level |
| Correction of Barometer Reading for Gravity |
| Temperature Conversions |
| Relative Humidity and Dew Point |
| Corrections of Barometer Reading for Temperature |
| Barometer Measurement Conversions |

# APPENDIX D

| NAVIGATIONAL COORDINATES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Coordinate | Symbol | Measured from | Measured along | Direction | Measured to | Units | Precision | Maximum value | Labels |
| latitude | L, lat. | equator | meridian | N, S | parallel | °, ' | 0.1' | 90° | N, S |
| colatitude | colat. | poles | meridian | S, N | parallel | °, ' | 0.1' | 90° | — |
| longitude | l, long. | prime meridian | parallel | E, W | local meridian | °, ' | 0.1' | 180° | E, W |
| declination | d, dec. | celestial equator | hour circle | N, S | parallel of declination | °, ' | 0.1' | 90° | N, S |
| polar distance | p | elevated pole | hour circle | S, N | parallel of declination | °, ' | 0.1' | 180° | — |
| altitude | h | horizon | vertical circle | up | parallel of altitude | °, ' | 0.1' | 90° | — |
| zenith distance | z | zenith | vertical circle | down | parallel of altitude | °, ' | 0.1' | 180° | — |
| azimuth | Zn | north | horizon | E | vertical circle | ° | 0.1° | 360° | — |
| azimuth angle | Z | north, south | horizon | E, W | vertical circle | ° | 0.1° | 180° or 90° | N, S...E, W |
| amplitude | A | east, west | horizon | N, S | body | ° | 0.1° | 90° | E, W...N, S |
| Greenwich hour angle | GHA | Greenwich celestial meridian | parallel of declination | W | hour circle | °, ' | 0.1' | 360° | — |
| local hour angle | LHA | local celestial meridian | parallel of declination | W | hour circle | °, ' | 0.1' | 360° | — |
| meridian angle | t | local celestial meridian | parallel of declination | E, W | hour circle | °, ' | 0.1' | 180° | E, W |
| sidereal hour angle | SHA | hour circle of vernal equinox | parallel of declination | W | hour circle | °, ' | 0.1' | 360° | — |
| right ascension | RA | hour circle of vernal equinox | parallel of declination | E | hour circle | h, m, s | $1^s$ | $24^h$ | — |
| Greenwich mean time | GMT | lower branch Greenwich celestial meridian | parallel of declination | W | hour circle mean Sun | h, m, s | $1^s$ | $24^h$ | — |
| local mean time | LMT | lower branch local celestial meridian | parallel of declination | W | hour circle mean Sun | h, m, s | $1^s$ | $24^h$ | — |
| zone time | ZT | lower branch zone celestial meridian | parallel of declination | W | hour circle mean Sun | h, m, s | $1^s$ | $24^h$ | — |
| Greenwich apparent time | GAT | lower branch Greenwich celestial meridian | parallel of declination | W | hour circle apparent Sun | h, m, s | $1^s$ | $24^h$ | — |
| local apparent time | LAT | lower branch local celestial meridian | parallel of declination | W | hour circle apparent Sun | h, m, s | $1^s$ | $24^h$ | — |
| Greenwich sidereal time | GST | Greenwich celestial meridian | parallel of declination | W | hour circle vernal equinox | h, m, s | $1^s$ | $24^h$ | — |
| local sidereal time | LST | local celestial meridian | parallel of declination | W | hour circle vernal equinox | h, m, s | $1^s$ | $24^h$ | — |

# APPENDIX E: EXTRACTS FROM 2024 NAUTICAL ALMANAC

## A2 ALTITUDE CORRECTION TABLES 10°-90°—SUN, STARS, PLANETS

**SUN**

| OCT.—MAR. App. Alt. | Lower Limb | Upper Limb | APR.—SEPT. App. Alt. | Lower Limb | Upper Limb |
|---|---|---|---|---|---|
| ° ′ | ′ | ′ | ° ′ | ′ | ′ |
| 9 33 | +10·8 | −21·5 | 9 39 | +10·6 | −21·2 |
| 9 45 | +10·9 | −21·4 | 9 50 | +10·7 | −21·1 |
| 9 56 | +11·0 | −21·3 | 10 02 | +10·8 | −21·0 |
| 10 08 | +11·1 | −21·2 | 10 14 | +10·9 | −20·9 |
| 10 20 | +11·2 | −21·1 | 10 27 | +11·0 | −20·8 |
| 10 33 | +11·3 | −21·0 | 10 40 | +11·1 | −20·7 |
| 10 46 | +11·4 | −20·9 | 10 53 | +11·2 | −20·6 |
| 11 00 | +11·5 | −20·8 | 11 07 | +11·3 | −20·5 |
| 11 15 | +11·6 | −20·7 | 11 22 | +11·4 | −20·4 |
| 11 30 | +11·7 | −20·6 | 11 37 | +11·5 | −20·3 |
| 11 45 | +11·8 | −20·5 | 11 53 | +11·6 | −20·2 |
| 12 01 | +11·9 | −20·4 | 12 10 | +11·7 | −20·1 |
| 12 18 | +12·0 | −20·3 | 12 27 | +11·8 | −20·0 |
| 12 36 | +12·1 | −20·2 | 12 45 | +11·9 | −19·9 |
| 12 54 | +12·2 | −20·1 | 13 04 | +12·0 | −19·8 |
| 13 14 | +12·3 | −20·0 | 13 24 | +12·1 | −19·7 |
| 13 34 | +12·4 | −19·9 | 13 44 | +12·2 | −19·6 |
| 13 55 | +12·5 | −19·8 | 14 06 | +12·3 | −19·5 |
| 14 17 | +12·6 | −19·7 | 14 29 | +12·4 | −19·4 |
| 14 41 | +12·7 | −19·6 | 14 53 | +12·5 | −19·3 |
| 15 05 | +12·8 | −19·5 | 15 18 | +12·6 | −19·2 |
| 15 31 | +12·9 | −19·4 | 15 45 | +12·7 | −19·1 |
| 15 59 | +13·0 | −19·3 | 16 13 | +12·8 | −19·0 |
| 16 27 | +13·1 | −19·2 | 16 43 | +12·9 | −18·9 |
| 16 58 | +13·2 | −19·1 | 17 14 | +13·0 | −18·8 |
| 17 30 | +13·3 | −19·0 | 17 47 | +13·1 | −18·7 |
| 18 05 | +13·4 | −18·9 | 18 23 | +13·2 | −18·6 |
| 18 41 | +13·5 | −18·8 | 19 00 | +13·3 | −18·5 |
| 19 20 | +13·6 | −18·7 | 19 41 | +13·4 | −18·4 |
| 20 02 | +13·7 | −18·6 | 20 24 | +13·5 | −18·3 |
| 20 46 | +13·8 | −18·5 | 21 10 | +13·6 | −18·2 |
| 21 34 | +13·9 | −18·4 | 21 59 | +13·7 | −18·1 |
| 22 25 | +14·0 | −18·3 | 22 52 | +13·8 | −18·0 |
| 23 20 | +14·1 | −18·2 | 23 49 | +13·9 | −17·9 |
| 24 20 | +14·2 | −18·1 | 24 51 | +14·0 | −17·8 |
| 25 24 | +14·3 | −18·0 | 25 58 | +14·1 | −17·7 |
| 26 34 | +14·4 | −17·9 | 27 11 | +14·2 | −17·6 |
| 27 50 | +14·5 | −17·8 | 28 31 | +14·3 | −17·5 |
| 29 13 | +14·6 | −17·7 | 29 58 | +14·4 | −17·4 |
| 30 44 | +14·7 | −17·6 | 31 33 | +14·5 | −17·3 |
| 32 24 | +14·8 | −17·5 | 33 18 | +14·6 | −17·2 |
| 34 15 | +14·9 | −17·4 | 35 15 | +14·7 | −17·1 |
| 36 17 | +15·0 | −17·3 | 37 24 | +14·8 | −17·0 |
| 38 34 | +15·1 | −17·2 | 39 48 | +14·9 | −16·9 |
| 41 06 | +15·2 | −17·1 | 42 28 | +15·0 | −16·8 |
| 43 56 | +15·3 | −17·0 | 45 29 | +15·1 | −16·7 |
| 47 07 | +15·4 | −16·9 | 48 52 | +15·2 | −16·6 |
| 50 43 | +15·5 | −16·8 | 52 41 | +15·3 | −16·5 |
| 54 46 | +15·6 | −16·7 | 56 59 | +15·4 | −16·4 |
| 59 21 | +15·7 | −16·6 | 61 50 | +15·5 | −16·3 |
| 64 28 | +15·8 | −16·5 | 67 15 | +15·6 | −16·2 |
| 70 10 | +15·9 | −16·4 | 73 14 | +15·7 | −16·1 |
| 76 24 | +16·0 | −16·3 | 79 42 | +15·8 | −16·0 |
| 83 05 | +16·1 | −16·2 | 86 31 | +15·9 | −15·9 |
| 90 00 | | | 90 00 | | |

**STARS AND PLANETS**

| App Alt. | Corr^n |
|---|---|
| ° ′ | ′ |
| 9 55 | −5·3 |
| 10 07 | −5·2 |
| 10 20 | −5·1 |
| 10 32 | −5·0 |
| 10 46 | −4·9 |
| 10 59 | −4·8 |
| 11 14 | −4·7 |
| 11 29 | −4·6 |
| 11 44 | −4·5 |
| 12 00 | −4·4 |
| 12 17 | −4·3 |
| 12 35 | −4·2 |
| 12 53 | −4·1 |
| 13 12 | −4·0 |
| 13 32 | −3·9 |
| 13 53 | −3·8 |
| 14 16 | −3·7 |
| 14 39 | −3·6 |
| 15 03 | −3·5 |
| 15 29 | −3·4 |
| 15 56 | −3·3 |
| 16 25 | −3·2 |
| 16 55 | −3·1 |
| 17 27 | −3·0 |
| 18 01 | −2·9 |
| 18 37 | −2·8 |
| 19 16 | −2·7 |
| 19 56 | −2·6 |
| 20 40 | −2·5 |
| 21 27 | −2·4 |
| 22 17 | −2·3 |
| 23 11 | −2·2 |
| 24 09 | −2·1 |
| 25 12 | −2·0 |
| 26 20 | −1·9 |
| 27 34 | −1·8 |
| 28 54 | −1·7 |
| 30 22 | −1·6 |
| 31 58 | −1·5 |
| 33 43 | −1·4 |
| 35 38 | −1·3 |
| 37 45 | −1·2 |
| 40 06 | −1·1 |
| 42 42 | −1·0 |
| 45 34 | −0·9 |
| 48 45 | −0·8 |
| 52 16 | −0·7 |
| 56 09 | −0·6 |
| 60 26 | −0·5 |
| 65 06 | −0·4 |
| 70 09 | −0·3 |
| 75 32 | −0·2 |
| 81 12 | −0·1 |
| 87 03 | 0·0 |
| 90 00 | |

| App. Alt. | Additional Corr^n |
|---|---|
| **2024** | |
| **VENUS** | |
| Jan. 1–Nov. 30 | |
| ° | ′ |
| 0 | +0·1 |
| 60 | |
| Dec. 1–Dec. 31 | |
| ° | ′ |
| 0 | +0·2 |
| 41 | +0·1 |
| 76 | |
| **MARS** | |
| Jan. 1–Nov. 6 | |
| ° | ′ |
| 0 | +0·1 |
| 60 | |
| Nov. 7–Dec. 31 | |
| ° | ′ |
| 0 | +0·2 |
| 41 | +0·1 |
| 76 | |

**DIP**

| Ht. of Eye | Corr^n | Ht. of Eye |
|---|---|---|
| m | ′ | ft. |
| 2·4 | −2·8 | 8·0 |
| 2·6 | −2·9 | 8·6 |
| 2·8 | −3·0 | 9·2 |
| 3·0 | −3·1 | 9·8 |
| 3·2 | −3·2 | 10·5 |
| 3·4 | −3·3 | 11·2 |
| 3·6 | −3·4 | 11·9 |
| 3·8 | −3·5 | 12·6 |
| 4·0 | −3·6 | 13·3 |
| 4·3 | −3·7 | 14·1 |
| 4·5 | −3·8 | 14·9 |
| 4·7 | −3·9 | 15·7 |
| 5·0 | −4·0 | 16·5 |
| 5·2 | −4·1 | 17·4 |
| 5·5 | −4·2 | 18·3 |
| 5·8 | −4·3 | 19·1 |
| 6·1 | −4·4 | 20·1 |
| 6·3 | −4·5 | 21·0 |
| 6·6 | −4·6 | 22·0 |
| 6·9 | −4·7 | 22·9 |
| 7·2 | −4·8 | 23·9 |
| 7·5 | −4·9 | 24·9 |
| 7·9 | −5·0 | 26·0 |
| 8·2 | −5·1 | 27·1 |
| 8·5 | −5·2 | 28·1 |
| 8·8 | −5·3 | 29·2 |
| 9·2 | −5·4 | 30·4 |
| 9·5 | −5·5 | 31·5 |
| 9·9 | −5·6 | 32·7 |
| 10·3 | −5·7 | 33·9 |
| 10·6 | −5·8 | 35·1 |
| 11·0 | −5·9 | 36·3 |
| 11·4 | −6·0 | 37·6 |
| 11·8 | −6·1 | 38·9 |
| 12·2 | −6·2 | 40·1 |
| 12·6 | −6·3 | 41·5 |
| 13·0 | −6·4 | 42·8 |
| 13·4 | −6·5 | 44·2 |
| 13·8 | −6·6 | 45·5 |
| 14·2 | −6·7 | 46·9 |
| 14·7 | −6·8 | 48·4 |
| 15·1 | −6·9 | 49·8 |
| 15·5 | −7·0 | 51·3 |
| 16·0 | −7·1 | 52·8 |
| 16·5 | −7·2 | 54·3 |
| 16·9 | −7·3 | 55·8 |
| 17·4 | −7·4 | 57·4 |
| 17·9 | −7·5 | 58·9 |
| 18·4 | −7·6 | 60·5 |
| 18·8 | −7·7 | 62·1 |
| 19·3 | −7·8 | 63·8 |
| 19·8 | −7·9 | 65·4 |
| 20·4 | −8·0 | 67·1 |
| 20·9 | −8·1 | 68·8 |
| 21·4 | | 70·5 |

| Ht. of Eye | Corr^n |
|---|---|
| m | ′ |
| 1·0 | − 1·8 |
| 1·5 | − 2·2 |
| 2·0 | − 2·5 |
| 2·5 | − 2·8 |
| 3·0 | − 3·0 |
| See table ← | |
| m | ′ |
| 20 | − 7·9 |
| 22 | − 8·3 |
| 24 | − 8·6 |
| 26 | − 9·0 |
| 28 | − 9·3 |
| 30 | − 9·6 |
| 32 | −10·0 |
| 34 | −10·3 |
| 36 | −10·6 |
| 38 | −10·8 |
| 40 | −11·1 |
| 42 | −11·4 |
| 44 | −11·7 |
| 46 | −11·9 |
| 48 | −12·2 |
| ft. | ′ |
| 2 | − 1·4 |
| 4 | − 1·9 |
| 6 | − 2·4 |
| 8 | − 2·7 |
| 10 | − 3·1 |
| See table ← | |
| ft. | ′ |
| 70 | − 8·1 |
| 75 | − 8·4 |
| 80 | − 8·7 |
| 85 | − 8·9 |
| 90 | − 9·2 |
| 95 | − 9·5 |
| 100 | − 9·7 |
| 105 | − 9·9 |
| 110 | −10·2 |
| 115 | −10·4 |
| 120 | −10·6 |
| 125 | −10·8 |
| 130 | −11·1 |
| 135 | −11·3 |
| 140 | −11·5 |
| 145 | −11·7 |
| 150 | −11·9 |
| 155 | −12·1 |

App. Alt. = Apparent altitude = Sextant altitude corrected for index error and dip.

# ALTITUDE CORRECTION TABLES 0°-10°—SUN, STARS, PLANETS A3

| App. Alt. | OCT.—MAR. SUN Lower Limb | OCT.—MAR. SUN Upper Limb | APR.—SEPT. SUN Lower Limb | APR.—SEPT. SUN Upper Limb | STARS PLANETS |
|---|---|---|---|---|---|
| ° ′ | ′ | ′ | ′ | ′ | ′ |
| 0 00 | −17·5 | −49·8 | −17·8 | −49·6 | −33·8 |
| 0 03 | 16·9 | 49·2 | 17·2 | 49·0 | 33·2 |
| 0 06 | 16·3 | 48·6 | 16·6 | 48·4 | 32·6 |
| 0 09 | 15·7 | 48·0 | 16·0 | 47·8 | 32·0 |
| 0 12 | 15·2 | 47·5 | 15·4 | 47·2 | 31·5 |
| 0 15 | 14·6 | 46·9 | 14·8 | 46·6 | 30·9 |
| 0 18 | −14·1 | −46·4 | −14·3 | −46·1 | −30·4 |
| 0 21 | 13·5 | 45·8 | 13·8 | 45·6 | 29·8 |
| 0 24 | 13·0 | 45·3 | 13·3 | 45·1 | 29·3 |
| 0 27 | 12·5 | 44·8 | 12·8 | 44·6 | 28·8 |
| 0 30 | 12·0 | 44·3 | 12·3 | 44·1 | 28·3 |
| 0 33 | 11·6 | 43·9 | 11·8 | 43·6 | 27·9 |
| 0 36 | −11·1 | −43·4 | −11·3 | −43·1 | −27·4 |
| 0 39 | 10·6 | 42·9 | 10·9 | 42·7 | 26·9 |
| 0 42 | 10·2 | 42·5 | 10·5 | 42·3 | 26·5 |
| 0 45 | 9·8 | 42·1 | 10·0 | 41·8 | 26·1 |
| 0 48 | 9·4 | 41·7 | 9·6 | 41·4 | 25·7 |
| 0 51 | 9·0 | 41·3 | 9·2 | 41·0 | 25·3 |
| 0 54 | − 8·6 | −40·9 | − 8·8 | −40·6 | −24·9 |
| 0 57 | 8·2 | 40·5 | 8·4 | 40·2 | 24·5 |
| 1 00 | 7·8 | 40·1 | 8·0 | 39·8 | 24·1 |
| 1 03 | 7·4 | 39·7 | 7·7 | 39·5 | 23·7 |
| 1 06 | 7·1 | 39·4 | 7·3 | 39·1 | 23·4 |
| 1 09 | 6·7 | 39·0 | 7·0 | 38·8 | 23·0 |
| 1 12 | − 6·4 | −38·7 | − 6·6 | −38·4 | −22·7 |
| 1 15 | 6·0 | 38·3 | 6·3 | 38·1 | 22·3 |
| 1 18 | 5·7 | 38·0 | 6·0 | 37·8 | 22·0 |
| 1 21 | 5·4 | 37·7 | 5·7 | 37·5 | 21·7 |
| 1 24 | 5·1 | 37·4 | 5·3 | 37·1 | 21·4 |
| 1 27 | 4·8 | 37·1 | 5·0 | 36·8 | 21·1 |
| 1 30 | − 4·5 | −36·8 | − 4·7 | −36·5 | −20·8 |
| 1 35 | 4·0 | 36·3 | 4·3 | 36·1 | 20·3 |
| 1 40 | 3·6 | 35·9 | 3·8 | 35·6 | 19·9 |
| 1 45 | 3·1 | 35·4 | 3·4 | 35·2 | 19·4 |
| 1 50 | 2·7 | 35·0 | 2·9 | 34·7 | 19·0 |
| 1 55 | 2·3 | 34·6 | 2·5 | 34·3 | 18·6 |
| 2 00 | − 1·9 | −34·2 | − 2·1 | −33·9 | −18·2 |
| 2 05 | 1·5 | 33·8 | 1·7 | 33·5 | 17·8 |
| 2 10 | 1·1 | 33·4 | 1·4 | 33·2 | 17·4 |
| 2 15 | 0·8 | 33·1 | 1·0 | 32·8 | 17·1 |
| 2 20 | 0·4 | 32·7 | 0·7 | 32·5 | 16·7 |
| 2 25 | − 0·1 | 32·4 | − 0·3 | 32·1 | 16·4 |
| 2 30 | + 0·2 | −32·1 | 0·0 | −31·8 | −16·1 |
| 2 35 | 0·5 | 31·8 | + 0·3 | 31·5 | 15·8 |
| 2 40 | 0·8 | 31·5 | 0·6 | 31·2 | 15·4 |
| 2 45 | 1·1 | 31·2 | 0·9 | 30·9 | 15·2 |
| 2 50 | 1·4 | 30·9 | 1·2 | 30·6 | 14·9 |
| 2 55 | 1·7 | 30·6 | 1·4 | 30·4 | 14·6 |
| 3 00 | + 2·0 | −30·3 | + 1·7 | −30·1 | −14·3 |
| 3 05 | 2·2 | 30·1 | 2·0 | 29·8 | 14·1 |
| 3 10 | 2·5 | 29·8 | 2·2 | 29·6 | 13·8 |
| 3 15 | 2·7 | 29·6 | 2·5 | 29·3 | 13·6 |
| 3 20 | 2·9 | 29·4 | 2·7 | 29·1 | 13·4 |
| 3 25 | 3·2 | 29·1 | 2·9 | 28·9 | 13·1 |
| 3 30 | + 3·4 | −28·9 | + 3·1 | −28·7 | −12·9 |

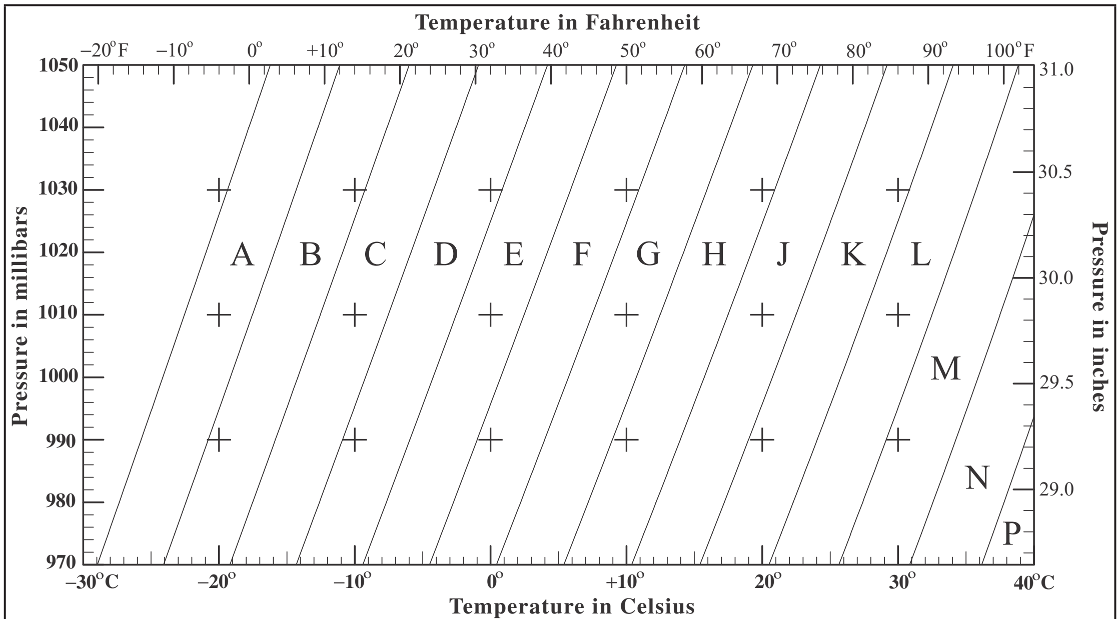
| App. Alt. | OCT.—MAR. SUN Lower Limb | OCT.—MAR. SUN Upper Limb | APR.—SEPT. SUN Lower Limb | APR.—SEPT. SUN Upper Limb | STARS PLANETS |
|---|---|---|---|---|---|
| ° ′ | ′ | ′ | ′ | ′ | ′ |
| 3 30 | + 3·4 | −28·9 | + 3·1 | −28·7 | −12·9 |
| 3 35 | 3·6 | 28·7 | 3·3 | 28·5 | 12·7 |
| 3 40 | 3·8 | 28·5 | 3·6 | 28·2 | 12·5 |
| 3 45 | 4·0 | 28·3 | 3·8 | 28·0 | 12·3 |
| 3 50 | 4·2 | 28·1 | 4·0 | 27·8 | 12·1 |
| 3 55 | 4·4 | 27·9 | 4·1 | 27·7 | 11·9 |
| 4 00 | + 4·6 | −27·7 | + 4·3 | −27·5 | −11·7 |
| 4 05 | 4·8 | 27·5 | 4·5 | 27·3 | 11·5 |
| 4 10 | 4·9 | 27·4 | 4·7 | 27·1 | 11·4 |
| 4 15 | 5·1 | 27·2 | 4·9 | 26·9 | 11·2 |
| 4 20 | 5·3 | 27·0 | 5·0 | 26·8 | 11·0 |
| 4 25 | 5·4 | 26·9 | 5·2 | 26·6 | 10·9 |
| 4 30 | + 5·6 | −26·7 | + 5·3 | −26·5 | −10·7 |
| 4 35 | 5·7 | 26·6 | 5·5 | 26·3 | 10·6 |
| 4 40 | 5·9 | 26·4 | 5·6 | 26·2 | 10·4 |
| 4 45 | 6·0 | 26·3 | 5·8 | 26·0 | 10·3 |
| 4 50 | 6·2 | 26·1 | 5·9 | 25·9 | 10·1 |
| 4 55 | 6·3 | 26·0 | 6·1 | 25·7 | 10·0 |
| 5 00 | + 6·4 | −25·9 | + 6·2 | −25·6 | − 9·8 |
| 5 05 | 6·6 | 25·7 | 6·3 | 25·5 | 9·7 |
| 5 10 | 6·7 | 25·6 | 6·5 | 25·3 | 9·6 |
| 5 15 | 6·8 | 25·5 | 6·6 | 25·2 | 9·5 |
| 5 20 | 7·0 | 25·3 | 6·7 | 25·1 | 9·3 |
| 5 25 | 7·1 | 25·2 | 6·8 | 25·0 | 9·2 |
| 5 30 | + 7·2 | −25·1 | + 6·9 | −24·9 | − 9·1 |
| 5 35 | 7·3 | 25·0 | 7·1 | 24·7 | 9·0 |
| 5 40 | 7·4 | 24·9 | 7·2 | 24·6 | 8·9 |
| 5 45 | 7·5 | 24·8 | 7·3 | 24·5 | 8·8 |
| 5 50 | 7·6 | 24·7 | 7·4 | 24·4 | 8·7 |
| 5 55 | 7·7 | 24·6 | 7·5 | 24·3 | 8·6 |
| 6 00 | + 7·8 | −24·5 | + 7·6 | −24·2 | − 8·5 |
| 6 10 | 8·0 | 24·3 | 7·8 | 24·0 | 8·3 |
| 6 20 | 8·2 | 24·1 | 8·0 | 23·8 | 8·1 |
| 6 30 | 8·4 | 23·9 | 8·2 | 23·6 | 7·9 |
| 6 40 | 8·6 | 23·7 | 8·3 | 23·5 | 7·7 |
| 6 50 | 8·7 | 23·6 | 8·5 | 23·3 | 7·6 |
| 7 00 | + 8·9 | −23·4 | + 8·7 | −23·1 | − 7·4 |
| 7 10 | 9·1 | 23·2 | 8·8 | 23·0 | 7·2 |
| 7 20 | 9·2 | 23·1 | 9·0 | 22·8 | 7·1 |
| 7 30 | 9·3 | 23·0 | 9·1 | 22·7 | 6·9 |
| 7 40 | 9·5 | 22·8 | 9·2 | 22·6 | 6·8 |
| 7 50 | 9·6 | 22·7 | 9·4 | 22·4 | 6·7 |
| 8 00 | + 9·7 | −22·6 | + 9·5 | −22·3 | − 6·6 |
| 8 10 | 9·9 | 22·4 | 9·6 | 22·2 | 6·4 |
| 8 20 | 10·0 | 22·3 | 9·7 | 22·1 | 6·3 |
| 8 30 | 10·1 | 22·2 | 9·9 | 21·9 | 6·2 |
| 8 40 | 10·2 | 22·1 | 10·0 | 21·8 | 6·1 |
| 8 50 | 10·3 | 22·0 | 10·1 | 21·7 | 6·0 |
| 9 00 | +10·4 | −21·9 | +10·2 | −21·6 | − 5·9 |
| 9 10 | 10·5 | 21·8 | 10·3 | 21·5 | 5·8 |
| 9 20 | 10·6 | 21·7 | 10·4 | 21·4 | 5·7 |
| 9 30 | 10·7 | 21·6 | 10·5 | 21·3 | 5·6 |
| 9 40 | 10·8 | 21·5 | 10·6 | 21·2 | 5·5 |
| 9 50 | 10·9 | 21·4 | 10·6 | 21·2 | 5·4 |
| 10 00 | +11·0 | −21·3 | +10·7 | −21·1 | − 5·3 |

Additional corrections for temperature and pressure are given on the following page.

For bubble sextant observations ignore dip and use the star corrections for Sun, planets and stars.

# A4 ALTITUDE CORRECTION TABLES—ADDITIONAL CORRECTIONS

## ADDITIONAL REFRACTION CORRECTIONS FOR NON-STANDARD CONDITIONS




| App. Alt. | A | B | C | D | E | F | G | H | J | K | L | M | N | P | App. Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ° ′ |
| **00 00** | −7·3 | −5·9 | −4·6 | −3·4 | −2·2 | −1·1 | 0·0 | +1·0 | +2·0 | +3·0 | +4·0 | +4·9 | +5·9 | +6·9 | **00 00** |
| **00 30** | 5·5 | 4·5 | 3·5 | 2·6 | 1·7 | 0·8 | 0·0 | 0·8 | 1·6 | 2·3 | 3·1 | 3·8 | 4·5 | 5·3 | **00 30** |
| **01 00** | 4·4 | 3·5 | 2·8 | 2·0 | 1·3 | 0·7 | 0·0 | 0·6 | 1·2 | 1·8 | 2·4 | 3·0 | 3·6 | 4·2 | **01 00** |
| **01 30** | 3·5 | 2·9 | 2·2 | 1·7 | 1·1 | 0·5 | 0·0 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 2·9 | 3·4 | **01 30** |
| **02 00** | 2·9 | 2·4 | 1·9 | 1·4 | 0·9 | 0·4 | 0·0 | 0·4 | 0·8 | 1·3 | 1·7 | 2·0 | 2·4 | 2·8 | **02 00** |
| **02 30** | −2·5 | −2·0 | −1·6 | −1·2 | −0·8 | −0·4 | 0·0 | +0·4 | +0·7 | +1·1 | +1·4 | +1·7 | +2·1 | +2·4 | **02 30** |
| **03 00** | 2·1 | 1·7 | 1·4 | 1·0 | 0·7 | 0·3 | 0·0 | 0·3 | 0·6 | 0·9 | 1·2 | 1·5 | 1·8 | 2·1 | **03 00** |
| **03 30** | 1·9 | 1·5 | 1·2 | 0·9 | 0·6 | 0·3 | 0·0 | 0·3 | 0·5 | 0·8 | 1·1 | 1·3 | 1·6 | 1·8 | **03 30** |
| **04 00** | 1·6 | 1·3 | 1·1 | 0·8 | 0·5 | 0·3 | 0·0 | 0·2 | 0·5 | 0·7 | 0·9 | 1·2 | 1·4 | 1·6 | **04 00** |
| **04 30** | 1·5 | 1·2 | 0·9 | 0·7 | 0·5 | 0·2 | 0·0 | 0·2 | 0·4 | 0·6 | 0·8 | 1·0 | 1·3 | 1·5 | **04 30** |
| **05 00** | −1·3 | −1·1 | −0·9 | −0·6 | −0·4 | −0·2 | 0·0 | +0·2 | +0·4 | +0·6 | +0·8 | +0·9 | +1·1 | +1·3 | **05 00** |
| **06** | 1·1 | 0·9 | 0·7 | 0·5 | 0·3 | 0·2 | 0·0 | 0·2 | 0·3 | 0·5 | 0·6 | 0·8 | 0·9 | 1·1 | **06** |
| **07** | 1·0 | 0·8 | 0·6 | 0·5 | 0·3 | 0·1 | 0·0 | 0·1 | 0·3 | 0·4 | 0·5 | 0·7 | 0·8 | 0·9 | **07** |
| **08** | 0·8 | 0·7 | 0·5 | 0·4 | 0·3 | 0·1 | 0·0 | 0·1 | 0·2 | 0·4 | 0·5 | 0·6 | 0·7 | 0·8 | **08** |
| **09** | 0·7 | 0·6 | 0·5 | 0·4 | 0·2 | 0·1 | 0·0 | 0·1 | 0·2 | 0·3 | 0·4 | 0·5 | 0·6 | 0·7 | **09** |
| **10 00** | −0·7 | −0·5 | −0·4 | −0·3 | −0·2 | −0·1 | 0·0 | +0·1 | +0·2 | +0·3 | +0·4 | +0·5 | +0·6 | +0·7 | **10 00** |
| **12** | 0·6 | 0·5 | 0·4 | 0·3 | 0·2 | 0·1 | 0·0 | 0·1 | 0·2 | 0·2 | 0·3 | 0·4 | 0·5 | 0·5 | **12** |
| **14** | 0·5 | 0·4 | 0·3 | 0·2 | 0·1 | 0·1 | 0·0 | 0·1 | 0·1 | 0·2 | 0·3 | 0·3 | 0·4 | 0·5 | **14** |
| **16** | 0·4 | 0·3 | 0·3 | 0·2 | 0·1 | 0·1 | 0·0 | 0·1 | 0·1 | 0·2 | 0·2 | 0·3 | 0·3 | 0·4 | **16** |
| **18** | 0·4 | 0·3 | 0·2 | 0·2 | 0·1 | −0·1 | 0·0 | +0·1 | 0·1 | 0·2 | 0·2 | 0·3 | 0·3 | 0·4 | **18** |
| **20 00** | −0·3 | −0·3 | −0·2 | −0·2 | −0·1 | 0·0 | 0·0 | 0·0 | +0·1 | +0·1 | +0·2 | +0·2 | +0·3 | +0·3 | **20 00** |
| **25** | 0·3 | 0·2 | 0·2 | 0·1 | 0·1 | 0·0 | 0·0 | 0·0 | 0·1 | 0·1 | 0·1 | 0·2 | 0·2 | 0·2 | **25** |
| **30** | 0·2 | 0·2 | 0·1 | 0·1 | 0·1 | 0·0 | 0·0 | 0·0 | +0·1 | 0·1 | 0·1 | 0·1 | 0·2 | 0·2 | **30** |
| **35** | 0·2 | 0·1 | 0·1 | 0·1 | −0·1 | 0·0 | 0·0 | 0·0 | 0·0 | 0·1 | 0·1 | 0·1 | 0·1 | 0·2 | **35** |
| **40** | 0·1 | 0·1 | 0·1 | −0·1 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | +0·1 | 0·1 | 0·1 | 0·1 | 0·1 | **40** |
| **50 00** | −0·1 | −0·1 | −0·1 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | 0·0 | +0·1 | +0·1 | +0·1 | +0·1 | **50 00** |

The graph is entered with arguments temperature and pressure to find a zone letter; using as arguments this zone letter and apparent altitude (sextant altitude corrected for index error and dip), a correction is taken from the table. This correction is to be applied to the sextant altitude in addition to the corrections for standard conditions (for the Sun, stars and planets from page A2-A3 and for the Moon from pages xxxiv and xxxv).

# 2024 MAY 24, 25, 26 (FRI., SAT., SUN.)

| UT d | UT h | ARIES GHA | VENUS −3·9 GHA | VENUS Dec | MARS +1·1 GHA | MARS Dec | JUPITER −2·0 GHA | JUPITER Dec | SATURN +1·0 GHA | SATURN Dec |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 24 | 00 | 242 05.1 | 183 57.9 | N19 41.3 | 225 09.6 | N 5 53.0 | 184 35.0 | N19 20.6 | 252 06.0 | S 6 17.8 |
| | 01 | 257 07.5 | 198 57.2 | 42.0 | 240 10.3 | 53.8 | 199 36.8 | 20.7 | 267 08.3 | 17.8 |
| | 02 | 272 10.0 | 213 56.5 | 42.7 | 255 11.0 | 54.5 | 214 38.7 | 20.8 | 282 10.6 | 17.7 |
| | 03 | 287 12.5 | 228 55.8 | . . 43.5 | 270 11.7 | . . 55.2 | 229 40.5 | . . 20.9 | 297 13.0 | . . 17.7 |
| | 04 | 302 14.9 | 243 55.1 | 44.2 | 285 12.5 | 56.0 | 244 42.4 | 21.1 | 312 15.3 | 17.6 |
| | 05 | 317 17.4 | 258 54.3 | 44.9 | 300 13.2 | 56.7 | 259 44.2 | 21.2 | 327 17.6 | 17.6 |
| | 06 | 332 19.9 | 273 53.6 | N19 45.7 | 315 13.9 | N 5 57.4 | 274 46.1 | N19 21.3 | 342 19.9 | S 6 17.5 |
| | 07 | 347 22.3 | 288 52.9 | 46.4 | 330 14.6 | 58.2 | 289 48.0 | 21.5 | 357 22.3 | 17.5 |
| | 08 | 2 24.8 | 303 52.2 | 47.1 | 345 15.3 | 58.9 | 304 49.8 | 21.6 | 12 24.6 | 17.4 |
| FRIDAY | 09 | 17 27.3 | 318 51.5 | . . 47.9 | 0 16.0 | 5 59.6 | 319 51.7 | . . 21.7 | 27 26.9 | . . 17.4 |
| | 10 | 32 29.7 | 333 50.8 | 48.6 | 15 16.7 | 6 00.3 | 334 53.5 | 21.8 | 42 29.3 | 17.3 |
| | 11 | 47 32.2 | 348 50.1 | 49.3 | 30 17.4 | 01.1 | 349 55.4 | 22.0 | 57 31.6 | 17.3 |
| | 12 | 62 34.6 | 3 49.4 | N19 50.0 | 45 18.1 | N 6 01.8 | 4 57.2 | N19 22.1 | 72 33.9 | S 6 17.2 |
| | 13 | 77 37.1 | 18 48.7 | 50.8 | 60 18.8 | 02.5 | 19 59.1 | 22.2 | 87 36.2 | 17.2 |
| | 14 | 92 39.6 | 33 48.0 | 51.5 | 75 19.6 | 03.2 | 35 00.9 | 22.4 | 102 38.6 | 17.1 |
| | 15 | 107 42.0 | 48 47.2 | . . 52.2 | 90 20.3 | . . 04.0 | 50 02.8 | . . 22.5 | 117 40.9 | . . 17.1 |
| | 16 | 122 44.5 | 63 46.5 | 52.9 | 105 21.0 | 04.7 | 65 04.7 | 22.6 | 132 43.2 | 17.0 |
| | 17 | 137 47.0 | 78 45.8 | 53.7 | 120 21.7 | 05.4 | 80 06.5 | 22.7 | 147 45.5 | 17.0 |
| | 18 | 152 49.4 | 93 45.1 | N19 54.4 | 135 22.4 | N 6 06.2 | 95 08.4 | N19 22.9 | 162 47.9 | S 6 16.9 |
| | 19 | 167 51.9 | 108 44.4 | 55.1 | 150 23.1 | 06.9 | 110 10.2 | 23.0 | 177 50.2 | 16.9 |
| | 20 | 182 54.4 | 123 43.7 | 55.8 | 165 23.8 | 07.6 | 125 12.1 | 23.1 | 192 52.5 | 16.9 |
| | 21 | 197 56.8 | 138 43.0 | . . 56.5 | 180 24.5 | . . 08.3 | 140 13.9 | . . 23.3 | 207 54.9 | . . 16.8 |
| | 22 | 212 59.3 | 153 42.2 | 57.3 | 195 25.2 | 09.1 | 155 15.8 | 23.4 | 222 57.2 | 16.8 |
| | 23 | 228 01.8 | 168 41.5 | 58.0 | 210 25.9 | 09.8 | 170 17.6 | 23.5 | 237 59.5 | 16.7 |
| 25 | 00 | 243 04.2 | 183 40.8 | N19 58.7 | 225 26.6 | N 6 10.5 | 185 19.5 | N19 23.6 | 253 01.8 | S 6 16.7 |
| | 01 | 258 06.7 | 198 40.1 | 19 59.4 | 240 27.4 | 11.2 | 200 21.3 | 23.8 | 268 04.2 | 16.6 |
| | 02 | 273 09.1 | 213 39.4 | 20 00.1 | 255 28.1 | 12.0 | 215 23.2 | 23.9 | 283 06.5 | 16.6 |
| | 03 | 288 11.6 | 228 38.6 | . . 00.8 | 270 28.8 | . . 12.7 | 230 25.1 | . . 24.0 | 298 08.8 | . . 16.5 |
| | 04 | 303 14.1 | 243 37.9 | 01.5 | 285 29.5 | 13.4 | 245 26.9 | 24.1 | 313 11.2 | 16.5 |
| | 05 | 318 16.5 | 258 37.2 | 02.3 | 300 30.2 | 14.1 | 260 28.8 | 24.3 | 328 13.5 | 16.4 |
| | 06 | 333 19.0 | 273 36.5 | N20 03.0 | 315 30.9 | N 6 14.9 | 275 30.6 | N19 24.4 | 343 15.8 | S 6 16.4 |
| | 07 | 348 21.5 | 288 35.8 | 03.7 | 330 31.6 | 15.6 | 290 32.5 | 24.5 | 358 18.1 | 16.3 |
| | 08 | 3 23.9 | 303 35.0 | 04.4 | 345 32.3 | 16.3 | 305 34.3 | 24.7 | 13 20.5 | 16.3 |
| SATURDAY | 09 | 18 26.4 | 318 34.3 | . . 05.1 | 0 33.0 | . . 17.0 | 320 36.2 | . . 24.8 | 28 22.8 | . . 16.2 |
| | 10 | 33 28.9 | 333 33.6 | 05.8 | 15 33.7 | 17.8 | 335 38.0 | 24.9 | 43 25.1 | 16.2 |
| | 11 | 48 31.3 | 348 32.9 | 06.5 | 30 34.4 | 18.5 | 350 39.9 | 25.0 | 58 27.5 | 16.2 |
| | 12 | 63 33.8 | 3 32.2 | N20 07.2 | 45 35.2 | N 6 19.2 | 5 41.8 | N19 25.2 | 73 29.8 | S 6 16.1 |
| | 13 | 78 36.2 | 18 31.4 | 07.9 | 60 35.9 | 19.9 | 20 43.6 | 25.3 | 88 32.1 | 16.1 |
| | 14 | 93 38.7 | 33 30.7 | 08.6 | 75 36.6 | 20.7 | 35 45.5 | 25.4 | 103 34.5 | 16.0 |
| | 15 | 108 41.2 | 48 30.0 | . . 09.3 | 90 37.3 | . . 21.4 | 50 47.3 | . . 25.5 | 118 36.8 | . . 16.0 |
| | 16 | 123 43.6 | 63 29.3 | 10.0 | 105 38.0 | 22.1 | 65 49.2 | 25.7 | 133 39.1 | 15.9 |
| | 17 | 138 46.1 | 78 28.5 | 10.7 | 120 38.7 | 22.8 | 80 51.0 | 25.8 | 148 41.5 | 15.9 |
| | 18 | 153 48.6 | 93 27.8 | N20 11.4 | 135 39.4 | N 6 23.6 | 95 52.9 | N19 25.9 | 163 43.8 | S 6 15.8 |
| | 19 | 168 51.0 | 108 27.1 | 12.1 | 150 40.1 | 24.3 | 110 54.7 | 26.1 | 178 46.1 | 15.8 |
| | 20 | 183 53.5 | 123 26.4 | 12.8 | 165 40.8 | 25.0 | 125 56.6 | 26.2 | 193 48.4 | 15.7 |
| | 21 | 198 56.0 | 138 25.6 | . . 13.5 | 180 41.5 | . . 25.7 | 140 58.5 | . . 26.3 | 208 50.8 | . . 15.7 |
| | 22 | 213 58.4 | 153 24.9 | 14.2 | 195 42.2 | 26.5 | 156 00.3 | 26.4 | 223 53.1 | 15.6 |
| | 23 | 229 00.9 | 168 24.2 | 14.9 | 210 43.0 | 27.2 | 171 02.2 | 26.6 | 238 55.4 | 15.6 |
| 26 | 00 | 244 03.4 | 183 23.4 | N20 15.6 | 225 43.7 | N 6 27.9 | 186 04.0 | N19 26.7 | 253 57.8 | S 6 15.6 |
| | 01 | 259 05.8 | 198 22.7 | 16.3 | 240 44.4 | 28.6 | 201 05.9 | 26.8 | 269 00.1 | 15.5 |
| | 02 | 274 08.3 | 213 22.0 | 17.0 | 255 45.1 | 29.4 | 216 07.7 | 26.9 | 284 02.4 | 15.5 |
| | 03 | 289 10.7 | 228 21.2 | . . 17.6 | 270 45.8 | . . 30.1 | 231 09.6 | . . 27.1 | 299 04.8 | . . 15.4 |
| | 04 | 304 13.2 | 243 20.5 | 18.3 | 285 46.5 | 30.8 | 246 11.4 | 27.2 | 314 07.1 | 15.4 |
| | 05 | 319 15.7 | 258 19.8 | 19.0 | 300 47.2 | 31.5 | 261 13.3 | 27.3 | 329 09.4 | 15.3 |
| | 06 | 334 18.1 | 273 19.1 | N20 19.7 | 315 47.9 | N 6 32.2 | 276 15.2 | N19 27.5 | 344 11.8 | S 6 15.3 |
| | 07 | 349 20.6 | 288 18.3 | 20.4 | 330 48.6 | 33.0 | 291 17.0 | 27.6 | 359 14.1 | 15.2 |
| | 08 | 4 23.1 | 303 17.6 | 21.1 | 345 49.3 | 33.7 | 306 18.9 | 27.7 | 14 16.4 | 15.2 |
| SUNDAY | 09 | 19 25.5 | 318 16.9 | . . 21.8 | 0 50.0 | . . 34.4 | 321 20.7 | . . 27.8 | 29 18.8 | . . 15.1 |
| | 10 | 34 28.0 | 333 16.1 | 22.4 | 15 50.8 | 35.1 | 336 22.6 | 28.0 | 44 21.1 | 15.1 |
| | 11 | 49 30.5 | 348 15.4 | 23.1 | 30 51.5 | 35.9 | 351 24.4 | 28.1 | 59 23.4 | 15.1 |
| | 12 | 64 32.9 | 3 14.7 | N20 23.8 | 45 52.2 | N 6 36.6 | 6 26.3 | N19 28.2 | 74 25.8 | S 6 15.0 |
| | 13 | 79 35.4 | 18 13.9 | 24.5 | 60 52.9 | 37.3 | 21 28.1 | 28.3 | 89 28.1 | 15.0 |
| | 14 | 94 37.9 | 33 13.2 | 25.2 | 75 53.6 | 38.0 | 36 30.0 | 28.5 | 104 30.4 | 14.9 |
| | 15 | 109 40.3 | 48 12.5 | . . 25.8 | 90 54.3 | . . 38.7 | 51 31.9 | . . 28.6 | 119 32.8 | . . 14.9 |
| | 16 | 124 42.8 | 63 11.7 | 26.5 | 105 55.0 | 39.5 | 66 33.7 | 28.7 | 134 35.1 | 14.8 |
| | 17 | 139 45.2 | 78 11.0 | 27.2 | 120 55.7 | 40.2 | 81 35.6 | 28.8 | 149 37.4 | 14.8 |
| | 18 | 154 47.7 | 93 10.2 | N20 27.9 | 135 56.4 | N 6 40.9 | 96 37.4 | N19 29.0 | 164 39.8 | S 6 14.7 |
| | 19 | 169 50.2 | 108 09.5 | 28.5 | 150 57.1 | 41.6 | 111 39.3 | 29.1 | 179 42.1 | 14.7 |
| | 20 | 184 52.6 | 123 08.8 | 29.2 | 165 57.8 | 42.3 | 126 41.1 | 29.2 | 194 44.4 | 14.7 |
| | 21 | 199 55.1 | 138 08.0 | . . 29.9 | 180 58.6 | . . 43.1 | 141 43.0 | . . 29.3 | 209 46.8 | . . 14.6 |
| | 22 | 214 57.6 | 153 07.3 | 30.6 | 195 59.3 | 43.8 | 156 44.8 | 29.5 | 224 49.1 | 14.6 |
| | 23 | 230 00.0 | 168 06.5 | 31.2 | 211 00.0 | 44.5 | 171 46.7 | 29.6 | 239 51.5 | 14.5 |
| Mer. Pass. | | h m 7 46.4 | v −0.7 | d 0.7 | v 0.7 | d 0.7 | v 1.9 | d 0.1 | v 2.3 | d 0.0 |

## STARS

| Name | SHA | Dec |
|---|---|---|
| | ° ′ | ° ′ |
| Acamar | 315 12.6 | S40 12.4 |
| Achernar | 335 21.0 | S57 06.6 |
| Acrux | 173 00.3 | S63 14.3 |
| Adhara | 255 06.6 | S29 00.4 |
| Aldebaran | 290 40.6 | N16 33.4 |
| Alioth | 166 13.1 | N55 49.8 |
| Alkaid | 152 52.0 | N49 11.6 |
| Alnair | 27 33.5 | S46 50.4 |
| Alnilam | 275 38.6 | S 1 11.2 |
| Alphard | 217 48.4 | S 8 45.9 |
| Alphecca | 126 03.8 | N26 37.9 |
| Alpheratz | 357 35.5 | N29 13.3 |
| Altair | 62 00.3 | N 8 55.8 |
| Ankaa | 353 07.9 | S42 10.3 |
| Antares | 112 16.1 | S26 29.2 |
| Arcturus | 145 48.1 | N19 03.3 |
| Atria | 107 10.3 | S69 04.2 |
| Avior | 234 15.3 | S59 35.5 |
| Bellatrix | 278 23.8 | N 6 22.3 |
| Betelgeuse | 270 53.0 | N 7 24.7 |
| Canopus | 263 53.1 | S52 42.6 |
| Capella | 280 23.2 | N46 01.4 |
| Deneb | 49 26.0 | N45 21.7 |
| Denebola | 182 25.4 | N14 26.2 |
| Diphda | 348 48.0 | S17 51.2 |
| Dubhe | 193 41.5 | N61 37.5 |
| Elnath | 278 02.9 | N28 37.7 |
| Eltanin | 90 41.9 | N51 28.9 |
| Enif | 33 39.3 | N 9 59.1 |
| Fomalhaut | 15 15.2 | S29 29.5 |
| Gacrux | 171 52.0 | S57 15.2 |
| Gienah | 175 44.0 | S17 40.8 |
| Hadar | 148 36.2 | S60 29.6 |
| Hamal | 327 52.1 | N23 34.5 |
| Kaus Aust. | 83 32.9 | S34 22.3 |
| Kochab | 137 18.6 | N74 03.4 |
| Markab | 13 30.5 | N15 20.0 |
| Menkar | 314 07.0 | N 4 11.1 |
| Menkent | 147 57.9 | S36 29.5 |
| Miaplacidus | 221 38.7 | S69 49.3 |
| Mirfak | 308 29.5 | N49 56.7 |
| Nunki | 75 48.1 | S26 16.0 |
| Peacock | 53 06.3 | S56 39.2 |
| Pollux | 243 18.2 | N27 58.1 |
| Procyon | 244 51.6 | N 5 09.7 |
| Rasalhague | 95 58.7 | N12 32.4 |
| Regulus | 207 35.0 | N11 50.9 |
| Rigel | 281 04.7 | S 8 10.5 |
| Rigil Kent. | 139 40.5 | S60 56.3 |
| Sabik | 102 03.1 | S15 45.3 |
| Schedar | 349 32.0 | N56 40.0 |
| Shaula | 96 10.7 | S37 07.3 |
| Sirius | 258 27.0 | S16 45.0 |
| Spica | 158 22.6 | S11 17.4 |
| Suhail | 222 46.9 | S43 32.1 |
| Vega | 80 33.2 | N38 48.2 |
| Zuben'ubi | 136 56.3 | S16 08.7 |

| | SHA | Mer. Pass. |
|---|---|---|
| | ° ′ | h m |
| Venus | 300 36.6 | 11 46 |
| Mars | 342 22.4 | 8 58 |
| Jupiter | 302 15.3 | 11 37 |
| Saturn | 9 57.6 | 7 07 |

# 2024 MAY 24, 25, 26 (FRI., SAT., SUN.)



| UT | SUN GHA | SUN Dec | MOON GHA | v | MOON Dec | d | HP |
|---|---|---|---|---|---|---|---|
| d h | ° ′ | ° ′ | ° ′ | ′ | ° ′ | ′ | ′ |
| 24 00 (FRIDAY) | 180 47.3 | N20 49.2 | 356 12.7 | 8.4 | S25 46.3 | 6.9 | 56.4 |
| 01 | 195 47.3 | 49.6 | 10 40.1 | 8.3 | 25 53.2 | 6.7 | 56.4 |
| 02 | 210 47.2 | 50.1 | 25 07.4 | 8.3 | 25 59.9 | 6.6 | 56.4 |
| 03 | 225 47.1 | . . 50.5 | 39 34.7 | 8.1 | 26 06.5 | 6.5 | 56.4 |
| 04 | 240 47.1 | 51.0 | 54 01.8 | 8.1 | 26 13.0 | 6.3 | 56.4 |
| 05 | 255 47.0 | 51.5 | 68 28.9 | 8.0 | 26 19.3 | 6.2 | 56.5 |
| 06 | 270 47.0 | N20 51.9 | 82 55.9 | 7.8 | S26 25.5 | 6.0 | 56.5 |
| 07 | 285 46.9 | 52.4 | 97 22.7 | 7.8 | 26 31.5 | 5.9 | 56.5 |
| 08 | 300 46.8 | 52.8 | 111 49.5 | 7.7 | 26 37.4 | 5.7 | 56.5 |
| 09 | 315 46.8 | . . 53.3 | 126 16.2 | 7.6 | 26 43.1 | 5.6 | 56.5 |
| 10 | 330 46.7 | 53.7 | 140 42.8 | 7.6 | 26 48.7 | 5.5 | 56.6 |
| 11 | 345 46.7 | 54.2 | 155 09.4 | 7.4 | 26 54.2 | 5.3 | 56.6 |
| 12 | 0 46.6 | N20 54.6 | 169 35.8 | 7.4 | S26 59.5 | 5.1 | 56.6 |
| 13 | 15 46.5 | 55.1 | 184 02.2 | 7.2 | 27 04.6 | 5.0 | 56.6 |
| 14 | 30 46.5 | 55.5 | 198 28.4 | 7.3 | 27 09.6 | 4.9 | 56.7 |
| 15 | 45 46.4 | . . 56.0 | 212 54.7 | 7.1 | 27 14.5 | 4.7 | 56.7 |
| 16 | 60 46.4 | 56.4 | 227 20.8 | 7.0 | 27 19.2 | 4.5 | 56.7 |
| 17 | 75 46.3 | 56.9 | 241 46.8 | 7.0 | 27 23.7 | 4.4 | 56.7 |
| 18 | 90 46.2 | N20 57.3 | 256 12.8 | 6.9 | S27 28.1 | 4.2 | 56.7 |
| 19 | 105 46.2 | 57.8 | 270 38.7 | 6.8 | 27 32.3 | 4.1 | 56.8 |
| 20 | 120 46.1 | 58.2 | 285 04.5 | 6.8 | 27 36.4 | 3.9 | 56.8 |
| 21 | 135 46.0 | . . 58.7 | 299 30.3 | 6.7 | 27 40.3 | 3.8 | 56.8 |
| 22 | 150 46.0 | 59.1 | 313 56.0 | 6.6 | 27 44.1 | 3.6 | 56.8 |
| 23 | 165 45.9 | 20 59.6 | 328 21.6 | 6.5 | 27 47.7 | 3.4 | 56.8 |
| 25 00 (SATURDAY) | 180 45.9 | N21 00.0 | 342 47.1 | 6.5 | S27 51.1 | 3.3 | 56.9 |
| 01 | 195 45.8 | 00.4 | 357 12.6 | 6.4 | 27 54.4 | 3.1 | 56.9 |
| 02 | 210 45.7 | 00.9 | 11 38.0 | 6.4 | 27 57.5 | 3.0 | 56.9 |
| 03 | 225 45.7 | . . 01.3 | 26 03.4 | 6.3 | 28 00.5 | 2.8 | 56.9 |
| 04 | 240 45.6 | 01.8 | 40 28.7 | 6.2 | 28 03.3 | 2.6 | 57.0 |
| 05 | 255 45.5 | 02.2 | 54 53.9 | 6.2 | 28 05.9 | 2.4 | 57.0 |
| 06 | 270 45.5 | N21 02.7 | 69 19.1 | 6.2 | S28 08.3 | 2.3 | 57.0 |
| 07 | 285 45.4 | 03.1 | 83 44.3 | 6.1 | 28 10.6 | 2.1 | 57.0 |
| 08 | 300 45.3 | 03.5 | 98 09.4 | 6.0 | 28 12.7 | 2.0 | 57.0 |
| 09 | 315 45.3 | . . 04.0 | 112 34.4 | 6.0 | 28 14.7 | 1.8 | 57.1 |
| 10 | 330 45.2 | 04.4 | 126 59.4 | 5.9 | 28 16.5 | 1.6 | 57.1 |
| 11 | 345 45.1 | 04.8 | 141 24.3 | 5.9 | 28 18.1 | 1.4 | 57.1 |
| 12 | 0 45.1 | N21 05.3 | 155 49.2 | 5.9 | S28 19.5 | 1.3 | 57.1 |
| 13 | 15 45.0 | 05.7 | 170 14.1 | 5.8 | 28 20.8 | 1.1 | 57.1 |
| 14 | 30 44.9 | 06.2 | 184 38.9 | 5.8 | 28 21.9 | 0.9 | 57.2 |
| 15 | 45 44.9 | . . 06.6 | 199 03.7 | 5.7 | 28 22.8 | 0.8 | 57.2 |
| 16 | 60 44.8 | 07.0 | 213 28.4 | 5.8 | 28 23.6 | 0.6 | 57.2 |
| 17 | 75 44.7 | 07.5 | 227 53.2 | 5.6 | 28 24.2 | 0.4 | 57.2 |
| 18 | 90 44.7 | N21 07.9 | 242 17.8 | 5.7 | S28 24.6 | 0.2 | 57.2 |
| 19 | 105 44.6 | 08.3 | 256 42.5 | 5.6 | 28 24.8 | 0.0 | 57.3 |
| 20 | 120 44.5 | 08.8 | 271 07.1 | 5.6 | 28 24.8 | 0.1 | 57.3 |
| 21 | 135 44.5 | . . 09.2 | 285 31.7 | 5.6 | 28 24.7 | 0.3 | 57.3 |
| 22 | 150 44.4 | 09.6 | 299 56.3 | 5.6 | 28 24.4 | 0.4 | 57.3 |
| 23 | 165 44.3 | 10.0 | 314 20.9 | 5.5 | 28 24.0 | 0.7 | 57.3 |
| 26 00 (SUNDAY) | 180 44.3 | N21 10.5 | 328 45.4 | 5.6 | S28 23.3 | 0.8 | 57.4 |
| 01 | 195 44.2 | 10.9 | 343 10.0 | 5.5 | 28 22.5 | 1.0 | 57.4 |
| 02 | 210 44.1 | 11.3 | 357 34.5 | 5.5 | 28 21.5 | 1.1 | 57.4 |
| 03 | 225 44.1 | . . 11.8 | 11 59.0 | 5.5 | 28 20.4 | 1.4 | 57.4 |
| 04 | 240 44.0 | 12.2 | 26 23.5 | 5.5 | 28 19.0 | 1.5 | 57.5 |
| 05 | 255 43.9 | 12.6 | 40 48.0 | 5.4 | 28 17.5 | 1.7 | 57.5 |
| 06 | 270 43.9 | N21 13.0 | 55 12.4 | 5.5 | S28 15.8 | 1.9 | 57.5 |
| 07 | 285 43.8 | 13.5 | 69 36.9 | 5.5 | 28 13.9 | 2.0 | 57.5 |
| 08 | 300 43.7 | 13.9 | 84 01.4 | 5.5 | 28 11.9 | 2.3 | 57.5 |
| 09 | 315 43.7 | . . 14.3 | 98 25.9 | 5.5 | 28 09.6 | 2.4 | 57.5 |
| 10 | 330 43.6 | 14.7 | 112 50.4 | 5.5 | 28 07.2 | 2.6 | 57.6 |
| 11 | 345 43.5 | 15.1 | 127 14.9 | 5.5 | 28 04.6 | 2.7 | 57.6 |
| 12 | 0 43.4 | N21 15.6 | 141 39.4 | 5.5 | S28 01.9 | 2.9 | 57.6 |
| 13 | 15 43.4 | 16.0 | 156 03.9 | 5.5 | 27 59.0 | 3.2 | 57.6 |
| 14 | 30 43.3 | 16.4 | 170 28.4 | 5.6 | 27 55.8 | 3.2 | 57.6 |
| 15 | 45 43.2 | . . 16.8 | 184 53.0 | 5.5 | 27 52.6 | 3.5 | 57.7 |
| 16 | 60 43.2 | 17.2 | 199 17.5 | 5.6 | 27 49.1 | 3.6 | 57.7 |
| 17 | 75 43.1 | 17.7 | 213 42.1 | 5.6 | 27 45.5 | 3.8 | 57.7 |
| 18 | 90 43.0 | N21 18.1 | 228 06.7 | 5.6 | S27 41.7 | 4.0 | 57.7 |
| 19 | 105 42.9 | 18.5 | 242 31.3 | 5.6 | 27 37.7 | 4.2 | 57.7 |
| 20 | 120 42.9 | 18.9 | 256 55.9 | 5.7 | 27 33.5 | 4.3 | 57.8 |
| 21 | 135 42.8 | . . 19.3 | 271 20.6 | 5.7 | 27 29.2 | 4.5 | 57.8 |
| 22 | 150 42.7 | 19.7 | 285 45.3 | 5.7 | 27 24.7 | 4.7 | 57.8 |
| 23 | 165 42.6 | 20.2 | 300 10.0 | 5.8 | S27 20.0 | 4.8 | 57.8 |
| | SD 15.8 | *d* 0.4 | SD | 15.4 | 15.6 | | 15.7 |

| Lat. | Twilight Naut. | Twilight Civil | Sunrise | Moonrise 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | □ | □ | □ | ■ | ■ | ■ | ■ |
| N 70 | □ | □ | □ | ■ | ■ | ■ | ■ |
| 68 | //// | //// | 00 26 | ■ | ■ | ■ | ■ |
| 66 | //// | //// | 01 40 | ■ | ■ | ■ | ■ |
| 64 | //// | //// | 02 15 | ■ | ■ | ■ | ■ |
| 62 | //// | 01 01 | 02 41 | ■ | ■ | ■ | 02 07 |
| 60 | //// | 01 46 | 03 00 | 23 35 | 24 48 | 00 48 | 01 18 |
| N 58 | //// | 02 14 | 03 16 | 22 59 | 24 07 | 00 07 | 00 47 |
| 56 | 00 55 | 02 36 | 03 30 | 22 32 | 23 39 | 24 23 | 00 23 |
| 54 | 01 36 | 02 53 | 03 42 | 22 12 | 23 17 | 24 04 | 00 04 |
| 52 | 02 03 | 03 08 | 03 52 | 21 54 | 22 59 | 23 48 | 24 21 |
| 50 | 02 23 | 03 20 | 04 02 | 21 40 | 22 44 | 23 34 | 24 10 |
| 45 | 02 59 | 03 45 | 04 21 | 21 10 | 22 13 | 23 05 | 23 46 |
| N 40 | 03 26 | 04 05 | 04 37 | 20 47 | 21 49 | 22 42 | 23 27 |
| 35 | 03 46 | 04 21 | 04 50 | 20 27 | 21 29 | 22 24 | 23 11 |
| 30 | 04 02 | 04 35 | 05 01 | 20 11 | 21 12 | 22 08 | 22 57 |
| 20 | 04 28 | 04 57 | 05 21 | 19 44 | 20 43 | 21 40 | 22 33 |
| N 10 | 04 49 | 05 15 | 05 38 | 19 20 | 20 19 | 21 17 | 22 12 |
| 0 | 05 05 | 05 31 | 05 53 | 18 58 | 19 56 | 20 55 | 21 53 |
| S 10 | 05 21 | 05 46 | 06 09 | 18 36 | 19 33 | 20 33 | 21 33 |
| 20 | 05 35 | 06 02 | 06 25 | 18 13 | 19 09 | 20 10 | 21 13 |
| 30 | 05 49 | 06 18 | 06 44 | 17 45 | 18 40 | 19 42 | 20 48 |
| 35 | 05 56 | 06 27 | 06 55 | 17 29 | 18 23 | 19 26 | 20 34 |
| 40 | 06 04 | 06 38 | 07 07 | 17 11 | 18 04 | 19 07 | 20 17 |
| 45 | 06 13 | 06 49 | 07 22 | 16 49 | 17 40 | 18 44 | 19 57 |
| S 50 | 06 23 | 07 03 | 07 40 | 16 20 | 17 09 | 18 15 | 19 32 |
| 52 | 06 27 | 07 09 | 07 48 | 16 06 | 16 54 | 18 00 | 19 20 |
| 54 | 06 32 | 07 16 | 07 58 | 15 50 | 16 37 | 17 43 | 19 06 |
| 56 | 06 37 | 07 24 | 08 09 | 15 32 | 16 15 | 17 23 | 18 50 |
| 58 | 06 42 | 07 32 | 08 21 | 15 08 | 15 48 | 16 58 | 18 30 |
| S 60 | 06 48 | 07 42 | 08 35 | 14 38 | 15 10 | 16 23 | 18 06 |

| Lat. | Sunset | Twilight Civil | Twilight Naut. | Moonset 24 | 25 | 26 | 27 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | □ | □ | □ | ■ | ■ | ■ | ■ |
| N 70 | □ | □ | □ | ■ | ■ | ■ | ■ |
| 68 | □ | □ | □ | ■ | ■ | ■ | ■ |
| 66 | 22 18 | //// | //// | ■ | ■ | ■ | ■ |
| 64 | 21 41 | //// | //// | 00 32 | ■ | ■ | ■ |
| 62 | 21 15 | 22 58 | //// | 01 51 | ■ | ■ | 04 18 |
| 60 | 20 55 | 22 11 | //// | 02 27 | 02 44 | 03 34 | 05 07 |
| N 58 | 20 39 | 21 42 | //// | 02 53 | 03 21 | 04 15 | 05 38 |
| 56 | 20 25 | 21 20 | 23 03 | 03 14 | 03 47 | 04 43 | 06 01 |
| 54 | 20 13 | 21 02 | 22 20 | 03 31 | 04 08 | 05 04 | 06 20 |
| 52 | 20 02 | 20 48 | 21 53 | 03 46 | 04 26 | 05 22 | 06 36 |
| 50 | 19 53 | 20 35 | 21 33 | 03 59 | 04 41 | 05 38 | 06 50 |
| 45 | 19 34 | 20 09 | 20 55 | 04 26 | 05 11 | 06 08 | 07 18 |
| N 40 | 19 18 | 19 49 | 20 29 | 04 47 | 05 34 | 06 32 | 07 40 |
| 35 | 19 04 | 19 33 | 20 09 | 05 04 | 05 54 | 06 52 | 07 58 |
| 30 | 18 53 | 19 20 | 19 52 | 05 20 | 06 10 | 07 09 | 08 13 |
| 20 | 18 33 | 18 57 | 19 26 | 05 46 | 06 39 | 07 37 | 08 40 |
| N 10 | 18 16 | 18 39 | 19 06 | 06 08 | 07 03 | 08 02 | 09 02 |
| 0 | 18 01 | 18 23 | 18 49 | 06 29 | 07 25 | 08 24 | 09 23 |
| S 10 | 17 45 | 18 07 | 18 33 | 06 50 | 07 48 | 08 47 | 09 44 |
| 20 | 17 29 | 17 52 | 18 19 | 07 12 | 08 12 | 09 11 | 10 06 |
| 30 | 17 10 | 17 36 | 18 05 | 07 38 | 08 41 | 09 39 | 10 32 |
| 35 | 16 59 | 17 26 | 17 57 | 07 54 | 08 57 | 09 56 | 10 47 |
| 40 | 16 46 | 17 16 | 17 49 | 08 12 | 09 17 | 10 15 | 11 04 |
| 45 | 16 32 | 17 04 | 17 41 | 08 34 | 09 40 | 10 38 | 11 25 |
| S 50 | 16 14 | 16 51 | 17 31 | 09 01 | 10 11 | 11 08 | 11 51 |
| 52 | 16 05 | 16 44 | 17 27 | 09 15 | 10 26 | 11 23 | 12 04 |
| 54 | 15 56 | 16 37 | 17 22 | 09 31 | 10 44 | 11 40 | 12 18 |
| 56 | 15 45 | 16 30 | 17 17 | 09 49 | 11 05 | 12 00 | 12 35 |
| 58 | 15 33 | 16 21 | 17 11 | 10 12 | 11 32 | 12 26 | 12 55 |
| S 60 | 15 19 | 16 11 | 17 05 | 10 42 | 12 10 | 13 01 | 13 20 |

| Day | SUN Eqn. of Time $00^h$ | SUN Eqn. of Time $12^h$ | SUN Mer. Pass. | MOON Mer. Pass. Upper | MOON Mer. Pass. Lower | MOON Age | MOON Phase |
|---|---|---|---|---|---|---|---|
| d | m s | m s | h m | h m | h m | d | % |
| 24 | 03 09 | 03 07 | 11 57 | 00 16 | 12 43 | 16 | 99 |
| 25 | 03 04 | 03 00 | 11 57 | 01 12 | 13 41 | 17 | 96 ○ |
| 26 | 02 57 | 02 54 | 11 57 | 02 10 | 14 40 | 18 | 90 |

# 2024 MAY 30, 31, JUNE 1 (THURS., FRI., SAT.)

| UT | ARIES | VENUS −3·9 | | MARS +1·1 | | JUPITER −2·0 | | SATURN +1·0 | |
|---|---|---|---|---|---|---|---|---|---|
| d h | GHA ° ′ | GHA ° ′ | Dec ° ′ | GHA ° ′ | Dec ° ′ | GHA ° ′ | Dec ° ′ | GHA ° ′ | Dec ° ′ |
| 30 00 (THURSDAY) | 247 59.9 | 182 11.3 | N21 17.5 | 226 51.7 | N 7 36.7 | 189 02.1 | N19 38.7 | 257 42.3 | S 6 11.5 |
| 01 | 263 02.4 | 197 10.6 | 18.1 | 241 52.4 | 37.4 | 204 04.0 | 38.8 | 272 44.6 | 11.4 |
| 02 | 278 04.8 | 212 09.8 | 18.7 | 256 53.1 | 38.1 | 219 05.9 | 38.9 | 287 47.0 | 11.4 |
| 03 | 293 07.3 | 227 09.0 | . . 19.3 | 271 53.8 | . . 38.8 | 234 07.7 | . . 39.0 | 302 49.3 | . . 11.4 |
| 04 | 308 09.8 | 242 08.2 | 19.9 | 286 54.5 | 39.5 | 249 09.6 | 39.2 | 317 51.7 | 11.3 |
| 05 | 323 12.2 | 257 07.5 | 20.5 | 301 55.2 | 40.2 | 264 11.4 | 39.3 | 332 54.0 | 11.3 |
| 06 | 338 14.7 | 272 06.7 | N21 21.1 | 316 55.9 | N 7 40.9 | 279 13.3 | N19 39.4 | 347 56.4 | S 6 11.2 |
| 07 | 353 17.2 | 287 05.9 | 21.7 | 331 56.6 | 41.6 | 294 15.1 | 39.5 | 2 58.7 | 11.2 |
| 08 | 8 19.6 | 302 05.1 | 22.2 | 346 57.3 | 42.4 | 309 17.0 | 39.6 | 18 01.1 | 11.2 |
| 09 | 23 22.1 | 317 04.4 | . . 22.8 | 1 58.0 | . . 43.1 | 324 18.8 | . . 39.8 | 33 03.4 | . . 11.1 |
| 10 | 38 24.6 | 332 03.6 | 23.4 | 16 58.7 | 43.8 | 339 20.7 | 39.9 | 48 05.8 | 11.1 |
| 11 | 53 27.0 | 347 02.8 | 24.0 | 31 59.4 | 44.5 | 354 22.6 | 40.0 | 63 08.1 | 11.0 |
| 12 | 68 29.5 | 2 02.0 | N21 24.6 | 47 00.1 | N 7 45.2 | 9 24.4 | N19 40.1 | 78 10.5 | S 6 11.0 |
| 13 | 83 32.0 | 17 01.3 | 25.2 | 62 00.8 | 45.9 | 24 26.3 | 40.3 | 93 12.8 | 11.0 |
| 14 | 98 34.4 | 32 00.5 | 25.8 | 77 01.5 | 46.6 | 39 28.1 | 40.4 | 108 15.2 | 10.9 |
| 15 | 113 36.9 | 46 59.7 | . . 26.3 | 92 02.3 | . . 47.3 | 54 30.0 | . . 40.5 | 123 17.5 | . . 10.9 |
| 16 | 128 39.3 | 61 58.9 | 26.9 | 107 03.0 | 48.0 | 69 31.8 | 40.6 | 138 19.8 | 10.8 |
| 17 | 143 41.8 | 76 58.1 | 27.5 | 122 03.7 | 48.7 | 84 33.7 | 40.7 | 153 22.2 | 10.8 |
| 18 | 158 44.3 | 91 57.4 | N21 28.1 | 137 04.4 | N 7 49.4 | 99 35.6 | N19 40.9 | 168 24.5 | S 6 10.8 |
| 19 | 173 46.7 | 106 56.6 | 28.7 | 152 05.1 | 50.1 | 114 37.4 | 41.0 | 183 26.9 | 10.7 |
| 20 | 188 49.2 | 121 55.8 | 29.2 | 167 05.8 | 50.8 | 129 39.3 | 41.1 | 198 29.2 | 10.7 |
| 21 | 203 51.7 | 136 55.0 | . . 29.8 | 182 06.5 | . . 51.5 | 144 41.1 | . . 41.2 | 213 31.6 | . . 10.7 |
| 22 | 218 54.1 | 151 54.2 | 30.4 | 197 07.2 | 52.3 | 159 43.0 | 41.4 | 228 33.9 | 10.6 |
| 23 | 233 56.6 | 166 53.5 | 31.0 | 212 07.9 | 53.0 | 174 44.8 | 41.5 | 243 36.3 | 10.6 |
| 31 00 (FRIDAY) | 248 59.1 | 181 52.7 | N21 31.5 | 227 08.6 | N 7 53.7 | 189 46.7 | N19 41.6 | 258 38.6 | S 6 10.5 |
| 01 | 264 01.5 | 196 51.9 | 32.1 | 242 09.3 | 54.4 | 204 48.5 | 41.7 | 273 41.0 | 10.5 |
| 02 | 279 04.0 | 211 51.1 | 32.7 | 257 10.0 | 55.1 | 219 50.4 | 41.8 | 288 43.3 | 10.5 |
| 03 | 294 06.4 | 226 50.3 | . . 33.2 | 272 10.7 | . . 55.8 | 234 52.3 | . . 42.0 | 303 45.7 | . . 10.4 |
| 04 | 309 08.9 | 241 49.5 | 33.8 | 287 11.4 | 56.5 | 249 54.1 | 42.1 | 318 48.0 | 10.4 |
| 05 | 324 11.4 | 256 48.7 | 34.4 | 302 12.1 | 57.2 | 264 56.0 | 42.2 | 333 50.4 | 10.4 |
| 06 | 339 13.8 | 271 48.0 | N21 34.9 | 317 12.9 | N 7 57.9 | 279 57.8 | N19 42.3 | 348 52.7 | S 6 10.3 |
| 07 | 354 16.3 | 286 47.2 | 35.5 | 332 13.6 | 58.6 | 294 59.7 | 42.4 | 3 55.1 | 10.3 |
| 08 | 9 18.8 | 301 46.4 | 36.1 | 347 14.3 | 7 59.3 | 310 01.5 | 42.6 | 18 57.4 | 10.2 |
| 09 | 24 21.2 | 316 45.6 | . . 36.6 | 2 15.0 | 8 00.0 | 325 03.4 | . . 42.7 | 33 59.8 | . . 10.2 |
| 10 | 39 23.7 | 331 44.8 | 37.2 | 17 15.7 | 00.7 | 340 05.2 | 42.8 | 49 02.1 | 10.2 |
| 11 | 54 26.2 | 346 44.0 | 37.8 | 32 16.4 | 01.4 | 355 07.1 | 42.9 | 64 04.5 | 10.1 |
| 12 | 69 28.6 | 1 43.2 | N21 38.3 | 47 17.1 | N 8 02.1 | 10 09.0 | N19 43.1 | 79 06.8 | S 6 10.1 |
| 13 | 84 31.1 | 16 42.5 | 38.9 | 62 17.8 | 02.8 | 25 10.8 | 43.2 | 94 09.2 | 10.1 |
| 14 | 99 33.6 | 31 41.7 | 39.4 | 77 18.5 | 03.5 | 40 12.7 | 43.3 | 109 11.5 | 10.0 |
| 15 | 114 36.0 | 46 40.9 | . . 40.0 | 92 19.2 | . . 04.2 | 55 14.5 | . . 43.4 | 124 13.9 | . . 10.0 |
| 16 | 129 38.5 | 61 40.1 | 40.6 | 107 19.9 | 04.9 | 70 16.4 | 43.5 | 139 16.2 | 09.9 |
| 17 | 144 40.9 | 76 39.3 | 41.1 | 122 20.6 | 05.6 | 85 18.2 | 43.7 | 154 18.6 | 09.9 |
| 18 | 159 43.4 | 91 38.5 | N21 41.7 | 137 21.3 | N 8 06.3 | 100 20.1 | N19 43.8 | 169 20.9 | S 6 09.9 |
| 19 | 174 45.9 | 106 37.7 | 42.2 | 152 22.0 | 07.0 | 115 22.0 | 43.9 | 184 23.3 | 09.8 |
| 20 | 189 48.3 | 121 36.9 | 42.8 | 167 22.7 | 07.7 | 130 23.8 | 44.0 | 199 25.6 | 09.8 |
| 21 | 204 50.8 | 136 36.1 | . . 43.3 | 182 23.4 | . . 08.4 | 145 25.7 | . . 44.1 | 214 28.0 | . . 09.8 |
| 22 | 219 53.3 | 151 35.3 | 43.9 | 197 24.2 | 09.1 | 160 27.5 | 44.3 | 229 30.3 | 09.7 |
| 23 | 234 55.7 | 166 34.6 | 44.4 | 212 24.9 | 09.8 | 175 29.4 | 44.4 | 244 32.7 | 09.7 |
| 1 00 (SATURDAY) | 249 58.2 | 181 33.8 | N21 45.0 | 227 25.6 | N 8 10.6 | 190 31.2 | N19 44.5 | 259 35.1 | S 6 09.7 |
| 01 | 265 00.7 | 196 33.0 | 45.5 | 242 26.3 | 11.3 | 205 33.1 | 44.6 | 274 37.4 | 09.6 |
| 02 | 280 03.1 | 211 32.2 | 46.1 | 257 27.0 | 12.0 | 220 34.9 | 44.7 | 289 39.8 | 09.6 |
| 03 | 295 05.6 | 226 31.4 | . . 46.6 | 272 27.7 | . . 12.7 | 235 36.8 | . . 44.9 | 304 42.1 | . . 09.5 |
| 04 | 310 08.0 | 241 30.6 | 47.1 | 287 28.4 | 13.4 | 250 38.7 | 45.0 | 319 44.5 | 09.5 |
| 05 | 325 10.5 | 256 29.8 | 47.7 | 302 29.1 | 14.1 | 265 40.5 | 45.1 | 334 46.8 | 09.5 |
| 06 | 340 13.0 | 271 29.0 | N21 48.2 | 317 29.8 | N 8 14.8 | 280 42.4 | N19 45.2 | 349 49.2 | S 6 09.4 |
| 07 | 355 15.4 | 286 28.2 | 48.8 | 332 30.5 | 15.5 | 295 44.2 | 45.3 | 4 51.5 | 09.4 |
| 08 | 10 17.9 | 301 27.4 | 49.3 | 347 31.2 | 16.2 | 310 46.1 | 45.5 | 19 53.9 | 09.4 |
| 09 | 25 20.4 | 316 26.6 | . . 49.8 | 2 31.9 | . . 16.9 | 325 47.9 | . . 45.6 | 34 56.2 | . . 09.3 |
| 10 | 40 22.8 | 331 25.8 | 50.4 | 17 32.6 | 17.6 | 340 49.8 | 45.7 | 49 58.6 | 09.3 |
| 11 | 55 25.3 | 346 25.0 | 50.9 | 32 33.3 | 18.3 | 355 51.7 | 45.8 | 65 00.9 | 09.3 |
| 12 | 70 27.8 | 1 24.2 | N21 51.5 | 47 34.0 | N 8 19.0 | 10 53.5 | N19 45.9 | 80 03.3 | S 6 09.2 |
| 13 | 85 30.2 | 16 23.4 | 52.0 | 62 34.7 | 19.7 | 25 55.4 | 46.1 | 95 05.6 | 09.2 |
| 14 | 100 32.7 | 31 22.6 | 52.5 | 77 35.4 | 20.4 | 40 57.2 | 46.2 | 110 08.0 | 09.1 |
| 15 | 115 35.2 | 46 21.8 | . . 53.1 | 92 36.2 | . . 21.1 | 55 59.1 | . . 46.3 | 125 10.4 | . . 09.1 |
| 16 | 130 37.6 | 61 21.0 | 53.6 | 107 36.9 | 21.8 | 71 00.9 | 46.4 | 140 12.7 | 09.1 |
| 17 | 145 40.1 | 76 20.2 | 54.1 | 122 37.6 | 22.5 | 86 02.8 | 46.5 | 155 15.1 | 09.0 |
| 18 | 160 42.5 | 91 19.4 | N21 54.6 | 137 38.3 | N 8 23.2 | 101 04.7 | N19 46.7 | 170 17.4 | S 6 09.0 |
| 19 | 175 45.0 | 106 18.6 | 55.2 | 152 39.0 | 23.9 | 116 06.5 | 46.8 | 185 19.8 | 09.0 |
| 20 | 190 47.5 | 121 17.8 | 55.7 | 167 39.7 | 24.6 | 131 08.4 | 46.9 | 200 22.1 | 08.9 |
| 21 | 205 49.9 | 136 17.0 | . . 56.2 | 182 40.4 | . . 25.2 | 146 10.2 | . . 47.0 | 215 24.5 | . . 08.9 |
| 22 | 220 52.4 | 151 16.2 | 56.7 | 197 41.1 | 25.9 | 161 12.1 | 47.1 | 230 26.8 | 08.9 |
| 23 | 235 54.9 | 166 15.4 | 57.3 | 212 41.8 | 26.6 | 176 13.9 | 47.3 | 245 29.2 | 08.8 |
| Mer. Pass. | h m 7 22.9 | *v* −0.8 | *d* 0.6 | *v* 0.7 | *d* 0.7 | *v* 1.9 | *d* 0.1 | *v* 2.4 | *d* 0.0 |

| STARS Name | SHA ° ′ | Dec ° ′ |
|---|---|---|
| Acamar | 315 12.6 | S40 12.3 |
| Achernar | 335 21.0 | S57 06.6 |
| Acrux | 173 00.4 | S63 14.3 |
| Adhara | 255 06.6 | S29 00.4 |
| Aldebaran | 290 40.6 | N16 33.5 |
| Alioth | 166 13.1 | N55 49.9 |
| Alkaid | 152 52.0 | N49 11.6 |
| Alnair | 27 33.5 | S46 50.4 |
| Alnilam | 275 38.6 | S 1 11.2 |
| Alphard | 217 48.4 | S 8 45.9 |
| Alphecca | 126 03.8 | N26 37.9 |
| Alpheratz | 357 35.5 | N29 13.3 |
| Altair | 62 00.2 | N 8 55.8 |
| Ankaa | 353 07.8 | S42 10.2 |
| Antares | 112 16.1 | S26 29.2 |
| Arcturus | 145 48.1 | N19 03.3 |
| Atria | 107 10.2 | S69 04.3 |
| Avior | 234 15.4 | S59 35.4 |
| Bellatrix | 278 23.8 | N 6 22.3 |
| Betelgeuse | 270 53.0 | N 7 24.7 |
| Canopus | 263 53.1 | S52 42.6 |
| Capella | 280 23.1 | N46 01.3 |
| Deneb | 49 25.9 | N45 21.7 |
| Denebola | 182 25.4 | N14 26.2 |
| Diphda | 348 48.0 | S17 51.1 |
| Dubhe | 193 41.6 | N61 37.5 |
| Elnath | 278 02.9 | N28 37.7 |
| Eltanin | 90 41.9 | N51 29.0 |
| Enif | 33 39.2 | N 9 59.1 |
| Fomalhaut | 15 15.1 | S29 29.5 |
| Gacrux | 171 52.0 | S57 15.2 |
| Gienah | 175 44.0 | S17 40.8 |
| Hadar | 148 36.3 | S60 29.6 |
| Hamal | 327 52.1 | N23 34.5 |
| Kaus Aust. | 83 32.8 | S34 22.3 |
| Kochab | 137 18.7 | N74 03.4 |
| Markab | 13 30.5 | N15 20.0 |
| Menkar | 314 07.0 | N 4 11.1 |
| Menkent | 147 57.9 | S36 29.5 |
| Miaplacidus | 221 38.8 | S69 49.3 |
| Mirfak | 308 29.5 | N49 56.7 |
| Nunki | 75 48.1 | S26 16.0 |
| Peacock | 53 06.2 | S56 39.2 |
| Pollux | 243 18.2 | N27 58.1 |
| Procyon | 244 51.6 | N 5 09.8 |
| Rasalhague | 95 58.7 | N12 32.4 |
| Regulus | 207 35.1 | N11 50.9 |
| Rigel | 281 04.7 | S 8 10.4 |
| Rigil Kent. | 139 40.5 | S60 56.3 |
| Sabik | 102 03.0 | S15 45.3 |
| Schedar | 349 32.0 | N56 40.0 |
| Shaula | 96 10.7 | S37 07.3 |
| Sirius | 258 27.0 | S16 45.0 |
| Spica | 158 22.6 | S11 17.4 |
| Suhail | 222 46.9 | S43 32.0 |
| Vega | 80 33.2 | N38 48.2 |
| Zuben'ubi | 136 56.3 | S16 08.7 |
| | **SHA** ° ′ | **Mer. Pass.** h m |
| Venus | 292 53.6 | 11 53 |
| Mars | 338 09.6 | 8 51 |
| Jupiter | 300 47.6 | 11 19 |
| Saturn | 9 39.6 | 6 44 |

## 2024 MAY 30, 31, JUNE 1 (THURS., FRI., SAT.) 111

| UT d | h | SUN GHA ° ′ | SUN Dec ° ′ | MOON GHA ° ′ | v ′ | MOON Dec ° ′ | d ′ | HP ′ |
|---|---|---|---|---|---|---|---|---|
| 30 | 00 | 180 36.8 | N21 48.7 | 274 54.9 | 10.5 | S14 56.1 | 14.6 | 59.0 |
| | 01 | 195 36.7 | 49.0 | 289 24.4 | 10.5 | 14 41.5 | 14.7 | 59.0 |
| | 02 | 210 36.6 | 49.4 | 303 53.9 | 10.6 | 14 26.8 | 14.7 | 59.0 |
| | 03 | 225 36.5 | . . 49.8 | 318 23.5 | 10.6 | 14 12.1 | 14.8 | 59.0 |
| | 04 | 240 36.4 | 50.1 | 332 53.1 | 10.7 | 13 57.3 | 14.9 | 59.0 |
| | 05 | 255 36.3 | 50.5 | 347 22.8 | 10.7 | 13 42.4 | 15.0 | 59.1 |
| | 06 | 270 36.2 | N21 50.9 | 1 52.5 | 10.8 | S13 27.4 | 15.1 | 59.1 |
| | 07 | 285 36.1 | 51.2 | 16 22.3 | 10.9 | 13 12.3 | 15.1 | 59.1 |
| T | 08 | 300 36.0 | 51.6 | 30 52.2 | 10.9 | 12 57.2 | 15.2 | 59.1 |
| H | 09 | 315 36.0 | . . 51.9 | 45 22.1 | 10.9 | 12 42.0 | 15.3 | 59.1 |
| U | 10 | 330 35.9 | 52.3 | 59 52.0 | 11.0 | 12 26.7 | 15.3 | 59.1 |
| R | 11 | 345 35.8 | 52.7 | 74 22.0 | 11.1 | 12 11.4 | 15.4 | 59.1 |
| S | 12 | 0 35.7 | N21 53.0 | 88 52.1 | 11.1 | S11 56.0 | 15.5 | 59.1 |
| D | 13 | 15 35.6 | 53.4 | 103 22.2 | 11.1 | 11 40.5 | 15.6 | 59.1 |
| A | 14 | 30 35.5 | 53.7 | 117 52.3 | 11.2 | 11 24.9 | 15.6 | 59.2 |
| Y | 15 | 45 35.4 | . . 54.1 | 132 22.5 | 11.3 | 11 09.3 | 15.7 | 59.2 |
| | 16 | 60 35.3 | 54.5 | 146 52.8 | 11.3 | 10 53.6 | 15.7 | 59.2 |
| | 17 | 75 35.2 | 54.8 | 161 23.1 | 11.3 | 10 37.9 | 15.8 | 59.2 |
| | 18 | 90 35.1 | N21 55.2 | 175 53.4 | 11.4 | S10 22.1 | 15.9 | 59.2 |
| | 19 | 105 35.1 | 55.5 | 190 23.8 | 11.4 | 10 06.2 | 15.9 | 59.2 |
| | 20 | 120 35.0 | 55.9 | 204 54.2 | 11.4 | 9 50.3 | 15.9 | 59.2 |
| | 21 | 135 34.9 | . . 56.2 | 219 24.6 | 11.5 | 9 34.4 | 16.1 | 59.2 |
| | 22 | 150 34.8 | 56.6 | 233 55.1 | 11.6 | 9 18.3 | 16.0 | 59.2 |
| | 23 | 165 34.7 | 56.9 | 248 25.7 | 11.5 | 9 02.3 | 16.2 | 59.3 |
| 31 | 00 | 180 34.6 | N21 57.3 | 262 56.2 | 11.7 | S 8 46.1 | 16.2 | 59.3 |
| | 01 | 195 34.5 | 57.6 | 277 26.9 | 11.6 | 8 29.9 | 16.2 | 59.3 |
| | 02 | 210 34.4 | 58.0 | 291 57.5 | 11.7 | 8 13.7 | 16.3 | 59.3 |
| | 03 | 225 34.3 | . . 58.3 | 306 28.2 | 11.7 | 7 57.4 | 16.3 | 59.3 |
| | 04 | 240 34.2 | 58.7 | 320 58.9 | 11.7 | 7 41.1 | 16.3 | 59.3 |
| | 05 | 255 34.1 | 59.0 | 335 29.6 | 11.8 | 7 24.8 | 16.5 | 59.3 |
| | 06 | 270 34.0 | N21 59.4 | 350 00.4 | 11.8 | S 7 08.3 | 16.4 | 59.3 |
| | 07 | 285 33.9 | 21 59.7 | 4 31.2 | 11.8 | 6 51.9 | 16.5 | 59.3 |
| | 08 | 300 33.8 | 22 00.1 | 19 02.0 | 11.8 | 6 35.4 | 16.5 | 59.3 |
| F | 09 | 315 33.8 | . . 00.4 | 33 32.8 | 11.9 | 6 18.9 | 16.6 | 59.4 |
| R | 10 | 330 33.7 | 00.8 | 48 03.7 | 11.9 | 6 02.3 | 16.6 | 59.4 |
| I | 11 | 345 33.6 | 01.1 | 62 34.6 | 11.9 | 5 45.7 | 16.6 | 59.4 |
| D | 12 | 0 33.5 | N22 01.5 | 77 05.5 | 11.9 | S 5 29.1 | 16.7 | 59.4 |
| A | 13 | 15 33.4 | 01.8 | 91 36.4 | 11.9 | 5 12.4 | 16.7 | 59.4 |
| Y | 14 | 30 33.3 | 02.1 | 106 07.3 | 12.0 | 4 55.7 | 16.7 | 59.4 |
| | 15 | 45 33.2 | . . 02.5 | 120 38.3 | 12.0 | 4 39.0 | 16.8 | 59.4 |
| | 16 | 60 33.1 | 02.8 | 135 09.3 | 12.0 | 4 22.2 | 16.8 | 59.4 |
| | 17 | 75 33.0 | 03.2 | 149 40.3 | 12.0 | 4 05.4 | 16.8 | 59.4 |
| | 18 | 90 32.9 | N22 03.5 | 164 11.3 | 12.0 | S 3 48.6 | 16.8 | 59.4 |
| | 19 | 105 32.8 | 03.8 | 178 42.3 | 12.0 | 3 31.8 | 16.9 | 59.4 |
| | 20 | 120 32.7 | 04.2 | 193 13.3 | 12.1 | 3 14.9 | 16.8 | 59.4 |
| | 21 | 135 32.6 | . . 04.5 | 207 44.4 | 12.0 | 2 58.1 | 16.9 | 59.4 |
| | 22 | 150 32.5 | 04.8 | 222 15.4 | 12.1 | 2 41.2 | 16.9 | 59.5 |
| | 23 | 165 32.4 | 05.2 | 236 46.5 | 12.0 | 2 24.3 | 17.0 | 59.5 |
| 1 | 00 | 180 32.3 | N22 05.5 | 251 17.5 | 12.1 | S 2 07.3 | 16.9 | 59.5 |
| | 01 | 195 32.2 | 05.9 | 265 48.6 | 12.0 | 1 50.4 | 17.0 | 59.5 |
| | 02 | 210 32.1 | 06.2 | 280 19.6 | 12.1 | 1 33.4 | 16.9 | 59.5 |
| | 03 | 225 32.0 | . . 06.5 | 294 50.7 | 12.1 | 1 16.5 | 17.0 | 59.5 |
| | 04 | 240 31.9 | 06.9 | 309 21.8 | 12.0 | 0 59.5 | 17.0 | 59.5 |
| | 05 | 255 31.8 | 07.2 | 323 52.8 | 12.1 | 0 42.5 | 17.0 | 59.5 |
| | 06 | 270 31.7 | N22 07.5 | 338 23.9 | 12.0 | S 0 25.5 | 17.0 | 59.5 |
| | 07 | 285 31.6 | 07.8 | 352 54.9 | 12.1 | S 0 08.5 | 17.0 | 59.5 |
| S | 08 | 300 31.5 | 08.2 | 7 26.0 | 12.0 | N 0 08.5 | 17.0 | 59.5 |
| A | 09 | 315 31.4 | . . 08.5 | 21 57.0 | 12.0 | 0 25.5 | 17.0 | 59.5 |
| T | 10 | 330 31.3 | 08.8 | 36 28.0 | 12.1 | 0 42.5 | 17.0 | 59.5 |
| U | 11 | 345 31.2 | 09.2 | 50 59.1 | 12.0 | 0 59.5 | 17.0 | 59.5 |
| R | 12 | 0 31.1 | N22 09.5 | 65 30.1 | 12.0 | N 1 16.5 | 17.0 | 59.5 |
| D | 13 | 15 31.0 | 09.8 | 80 01.1 | 11.9 | 1 33.5 | 17.0 | 59.5 |
| A | 14 | 30 30.9 | 10.1 | 94 32.0 | 12.0 | 1 50.5 | 17.0 | 59.5 |
| Y | 15 | 45 30.8 | . . 10.5 | 109 03.0 | 12.0 | 2 07.5 | 17.0 | 59.5 |
| | 16 | 60 30.7 | 10.8 | 123 34.0 | 11.9 | 2 24.5 | 17.0 | 59.5 |
| | 17 | 75 30.6 | 11.1 | 138 04.9 | 11.9 | 2 41.5 | 16.9 | 59.5 |
| | 18 | 90 30.5 | N22 11.4 | 152 35.8 | 11.9 | N 2 58.4 | 17.0 | 59.5 |
| | 19 | 105 30.4 | 11.8 | 167 06.7 | 11.8 | 3 15.4 | 16.9 | 59.6 |
| | 20 | 120 30.3 | 12.1 | 181 37.5 | 11.9 | 3 32.3 | 16.9 | 59.6 |
| | 21 | 135 30.2 | . . 12.4 | 196 08.4 | 11.8 | 3 49.2 | 17.0 | 59.6 |
| | 22 | 150 30.1 | 12.7 | 210 39.2 | 11.8 | 4 06.2 | 16.8 | 59.6 |
| | 23 | 165 30.0 | 13.0 | 225 10.0 | 11.8 | N 4 23.0 | 16.9 | 59.6 |
| | | SD 15.8 | *d* 0.3 | SD | 16.1 | | 16.2 | 16.2 |

| Lat. ° | Twilight Naut. h m | Twilight Civil h m | Sunrise h m | Moonrise 30 h m | Moonrise 31 h m | Moonrise 1 h m | Moonrise 2 h m |
|---|---|---|---|---|---|---|---|
| N 72 | ▭ | ▭ | ▭ | 03 13 | 02 19 | 01 40 | 01 03 |
| N 70 | ▭ | ▭ | ▭ | 02 46 | 02 08 | 01 38 | 01 10 |
| 68 | ▭ | ▭ | ▭ | 02 24 | 01 58 | 01 36 | 01 15 |
| 66 | //// | //// | 01 15 | 02 08 | 01 50 | 01 34 | 01 20 |
| 64 | //// | //// | 01 59 | 01 54 | 01 43 | 01 33 | 01 24 |
| 62 | //// | 00 11 | 02 28 | 01 42 | 01 37 | 01 32 | 01 27 |
| 60 | //// | 01 28 | 02 50 | 01 32 | 01 31 | 01 31 | 01 30 |
| N 58 | //// | 02 01 | 03 08 | 01 23 | 01 27 | 01 30 | 01 33 |
| 56 | 00 10 | 02 25 | 03 23 | 01 15 | 01 23 | 01 29 | 01 35 |
| 54 | 01 20 | 02 44 | 03 35 | 01 08 | 01 19 | 01 28 | 01 37 |
| 52 | 01 51 | 03 00 | 03 46 | 01 02 | 01 15 | 01 27 | 01 39 |
| 50 | 02 14 | 03 14 | 03 56 | 00 56 | 01 12 | 01 27 | 01 41 |
| 45 | 02 53 | 03 41 | 04 17 | 00 44 | 01 06 | 01 25 | 01 45 |
| N 40 | 03 21 | 04 01 | 04 34 | 00 34 | 01 00 | 01 24 | 01 48 |
| 35 | 03 43 | 04 18 | 04 47 | 00 25 | 00 55 | 01 23 | 01 51 |
| 30 | 04 00 | 04 33 | 05 00 | 00 17 | 00 51 | 01 22 | 01 54 |
| 20 | 04 27 | 04 56 | 05 20 | 00 03 | 00 43 | 01 21 | 01 58 |
| N 10 | 04 48 | 05 15 | 05 38 | 24 36 | 00 36 | 01 19 | 02 02 |
| 0 | 05 06 | 05 32 | 05 54 | 24 30 | 00 30 | 01 18 | 02 06 |
| S 10 | 05 22 | 05 48 | 06 10 | 24 23 | 00 23 | 01 17 | 02 10 |
| 20 | 05 37 | 06 04 | 06 28 | 24 17 | 00 17 | 01 15 | 02 14 |
| 30 | 05 52 | 06 21 | 06 47 | 24 09 | 00 09 | 01 14 | 02 19 |
| 35 | 06 00 | 06 31 | 06 59 | 24 04 | 00 04 | 01 13 | 02 22 |
| 40 | 06 08 | 06 42 | 07 12 | 23 59 | 25 12 | 01 12 | 02 25 |
| 45 | 06 18 | 06 54 | 07 28 | 23 53 | 25 11 | 01 11 | 02 29 |
| S 50 | 06 28 | 07 09 | 07 47 | 23 46 | 25 09 | 01 09 | 02 33 |
| 52 | 06 33 | 07 16 | 07 56 | 23 43 | 25 09 | 01 09 | 02 35 |
| 54 | 06 38 | 07 23 | 08 06 | 23 39 | 25 08 | 01 08 | 02 37 |
| 56 | 06 43 | 07 31 | 08 17 | 23 35 | 25 07 | 01 07 | 02 40 |
| 58 | 06 49 | 07 41 | 08 30 | 23 30 | 25 07 | 01 07 | 02 43 |
| S 60 | 06 56 | 07 51 | 08 46 | 23 25 | 25 06 | 01 06 | 02 46 |

| Lat. ° | Sunset h m | Twilight Civil h m | Twilight Naut. h m | Moonset 30 h m | Moonset 31 h m | Moonset 1 h m | Moonset 2 h m |
|---|---|---|---|---|---|---|---|
| N 72 | ▭ | ▭ | ▭ | 09 00 | 11 39 | 14 03 | 16 32 |
| N 70 | ▭ | ▭ | ▭ | 09 26 | 11 48 | 14 00 | 16 17 |
| 68 | ▭ | ▭ | ▭ | 09 45 | 11 55 | 13 58 | 16 05 |
| 66 | 22 45 | //// | //// | 10 00 | 12 00 | 13 57 | 15 55 |
| 64 | 21 59 | //// | //// | 10 12 | 12 05 | 13 55 | 15 47 |
| 62 | 21 29 | //// | //// | 10 23 | 12 09 | 13 54 | 15 40 |
| 60 | 21 07 | 22 31 | //// | 10 31 | 12 13 | 13 53 | 15 34 |
| N 58 | 20 49 | 21 56 | //// | 10 39 | 12 16 | 13 52 | 15 29 |
| 56 | 20 34 | 21 32 | //// | 10 46 | 12 19 | 13 51 | 15 24 |
| 54 | 20 21 | 21 12 | 22 38 | 10 52 | 12 21 | 13 50 | 15 20 |
| 52 | 20 10 | 20 56 | 22 06 | 10 57 | 12 24 | 13 50 | 15 17 |
| 50 | 20 00 | 20 43 | 21 43 | 11 02 | 12 26 | 13 49 | 15 13 |
| 45 | 19 39 | 20 15 | 21 03 | 11 12 | 12 30 | 13 48 | 15 06 |
| N 40 | 19 22 | 19 55 | 20 35 | 11 21 | 12 34 | 13 47 | 15 00 |
| 35 | 19 08 | 19 38 | 20 13 | 11 28 | 12 37 | 13 46 | 14 55 |
| 30 | 18 56 | 19 23 | 19 56 | 11 35 | 12 40 | 13 45 | 14 50 |
| 20 | 18 36 | 19 00 | 19 29 | 11 46 | 12 45 | 13 43 | 14 42 |
| N 10 | 18 18 | 18 41 | 19 07 | 11 55 | 12 49 | 13 42 | 14 36 |
| 0 | 18 01 | 18 24 | 18 50 | 12 04 | 12 53 | 13 41 | 14 29 |
| S 10 | 17 45 | 18 08 | 18 34 | 12 13 | 12 57 | 13 39 | 14 23 |
| 20 | 17 28 | 17 52 | 18 19 | 12 22 | 13 01 | 13 38 | 14 16 |
| 30 | 17 08 | 17 34 | 18 04 | 12 33 | 13 05 | 13 36 | 14 08 |
| 35 | 16 56 | 17 24 | 17 56 | 12 39 | 13 08 | 13 35 | 14 04 |
| 40 | 16 43 | 17 13 | 17 47 | 12 45 | 13 10 | 13 34 | 13 59 |
| 45 | 16 28 | 17 01 | 17 38 | 12 53 | 13 14 | 13 33 | 13 53 |
| S 50 | 16 09 | 16 46 | 17 27 | 13 03 | 13 18 | 13 32 | 13 46 |
| 52 | 16 00 | 16 39 | 17 22 | 13 07 | 13 20 | 13 31 | 13 43 |
| 54 | 15 50 | 16 32 | 17 17 | 13 12 | 13 21 | 13 30 | 13 40 |
| 56 | 15 38 | 16 24 | 17 12 | 13 17 | 13 24 | 13 30 | 13 36 |
| 58 | 15 25 | 16 15 | 17 06 | 13 23 | 13 26 | 13 29 | 13 32 |
| S 60 | 15 10 | 16 04 | 16 59 | 13 29 | 13 29 | 13 28 | 13 27 |

| Day d | SUN Eqn. of Time $00^h$ m s | SUN Eqn. of Time $12^h$ m s | SUN Mer. Pass. h m | MOON Mer. Pass. Upper h m | MOON Mer. Pass. Lower h m | MOON Age d | MOON Phase % |
|---|---|---|---|---|---|---|---|
| 30 | 02 27 | 02 23 | 11 58 | 05 52 | 18 17 | 22 | 53 |
| 31 | 02 19 | 02 14 | 11 58 | 06 41 | 19 05 | 23 | 41 |
| 1 | 02 09 | 02 05 | 11 58 | 07 29 | 19 53 | 24 | 30 |

## 2024 JUNE 2, 3, 4 (SUN., MON., TUES.)

| UT (d h) | ARIES GHA | VENUS −3·9 GHA | VENUS Dec | MARS +1·0 GHA | MARS Dec | JUPITER −2·0 GHA | JUPITER Dec | SATURN +1·0 GHA | SATURN Dec |
|---|---|---|---|---|---|---|---|---|---|
| | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
| 2 SUNDAY 00 | 250 57.3 | 181 14.6 | N21 57.8 | 227 42.5 | N 8 27.3 | 191 15.8 | N19 47.4 | 260 31.6 | S 6 08.8 |
| 01 | 265 59.8 | 196 13.8 | 58.3 | 242 43.2 | 28.0 | 206 17.6 | 47.5 | 275 33.9 | 08.8 |
| 02 | 281 02.3 | 211 13.0 | 58.8 | 257 43.9 | 28.7 | 221 19.5 | 47.6 | 290 36.3 | 08.7 |
| 03 | 296 04.7 | 226 12.2 | . . 59.4 | 272 44.6 | . . 29.4 | 236 21.4 | . . 47.7 | 305 38.6 | . . 08.7 |
| 04 | 311 07.2 | 241 11.4 | 21 59.9 | 287 45.3 | 30.1 | 251 23.2 | 47.9 | 320 41.0 | 08.7 |
| 05 | 326 09.7 | 256 10.6 | 22 00.4 | 302 46.0 | 30.8 | 266 25.1 | 48.0 | 335 43.3 | 08.6 |
| 06 | 341 12.1 | 271 09.8 | N22 00.9 | 317 46.7 | N 8 31.5 | 281 26.9 | N19 48.1 | 350 45.7 | S 6 08.6 |
| 07 | 356 14.6 | 286 09.0 | 01.4 | 332 47.4 | 32.2 | 296 28.8 | 48.2 | 5 48.1 | 08.6 |
| 08 | 11 17.0 | 301 08.2 | 01.9 | 347 48.1 | 32.9 | 311 30.6 | 48.3 | 20 50.4 | 08.5 |
| 09 | 26 19.5 | 316 07.4 | . . 02.4 | 2 48.9 | . . 33.6 | 326 32.5 | . . 48.5 | 35 52.8 | . . 08.5 |
| 10 | 41 22.0 | 331 06.6 | 03.0 | 17 49.6 | 34.3 | 341 34.4 | 48.6 | 50 55.1 | 08.4 |
| 11 | 56 24.4 | 346 05.8 | 03.5 | 32 50.3 | 35.0 | 356 36.2 | 48.7 | 65 57.5 | 08.4 |
| 12 | 71 26.9 | 1 04.9 | N22 04.0 | 47 51.0 | N 8 35.7 | 11 38.1 | N19 48.8 | 80 59.8 | S 6 08.4 |
| 13 | 86 29.4 | 16 04.1 | 04.5 | 62 51.7 | 36.4 | 26 39.9 | 48.9 | 96 02.2 | 08.3 |
| 14 | 101 31.8 | 31 03.3 | 05.0 | 77 52.4 | 37.1 | 41 41.8 | 49.1 | 111 04.6 | 08.3 |
| 15 | 116 34.3 | 46 02.5 | . . 05.5 | 92 53.1 | . . 37.8 | 56 43.6 | . . 49.2 | 126 06.9 | . . 08.3 |
| 16 | 131 36.8 | 61 01.7 | 06.0 | 107 53.8 | 38.5 | 71 45.5 | 49.3 | 141 09.3 | 08.2 |
| 17 | 146 39.2 | 76 00.9 | 06.5 | 122 54.5 | 39.2 | 86 47.4 | 49.4 | 156 11.6 | 08.2 |
| 18 | 161 41.7 | 91 00.1 | N22 07.0 | 137 55.2 | N 8 39.9 | 101 49.2 | N19 49.5 | 171 14.0 | S 6 08.2 |
| 19 | 176 44.1 | 105 59.3 | 07.5 | 152 55.9 | 40.6 | 116 51.1 | 49.7 | 186 16.3 | 08.1 |
| 20 | 191 46.6 | 120 58.5 | 08.0 | 167 56.6 | 41.3 | 131 52.9 | 49.8 | 201 18.7 | 08.1 |
| 21 | 206 49.1 | 135 57.7 | . . 08.5 | 182 57.3 | . . 42.0 | 146 54.8 | . . 49.9 | 216 21.1 | . . 08.1 |
| 22 | 221 51.5 | 150 56.9 | 09.0 | 197 58.0 | 42.7 | 161 56.6 | 50.0 | 231 23.4 | 08.0 |
| 23 | 236 54.0 | 165 56.0 | 09.5 | 212 58.7 | 43.3 | 176 58.5 | 50.1 | 246 25.8 | 08.0 |
| 3 MONDAY 00 | 251 56.5 | 180 55.2 | N22 10.0 | 227 59.4 | N 8 44.0 | 192 00.4 | N19 50.2 | 261 28.1 | S 6 08.0 |
| 01 | 266 58.9 | 195 54.4 | 10.5 | 243 00.1 | 44.7 | 207 02.2 | 50.4 | 276 30.5 | 07.9 |
| 02 | 282 01.4 | 210 53.6 | 11.0 | 258 00.8 | 45.4 | 222 04.1 | 50.5 | 291 32.9 | 07.9 |
| 03 | 297 03.9 | 225 52.8 | . . 11.5 | 273 01.5 | . . 46.1 | 237 05.9 | . . 50.6 | 306 35.2 | . . 07.9 |
| 04 | 312 06.3 | 240 52.0 | 12.0 | 288 02.2 | 46.8 | 252 07.8 | 50.7 | 321 37.6 | 07.8 |
| 05 | 327 08.8 | 255 51.2 | 12.5 | 303 02.9 | 47.5 | 267 09.6 | 50.8 | 336 39.9 | 07.8 |
| 06 | 342 11.3 | 270 50.3 | N22 13.0 | 318 03.7 | N 8 48.2 | 282 11.5 | N19 51.0 | 351 42.3 | S 6 07.8 |
| 07 | 357 13.7 | 285 49.5 | 13.4 | 333 04.4 | 48.9 | 297 13.4 | 51.1 | 6 44.7 | 07.7 |
| 08 | 12 16.2 | 300 48.7 | 13.9 | 348 05.1 | 49.6 | 312 15.2 | 51.2 | 21 47.0 | 07.7 |
| 09 | 27 18.6 | 315 47.9 | . . 14.4 | 3 05.8 | . . 50.3 | 327 17.1 | . . 51.3 | 36 49.4 | . . 07.7 |
| 10 | 42 21.1 | 330 47.1 | 14.9 | 18 06.5 | 51.0 | 342 18.9 | 51.4 | 51 51.7 | 07.6 |
| 11 | 57 23.6 | 345 46.3 | 15.4 | 33 07.2 | 51.7 | 357 20.8 | 51.5 | 66 54.1 | 07.6 |
| 12 | 72 26.0 | 0 45.5 | N22 15.9 | 48 07.9 | N 8 52.4 | 12 22.6 | N19 51.7 | 81 56.5 | S 6 07.6 |
| 13 | 87 28.5 | 15 44.6 | 16.3 | 63 08.6 | 53.0 | 27 24.5 | 51.8 | 96 58.8 | 07.5 |
| 14 | 102 31.0 | 30 43.8 | 16.8 | 78 09.3 | 53.7 | 42 26.4 | 51.9 | 112 01.2 | 07.5 |
| 15 | 117 33.4 | 45 43.0 | . . 17.3 | 93 10.0 | . . 54.4 | 57 28.2 | . . 52.0 | 127 03.6 | . . 07.5 |
| 16 | 132 35.9 | 60 42.2 | 17.8 | 108 10.7 | 55.1 | 72 30.1 | 52.1 | 142 05.9 | 07.4 |
| 17 | 147 38.4 | 75 41.4 | 18.3 | 123 11.4 | 55.8 | 87 31.9 | 52.3 | 157 08.3 | 07.4 |
| 18 | 162 40.8 | 90 40.6 | N22 18.7 | 138 12.1 | N 8 56.5 | 102 33.8 | N19 52.4 | 172 10.6 | S 6 07.4 |
| 19 | 177 43.3 | 105 39.7 | 19.2 | 153 12.8 | 57.2 | 117 35.6 | 52.5 | 187 13.0 | 07.3 |
| 20 | 192 45.8 | 120 38.9 | 19.7 | 168 13.5 | 57.9 | 132 37.5 | 52.6 | 202 15.4 | 07.3 |
| 21 | 207 48.2 | 135 38.1 | . . 20.2 | 183 14.2 | . . 58.6 | 147 39.4 | . . 52.7 | 217 17.7 | . . 07.3 |
| 22 | 222 50.7 | 150 37.3 | 20.6 | 198 14.9 | 59.3 | 162 41.2 | 52.8 | 232 20.1 | 07.3 |
| 23 | 237 53.1 | 165 36.5 | 21.1 | 213 15.6 | 8 59.9 | 177 43.1 | 53.0 | 247 22.5 | 07.2 |
| 4 TUESDAY 00 | 252 55.6 | 180 35.6 | N22 21.6 | 228 16.3 | N 9 00.6 | 192 44.9 | N19 53.1 | 262 24.8 | S 6 07.2 |
| 01 | 267 58.1 | 195 34.8 | 22.0 | 243 17.0 | 01.3 | 207 46.8 | 53.2 | 277 27.2 | 07.2 |
| 02 | 283 00.5 | 210 34.0 | 22.5 | 258 17.7 | 02.0 | 222 48.6 | 53.3 | 292 29.5 | 07.1 |
| 03 | 298 03.0 | 225 33.2 | . . 23.0 | 273 18.4 | . . 02.7 | 237 50.5 | . . 53.4 | 307 31.9 | . . 07.1 |
| 04 | 313 05.5 | 240 32.3 | 23.4 | 288 19.1 | 03.4 | 252 52.4 | 53.5 | 322 34.3 | 07.1 |
| 05 | 328 07.9 | 255 31.5 | 23.9 | 303 19.9 | 04.1 | 267 54.2 | 53.7 | 337 36.6 | 07.0 |
| 06 | 343 10.4 | 270 30.7 | N22 24.4 | 318 20.6 | N 9 04.8 | 282 56.1 | N19 53.8 | 352 39.0 | S 6 07.0 |
| 07 | 358 12.9 | 285 29.9 | 24.8 | 333 21.3 | 05.5 | 297 57.9 | 53.9 | 7 41.4 | 07.0 |
| 08 | 13 15.3 | 300 29.1 | 25.3 | 348 22.0 | 06.1 | 312 59.8 | 54.0 | 22 43.7 | 06.9 |
| 09 | 28 17.8 | 315 28.2 | . . 25.7 | 3 22.7 | . . 06.8 | 328 01.6 | . . 54.1 | 37 46.1 | . . 06.9 |
| 10 | 43 20.2 | 330 27.4 | 26.2 | 18 23.4 | 07.5 | 343 03.5 | 54.2 | 52 48.5 | 06.9 |
| 11 | 58 22.7 | 345 26.6 | 26.6 | 33 24.1 | 08.2 | 358 05.4 | 54.4 | 67 50.8 | 06.8 |
| 12 | 73 25.2 | 0 25.8 | N22 27.1 | 48 24.8 | N 9 08.9 | 13 07.2 | N19 54.5 | 82 53.2 | S 6 06.8 |
| 13 | 88 27.6 | 15 24.9 | 27.5 | 63 25.5 | 09.6 | 28 09.1 | 54.6 | 97 55.5 | 06.8 |
| 14 | 103 30.1 | 30 24.1 | 28.0 | 78 26.2 | 10.3 | 43 10.9 | 54.7 | 112 57.9 | 06.7 |
| 15 | 118 32.6 | 45 23.3 | . . 28.4 | 93 26.9 | . . 11.0 | 58 12.8 | . . 54.8 | 128 00.3 | . . 06.7 |
| 16 | 133 35.0 | 60 22.4 | 28.9 | 108 27.6 | 11.6 | 73 14.7 | 54.9 | 143 02.6 | 06.7 |
| 17 | 148 37.5 | 75 21.6 | 29.3 | 123 28.3 | 12.3 | 88 16.5 | 55.1 | 158 05.0 | 06.7 |
| 18 | 163 40.0 | 90 20.7 | N22 29.8 | 138 29.0 | N 9 13.0 | 103 18.4 | N19 55.2 | 173 07.4 | S 6 06.6 |
| 19 | 178 42.4 | 105 19.9 | 30.3 | 153 29.7 | 13.7 | 118 20.2 | 55.3 | 188 09.7 | 06.6 |
| 20 | 193 44.9 | 120 19.1 | 30.7 | 168 30.4 | 14.4 | 133 22.1 | 55.4 | 203 12.1 | 06.6 |
| 21 | 208 47.4 | 135 18.3 | . . 31.2 | 183 31.1 | . . 15.1 | 148 23.9 | . . 55.5 | 218 14.5 | . . 06.5 |
| 22 | 223 49.8 | 150 17.4 | 31.6 | 198 31.8 | 15.8 | 163 25.8 | 55.6 | 233 16.8 | 06.5 |
| 23 | 238 52.3 | 165 16.6 | 32.1 | 213 32.5 | 16.4 | 178 27.7 | 55.8 | 248 19.2 | 06.5 |
| Mer. Pass. | h m 7 11.1 | v −0.8 | d 0.5 | v 0.7 | d 0.7 | v 1.9 | d 0.1 | v 2.4 | d 0.0 |

STARS

| Name | SHA | Dec |
|---|---|---|
| | ° ′ | ° ′ |
| Acamar | 315 12.5 | S40 12.3 |
| Achernar | 335 21.0 | S57 06.6 |
| Acrux | 173 00.4 | S63 14.3 |
| Adhara | 255 06.6 | S29 00.4 |
| Aldebaran | 290 40.6 | N16 33.5 |
| Alioth | 166 13.1 | N55 49.9 |
| Alkaid | 152 52.1 | N49 11.6 |
| Alnair | 27 33.4 | S46 50.4 |
| Alnilam | 275 38.6 | S 1 11.2 |
| Alphard | 217 48.4 | S 8 45.9 |
| Alphecca | 126 03.8 | N26 37.9 |
| Alpheratz | 357 35.4 | N29 13.3 |
| Altair | 62 00.2 | N 8 55.9 |
| Ankaa | 353 07.8 | S42 10.2 |
| Antares | 112 16.1 | S26 29.2 |
| Arcturus | 145 48.1 | N19 03.4 |
| Atria | 107 10.2 | S69 04.3 |
| Avior | 234 15.4 | S59 35.4 |
| Bellatrix | 278 23.8 | N 6 22.3 |
| Betelgeuse | 270 53.0 | N 7 24.7 |
| Canopus | 263 53.1 | S52 42.6 |
| Capella | 280 23.1 | N46 01.3 |
| Deneb | 49 25.9 | N45 21.8 |
| Denebola | 182 25.4 | N14 26.2 |
| Diphda | 348 48.0 | S17 51.1 |
| Dubhe | 193 41.6 | N61 37.5 |
| Elnath | 278 02.9 | N28 37.7 |
| Eltanin | 90 41.9 | N51 29.0 |
| Enif | 33 39.2 | N 9 59.1 |
| Fomalhaut | 15 15.1 | S29 29.5 |
| Gacrux | 171 52.0 | S57 15.2 |
| Gienah | 175 44.0 | S17 40.8 |
| Hadar | 148 36.3 | S60 29.6 |
| Hamal | 327 52.1 | N23 34.5 |
| Kaus Aust. | 83 32.8 | S34 22.3 |
| Kochab | 137 18.7 | N74 03.4 |
| Markab | 13 30.4 | N15 20.0 |
| Menkar | 314 07.0 | N 4 11.1 |
| Menkent | 147 57.9 | S36 29.6 |
| Miaplacidus | 221 38.9 | S69 49.3 |
| Mirfak | 308 29.5 | N49 56.7 |
| Nunki | 75 48.1 | S26 16.0 |
| Peacock | 53 06.2 | S56 39.2 |
| Pollux | 243 18.2 | N27 58.1 |
| Procyon | 244 51.6 | N 5 09.8 |
| Rasalhague | 95 58.7 | N12 32.5 |
| Regulus | 207 35.1 | N11 50.9 |
| Rigel | 281 04.7 | S 8 10.4 |
| Rigil Kent. | 139 40.5 | S60 56.3 |
| Sabik | 102 03.0 | S15 45.3 |
| Schedar | 349 31.9 | N56 40.0 |
| Shaula | 96 10.7 | S37 07.3 |
| Sirius | 258 27.0 | S16 45.0 |
| Spica | 158 22.6 | S11 17.4 |
| Suhail | 222 46.9 | S43 32.0 |
| Vega | 80 33.2 | N38 48.2 |
| Zuben'ubi | 136 56.3 | S16 08.7 |

| | SHA | Mer. Pass. |
|---|---|---|
| | ° ′ | h m |
| Venus | 288 58.8 | 11 57 |
| Mars | 336 03.0 | 8 48 |
| Jupiter | 300 03.9 | 11 11 |
| Saturn | 9 31.7 | 6 33 |

# 2024 JUNE 2, 3, 4 (SUN., MON., TUES.)



| UT | SUN GHA | SUN Dec | MOON GHA | *v* | MOON Dec | *d* | HP |
|---|---|---|---|---|---|---|---|
| d h | ° ′ | ° ′ | ° ′ | ′ | ° ′ | ′ | ′ |
| 2 00 | 180 29.9 | N22 13.4 | 239 40.8 | 11.7 | N 4 39.9 | 16.8 | 59.6 |
| 01 | 195 29.8 | 13.7 | 254 11.5 | 11.7 | 4 56.7 | 16.9 | 59.6 |
| 02 | 210 29.7 | 14.0 | 268 42.2 | 11.7 | 5 13.6 | 16.8 | 59.6 |
| 03 | 225 29.6 | . . 14.3 | 283 12.9 | 11.6 | 5 30.4 | 16.7 | 59.6 |
| 04 | 240 29.5 | 14.6 | 297 43.5 | 11.6 | 5 47.1 | 16.8 | 59.6 |
| 05 | 255 29.4 | 15.0 | 312 14.1 | 11.6 | 6 03.9 | 16.7 | 59.6 |
| 06 | 270 29.3 | N22 15.3 | 326 44.7 | 11.5 | N 6 20.6 | 16.7 | 59.6 |
| 07 | 285 29.2 | 15.6 | 341 15.2 | 11.5 | 6 37.3 | 16.6 | 59.6 |
| S 08 | 300 29.1 | 15.9 | 355 45.7 | 11.4 | 6 53.9 | 16.6 | 59.6 |
| U 09 | 315 29.0 | . . 16.2 | 10 16.1 | 11.5 | 7 10.5 | 16.6 | 59.6 |
| N 10 | 330 28.9 | 16.5 | 24 46.6 | 11.3 | 7 27.1 | 16.5 | 59.6 |
| D 11 | 345 28.8 | 16.8 | 39 16.9 | 11.4 | 7 43.6 | 16.5 | 59.6 |
| A 12 | 0 28.7 | N22 17.1 | 53 47.3 | 11.2 | N 8 00.1 | 16.5 | 59.6 |
| Y 13 | 15 28.6 | 17.5 | 68 17.5 | 11.3 | 8 16.6 | 16.4 | 59.6 |
| 14 | 30 28.5 | 17.8 | 82 47.8 | 11.2 | 8 33.0 | 16.4 | 59.6 |
| 15 | 45 28.4 | . . 18.1 | 97 18.0 | 11.1 | 8 49.4 | 16.3 | 59.6 |
| 16 | 60 28.3 | 18.4 | 111 48.1 | 11.1 | 9 05.7 | 16.2 | 59.6 |
| 17 | 75 28.2 | 18.7 | 126 18.2 | 11.0 | 9 21.9 | 16.3 | 59.6 |
| 18 | 90 28.1 | N22 19.0 | 140 48.2 | 11.0 | N 9 38.2 | 16.1 | 59.6 |
| 19 | 105 28.0 | 19.3 | 155 18.2 | 11.0 | 9 54.3 | 16.2 | 59.6 |
| 20 | 120 27.9 | 19.6 | 169 48.2 | 10.9 | 10 10.5 | 16.0 | 59.5 |
| 21 | 135 27.8 | . . 19.9 | 184 18.1 | 10.8 | 10 26.5 | 16.0 | 59.5 |
| 22 | 150 27.7 | 20.2 | 198 47.9 | 10.8 | 10 42.5 | 16.0 | 59.5 |
| 23 | 165 27.6 | 20.5 | 213 17.7 | 10.7 | 10 58.5 | 15.9 | 59.5 |
| 3 00 | 180 27.5 | N22 20.8 | 227 47.4 | 10.6 | N11 14.4 | 15.8 | 59.5 |
| 01 | 195 27.4 | 21.1 | 242 17.0 | 10.6 | 11 30.2 | 15.8 | 59.5 |
| 02 | 210 27.3 | 21.4 | 256 46.6 | 10.6 | 11 46.0 | 15.7 | 59.5 |
| 03 | 225 27.1 | . . 21.7 | 271 16.2 | 10.4 | 12 01.7 | 15.6 | 59.5 |
| 04 | 240 27.0 | 22.0 | 285 45.6 | 10.5 | 12 17.3 | 15.6 | 59.5 |
| 05 | 255 26.9 | 22.3 | 300 15.1 | 10.3 | 12 32.9 | 15.5 | 59.5 |
| 06 | 270 26.8 | N22 22.6 | 314 44.4 | 10.3 | N12 48.4 | 15.4 | 59.5 |
| 07 | 285 26.7 | 22.9 | 329 13.7 | 10.2 | 13 03.8 | 15.4 | 59.5 |
| 08 | 300 26.6 | 23.2 | 343 42.9 | 10.2 | 13 19.2 | 15.3 | 59.5 |
| M 09 | 315 26.5 | . . 23.5 | 358 12.1 | 10.1 | 13 34.5 | 15.2 | 59.5 |
| O 10 | 330 26.4 | 23.8 | 12 41.2 | 10.0 | 13 49.7 | 15.1 | 59.5 |
| N 11 | 345 26.3 | 24.1 | 27 10.2 | 10.0 | 14 04.8 | 15.1 | 59.5 |
| D 12 | 0 26.2 | N22 24.4 | 41 39.2 | 9.8 | N14 19.9 | 14.9 | 59.5 |
| A 13 | 15 26.1 | 24.7 | 56 08.0 | 9.9 | 14 34.8 | 14.9 | 59.5 |
| Y 14 | 30 26.0 | 25.0 | 70 36.9 | 9.7 | 14 49.7 | 14.8 | 59.5 |
| 15 | 45 25.9 | . . 25.3 | 85 05.6 | 9.7 | 15 04.5 | 14.7 | 59.4 |
| 16 | 60 25.8 | 25.6 | 99 34.3 | 9.6 | 15 19.2 | 14.7 | 59.4 |
| 17 | 75 25.7 | 25.9 | 114 02.9 | 9.5 | 15 33.9 | 14.5 | 59.4 |
| 18 | 90 25.5 | N22 26.2 | 128 31.4 | 9.5 | N15 48.4 | 14.5 | 59.4 |
| 19 | 105 25.4 | 26.5 | 142 59.9 | 9.3 | 16 02.9 | 14.3 | 59.4 |
| 20 | 120 25.3 | 26.7 | 157 28.2 | 9.4 | 16 17.2 | 14.3 | 59.4 |
| 21 | 135 25.2 | . . 27.0 | 171 56.6 | 9.2 | 16 31.5 | 14.1 | 59.4 |
| 22 | 150 25.1 | 27.3 | 186 24.8 | 9.1 | 16 45.6 | 14.1 | 59.4 |
| 23 | 165 25.0 | 27.6 | 200 52.9 | 9.1 | 16 59.7 | 13.9 | 59.4 |
| 4 00 | 180 24.9 | N22 27.9 | 215 21.0 | 9.0 | N17 13.6 | 13.9 | 59.4 |
| 01 | 195 24.8 | 28.2 | 229 49.0 | 9.0 | 17 27.5 | 13.8 | 59.4 |
| 02 | 210 24.7 | 28.5 | 244 17.0 | 8.8 | 17 41.3 | 13.6 | 59.3 |
| 03 | 225 24.6 | . . 28.7 | 258 44.8 | 8.8 | 17 54.9 | 13.6 | 59.3 |
| 04 | 240 24.5 | 29.0 | 273 12.6 | 8.7 | 18 08.5 | 13.4 | 59.3 |
| 05 | 255 24.4 | 29.3 | 287 40.3 | 8.6 | 18 21.9 | 13.3 | 59.3 |
| 06 | 270 24.2 | N22 29.6 | 302 07.9 | 8.5 | N18 35.2 | 13.2 | 59.3 |
| 07 | 285 24.1 | 29.9 | 316 35.4 | 8.5 | 18 48.4 | 13.1 | 59.3 |
| T 08 | 300 24.0 | 30.2 | 331 02.9 | 8.4 | 19 01.5 | 13.0 | 59.3 |
| U 09 | 315 23.9 | . . 30.4 | 345 30.3 | 8.3 | 19 14.5 | 12.9 | 59.3 |
| E 10 | 330 23.8 | 30.7 | 359 57.6 | 8.2 | 19 27.4 | 12.7 | 59.2 |
| S 11 | 345 23.7 | 31.0 | 14 24.8 | 8.1 | 19 40.1 | 12.7 | 59.2 |
| D 12 | 0 23.6 | N22 31.3 | 28 51.9 | 8.1 | N19 52.8 | 12.5 | 59.2 |
| A 13 | 15 23.5 | 31.6 | 43 19.0 | 8.0 | 20 05.3 | 12.4 | 59.2 |
| Y 14 | 30 23.4 | 31.8 | 57 46.0 | 7.9 | 20 17.7 | 12.2 | 59.2 |
| 15 | 45 23.2 | . . 32.1 | 72 12.9 | 7.8 | 20 29.9 | 12.1 | 59.2 |
| 16 | 60 23.1 | 32.4 | 86 39.7 | 7.7 | 20 42.0 | 12.1 | 59.2 |
| 17 | 75 23.0 | 32.7 | 101 06.4 | 7.7 | 20 54.1 | 11.8 | 59.1 |
| 18 | 90 22.9 | N22 32.9 | 115 33.1 | 7.6 | N21 05.9 | 11.8 | 59.1 |
| 19 | 105 22.8 | 33.2 | 129 59.7 | 7.5 | 21 17.7 | 11.6 | 59.1 |
| 20 | 120 22.7 | 33.5 | 144 26.2 | 7.4 | 21 29.3 | 11.5 | 59.1 |
| 21 | 135 22.6 | . . 33.8 | 158 52.6 | 7.4 | 21 40.8 | 11.3 | 59.1 |
| 22 | 150 22.5 | 34.0 | 173 19.0 | 7.2 | 21 52.1 | 11.2 | 59.1 |
| 23 | 165 22.4 | 34.3 | 187 45.2 | 7.2 | N22 03.3 | 11.1 | 59.1 |
| | SD 15.8 | *d* 0.3 | SD 16.2 | | 16.2 | | 16.1 |

| Lat. | Twilight Naut. | Twilight Civil | Sunrise | Moonrise 2 | Moonrise 3 | Moonrise 4 | Moonrise 5 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | ▭ | ▭ | ▭ | 01 03 | {00 20 / 23 02} | ▭ | ▭ |
| N 70 | ▭ | ▭ | ▭ | 01 10 | {00 38 / 23 49} | ▭ | ▭ |
| 68 | ▭ | ▭ | ▭ | 01 15 | 00 52 | {00 20 / 22 53} | ▭ |
| 66 | //// | //// | 01 01 | 01 20 | 01 04 | 00 43 | 00 08 |
| 64 | //// | //// | 01 52 | 01 24 | 01 14 | 01 02 | 00 45 |
| 62 | //// | //// | 02 23 | 01 27 | 01 22 | 01 17 | 01 12 |
| 60 | //// | 01 19 | 02 46 | 01 30 | 01 30 | 01 30 | 01 33 |
| N 58 | //// | 01 56 | 03 04 | 01 33 | 01 36 | 01 41 | 01 50 |
| 56 | //// | 02 21 | 03 20 | 01 35 | 01 42 | 01 51 | 02 05 |
| 54 | 01 12 | 02 41 | 03 33 | 01 37 | 01 47 | 02 00 | 02 18 |
| 52 | 01 46 | 02 57 | 03 44 | 01 39 | 01 52 | 02 08 | 02 29 |
| 50 | 02 10 | 03 11 | 03 54 | 01 41 | 01 56 | 02 15 | 02 39 |
| 45 | 02 51 | 03 39 | 04 15 | 01 45 | 02 06 | 02 30 | 03 00 |
| N 40 | 03 19 | 04 00 | 04 32 | 01 48 | 02 14 | 02 43 | 03 17 |
| 35 | 03 41 | 04 17 | 04 47 | 01 51 | 02 21 | 02 53 | 03 31 |
| 30 | 03 59 | 04 32 | 04 59 | 01 54 | 02 27 | 03 03 | 03 44 |
| 20 | 04 27 | 04 56 | 05 20 | 01 58 | 02 37 | 03 19 | 04 06 |
| N 10 | 04 48 | 05 15 | 05 38 | 02 02 | 02 47 | 03 34 | 04 25 |
| 0 | 05 06 | 05 32 | 05 55 | 02 06 | 02 55 | 03 47 | 04 43 |
| S 10 | 05 22 | 05 49 | 06 11 | 02 10 | 03 04 | 04 01 | 05 01 |
| 20 | 05 38 | 06 05 | 06 29 | 02 14 | 03 14 | 04 16 | 05 20 |
| 30 | 05 53 | 06 23 | 06 49 | 02 19 | 03 25 | 04 33 | 05 42 |
| 35 | 06 01 | 06 33 | 07 01 | 02 22 | 03 32 | 04 43 | 05 56 |
| 40 | 06 10 | 06 44 | 07 14 | 02 25 | 03 39 | 04 55 | 06 11 |
| 45 | 06 20 | 06 57 | 07 30 | 02 29 | 03 48 | 05 08 | 06 29 |
| S 50 | 06 31 | 07 12 | 07 49 | 02 33 | 03 58 | 05 25 | 06 53 |
| 52 | 06 35 | 07 19 | 07 59 | 02 35 | 04 03 | 05 33 | 07 04 |
| 54 | 06 41 | 07 26 | 08 09 | 02 37 | 04 08 | 05 42 | 07 16 |
| 56 | 06 46 | 07 35 | 08 21 | 02 40 | 04 14 | 05 52 | 07 31 |
| 58 | 06 53 | 07 44 | 08 34 | 02 43 | 04 21 | 06 03 | 07 48 |
| S 60 | 06 59 | 07 55 | 08 50 | 02 46 | 04 29 | 06 17 | 08 09 |

| Lat. | Sunset | Twilight Civil | Twilight Naut. | Moonset 2 | Moonset 3 | Moonset 4 | Moonset 5 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | ▭ | ▭ | ▭ | 16 32 | 19 38 | ▭ | ▭ |
| N 70 | ▭ | ▭ | ▭ | 16 17 | 18 53 | ▭ | ▭ |
| 68 | ▭ | ▭ | ▭ | 16 05 | 18 24 | 21 44 | ▭ |
| 66 | 22 59 | //// | //// | 15 55 | 18 02 | 20 31 | ▭ |
| 64 | 22 07 | //// | //// | 15 47 | 17 45 | 19 55 | 22 41 |
| 62 | 21 35 | //// | //// | 15 40 | 17 31 | 19 29 | 21 35 |
| 60 | 21 12 | 22 40 | //// | 15 34 | 17 19 | 19 09 | 21 01 |
| N 58 | 20 53 | 22 02 | //// | 15 29 | 17 09 | 18 52 | 20 36 |
| 56 | 20 38 | 21 37 | //// | 15 24 | 17 00 | 18 38 | 20 16 |
| 54 | 20 24 | 21 17 | 22 47 | 15 20 | 16 52 | 18 26 | 19 59 |
| 52 | 20 13 | 21 00 | 22 12 | 15 17 | 16 45 | 18 16 | 19 45 |
| 50 | 20 03 | 20 46 | 21 48 | 15 13 | 16 39 | 18 07 | 19 32 |
| 45 | 19 42 | 20 18 | 21 06 | 15 06 | 16 26 | 17 47 | 19 07 |
| N 40 | 19 24 | 19 57 | 20 38 | 15 00 | 16 15 | 17 31 | 18 47 |
| 35 | 19 10 | 19 39 | 20 16 | 14 55 | 16 05 | 17 18 | 18 30 |
| 30 | 18 58 | 19 25 | 19 58 | 14 50 | 15 57 | 17 06 | 18 15 |
| 20 | 18 37 | 19 01 | 19 30 | 14 42 | 15 43 | 16 46 | 17 51 |
| N 10 | 18 19 | 18 42 | 19 08 | 14 36 | 15 31 | 16 29 | 17 30 |
| 0 | 18 02 | 18 24 | 18 50 | 14 29 | 15 20 | 16 13 | 17 10 |
| S 10 | 17 45 | 18 08 | 18 34 | 14 23 | 15 08 | 15 57 | 16 50 |
| 20 | 17 28 | 17 51 | 18 19 | 14 16 | 14 56 | 15 40 | 16 29 |
| 30 | 17 07 | 17 34 | 18 03 | 14 08 | 14 43 | 15 21 | 16 05 |
| 35 | 16 56 | 17 24 | 17 55 | 14 04 | 14 35 | 15 10 | 15 51 |
| 40 | 16 42 | 17 12 | 17 46 | 13 59 | 14 26 | 14 57 | 15 35 |
| 45 | 16 26 | 17 00 | 17 37 | 13 53 | 14 15 | 14 42 | 15 15 |
| S 50 | 16 07 | 16 45 | 17 26 | 13 46 | 14 03 | 14 24 | 14 51 |
| 52 | 15 58 | 16 38 | 17 21 | 13 43 | 13 57 | 14 15 | 14 40 |
| 54 | 15 47 | 16 30 | 17 16 | 13 40 | 13 51 | 14 05 | 14 26 |
| 56 | 15 35 | 16 22 | 17 10 | 13 36 | 13 44 | 13 55 | 14 11 |
| 58 | 15 22 | 16 12 | 17 04 | 13 32 | 13 36 | 13 42 | 13 53 |
| S 60 | 15 06 | 16 01 | 16 57 | 13 27 | 13 27 | 13 28 | 13 32 |

| Day | SUN Eqn. of Time $00^h$ | SUN Eqn. of Time $12^h$ | SUN Mer. Pass. | MOON Mer. Pass. Upper | MOON Mer. Pass. Lower | MOON Age | MOON Phase |
|---|---|---|---|---|---|---|---|
| d | m s | m s | h m | h m | h m | d % | |
| 2 | 02 00 | 01 55 | 11 58 | 08 18 | 20 42 | 25 20 | |
| 3 | 01 50 | 01 45 | 11 58 | 09 07 | 21 33 | 26 12 | |
| 4 | 01 40 | 01 35 | 11 58 | 10 00 | 22 28 | 27 5 | |

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## 2024 JUNE 11, 12, 13 (TUES., WED., THURS.)

| UT | | ARIES | VENUS −3·9 | | MARS +1·0 | | JUPITER −2·0 | | SATURN +1·0 | | STARS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GHA | GHA | Dec | GHA | Dec | GHA | Dec | GHA | Dec | Name | SHA | Dec |
| d | h | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | | ° ′ | ° ′ |
| 11 | 00 | 259 49.6 | 178 13.1 | N23 24.4 | 230 14.2 | N10 53.8 | 197 57.4 | N20 12.2 | 269 03.9 | S 6 02.8 | Acamar | 315 12.5 | S40 12.3 |
| | 01 | 274 52.1 | 193 12.2 | 24.7 | 245 14.9 | 54.5 | 212 59.2 | 12.3 | 284 06.3 | 02.7 | Achernar | 335 20.9 | S57 06.5 |
| | 02 | 289 54.5 | 208 11.3 | 25.0 | 260 15.6 | 55.1 | 228 01.1 | 12.4 | 299 08.7 | 02.7 | Acrux | 173 00.4 | S63 14.4 |
| | 03 | 304 57.0 | 223 10.5 | . . 25.3 | 275 16.3 | . . 55.8 | 243 03.0 | . . 12.5 | 314 11.1 | . . 02.7 | Adhara | 255 06.6 | S29 00.3 |
| | 04 | 319 59.5 | 238 09.6 | 25.5 | 290 17.0 | 56.4 | 258 04.8 | 12.6 | 329 13.5 | 02.7 | Aldebaran | 290 40.5 | N16 33.5 |
| | 05 | 335 01.9 | 253 08.7 | 25.8 | 305 17.7 | 57.1 | 273 06.7 | 12.7 | 344 15.9 | 02.7 | | | |
| | 06 | 350 04.4 | 268 07.8 | N23 26.1 | 320 18.4 | N10 57.7 | 288 08.5 | N20 12.8 | 359 18.3 | S 6 02.6 | Alioth | 166 13.2 | N55 49.9 |
| | 07 | 5 06.8 | 283 07.0 | 26.3 | 335 19.1 | 58.4 | 303 10.4 | 12.9 | 14 20.7 | 02.6 | Alkaid | 152 52.1 | N49 11.7 |
| T | 08 | 20 09.3 | 298 06.1 | 26.6 | 350 19.8 | 59.1 | 318 12.3 | 13.0 | 29 23.1 | 02.6 | Alnair | 27 33.3 | S46 50.4 |
| U | 09 | 35 11.8 | 313 05.2 | . . 26.9 | 5 20.5 | 10 59.7 | 333 14.1 | . . 13.2 | 44 25.4 | . . 02.6 | Alnilam | 275 38.6 | S 1 11.2 |
| E | 10 | 50 14.2 | 328 04.4 | 27.1 | 20 21.2 | 11 00.4 | 348 16.0 | 13.3 | 59 27.8 | 02.6 | Alphard | 217 48.4 | S 8 45.9 |
| S | 11 | 65 16.7 | 343 03.5 | 27.4 | 35 21.9 | 01.0 | 3 17.9 | 13.4 | 74 30.2 | 02.5 | | | |
| D | 12 | 80 19.2 | 358 02.6 | N23 27.7 | 50 22.6 | N11 01.7 | 18 19.7 | N20 13.5 | 89 32.6 | S 6 02.5 | Alphecca | 126 03.8 | N26 38.0 |
| A | 13 | 95 21.6 | 13 01.7 | 27.9 | 65 23.3 | 02.3 | 33 21.6 | 13.6 | 104 35.0 | 02.5 | Alpheratz | 357 35.4 | N29 13.3 |
| Y | 14 | 110 24.1 | 28 00.9 | 28.2 | 80 24.0 | 03.0 | 48 23.4 | 13.7 | 119 37.4 | 02.5 | Altair | 62 00.2 | N 8 55.9 |
| | 15 | 125 26.6 | 43 00.0 | . . 28.4 | 95 24.7 | . . 03.6 | 63 25.3 | . . 13.8 | 134 39.8 | . . 02.5 | Ankaa | 353 07.7 | S42 10.2 |
| | 16 | 140 29.0 | 57 59.1 | 28.7 | 110 25.4 | 04.3 | 78 27.2 | 13.9 | 149 42.2 | 02.4 | Antares | 112 16.1 | S26 29.2 |
| | 17 | 155 31.5 | 72 58.2 | 29.0 | 125 26.1 | 04.9 | 93 29.0 | 14.0 | 164 44.6 | 02.4 | | | |
| | 18 | 170 33.9 | 87 57.4 | N23 29.2 | 140 26.8 | N11 05.6 | 108 30.9 | N20 14.1 | 179 47.0 | S 6 02.4 | Arcturus | 145 48.1 | N19 03.4 |
| | 19 | 185 36.4 | 102 56.5 | 29.5 | 155 27.5 | 06.3 | 123 32.8 | 14.3 | 194 49.4 | 02.4 | Atria | 107 10.2 | S69 04.3 |
| | 20 | 200 38.9 | 117 55.6 | 29.7 | 170 28.2 | 06.9 | 138 34.6 | 14.4 | 209 51.7 | 02.4 | Avior | 234 15.4 | S59 35.4 |
| | 21 | 215 41.3 | 132 54.7 | . . 30.0 | 185 28.9 | . . 07.6 | 153 36.5 | . . 14.5 | 224 54.1 | . . 02.3 | Bellatrix | 278 23.7 | N 6 22.3 |
| | 22 | 230 43.8 | 147 53.9 | 30.2 | 200 29.6 | 08.2 | 168 38.3 | 14.6 | 239 56.5 | 02.3 | Betelgeuse | 270 53.0 | N 7 24.7 |
| | 23 | 245 46.3 | 162 53.0 | 30.5 | 215 30.3 | 08.9 | 183 40.2 | 14.7 | 254 58.9 | 02.3 | | | |
| 12 | 00 | 260 48.7 | 177 52.1 | N23 30.7 | 230 31.0 | N11 09.5 | 198 42.1 | N20 14.8 | 270 01.3 | S 6 02.3 | Canopus | 263 53.2 | S52 42.5 |
| | 01 | 275 51.2 | 192 51.2 | 31.0 | 245 31.7 | 10.2 | 213 43.9 | 14.9 | 285 03.7 | 02.3 | Capella | 280 23.1 | N46 01.3 |
| | 02 | 290 53.7 | 207 50.3 | 31.2 | 260 32.4 | 10.8 | 228 45.8 | 15.0 | 300 06.1 | 02.2 | Deneb | 49 25.8 | N45 21.8 |
| | 03 | 305 56.1 | 222 49.5 | . . 31.5 | 275 33.1 | . . 11.5 | 243 47.7 | . . 15.1 | 315 08.5 | . . 02.2 | Denebola | 182 25.4 | N14 26.2 |
| | 04 | 320 58.6 | 237 48.6 | 31.7 | 290 33.8 | 12.1 | 258 49.5 | 15.2 | 330 10.9 | 02.2 | Diphda | 348 47.9 | S17 51.1 |
| | 05 | 336 01.1 | 252 47.7 | 32.0 | 305 34.5 | 12.8 | 273 51.4 | 15.3 | 345 13.3 | 02.2 | | | |
| | 06 | 351 03.5 | 267 46.8 | N23 32.2 | 320 35.2 | N11 13.4 | 288 53.3 | N20 15.4 | 0 15.7 | S 6 02.2 | Dubhe | 193 41.7 | N61 37.5 |
| W | 07 | 6 06.0 | 282 46.0 | 32.4 | 335 35.9 | 14.1 | 303 55.1 | 15.6 | 15 18.1 | 02.1 | Elnath | 278 02.9 | N28 37.7 |
| E | 08 | 21 08.4 | 297 45.1 | 32.7 | 350 36.6 | 14.7 | 318 57.0 | 15.7 | 30 20.5 | 02.1 | Eltanin | 90 41.9 | N51 29.0 |
| D | 09 | 36 10.9 | 312 44.2 | . . 32.9 | 5 37.3 | . . 15.4 | 333 58.8 | . . 15.8 | 45 22.9 | . . 02.1 | Enif | 33 39.1 | N 9 59.1 |
| N | 10 | 51 13.4 | 327 43.3 | 33.2 | 20 38.0 | 16.0 | 349 00.7 | 15.9 | 60 25.2 | 02.1 | Fomalhaut | 15 15.0 | S29 29.4 |
| E | 11 | 66 15.8 | 342 42.4 | 33.4 | 35 38.7 | 16.7 | 4 02.6 | 16.0 | 75 27.6 | 02.1 | | | |
| S | 12 | 81 18.3 | 357 41.6 | N23 33.6 | 50 39.4 | N11 17.3 | 19 04.4 | N20 16.1 | 90 30.0 | S 6 02.1 | Gacrux | 171 52.1 | S57 15.3 |
| D | 13 | 96 20.8 | 12 40.7 | 33.9 | 65 40.1 | 18.0 | 34 06.3 | 16.2 | 105 32.4 | 02.0 | Gienah | 175 44.0 | S17 40.8 |
| A | 14 | 111 23.2 | 27 39.8 | 34.1 | 80 40.8 | 18.6 | 49 08.2 | 16.3 | 120 34.8 | 02.0 | Hadar | 148 36.3 | S60 29.7 |
| Y | 15 | 126 25.7 | 42 38.9 | . . 34.3 | 95 41.5 | . . 19.3 | 64 10.0 | . . 16.4 | 135 37.2 | . . 02.0 | Hamal | 327 52.0 | N23 34.5 |
| | 16 | 141 28.2 | 57 38.0 | 34.5 | 110 42.2 | 19.9 | 79 11.9 | 16.5 | 150 39.6 | 02.0 | Kaus Aust. | 83 32.8 | S34 22.4 |
| | 17 | 156 30.6 | 72 37.2 | 34.8 | 125 42.9 | 20.6 | 94 13.8 | 16.6 | 165 42.0 | 02.0 | | | |
| | 18 | 171 33.1 | 87 36.3 | N23 35.0 | 140 43.6 | N11 21.2 | 109 15.6 | N20 16.7 | 180 44.4 | S 6 01.9 | Kochab | 137 18.8 | N74 03.5 |
| | 19 | 186 35.6 | 102 35.4 | 35.2 | 155 44.3 | 21.9 | 124 17.5 | 16.9 | 195 46.8 | 01.9 | Markab | 13 30.3 | N15 20.1 |
| | 20 | 201 38.0 | 117 34.5 | 35.5 | 170 45.0 | 22.5 | 139 19.4 | 17.0 | 210 49.2 | 01.9 | Menkar | 314 06.9 | N 4 11.1 |
| | 21 | 216 40.5 | 132 33.6 | . . 35.7 | 185 45.7 | . . 23.2 | 154 21.2 | . . 17.1 | 225 51.6 | . . 01.9 | Menkent | 147 57.9 | S36 29.6 |
| | 22 | 231 42.9 | 147 32.8 | 35.9 | 200 46.4 | 23.8 | 169 23.1 | 17.2 | 240 54.0 | 01.9 | Miaplacidus | 221 39.0 | S69 49.2 |
| | 23 | 246 45.4 | 162 31.9 | 36.1 | 215 47.1 | 24.4 | 184 24.9 | 17.3 | 255 56.4 | 01.9 | | | |
| 13 | 00 | 261 47.9 | 177 31.0 | N23 36.3 | 230 47.8 | N11 25.1 | 199 26.8 | N20 17.4 | 270 58.8 | S 6 01.8 | Mirfak | 308 29.4 | N49 56.7 |
| | 01 | 276 50.3 | 192 30.1 | 36.6 | 245 48.5 | 25.7 | 214 28.7 | 17.5 | 286 01.2 | 01.8 | Nunki | 75 48.0 | S26 16.0 |
| | 02 | 291 52.8 | 207 29.2 | 36.8 | 260 49.2 | 26.4 | 229 30.5 | 17.6 | 301 03.6 | 01.8 | Peacock | 53 06.0 | S56 39.2 |
| | 03 | 306 55.3 | 222 28.4 | . . 37.0 | 275 49.9 | . . 27.0 | 244 32.4 | . . 17.7 | 316 06.0 | . . 01.8 | Pollux | 243 18.2 | N27 58.1 |
| | 04 | 321 57.7 | 237 27.5 | 37.2 | 290 50.6 | 27.7 | 259 34.3 | 17.8 | 331 08.4 | 01.8 | Procyon | 244 51.6 | N 5 09.8 |
| | 05 | 337 00.2 | 252 26.6 | 37.4 | 305 51.2 | 28.3 | 274 36.1 | 17.9 | 346 10.8 | 01.7 | | | |
| | 06 | 352 02.7 | 267 25.7 | N23 37.6 | 320 51.9 | N11 29.0 | 289 38.0 | N20 18.0 | 1 13.2 | S 6 01.7 | Rasalhague | 95 58.7 | N12 32.5 |
| | 07 | 7 05.1 | 282 24.8 | 37.8 | 335 52.6 | 29.6 | 304 39.9 | 18.1 | 16 15.5 | 01.7 | Regulus | 207 35.1 | N11 50.9 |
| T | 08 | 22 07.6 | 297 23.9 | 38.1 | 350 53.3 | 30.3 | 319 41.7 | 18.2 | 31 17.9 | 01.7 | Rigel | 281 04.7 | S 8 10.4 |
| H | 09 | 37 10.0 | 312 23.1 | . . 38.3 | 5 54.0 | . . 30.9 | 334 43.6 | . . 18.4 | 46 20.3 | . . 01.7 | Rigil Kent. | 139 40.5 | S60 56.3 |
| U | 10 | 52 12.5 | 327 22.2 | 38.5 | 20 54.7 | 31.6 | 349 45.5 | 18.5 | 61 22.7 | 01.7 | Sabik | 102 03.0 | S15 45.3 |
| R | 11 | 67 15.0 | 342 21.3 | 38.7 | 35 55.4 | 32.2 | 4 47.3 | 18.6 | 76 25.1 | 01.6 | | | |
| S | 12 | 82 17.4 | 357 20.4 | N23 38.9 | 50 56.1 | N11 32.8 | 19 49.2 | N20 18.7 | 91 27.5 | S 6 01.6 | Schedar | 349 31.8 | N56 40.0 |
| D | 13 | 97 19.9 | 12 19.5 | 39.1 | 65 56.8 | 33.5 | 34 51.1 | 18.8 | 106 29.9 | 01.6 | Shaula | 96 10.6 | S37 07.3 |
| A | 14 | 112 22.4 | 27 18.6 | 39.3 | 80 57.5 | 34.1 | 49 52.9 | 18.9 | 121 32.3 | 01.6 | Sirius | 258 27.0 | S16 45.0 |
| Y | 15 | 127 24.8 | 42 17.8 | . . 39.5 | 95 58.2 | . . 34.8 | 64 54.8 | . . 19.0 | 136 34.7 | . . 01.6 | Spica | 158 22.7 | S11 17.4 |
| | 16 | 142 27.3 | 57 16.9 | 39.7 | 110 58.9 | 35.4 | 79 56.6 | 19.1 | 151 37.1 | 01.6 | Suhail | 222 47.0 | S43 32.0 |
| | 17 | 157 29.8 | 72 16.0 | 39.9 | 125 59.6 | 36.1 | 94 58.5 | 19.2 | 166 39.5 | 01.5 | | | |
| | 18 | 172 32.2 | 87 15.1 | N23 40.1 | 141 00.3 | N11 36.7 | 110 00.4 | N20 19.3 | 181 41.9 | S 6 01.5 | Vega | 80 33.1 | N38 48.2 |
| | 19 | 187 34.7 | 102 14.2 | 40.3 | 156 01.0 | 37.3 | 125 02.2 | 19.4 | 196 44.3 | 01.5 | Zuben'ubi | 136 56.3 | S16 08.7 |
| | 20 | 202 37.2 | 117 13.3 | 40.5 | 171 01.7 | 38.0 | 140 04.1 | 19.5 | 211 46.7 | 01.5 | | | |
| | 21 | 217 39.6 | 132 12.5 | . . 40.7 | 186 02.4 | . . 38.6 | 155 06.0 | . . 19.6 | 226 49.1 | . . 01.5 | | | |
| | 22 | 232 42.1 | 147 11.6 | 40.9 | 201 03.1 | 39.3 | 170 07.8 | 19.7 | 241 51.5 | 01.5 | | | |
| | 23 | 247 44.5 | 162 10.7 | 41.1 | 216 03.8 | 39.9 | 185 09.7 | 19.8 | 256 53.9 | 01.5 | | | |
| Mer. Pass. | | h m 6 35.7 | *v* −0.9 | *d* 0.2 | *v* 0.7 | *d* 0.6 | *v* 1.9 | *d* 0.1 | *v* 2.4 | *d* 0.0 | | | |

| | SHA | Mer. Pass. |
|---|---|---|
| | ° ′ | h m |
| Venus | 277 03.4 | 12 09 |
| Mars | 329 42.3 | 8 38 |
| Jupiter | 297 53.3 | 10 44 |
| Saturn | 9 12.6 | 5 59 |

## 2024 JUNE 11, 12, 13 (TUES., WED., THURS.) 119

| UT d h | SUN GHA ° ′ | SUN Dec ° ′ | MOON GHA ° ′ | v ′ | MOON Dec ° ′ | d ′ | HP ′ |
|---|---|---|---|---|---|---|---|
| 11 00 (TUESDAY) | 180 04.8 | N23 06.2 | 121 06.0 | 12.6 | N20 28.1 | 10.7 | 55.3 |
| 01 | 195 04.7 | 06.4 | 135 37.6 | 12.6 | 20 17.4 | 10.7 | 55.3 |
| 02 | 210 04.5 | 06.6 | 150 09.2 | 12.8 | 20 06.7 | 10.9 | 55.3 |
| 03 | 225 04.4 | . . 06.7 | 164 41.0 | 12.9 | 19 55.8 | 10.9 | 55.2 |
| 04 | 240 04.3 | 06.9 | 179 12.9 | 12.9 | 19 44.9 | 10.9 | 55.2 |
| 05 | 255 04.2 | 07.1 | 193 44.8 | 13.1 | 19 34.0 | 11.1 | 55.2 |
| 06 | 270 04.0 | N23 07.2 | 208 16.9 | 13.1 | N19 22.9 | 11.1 | 55.2 |
| 07 | 285 03.9 | 07.4 | 222 49.0 | 13.3 | 19 11.8 | 11.2 | 55.2 |
| 08 | 300 03.8 | 07.6 | 237 21.3 | 13.3 | 19 00.6 | 11.3 | 55.1 |
| 09 | 315 03.6 | . . 07.7 | 251 53.6 | 13.4 | 18 49.3 | 11.3 | 55.1 |
| 10 | 330 03.5 | 07.9 | 266 26.0 | 13.6 | 18 38.0 | 11.4 | 55.1 |
| 11 | 345 03.4 | 08.0 | 280 58.6 | 13.6 | 18 26.6 | 11.5 | 55.1 |
| 12 | 0 03.3 | N23 08.2 | 295 31.2 | 13.7 | N18 15.1 | 11.6 | 55.0 |
| 13 | 15 03.1 | 08.4 | 310 03.9 | 13.8 | 18 03.5 | 11.6 | 55.0 |
| 14 | 30 03.0 | 08.5 | 324 36.7 | 13.9 | 17 51.9 | 11.7 | 55.0 |
| 15 | 45 02.9 | . . 08.7 | 339 09.6 | 13.9 | 17 40.2 | 11.7 | 55.0 |
| 16 | 60 02.7 | 08.8 | 353 42.5 | 14.1 | 17 28.5 | 11.8 | 55.0 |
| 17 | 75 02.6 | 09.0 | 8 15.6 | 14.1 | 17 16.7 | 11.9 | 55.0 |
| 18 | 90 02.5 | N23 09.2 | 22 48.7 | 14.3 | N17 04.8 | 11.9 | 54.9 |
| 19 | 105 02.3 | 09.3 | 37 22.0 | 14.3 | 16 52.9 | 12.0 | 54.9 |
| 20 | 120 02.2 | 09.5 | 51 55.3 | 14.4 | 16 40.9 | 12.1 | 54.9 |
| 21 | 135 02.1 | . . 09.6 | 66 28.7 | 14.4 | 16 28.8 | 12.1 | 54.9 |
| 22 | 150 02.0 | 09.8 | 81 02.1 | 14.6 | 16 16.7 | 12.2 | 54.9 |
| 23 | 165 01.8 | 09.9 | 95 35.7 | 14.6 | 16 04.5 | 12.2 | 54.8 |
| 12 00 (WEDNESDAY) | 180 01.7 | N23 10.1 | 110 09.3 | 14.7 | N15 52.3 | 12.3 | 54.8 |
| 01 | 195 01.6 | 10.2 | 124 43.0 | 14.8 | 15 40.0 | 12.3 | 54.8 |
| 02 | 210 01.4 | 10.4 | 139 16.8 | 14.9 | 15 27.7 | 12.4 | 54.8 |
| 03 | 225 01.3 | . . 10.5 | 153 50.7 | 14.9 | 15 15.3 | 12.4 | 54.8 |
| 04 | 240 01.2 | 10.7 | 168 24.6 | 15.1 | 15 02.9 | 12.5 | 54.8 |
| 05 | 255 01.0 | 10.8 | 182 58.7 | 15.1 | 14 50.4 | 12.6 | 54.7 |
| 06 | 270 00.9 | N23 11.0 | 197 32.8 | 15.1 | N14 37.8 | 12.5 | 54.7 |
| 07 | 285 00.8 | 11.1 | 212 06.9 | 15.2 | 14 25.3 | 12.7 | 54.7 |
| 08 | 300 00.7 | 11.3 | 226 41.1 | 15.4 | 14 12.6 | 12.7 | 54.7 |
| 09 | 315 00.5 | . . 11.4 | 241 15.5 | 15.3 | 13 59.9 | 12.7 | 54.7 |
| 10 | 330 00.4 | 11.6 | 255 49.8 | 15.5 | 13 47.2 | 12.8 | 54.7 |
| 11 | 345 00.3 | 11.7 | 270 24.3 | 15.5 | 13 34.4 | 12.8 | 54.6 |
| 12 | 0 00.1 | N23 11.9 | 284 58.8 | 15.6 | N13 21.6 | 12.8 | 54.6 |
| 13 | 15 00.0 | 12.0 | 299 33.4 | 15.6 | 13 08.8 | 13.0 | 54.6 |
| 14 | 29 59.9 | 12.1 | 314 08.0 | 15.7 | 12 55.8 | 12.9 | 54.6 |
| 15 | 44 59.7 | . . 12.3 | 328 42.7 | 15.8 | 12 42.9 | 13.0 | 54.6 |
| 16 | 59 59.6 | 12.4 | 343 17.5 | 15.8 | 12 29.9 | 13.0 | 54.6 |
| 17 | 74 59.5 | 12.6 | 357 52.3 | 15.9 | 12 16.9 | 13.1 | 54.6 |
| 18 | 89 59.3 | N23 12.7 | 12 27.2 | 15.9 | N12 03.8 | 13.1 | 54.5 |
| 19 | 104 59.2 | 12.8 | 27 02.1 | 16.0 | 11 50.7 | 13.1 | 54.5 |
| 20 | 119 59.1 | 13.0 | 41 37.1 | 16.1 | 11 37.6 | 13.2 | 54.5 |
| 21 | 134 59.0 | . . 13.1 | 56 12.2 | 16.1 | 11 24.4 | 13.2 | 54.5 |
| 22 | 149 58.8 | 13.3 | 70 47.3 | 16.2 | 11 11.2 | 13.3 | 54.5 |
| 23 | 164 58.7 | 13.4 | 85 22.5 | 16.2 | 10 57.9 | 13.3 | 54.5 |
| 13 00 (THURSDAY) | 179 58.6 | N23 13.5 | 99 57.7 | 16.3 | N10 44.6 | 13.3 | 54.5 |
| 01 | 194 58.4 | 13.7 | 114 33.0 | 16.3 | 10 31.3 | 13.4 | 54.5 |
| 02 | 209 58.3 | 13.8 | 129 08.3 | 16.4 | 10 17.9 | 13.3 | 54.5 |
| 03 | 224 58.2 | . . 13.9 | 143 43.7 | 16.4 | 10 04.6 | 13.5 | 54.4 |
| 04 | 239 58.0 | 14.1 | 158 19.1 | 16.5 | 9 51.1 | 13.4 | 54.4 |
| 05 | 254 57.9 | 14.2 | 172 54.6 | 16.5 | 9 37.7 | 13.5 | 54.4 |
| 06 | 269 57.8 | N23 14.3 | 187 30.1 | 16.6 | N 9 24.2 | 13.5 | 54.4 |
| 07 | 284 57.6 | 14.5 | 202 05.7 | 16.6 | 9 10.7 | 13.5 | 54.4 |
| 08 | 299 57.5 | 14.6 | 216 41.3 | 16.6 | 8 57.2 | 13.6 | 54.4 |
| 09 | 314 57.4 | . . 14.7 | 231 16.9 | 16.7 | 8 43.6 | 13.6 | 54.4 |
| 10 | 329 57.2 | 14.8 | 245 52.6 | 16.7 | 8 30.0 | 13.6 | 54.4 |
| 11 | 344 57.1 | 15.0 | 260 28.3 | 16.8 | 8 16.4 | 13.6 | 54.4 |
| 12 | 359 57.0 | N23 15.1 | 275 04.1 | 16.8 | N 8 02.8 | 13.7 | 54.4 |
| 13 | 14 56.8 | 15.2 | 289 39.9 | 16.9 | 7 49.1 | 13.7 | 54.4 |
| 14 | 29 56.7 | 15.4 | 304 15.8 | 16.9 | 7 35.4 | 13.7 | 54.3 |
| 15 | 44 56.6 | . . 15.5 | 318 51.7 | 16.9 | 7 21.7 | 13.7 | 54.3 |
| 16 | 59 56.4 | 15.6 | 333 27.6 | 16.9 | 7 08.0 | 13.8 | 54.3 |
| 17 | 74 56.3 | 15.7 | 348 03.5 | 17.0 | 6 54.2 | 13.8 | 54.3 |
| 18 | 89 56.2 | N23 15.8 | 2 39.5 | 17.0 | N 6 40.4 | 13.8 | 54.3 |
| 19 | 104 56.0 | 16.0 | 17 15.5 | 17.1 | 6 26.6 | 13.8 | 54.3 |
| 20 | 119 55.9 | 16.1 | 31 51.6 | 17.0 | 6 12.8 | 13.8 | 54.3 |
| 21 | 134 55.8 | . . 16.2 | 46 27.6 | 17.1 | 5 59.0 | 13.9 | 54.3 |
| 22 | 149 55.6 | 16.3 | 61 03.7 | 17.2 | 5 45.1 | 13.8 | 54.3 |
| 23 | 164 55.5 | 16.4 | 75 39.9 | 17.1 | N 5 31.3 | 13.9 | 54.3 |
| | SD 15.8 | *d* 0.1 | SD 15.0 | | 14.9 | | 14.8 |

| Lat. ° | Twilight Naut. h m | Twilight Civil h m | Sunrise h m | Moonrise 11 h m | Moonrise 12 h m | Moonrise 13 h m | Moonrise 14 h m |
|---|---|---|---|---|---|---|---|
| N 72 | ▭ | ▭ | ▭ | ▭ | 07 27 | 09 47 | 11 47 |
| N 70 | ▭ | ▭ | ▭ | 05 01 | 07 58 | 10 01 | 11 51 |
| 68 | ▭ | ▭ | ▭ | 06 08 | 08 21 | 10 12 | 11 54 |
| 66 | ▭ | ▭ | ▭ | 06 43 | 08 38 | 10 20 | 11 56 |
| 64 | //// | //// | 01 36 | 07 09 | 08 53 | 10 28 | 11 58 |
| 62 | //// | //// | 02 12 | 07 28 | 09 04 | 10 34 | 12 00 |
| 60 | //// | 00 57 | 02 37 | 07 44 | 09 14 | 10 39 | 12 01 |
| N 58 | //// | 01 44 | 02 57 | 07 58 | 09 23 | 10 44 | 12 03 |
| 56 | //// | 02 12 | 03 14 | 08 09 | 09 31 | 10 48 | 12 04 |
| 54 | 00 52 | 02 34 | 03 28 | 08 19 | 09 37 | 10 52 | 12 05 |
| 52 | 01 35 | 02 51 | 03 40 | 08 28 | 09 43 | 10 56 | 12 06 |
| 50 | 02 02 | 03 06 | 03 51 | 08 36 | 09 49 | 10 59 | 12 07 |
| 45 | 02 46 | 03 36 | 04 13 | 08 53 | 10 00 | 11 05 | 12 09 |
| N 40 | 03 16 | 03 58 | 04 31 | 09 07 | 10 10 | 11 11 | 12 10 |
| 35 | 03 39 | 04 16 | 04 45 | 09 18 | 10 18 | 11 16 | 12 12 |
| 30 | 03 58 | 04 31 | 04 58 | 09 29 | 10 26 | 11 20 | 12 13 |
| 20 | 04 26 | 04 56 | 05 20 | 09 46 | 10 38 | 11 27 | 12 15 |
| N 10 | 04 49 | 05 16 | 05 39 | 10 01 | 10 49 | 11 34 | 12 17 |
| 0 | 05 08 | 05 34 | 05 56 | 10 15 | 10 59 | 11 40 | 12 19 |
| S 10 | 05 24 | 05 51 | 06 14 | 10 29 | 11 09 | 11 45 | 12 21 |
| 20 | 05 40 | 06 08 | 06 32 | 10 44 | 11 19 | 11 52 | 12 22 |
| 30 | 05 57 | 06 27 | 06 53 | 11 01 | 11 32 | 11 59 | 12 25 |
| 35 | 06 05 | 06 37 | 07 05 | 11 11 | 11 38 | 12 03 | 12 26 |
| 40 | 06 15 | 06 49 | 07 19 | 11 22 | 11 46 | 12 08 | 12 27 |
| 45 | 06 25 | 07 02 | 07 36 | 11 35 | 11 56 | 12 13 | 12 29 |
| S 50 | 06 36 | 07 18 | 07 56 | 11 51 | 12 07 | 12 19 | 12 31 |
| 52 | 06 42 | 07 25 | 08 06 | 11 59 | 12 12 | 12 22 | 12 31 |
| 54 | 06 47 | 07 33 | 08 17 | 12 07 | 12 17 | 12 25 | 12 32 |
| 56 | 06 53 | 07 42 | 08 29 | 12 16 | 12 23 | 12 29 | 12 33 |
| 58 | 07 00 | 07 52 | 08 44 | 12 26 | 12 30 | 12 33 | 12 35 |
| S 60 | 07 07 | 08 04 | 09 01 | 12 38 | 12 38 | 12 37 | 12 36 |

| Lat. ° | Sunset h m | Twilight Civil h m | Twilight Naut. h m | Moonset 11 h m | Moonset 12 h m | Moonset 13 h m | Moonset 14 h m |
|---|---|---|---|---|---|---|---|
| N 72 | ▭ | ▭ | ▭ | ▭ | 02 32 | 01 39 | 01 02 |
| N 70 | ▭ | ▭ | ▭ | 03 24 | 01 59 | 01 23 | 00 56 |
| 68 | ▭ | ▭ | ▭ | 02 16 | 01 35 | 01 10 | 00 50 |
| 66 | ▭ | ▭ | ▭ | 01 39 | 01 16 | 00 59 | 00 46 |
| 64 | 22 25 | //// | //// | 01 13 | 01 00 | 00 50 | 00 42 |
| 62 | 21 49 | //// | //// | 00 52 | 00 47 | 00 43 | 00 38 |
| 60 | 21 23 | 23 04 | //// | 00 36 | 00 36 | 00 36 | 00 35 |
| N 58 | 21 03 | 22 17 | //// | 00 21 | 00 27 | 00 30 | 00 32 |
| 56 | 20 47 | 21 48 | //// | 00 09 | 00 18 | 00 25 | 00 30 |
| 54 | 20 33 | 21 27 | 23 09 | 24 11 | 00 11 | 00 20 | 00 28 |
| 52 | 20 20 | 21 09 | 22 26 | 24 04 | 00 04 | 00 16 | 00 26 |
| 50 | 20 10 | 20 54 | 21 59 | 23 58 | 24 12 | 00 12 | 00 24 |
| 45 | 19 47 | 20 25 | 21 14 | 23 45 | 24 03 | 00 03 | 00 20 |
| N 40 | 19 30 | 20 02 | 20 44 | 23 34 | 23 56 | 24 16 | 00 16 |
| 35 | 19 15 | 19 44 | 20 21 | 23 24 | 23 50 | 24 14 | 00 14 |
| 30 | 19 02 | 19 29 | 20 02 | 23 16 | 23 45 | 24 11 | 00 11 |
| 20 | 18 40 | 19 04 | 19 34 | 23 01 | 23 35 | 24 06 | 00 06 |
| N 10 | 18 21 | 18 44 | 19 11 | 22 49 | 23 27 | 24 02 | 00 02 |
| 0 | 18 04 | 18 26 | 18 52 | 22 37 | 23 19 | 23 59 | 24 37 |
| S 10 | 17 46 | 18 09 | 18 36 | 22 24 | 23 11 | 23 55 | 24 38 |
| 20 | 17 28 | 17 52 | 18 19 | 22 11 | 23 02 | 23 51 | 24 38 |
| 30 | 17 07 | 17 33 | 18 03 | 21 56 | 22 52 | 23 46 | 24 38 |
| 35 | 16 55 | 17 23 | 17 55 | 21 48 | 22 46 | 23 43 | 24 39 |
| 40 | 16 41 | 17 11 | 17 45 | 21 38 | 22 40 | 23 40 | 24 39 |
| 45 | 16 24 | 16 58 | 17 35 | 21 26 | 22 32 | 23 36 | 24 39 |
| S 50 | 16 04 | 16 42 | 17 23 | 21 11 | 22 23 | 23 32 | 24 40 |
| 52 | 15 54 | 16 35 | 17 18 | 21 05 | 22 18 | 23 30 | 24 40 |
| 54 | 15 43 | 16 27 | 17 13 | 20 57 | 22 14 | 23 27 | 24 40 |
| 56 | 15 30 | 16 18 | 17 07 | 20 49 | 22 08 | 23 25 | 24 40 |
| 58 | 15 16 | 16 07 | 17 00 | 20 39 | 22 02 | 23 22 | 24 40 |
| S 60 | 14 59 | 15 56 | 16 53 | 20 28 | 21 56 | 23 19 | 24 40 |

| Day d | SUN Eqn. of Time $00^h$ m s | SUN Eqn. of Time $12^h$ m s | SUN Mer. Pass. h m | MOON Mer. Pass. Upper h m | MOON Mer. Pass. Lower h m | Age d | Phase % |
|---|---|---|---|---|---|---|---|
| 11 | 00 19 | 00 13 | 12 00 | 16 26 | 04 03 | 05 | 25 |
| 12 | 00 07 | 00 01 | 12 00 | 17 09 | 04 48 | 06 | 34 |
| 13 | 00 06 | 00 12 | 12 00 | 17 49 | 05 29 | 07 | 43 |

# 2024 JULY 8, 9, 10 (MON., TUES., WED.)

| UT | ARIES | VENUS −3·9 | | MARS +1·0 | | JUPITER −2·0 | | SATURN +0·8 | | STARS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GHA | GHA | Dec | GHA | Dec | GHA | Dec | GHA | Dec | Name | SHA | Dec |
| d h | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | | ° ′ | ° ′ |
| 8 00 (MONDAY) | 286 26.4 | 168 46.3 | N22 08.8 | 237 39.5 | N17 09.0 | 218 16.5 | N21 13.2 | 295 24.9 | S 6 03.5 | Acamar | 315 12.3 | S40 12.1 |
| 01 | 301 28.8 | 183 45.5 | 08.3 | 252 40.2 | 09.5 | 233 18.4 | 13.3 | 310 27.4 | 03.5 | Achernar | 335 20.6 | S57 06.4 |
| 02 | 316 31.3 | 198 44.7 | 07.8 | 267 40.9 | 10.0 | 248 20.3 | 13.4 | 325 29.9 | 03.5 | Acrux | 173 00.7 | S63 14.4 |
| 03 | 331 33.8 | 213 43.9 | . . 07.3 | 282 41.6 | . . 10.5 | 263 22.2 | . . 13.4 | 340 32.4 | . . 03.5 | Adhara | 255 06.6 | S29 00.2 |
| 04 | 346 36.2 | 228 43.1 | 06.8 | 297 42.2 | 11.0 | 278 24.1 | 13.5 | 355 34.9 | 03.5 | Aldebaran | 290 40.4 | N16 33.5 |
| 05 | 1 38.7 | 243 42.3 | 06.3 | 312 42.9 | 11.4 | 293 26.1 | 13.6 | 10 37.3 | 03.6 | | | |
| 06 | 16 41.1 | 258 41.5 | N22 05.8 | 327 43.6 | N17 11.9 | 308 28.0 | N21 13.7 | 25 39.8 | S 6 03.6 | Alioth | 166 13.3 | N55 49.9 |
| 07 | 31 43.6 | 273 40.7 | 05.3 | 342 44.3 | 12.4 | 323 29.9 | 13.8 | 40 42.3 | 03.6 | Alkaid | 152 52.2 | N49 11.7 |
| 08 | 46 46.1 | 288 39.9 | 04.8 | 357 45.0 | 12.9 | 338 31.8 | 13.8 | 55 44.8 | 03.6 | Alnair | 27 33.1 | S46 50.3 |
| 09 | 61 48.5 | 303 39.1 | . . 04.2 | 12 45.6 | . . 13.4 | 353 33.7 | . . 13.9 | 70 47.3 | . . 03.7 | Alnilam | 275 38.5 | S 1 11.1 |
| 10 | 76 51.0 | 318 38.3 | 03.7 | 27 46.3 | 13.9 | 8 35.6 | 14.0 | 85 49.8 | 03.7 | Alphard | 217 48.4 | S 8 45.9 |
| 11 | 91 53.5 | 333 37.5 | 03.2 | 42 47.0 | 14.4 | 23 37.5 | 14.1 | 100 52.3 | 03.7 | | | |
| 12 | 106 55.9 | 348 36.7 | N22 02.7 | 57 47.7 | N17 14.9 | 38 39.4 | N21 14.1 | 115 54.8 | S 6 03.7 | Alphecca | 126 03.9 | N26 38.1 |
| 13 | 121 58.4 | 3 35.8 | 02.2 | 72 48.3 | 15.4 | 53 41.3 | 14.2 | 130 57.3 | 03.8 | Alpheratz | 357 35.1 | N29 13.4 |
| 14 | 137 00.9 | 18 35.0 | 01.7 | 87 49.0 | 15.8 | 68 43.2 | 14.3 | 145 59.8 | 03.8 | Altair | 62 00.0 | N 8 56.0 |
| 15 | 152 03.3 | 33 34.2 | . . 01.2 | 102 49.7 | . . 16.3 | 83 45.1 | . . 14.4 | 161 02.3 | . . 03.8 | Ankaa | 353 07.5 | S42 10.1 |
| 16 | 167 05.8 | 48 33.4 | 00.6 | 117 50.4 | 16.8 | 98 47.0 | 14.5 | 176 04.8 | 03.8 | Antares | 112 16.0 | S26 29.2 |
| 17 | 182 08.3 | 63 32.6 | 22 00.1 | 132 51.0 | 17.3 | 113 49.0 | 14.5 | 191 07.3 | 03.9 | | | |
| 18 | 197 10.7 | 78 31.8 | N21 59.6 | 147 51.7 | N17 17.8 | 128 50.9 | N21 14.6 | 206 09.8 | S 6 03.9 | Arcturus | 145 48.2 | N19 03.4 |
| 19 | 212 13.2 | 93 31.0 | 59.1 | 162 52.4 | 18.3 | 143 52.8 | 14.7 | 221 12.3 | 03.9 | Atria | 107 10.2 | S69 04.4 |
| 20 | 227 15.6 | 108 30.2 | 58.5 | 177 53.1 | 18.8 | 158 54.7 | 14.8 | 236 14.8 | 03.9 | Avior | 234 15.6 | S59 35.3 |
| 21 | 242 18.1 | 123 29.4 | . . 58.0 | 192 53.7 | . . 19.2 | 173 56.6 | . . 14.8 | 251 17.2 | . . 04.0 | Bellatrix | 278 23.6 | N 6 22.4 |
| 22 | 257 20.6 | 138 28.6 | 57.5 | 207 54.4 | 19.7 | 188 58.5 | 14.9 | 266 19.7 | 04.0 | Betelgeuse | 270 52.9 | N 7 24.7 |
| 23 | 272 23.0 | 153 27.8 | 57.0 | 222 55.1 | 20.2 | 204 00.4 | 15.0 | 281 22.2 | 04.0 | | | |
| 9 00 (TUESDAY) | 287 25.5 | 168 27.0 | N21 56.4 | 237 55.8 | N17 20.7 | 219 02.3 | N21 15.1 | 296 24.7 | S 6 04.0 | Canopus | 263 53.1 | S52 42.4 |
| 01 | 302 28.0 | 183 26.2 | 55.9 | 252 56.5 | 21.2 | 234 04.2 | 15.2 | 311 27.2 | 04.0 | Capella | 280 22.9 | N46 01.3 |
| 02 | 317 30.4 | 198 25.4 | 55.4 | 267 57.1 | 21.7 | 249 06.1 | 15.2 | 326 29.7 | 04.1 | Deneb | 49 25.7 | N45 22.0 |
| 03 | 332 32.9 | 213 24.6 | . . 54.8 | 282 57.8 | . . 22.1 | 264 08.1 | . . 15.3 | 341 32.2 | . . 04.1 | Denebola | 182 25.5 | N14 26.2 |
| 04 | 347 35.4 | 228 23.8 | 54.3 | 297 58.5 | 22.6 | 279 10.0 | 15.4 | 356 34.7 | 04.1 | Diphda | 348 47.7 | S17 51.0 |
| 05 | 2 37.8 | 243 23.0 | 53.8 | 312 59.2 | 23.1 | 294 11.9 | 15.5 | 11 37.2 | 04.1 | | | |
| 06 | 17 40.3 | 258 22.3 | N21 53.2 | 327 59.8 | N17 23.6 | 309 13.8 | N21 15.5 | 26 39.7 | S 6 04.2 | Dubhe | 193 41.8 | N61 37.4 |
| 07 | 32 42.8 | 273 21.5 | 52.7 | 343 00.5 | 24.1 | 324 15.7 | 15.6 | 41 42.2 | 04.2 | Elnath | 278 02.7 | N28 37.7 |
| 08 | 47 45.2 | 288 20.7 | 52.2 | 358 01.2 | 24.6 | 339 17.6 | 15.7 | 56 44.7 | 04.2 | Eltanin | 90 41.9 | N51 29.2 |
| 09 | 62 47.7 | 303 19.9 | . . 51.6 | 13 01.9 | . . 25.0 | 354 19.5 | . . 15.8 | 71 47.2 | . . 04.2 | Enif | 33 38.9 | N 9 59.2 |
| 10 | 77 50.1 | 318 19.1 | 51.1 | 28 02.5 | 25.5 | 9 21.4 | 15.8 | 86 49.7 | 04.3 | Fomalhaut | 15 14.8 | S29 29.4 |
| 11 | 92 52.6 | 333 18.3 | 50.5 | 43 03.2 | 26.0 | 24 23.3 | 15.9 | 101 52.2 | 04.3 | | | |
| 12 | 107 55.1 | 348 17.5 | N21 50.0 | 58 03.9 | N17 26.5 | 39 25.2 | N21 16.0 | 116 54.7 | S 6 04.3 | Gacrux | 171 52.2 | S57 15.3 |
| 13 | 122 57.5 | 3 16.7 | 49.5 | 73 04.6 | 27.0 | 54 27.2 | 16.1 | 131 57.2 | 04.3 | Gienah | 175 44.1 | S17 40.7 |
| 14 | 138 00.0 | 18 15.9 | 48.9 | 88 05.2 | 27.4 | 69 29.1 | 16.2 | 146 59.7 | 04.4 | Hadar | 148 36.4 | S60 29.7 |
| 15 | 153 02.5 | 33 15.1 | . . 48.4 | 103 05.9 | . . 27.9 | 84 31.0 | . . 16.2 | 162 02.2 | . . 04.4 | Hamal | 327 51.8 | N23 34.6 |
| 16 | 168 04.9 | 48 14.3 | 47.8 | 118 06.6 | 28.4 | 99 32.9 | 16.3 | 177 04.7 | 04.4 | Kaus Aust. | 83 32.7 | S34 22.4 |
| 17 | 183 07.4 | 63 13.5 | 47.3 | 133 07.3 | 28.9 | 114 34.8 | 16.4 | 192 07.2 | 04.5 | | | |
| 18 | 198 09.9 | 78 12.7 | N21 46.7 | 148 07.9 | N17 29.4 | 129 36.7 | N21 16.5 | 207 09.7 | S 6 04.5 | Kochab | 137 19.2 | N74 03.5 |
| 19 | 213 12.3 | 93 11.9 | 46.2 | 163 08.6 | 29.8 | 144 38.6 | 16.5 | 222 12.2 | 04.5 | Markab | 13 30.1 | N15 20.2 |
| 20 | 228 14.8 | 108 11.1 | 45.6 | 178 09.3 | 30.3 | 159 40.5 | 16.6 | 237 14.7 | 04.5 | Menkar | 314 06.7 | N 4 11.2 |
| 21 | 243 17.3 | 123 10.4 | . . 45.1 | 193 10.0 | . . 30.8 | 174 42.5 | . . 16.7 | 252 17.2 | . . 04.6 | Menkent | 147 58.0 | S36 29.6 |
| 22 | 258 19.7 | 138 09.6 | 44.5 | 208 10.6 | 31.3 | 189 44.4 | 16.8 | 267 19.7 | 04.6 | Miaplacidus | 221 39.2 | S69 49.2 |
| 23 | 273 22.2 | 153 08.8 | 44.0 | 223 11.3 | 31.8 | 204 46.3 | 16.8 | 282 22.2 | 04.6 | | | |
| 10 00 (WEDNESDAY) | 288 24.6 | 168 08.0 | N21 43.4 | 238 12.0 | N17 32.2 | 219 48.2 | N21 16.9 | 297 24.7 | S 6 04.6 | Mirfak | 308 29.2 | N49 56.7 |
| 01 | 303 27.1 | 183 07.2 | 42.9 | 253 12.7 | 32.7 | 234 50.1 | 17.0 | 312 27.2 | 04.7 | Nunki | 75 47.9 | S26 16.0 |
| 02 | 318 29.6 | 198 06.4 | 42.3 | 268 13.4 | 33.2 | 249 52.0 | 17.1 | 327 29.7 | 04.7 | Peacock | 53 05.8 | S56 39.3 |
| 03 | 333 32.0 | 213 05.6 | . . 41.7 | 283 14.0 | . . 33.7 | 264 53.9 | . . 17.1 | 342 32.2 | . . 04.7 | Pollux | 243 18.2 | N27 58.1 |
| 04 | 348 34.5 | 228 04.8 | 41.2 | 298 14.7 | 34.1 | 279 55.8 | 17.2 | 357 34.7 | 04.7 | Procyon | 244 51.6 | N 5 09.8 |
| 05 | 3 37.0 | 243 04.0 | 40.6 | 313 15.4 | 34.6 | 294 57.8 | 17.3 | 12 37.2 | 04.8 | | | |
| 06 | 18 39.4 | 258 03.3 | N21 40.1 | 328 16.1 | N17 35.1 | 309 59.7 | N21 17.4 | 27 39.7 | S 6 04.8 | Rasalhague | 95 58.6 | N12 32.6 |
| 07 | 33 41.9 | 273 02.5 | 39.5 | 343 16.7 | 35.6 | 325 01.6 | 17.4 | 42 42.2 | 04.8 | Regulus | 207 35.1 | N11 51.0 |
| 08 | 48 44.4 | 288 01.7 | 38.9 | 358 17.4 | 36.0 | 340 03.5 | 17.5 | 57 44.7 | 04.8 | Rigel | 281 04.6 | S 8 10.3 |
| 09 | 63 46.8 | 303 00.9 | . . 38.4 | 13 18.1 | . . 36.5 | 355 05.4 | . . 17.6 | 72 47.2 | . . 04.9 | Rigil Kent. | 139 40.6 | S60 56.4 |
| 10 | 78 49.3 | 318 00.1 | 37.8 | 28 18.8 | 37.0 | 10 07.3 | 17.7 | 87 49.7 | 04.9 | Sabik | 102 02.9 | S15 45.3 |
| 11 | 93 51.7 | 332 59.3 | 37.2 | 43 19.4 | 37.5 | 25 09.2 | 17.8 | 102 52.2 | 04.9 | | | |
| 12 | 108 54.2 | 347 58.6 | N21 36.7 | 58 20.1 | N17 37.9 | 40 11.1 | N21 17.8 | 117 54.7 | S 6 05.0 | Schedar | 349 31.5 | N56 40.0 |
| 13 | 123 56.7 | 2 57.8 | 36.1 | 73 20.8 | 38.4 | 55 13.1 | 17.9 | 132 57.2 | 05.0 | Shaula | 96 10.5 | S37 07.3 |
| 14 | 138 59.1 | 17 57.0 | 35.5 | 88 21.5 | 38.9 | 70 15.0 | 18.0 | 147 59.7 | 05.0 | Sirius | 258 27.0 | S16 44.9 |
| 15 | 154 01.6 | 32 56.2 | . . 35.0 | 103 22.1 | . . 39.3 | 85 16.9 | . . 18.1 | 163 02.2 | . . 05.0 | Spica | 158 22.7 | S11 17.4 |
| 16 | 169 04.1 | 47 55.4 | 34.4 | 118 22.8 | 39.8 | 100 18.8 | 18.1 | 178 04.7 | 05.1 | Suhail | 222 47.0 | S43 31.9 |
| 17 | 184 06.5 | 62 54.6 | 33.8 | 133 23.5 | 40.3 | 115 20.7 | 18.2 | 193 07.2 | 05.1 | | | |
| 18 | 199 09.0 | 77 53.9 | N21 33.2 | 148 24.2 | N17 40.8 | 130 22.6 | N21 18.3 | 208 09.7 | S 6 05.1 | Vega | 80 33.1 | N38 48.4 |
| 19 | 214 11.5 | 92 53.1 | 32.7 | 163 24.8 | 41.2 | 145 24.5 | 18.4 | 223 12.2 | 05.1 | Zuben'ubi | 136 56.3 | S16 08.7 |
| 20 | 229 13.9 | 107 52.3 | 32.1 | 178 25.5 | 41.7 | 160 26.5 | 18.4 | 238 14.7 | 05.2 | | | |
| 21 | 244 16.4 | 122 51.5 | . . 31.5 | 193 26.2 | . . 42.2 | 175 28.4 | . . 18.5 | 253 17.2 | . . 05.2 | | | |
| 22 | 259 18.9 | 137 50.7 | 30.9 | 208 26.9 | 42.6 | 190 30.3 | 18.6 | 268 19.7 | 05.2 | | | |
| 23 | 274 21.3 | 152 50.0 | 30.4 | 223 27.5 | 43.1 | 205 32.2 | 18.7 | 283 22.2 | 05.2 | | | |

| | SHA | Mer. Pass. |
|---|---|---|
| | ° ′ | h m |
| Venus | 241 01.5 | 12 47 |
| Mars | 310 30.3 | 8 08 |
| Jupiter | 291 36.8 | 9 23 |
| Saturn | 8 59.2 | 4 14 |

| Mer. Pass. | ARIES | VENUS | MARS | JUPITER | SATURN |
|---|---|---|---|---|---|
| | h m 4 49.5 | *v* −0.8 *d* 0.5 | *v* 0.7 *d* 0.5 | *v* 1.9 *d* 0.1 | *v* 2.5 *d* 0.0 |

## 2024 JULY 8, 9, 10 (MON., TUES., WED.) 137

| d | h | SUN GHA | SUN Dec | MOON GHA | v | MOON Dec | d | HP |
|---|---|---|---|---|---|---|---|---|
| | | ° ′ | ° ′ | ° ′ | ′ | ° ′ | ′ | ′ |
| 8 | 00 | 178 43.2 | N22 26.4 | 152 08.6 | 11.6 | N21 45.2 | 10.0 | 55.5 |
| | 01 | 193 43.1 | 26.1 | 166 39.2 | 11.7 | 21 35.2 | 10.2 | 55.5 |
| | 02 | 208 43.0 | 25.8 | 181 09.9 | 11.8 | 21 25.0 | 10.3 | 55.5 |
| | 03 | 223 42.9 | . . 25.5 | 195 40.7 | 11.9 | 21 14.7 | 10.3 | 55.5 |
| | 04 | 238 42.8 | 25.2 | 210 11.6 | 12.0 | 21 04.4 | 10.4 | 55.4 |
| | 05 | 253 42.7 | 24.9 | 224 42.6 | 12.2 | 20 54.0 | 10.6 | 55.4 |
| | 06 | 268 42.6 | N22 24.6 | 239 13.8 | 12.2 | N20 43.4 | 10.6 | 55.4 |
| | 07 | 283 42.5 | 24.3 | 253 45.0 | 12.3 | 20 32.8 | 10.7 | 55.4 |
| | 08 | 298 42.4 | 24.0 | 268 16.3 | 12.4 | 20 22.1 | 10.7 | 55.4 |
| M | 09 | 313 42.3 | . . 23.7 | 282 47.7 | 12.5 | 20 11.4 | 10.9 | 55.3 |
| O | 10 | 328 42.2 | 23.4 | 297 19.2 | 12.6 | 20 00.5 | 10.9 | 55.3 |
| N | 11 | 343 42.1 | 23.1 | 311 50.8 | 12.7 | 19 49.6 | 11.1 | 55.3 |
| D | 12 | 358 42.0 | N22 22.8 | 326 22.5 | 12.8 | N19 38.5 | 11.1 | 55.3 |
| A | 13 | 13 41.9 | 22.5 | 340 54.3 | 12.9 | 19 27.4 | 11.1 | 55.3 |
| Y | 14 | 28 41.9 | 22.2 | 355 26.2 | 13.0 | 19 16.3 | 11.3 | 55.2 |
| | 15 | 43 41.8 | . . 21.9 | 9 58.2 | 13.0 | 19 05.0 | 11.3 | 55.2 |
| | 16 | 58 41.7 | 21.6 | 24 30.2 | 13.2 | 18 53.7 | 11.4 | 55.2 |
| | 17 | 73 41.6 | 21.4 | 39 02.4 | 13.3 | 18 42.3 | 11.5 | 55.2 |
| | 18 | 88 41.5 | N22 21.0 | 53 34.7 | 13.3 | N18 30.8 | 11.5 | 55.2 |
| | 19 | 103 41.4 | 20.7 | 68 07.0 | 13.5 | 18 19.3 | 11.6 | 55.1 |
| | 20 | 118 41.3 | 20.4 | 82 39.5 | 13.5 | 18 07.7 | 11.7 | 55.1 |
| | 21 | 133 41.2 | . . 20.1 | 97 12.0 | 13.6 | 17 56.0 | 11.8 | 55.1 |
| | 22 | 148 41.1 | 19.8 | 111 44.6 | 13.7 | 17 44.2 | 11.8 | 55.1 |
| | 23 | 163 41.0 | 19.5 | 126 17.3 | 13.8 | 17 32.4 | 11.9 | 55.1 |
| 9 | 00 | 178 40.9 | N22 19.2 | 140 50.1 | 13.9 | N17 20.5 | 11.9 | 55.0 |
| | 01 | 193 40.8 | 18.9 | 155 23.0 | 14.0 | 17 08.6 | 12.0 | 55.0 |
| | 02 | 208 40.7 | 18.6 | 169 56.0 | 14.0 | 16 56.6 | 12.1 | 55.0 |
| | 03 | 223 40.6 | . . 18.3 | 184 29.0 | 14.2 | 16 44.5 | 12.1 | 55.0 |
| | 04 | 238 40.6 | 18.0 | 199 02.2 | 14.2 | 16 32.4 | 12.2 | 55.0 |
| | 05 | 253 40.5 | 17.7 | 213 35.4 | 14.3 | 16 20.2 | 12.3 | 55.0 |
| | 06 | 268 40.4 | N22 17.4 | 228 08.7 | 14.4 | N16 07.9 | 12.3 | 54.9 |
| | 07 | 283 40.3 | 17.1 | 242 42.1 | 14.4 | 15 55.6 | 12.3 | 54.9 |
| T | 08 | 298 40.2 | 16.8 | 257 15.5 | 14.6 | 15 43.3 | 12.4 | 54.9 |
| U | 09 | 313 40.1 | . . 16.5 | 271 49.1 | 14.6 | 15 30.9 | 12.5 | 54.9 |
| E | 10 | 328 40.0 | 16.2 | 286 22.7 | 14.7 | 15 18.4 | 12.5 | 54.9 |
| S | 11 | 343 39.9 | 15.8 | 300 56.4 | 14.8 | 15 05.9 | 12.6 | 54.9 |
| D | 12 | 358 39.8 | N22 15.5 | 315 30.2 | 14.8 | N14 53.3 | 12.6 | 54.8 |
| A | 13 | 13 39.7 | 15.2 | 330 04.0 | 15.0 | 14 40.7 | 12.7 | 54.8 |
| Y | 14 | 28 39.6 | 14.9 | 344 38.0 | 15.0 | 14 28.0 | 12.7 | 54.8 |
| | 15 | 43 39.6 | . . 14.6 | 359 12.0 | 15.0 | 14 15.3 | 12.8 | 54.8 |
| | 16 | 58 39.5 | 14.3 | 13 46.0 | 15.2 | 14 02.5 | 12.8 | 54.8 |
| | 17 | 73 39.4 | 14.0 | 28 20.2 | 15.2 | 13 49.7 | 12.9 | 54.8 |
| | 18 | 88 39.3 | N22 13.6 | 42 54.4 | 15.3 | N13 36.8 | 12.9 | 54.7 |
| | 19 | 103 39.2 | 13.3 | 57 28.7 | 15.3 | 13 23.9 | 12.9 | 54.7 |
| | 20 | 118 39.1 | 13.0 | 72 03.0 | 15.5 | 13 11.0 | 13.0 | 54.7 |
| | 21 | 133 39.0 | . . 12.7 | 86 37.5 | 15.4 | 12 58.0 | 13.1 | 54.7 |
| | 22 | 148 38.9 | 12.4 | 101 11.9 | 15.6 | 12 44.9 | 13.1 | 54.7 |
| | 23 | 163 38.8 | 12.0 | 115 46.5 | 15.6 | 12 31.8 | 13.1 | 54.7 |
| 10 | 00 | 178 38.8 | N22 11.7 | 130 21.1 | 15.7 | N12 18.7 | 13.1 | 54.6 |
| | 01 | 193 38.7 | 11.4 | 144 55.8 | 15.7 | 12 05.6 | 13.2 | 54.6 |
| | 02 | 208 38.6 | 11.1 | 159 30.5 | 15.8 | 11 52.4 | 13.3 | 54.6 |
| | 03 | 223 38.5 | . . 10.8 | 174 05.3 | 15.9 | 11 39.1 | 13.2 | 54.6 |
| | 04 | 238 38.4 | 10.4 | 188 40.2 | 15.9 | 11 25.9 | 13.4 | 54.6 |
| | 05 | 253 38.3 | 10.1 | 203 15.1 | 16.0 | 11 12.5 | 13.3 | 54.6 |
| | 06 | 268 38.2 | N22 09.8 | 217 50.1 | 16.1 | N10 59.2 | 13.4 | 54.6 |
| W | 07 | 283 38.2 | 09.5 | 232 25.2 | 16.1 | 10 45.8 | 13.4 | 54.6 |
| E | 08 | 298 38.1 | 09.1 | 247 00.3 | 16.1 | 10 32.4 | 13.4 | 54.5 |
| D | 09 | 313 38.0 | . . 08.8 | 261 35.4 | 16.2 | 10 19.0 | 13.5 | 54.5 |
| N | 10 | 328 37.9 | 08.5 | 276 10.6 | 16.3 | 10 05.5 | 13.5 | 54.5 |
| E | 11 | 343 37.8 | 08.2 | 290 45.9 | 16.3 | 9 52.0 | 13.5 | 54.5 |
| S | 12 | 358 37.7 | N22 07.8 | 305 21.2 | 16.3 | N 9 38.5 | 13.6 | 54.5 |
| D | 13 | 13 37.6 | 07.5 | 319 56.5 | 16.4 | 9 24.9 | 13.6 | 54.5 |
| A | 14 | 28 37.6 | 07.2 | 334 31.9 | 16.5 | 9 11.3 | 13.6 | 54.5 |
| Y | 15 | 43 37.5 | . . 06.8 | 349 07.4 | 16.5 | 8 57.7 | 13.6 | 54.5 |
| | 16 | 58 37.4 | 06.5 | 3 42.9 | 16.5 | 8 44.1 | 13.7 | 54.4 |
| | 17 | 73 37.3 | 06.2 | 18 18.4 | 16.6 | 8 30.4 | 13.7 | 54.4 |
| | 18 | 88 37.2 | N22 05.8 | 32 54.0 | 16.7 | N 8 16.7 | 13.7 | 54.4 |
| | 19 | 103 37.1 | 05.5 | 47 29.7 | 16.6 | 8 03.0 | 13.7 | 54.4 |
| | 20 | 118 37.0 | 05.2 | 62 05.3 | 16.8 | 7 49.3 | 13.8 | 54.4 |
| | 21 | 133 37.0 | . . 04.8 | 76 41.1 | 16.7 | 7 35.5 | 13.8 | 54.4 |
| | 22 | 148 36.9 | 04.5 | 91 16.8 | 16.8 | 7 21.7 | 13.8 | 54.4 |
| | 23 | 163 36.8 | 04.2 | 105 52.6 | 16.8 | N 7 07.9 | 13.8 | 54.4 |
| | | SD 15.8 | *d* 0.3 | SD | 15.1 | 14.9 | | 14.8 |

| Lat. | Twilight Naut. | Twilight Civil | Sunrise | Moonrise 8 | Moonrise 9 | Moonrise 10 | Moonrise 11 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | ▭ | ▭ | ▭ | ▭ | 04 27 | 07 09 | 09 15 |
| N 70 | ▭ | ▭ | ▭ | ▭ | 05 15 | 07 28 | 09 22 |
| 68 | ▭ | ▭ | ▭ | 03 06 | 05 45 | 07 42 | 09 27 |
| 66 | //// | //// | 01 10 | 04 02 | 06 07 | 07 54 | 09 32 |
| 64 | //// | //// | 02 00 | 04 35 | 06 25 | 08 03 | 09 36 |
| 62 | //// | //// | 02 31 | 04 59 | 06 39 | 08 12 | 09 39 |
| 60 | //// | 01 27 | 02 54 | 05 18 | 06 51 | 08 19 | 09 42 |
| N 58 | //// | 02 03 | 03 12 | 05 34 | 07 01 | 08 25 | 09 45 |
| 56 | //// | 02 29 | 03 27 | 05 47 | 07 10 | 08 30 | 09 47 |
| 54 | 01 20 | 02 49 | 03 40 | 05 58 | 07 18 | 08 35 | 09 49 |
| 52 | 01 54 | 03 05 | 03 52 | 06 09 | 07 25 | 08 39 | 09 51 |
| 50 | 02 17 | 03 19 | 04 02 | 06 18 | 07 32 | 08 43 | 09 52 |
| 45 | 02 58 | 03 46 | 04 23 | 06 37 | 07 46 | 08 52 | 09 56 |
| N 40 | 03 27 | 04 08 | 04 40 | 06 52 | 07 57 | 08 59 | 09 59 |
| 35 | 03 49 | 04 25 | 04 54 | 07 05 | 08 06 | 09 05 | 10 02 |
| 30 | 04 06 | 04 39 | 05 06 | 07 16 | 08 15 | 09 10 | 10 04 |
| 20 | 04 34 | 05 03 | 05 27 | 07 35 | 08 29 | 09 19 | 10 08 |
| N 10 | 04 55 | 05 22 | 05 45 | 07 52 | 08 41 | 09 28 | 10 12 |
| 0 | 05 13 | 05 39 | 06 02 | 08 08 | 08 53 | 09 35 | 10 15 |
| S 10 | 05 29 | 05 56 | 06 18 | 08 23 | 09 04 | 09 42 | 10 18 |
| 20 | 05 45 | 06 12 | 06 36 | 08 40 | 09 17 | 09 50 | 10 22 |
| 30 | 06 00 | 06 30 | 06 56 | 08 58 | 09 31 | 09 59 | 10 26 |
| 35 | 06 08 | 06 40 | 07 07 | 09 09 | 09 39 | 10 04 | 10 28 |
| 40 | 06 17 | 06 51 | 07 21 | 09 22 | 09 48 | 10 10 | 10 30 |
| 45 | 06 26 | 07 03 | 07 37 | 09 36 | 09 59 | 10 17 | 10 33 |
| S 50 | 06 37 | 07 18 | 07 56 | 09 54 | 10 11 | 10 25 | 10 37 |
| 52 | 06 42 | 07 25 | 08 05 | 10 03 | 10 17 | 10 29 | 10 38 |
| 54 | 06 47 | 07 33 | 08 15 | 10 12 | 10 24 | 10 33 | 10 40 |
| 56 | 06 53 | 07 41 | 08 27 | 10 23 | 10 31 | 10 37 | 10 42 |
| 58 | 06 59 | 07 50 | 08 40 | 10 34 | 10 39 | 10 42 | 10 44 |
| S 60 | 07 06 | 08 01 | 08 56 | 10 48 | 10 49 | 10 48 | 10 47 |

| Lat. | Sunset | Twilight Civil | Twilight Naut. | Moonset 8 | Moonset 9 | Moonset 10 | Moonset 11 |
|---|---|---|---|---|---|---|---|
| ° | h m | h m | h m | h m | h m | h m | h m |
| N 72 | ▭ | ▭ | ▭ | ▭ | 01 19 | {00 05 / 23 25} | 22 53 |
| N 70 | ▭ | ▭ | ▭ | ▭ | {00 29 / 23 45} | 23 15 | 22 51 |
| 68 | ▭ | ▭ | ▭ | {01 01 / 23 57} | 23 29 | 23 08 | 22 49 |
| 66 | 22 57 | //// | //// | {00 03 / 23 34} | 23 15 | 23 01 | 22 48 |
| 64 | 22 09 | //// | //// | 23 15 | 23 04 | 22 55 | 22 47 |
| 62 | 21 38 | //// | //// | 23 00 | 22 55 | 22 50 | 22 45 |
| 60 | 21 16 | 22 41 | //// | 22 47 | 22 47 | 22 46 | 22 45 |
| N 58 | 20 58 | 22 06 | //// | 22 35 | 22 39 | 22 42 | 22 44 |
| 56 | 20 43 | 21 41 | //// | 22 26 | 22 33 | 22 39 | 22 43 |
| 54 | 20 30 | 21 21 | 22 48 | 22 17 | 22 27 | 22 35 | 22 42 |
| 52 | 20 18 | 21 05 | 22 16 | 22 09 | 22 22 | 22 33 | 22 42 |
| 50 | 20 08 | 20 51 | 21 52 | 22 02 | 22 17 | 22 30 | 22 41 |
| 45 | 19 47 | 20 24 | 21 12 | 21 47 | 22 07 | 22 24 | 22 40 |
| N 40 | 19 31 | 20 03 | 20 43 | 21 34 | 21 58 | 22 20 | 22 39 |
| 35 | 19 16 | 19 46 | 20 22 | 21 24 | 21 51 | 22 15 | 22 38 |
| 30 | 19 04 | 19 31 | 20 04 | 21 14 | 21 44 | 22 12 | 22 37 |
| 20 | 18 43 | 19 08 | 19 37 | 20 58 | 21 33 | 22 05 | 22 36 |
| N 10 | 18 26 | 18 48 | 19 15 | 20 43 | 21 23 | 22 00 | 22 35 |
| 0 | 18 09 | 18 31 | 18 57 | 20 30 | 21 13 | 21 54 | 22 34 |
| S 10 | 17 53 | 18 15 | 18 41 | 20 16 | 21 04 | 21 49 | 22 32 |
| 20 | 17 35 | 17 59 | 18 26 | 20 02 | 20 54 | 21 43 | 22 31 |
| 30 | 17 15 | 17 41 | 18 11 | 19 45 | 20 42 | 21 36 | 22 30 |
| 35 | 17 03 | 17 31 | 18 03 | 19 35 | 20 35 | 21 33 | 22 29 |
| 40 | 16 50 | 17 20 | 17 54 | 19 23 | 20 27 | 21 28 | 22 28 |
| 45 | 16 34 | 17 08 | 17 44 | 19 10 | 20 18 | 21 23 | 22 27 |
| S 50 | 16 15 | 16 53 | 17 34 | 18 54 | 20 07 | 21 17 | 22 25 |
| 52 | 16 06 | 16 46 | 17 29 | 18 46 | 20 01 | 21 14 | 22 25 |
| 54 | 15 56 | 16 38 | 17 24 | 18 37 | 19 56 | 21 11 | 22 24 |
| 56 | 15 44 | 16 30 | 17 18 | 18 27 | 19 49 | 21 07 | 22 23 |
| 58 | 15 31 | 16 21 | 17 12 | 18 16 | 19 42 | 21 03 | 22 22 |
| S 60 | 15 15 | 16 10 | 17 05 | 18 03 | 19 34 | 20 59 | 22 21 |

| Day | SUN Eqn. of Time $00^h$ | SUN Eqn. of Time $12^h$ | SUN Mer. Pass. | MOON Mer. Pass. Upper | MOON Mer. Pass. Lower | MOON Age | MOON Phase |
|---|---|---|---|---|---|---|---|
| d | m s | m s | h m | h m | h m | d | % |
| 8 | 05 07 | 05 12 | 12 05 | 14 19 | 01 55 | 03 | 7 |
| 9 | 05 16 | 05 21 | 12 05 | 15 03 | 02 42 | 04 | 13 |
| 10 | 05 25 | 05 29 | 12 05 | 15 45 | 03 24 | 05 | 20 |

## 270 STARS, 2024 JANUARY — JUNE

| Mag. | Name and Number | | SHA | | | | | | | Declination | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | JAN. | FEB. | MAR. | APR. | MAY | JUNE | | JAN. | FEB. | MAR. | APR. | MAY | JUNE |
| | | | ° | ′ | ′ | ′ | ′ | ′ | ′ | ° | ′ | ′ | ′ | ′ | ′ | ′ |
| 2·9 | γ Trianguli Aust. | | **129** | 43·0 | 42·4 | 41·8 | 41·4 | 41·2 | 41·1 | **S 68** | 45·8 | 45·8 | 45·9 | 46·0 | 46·2 | 46·3 |
| 3·1 | γ Ursæ Minoris | | **129** | 49·6 | 49·0 | 48·5 | 48·1 | 48·0 | 48·2 | **N 71** | 44·5 | 44·4 | 44·5 | 44·6 | 44·8 | 44·9 |
| 2·6 | β Libræ | | **130** | 25·7 | 25·4 | 25·2 | 25·0 | 24·9 | 24·9 | **S 9** | 28·3 | 28·4 | 28·4 | 28·5 | 28·5 | 28·4 |
| 2·7 | β Lupi | | **134** | 58·6 | 58·3 | 58·0 | 57·8 | 57·7 | 57·6 | **S 43** | 13·6 | 13·7 | 13·8 | 13·9 | 14·0 | 14·1 |
| 2·8 | α Libræ | 39 | **136** | 57·0 | 56·8 | 56·6 | 56·4 | 56·3 | 56·3 | **S 16** | 08·5 | 08·5 | 08·6 | 08·6 | 08·7 | 08·7 |
| 2·1 | β Ursæ Minoris | 40 | **137** | 20·2 | 19·5 | 19·0 | 18·6 | 18·6 | 18·8 | **N 74** | 03·0 | 03·0 | 03·0 | 03·2 | 03·3 | 03·5 |
| 2·4 | ε Bootis | | **138** | 29·6 | 29·3 | 29·1 | 29·0 | 28·9 | 28·9 | **N 26** | 58·2 | 58·1 | 58·1 | 58·2 | 58·3 | 58·4 |
| 2·3 | α Lupi | | **139** | 07·3 | 06·9 | 06·6 | 06·4 | 06·3 | 06·3 | **S 47** | 29·3 | 29·3 | 29·4 | 29·6 | 29·7 | 29·7 |
| −0·3 | α Centauri | 38 | **139** | 41·6 | 41·2 | 40·8 | 40·6 | 40·5 | 40·5 | **S 60** | 55·8 | 55·8 | 55·9 | 56·1 | 56·2 | 56·3 |
| 2·3 | η Centauri | | **140** | 44·7 | 44·4 | 44·1 | 43·9 | 43·8 | 43·8 | **S 42** | 15·6 | 15·7 | 15·8 | 15·9 | 16·0 | 16·1 |
| 3·0 | γ Bootis | | **141** | 44·4 | 44·1 | 43·9 | 43·7 | 43·7 | 43·7 | **N 38** | 11·9 | 11·9 | 11·9 | 12·0 | 12·1 | 12·2 |
| 0·0 | α Bootis | 37 | **145** | 48·7 | 48·5 | 48·3 | 48·1 | 48·1 | 48·1 | **N 19** | 03·3 | 03·2 | 03·2 | 03·2 | 03·3 | 03·4 |
| 2·1 | θ Centauri | 36 | **147** | 58·7 | 58·4 | 58·1 | 58·0 | 57·9 | 57·9 | **S 36** | 29·1 | 29·2 | 29·3 | 29·4 | 29·5 | 29·6 |
| 0·6 | β Centauri | 35 | **148** | 37·3 | 36·9 | 36·5 | 36·3 | 36·2 | 36·3 | **S 60** | 29·0 | 29·1 | 29·3 | 29·4 | 29·6 | 29·7 |
| 2·6 | ζ Centauri | | **150** | 44·5 | 44·2 | 43·9 | 43·8 | 43·7 | 43·8 | **S 47** | 24·2 | 24·3 | 24·4 | 24·5 | 24·6 | 24·7 |
| 2·7 | η Bootis | | **151** | 02·6 | 02·4 | 02·2 | 02·1 | 02·0 | 02·1 | **N 18** | 16·5 | 16·4 | 16·4 | 16·4 | 16·5 | 16·6 |
| 1·9 | η Ursæ Majoris | 34 | **152** | 52·7 | 52·4 | 52·1 | 52·0 | 52·0 | 52·1 | **N 49** | 11·3 | 11·3 | 11·3 | 11·4 | 11·6 | 11·7 |
| 2·3 | ε Centauri | | **154** | 38·9 | 38·5 | 38·3 | 38·1 | 38·1 | 38·2 | **S 53** | 35·0 | 35·1 | 35·3 | 35·4 | 35·6 | 35·7 |
| 1·0 | α Virginis | 33 | **158** | 23·2 | 22·9 | 22·7 | 22·6 | 22·6 | 22·7 | **S 11** | 17·2 | 17·3 | 17·3 | 17·4 | 17·4 | 17·4 |
| 2·3 | ζ Ursæ Majoris | | **158** | 46·5 | 46·2 | 45·9 | 45·8 | 45·9 | 46·0 | **N 54** | 47·7 | 47·7 | 47·7 | 47·9 | 48·0 | 48·1 |
| 2·8 | ι Centauri | | **159** | 30·8 | 30·5 | 30·4 | 30·2 | 30·2 | 30·3 | **S 36** | 50·2 | 50·3 | 50·4 | 50·5 | 50·6 | 50·7 |
| 2·8 | ε Virginis | | **164** | 09·4 | 09·2 | 09·0 | 08·9 | 08·9 | 09·0 | **N 10** | 49·7 | 49·6 | 49·6 | 49·6 | 49·7 | 49·7 |
| 2·9 | α Canum Venat. | | **165** | 42·7 | 42·4 | 42·2 | 42·2 | 42·2 | 42·3 | **N 38** | 11·1 | 11·1 | 11·1 | 11·2 | 11·3 | 11·4 |
| 1·8 | ε Ursæ Majoris | 32 | **166** | 13·6 | 13·2 | 13·0 | 12·9 | 13·0 | 13·2 | **N 55** | 49·5 | 49·5 | 49·6 | 49·7 | 49·8 | 49·9 |
| 1·3 | β Crucis | | **167** | 43·0 | 42·7 | 42·5 | 42·4 | 42·4 | 42·6 | **S 59** | 48·9 | 49·1 | 49·2 | 49·4 | 49·5 | 49·6 |
| 2·9 | γ Virginis | | **169** | 16·8 | 16·6 | 16·5 | 16·4 | 16·4 | 16·5 | **S 1** | 34·9 | 35·0 | 35·1 | 35·1 | 35·1 | 35·0 |
| 2·2 | γ Centauri | | **169** | 17·3 | 17·0 | 16·8 | 16·8 | 16·8 | 16·9 | **S 49** | 05·3 | 05·4 | 05·6 | 05·7 | 05·8 | 05·9 |
| 2·7 | α Muscæ | | **170** | 20·6 | 20·1 | 19·8 | 19·7 | 19·9 | 20·1 | **S 69** | 15·8 | 15·9 | 16·1 | 16·3 | 16·4 | 16·5 |
| 2·7 | β Corvi | | **171** | 05·2 | 05·0 | 04·9 | 04·8 | 04·8 | 04·9 | **S 23** | 31·7 | 31·8 | 31·9 | 32·0 | 32·0 | 32·0 |
| 1·6 | γ Crucis | 31 | **171** | 52·4 | 52·1 | 51·9 | 51·8 | 51·9 | 52·1 | **S 57** | 14·6 | 14·7 | 14·9 | 15·1 | 15·2 | 15·3 |
| 1·3 | α Crucis | 30 | **173** | 00·8 | 00·4 | 00·2 | 00·2 | 00·3 | 00·5 | **S 63** | 13·6 | 13·8 | 14·0 | 14·1 | 14·3 | 14·4 |
| 2·6 | γ Corvi | 29 | **175** | 44·3 | 44·1 | 44·0 | 43·9 | 44·0 | 44·0 | **S 17** | 40·4 | 40·6 | 40·7 | 40·7 | 40·8 | 40·8 |
| 2·6 | δ Centauri | | **177** | 35·8 | 35·6 | 35·4 | 35·4 | 35·5 | 35·6 | **S 50** | 51·1 | 51·3 | 51·4 | 51·6 | 51·7 | 51·8 |
| 2·4 | γ Ursæ Majoris | | **181** | 13·4 | 13·1 | 12·9 | 12·9 | 13·0 | 13·2 | **N 53** | 33·4 | 33·4 | 33·5 | 33·7 | 33·8 | 33·8 |
| 2·1 | β Leonis | 28 | **182** | 25·6 | 25·4 | 25·3 | 25·3 | 25·3 | 25·4 | **N 14** | 26·2 | 26·1 | 26·1 | 26·1 | 26·2 | 26·2 |
| 2·6 | δ Leonis | | **191** | 09·1 | 08·9 | 08·8 | 08·8 | 08·9 | 09·0 | **N 20** | 23·4 | 23·4 | 23·4 | 23·4 | 23·5 | 23·5 |
| 3·0 | ψ Ursæ Majoris | | **192** | 14·6 | 14·4 | 14·3 | 14·3 | 14·4 | 14·5 | **N 44** | 21·9 | 21·9 | 22·0 | 22·1 | 22·2 | 22·2 |
| 1·8 | α Ursæ Majoris | 27 | **193** | 41·6 | 41·2 | 41·1 | 41·2 | 41·4 | 41·7 | **N 61** | 37·0 | 37·1 | 37·2 | 37·4 | 37·4 | 37·5 |
| 2·4 | β Ursæ Majoris | | **194** | 10·4 | 10·1 | 10·0 | 10·1 | 10·2 | 10·4 | **N 56** | 15·0 | 15·0 | 15·2 | 15·3 | 15·4 | 15·4 |
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| 2·8 | θ Carinæ | | **199** | 02·5 | 02·3 | 02·3 | 02·4 | 02·7 | 03·0 | **S 64** | 31·0 | 31·1 | 31·3 | 31·5 | 31·6 | 31·6 |
| 2·3 | γ Leonis | | **204** | 40·4 | 40·2 | 40·2 | 40·2 | 40·3 | 40·4 | **N 19** | 43·1 | 43·1 | 43·1 | 43·1 | 43·2 | 43·2 |
| 1·4 | α Leonis | 26 | **207** | 35·0 | 34·9 | 34·9 | 34·9 | 35·0 | 35·1 | **N 11** | 50·9 | 50·9 | 50·9 | 50·9 | 50·9 | 50·9 |
| 3·0 | ε Leonis | | **213** | 11·6 | 11·4 | 11·4 | 11·5 | 11·6 | 11·7 | **N 23** | 39·7 | 39·7 | 39·7 | 39·8 | 39·8 | 39·8 |
| 3·1 | N Velorum | | **217** | 00·4 | 00·3 | 00·4 | 00·6 | 00·8 | 01·0 | **S 57** | 08·2 | 08·4 | 08·6 | 08·7 | 08·8 | 08·7 |
| 2·0 | α Hydræ | 25 | **217** | 48·3 | 48·2 | 48·2 | 48·2 | 48·3 | 48·4 | **S 8** | 45·8 | 45·9 | 45·9 | 45·9 | 45·9 | 45·9 |
| 2·5 | κ Velorum | | **219** | 16·8 | 16·7 | 16·8 | 17·0 | 17·2 | 17·4 | **S 55** | 06·6 | 06·8 | 07·0 | 07·1 | 07·1 | 07·1 |
| 2·2 | ι Carinæ | | **220** | 33·6 | 33·6 | 33·7 | 33·9 | 34·2 | 34·4 | **S 59** | 22·4 | 22·6 | 22·7 | 22·9 | 22·9 | 22·8 |
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| 2·0 | δ Velorum | | **228** | 39·1 | 39·1 | 39·2 | 39·4 | 39·7 | 39·9 | **S 54** | 47·7 | 47·9 | 48·0 | 48·1 | 48·1 | 48·0 |
| 1·9 | ε Carinæ | 22 | **234** | 14·4 | 14·5 | 14·6 | 14·9 | 15·2 | 15·5 | **S 59** | 35·1 | 35·3 | 35·4 | 35·5 | 35·5 | 35·4 |
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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | ° | ′ | ′ | ′ | ′ | ′ | ′ | ° | ′ | ′ | ′ | ′ | ′ | ′ |
| 2·9 | γ Trianguli Aust. | | **129** | 41·3 | 41·6 | 42·0 | 42·2 | 42·2 | 41·9 | S **68** | 46·4 | 46·4 | 46·4 | 46·3 | 46·2 | 46·1 |
| 3·1 | *Pherkad* | | **129** | 48·6 | 49·1 | 49·6 | 50·0 | 50·1 | 50·0 | N **71** | 45·0 | 45·0 | 44·9 | 44·8 | 44·6 | 44·4 |
| 2·6 | *Zubeneschamali* | | **130** | 24·9 | 25·0 | 25·1 | 25·2 | 25·2 | 25·0 | S **9** | 28·4 | 28·4 | 28·4 | 28·4 | 28·4 | 28·5 |
| 2·7 | β Lupi | | **134** | 57·7 | 57·8 | 58·0 | 58·1 | 58·0 | 57·8 | S **43** | 14·1 | 14·1 | 14·1 | 14·0 | 13·9 | 13·9 |
| 2·8 | *Zubenelgenubi* | 39 | **136** | 56·3 | 56·4 | 56·5 | 56·6 | 56·5 | 56·4 | S **16** | 08·7 | 08·6 | 08·6 | 08·6 | 08·6 | 08·7 |
| 2·1 | *Kochab* | 40 | **137** | 19·3 | 19·9 | 20·4 | 20·8 | 20·9 | 20·7 | N **74** | 03·5 | 03·5 | 03·4 | 03·3 | 03·1 | 02·9 |
| 2·4 | *Izar* | | **138** | 29·0 | 29·1 | 29·2 | 29·3 | 29·3 | 29·1 | N **26** | 58·5 | 58·5 | 58·4 | 58·4 | 58·2 | 58·1 |
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| 3·0 | *Seginus* | | **141** | 43·8 | 44·0 | 44·1 | 44·2 | 44·2 | 44·0 | N **38** | 12·3 | 12·3 | 12·2 | 12·1 | 11·9 | 11·8 |
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| 0·6 | *Hadar* | 35 | **148** | 36·5 | 36·7 | 36·9 | 37·0 | 36·9 | 36·5 | S **60** | 29·7 | 29·7 | 29·6 | 29·5 | 29·4 | 29·3 |
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| 3·0 | ψ Ursæ Majoris | | **192** | 14·7 | 14·7 | 14·7 | 14·5 | 14·3 | 14·0 | N **44** | 22·2 | 22·1 | 22·0 | 21·8 | 21·7 | 21·6 |
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| 2·8 | θ Carinæ | | **199** | 03·2 | 03·4 | 03·4 | 03·2 | 02·8 | 02·3 | S **64** | 31·5 | 31·4 | 31·3 | 31·2 | 31·1 | 31·2 |
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| 2·2 | *Aspidiske* | | **220** | 34·6 | 34·6 | 34·5 | 34·2 | 33·8 | 33·4 | S **59** | 22·7 | 22·6 | 22·4 | 22·4 | 22·4 | 22·5 |
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| 2·2 | *Suhail* | 23 | **222** | 47·0 | 47·0 | 46·9 | 46·7 | 46·4 | 46·1 | S **43** | 31·9 | 31·8 | 31·7 | 31·6 | 31·6 | 31·8 |
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| 1·8 | γ Velorum | | **237** | 26·3 | 26·2 | 26·0 | 25·7 | 25·4 | 25·2 | S **47** | 24·5 | 24·3 | 24·2 | 24·2 | 24·2 | 24·4 |
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| ° | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ |
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| **7** | 34·2 | 31·3 | 27·4 | 22·7 | 17·2 | 11·2 | 04·8 | 58·2 | 51·7 | 45·3 | 39·3 | 34·0 |
| **8** | 33·9 | 30·9 | 27·0 | 22·2 | 16·7 | 10·6 | 04·2 | 57·6 | 51·0 | 44·7 | 38·8 | 33·5 |
| **9** | 33·7 | 30·6 | 26·5 | 21·7 | 16·1 | 10·0 | 03·5 | 56·9 | 50·4 | 44·1 | 38·2 | 33·0 |
| **10** | 1 33·4 | 1 30·2 | 1 26·1 | 1 21·1 | 1 15·5 | 1 09·3 | 1 02·9 | 0 56·3 | 0 49·7 | 0 43·5 | 0 37·7 | 0 32·5 |
| Lat. | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ | $a_1$ |
| ° | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| **0** | 0·6 | 0·5 | 0·5 | 0·5 | 0·4 | 0·4 | 0·4 | 0·4 | 0·4 | 0·4 | 0·4 | 0·5 |
| **10** | ·6 | ·5 | ·5 | ·5 | ·4 | ·4 | ·4 | ·4 | ·4 | ·4 | ·4 | ·5 |
| **20** | ·6 | ·6 | ·5 | ·5 | ·5 | ·4 | ·4 | ·4 | ·4 | ·4 | ·5 | ·5 |
| **30** | ·6 | ·6 | ·5 | ·5 | ·5 | ·5 | ·5 | ·5 | ·5 | ·5 | ·5 | ·5 |
| **40** | 0·6 | 0·6 | 0·6 | 0·6 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·6 |
| **45** | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 |
| **50** | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 |
| **55** | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 | ·6 |
| **60** | ·6 | ·6 | ·6 | ·7 | ·7 | ·7 | ·7 | ·7 | ·7 | ·7 | ·7 | ·7 |
| **62** | 0·6 | 0·6 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 | 0·7 |
| **64** | ·6 | ·6 | ·7 | ·7 | ·7 | ·8 | ·8 | ·8 | ·8 | ·8 | ·7 | ·7 |
| **66** | ·6 | ·7 | ·7 | ·7 | ·8 | ·8 | ·8 | ·8 | ·8 | ·8 | ·8 | ·7 |
| **68** | 0·6 | 0·7 | 0·7 | 0·8 | 0·8 | 0·8 | 0·9 | 0·9 | 0·9 | 0·8 | 0·8 | 0·8 |
| Month | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ | $a_2$ |
| | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| **Jan.** | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·5 | 0·6 | 0·6 | 0·6 | 0·6 | 0·6 | 0·7 |
| **Feb.** | ·4 | ·4 | ·4 | ·4 | ·4 | ·4 | ·4 | ·4 | ·5 | ·5 | ·5 | ·6 |
| **Mar.** | ·4 | ·4 | ·3 | ·3 | ·3 | ·3 | ·3 | ·3 | ·3 | ·3 | ·4 | ·4 |
| **Apr.** | 0·5 | 0·4 | 0·4 | 0·3 | 0·3 | 0·3 | 0·2 | 0·2 | 0·2 | 0·2 | 0·3 | 0·3 |
| **May** | ·6 | ·6 | ·5 | ·4 | ·4 | ·3 | ·3 | ·2 | ·2 | ·2 | ·2 | ·2 |
| **June** | ·8 | ·7 | ·6 | ·6 | ·5 | ·4 | ·4 | ·3 | ·3 | ·2 | ·2 | ·2 |
| **July** | 0·9 | 0·8 | 0·8 | 0·7 | 0·7 | 0·6 | 0·5 | 0·5 | 0·4 | 0·4 | 0·3 | 0·3 |
| **Aug.** | ·9 | ·9 | ·9 | ·9 | ·8 | ·8 | ·7 | ·6 | ·6 | ·5 | ·5 | ·4 |
| **Sept.** | ·9 | ·9 | ·9 | ·9 | ·9 | ·9 | ·9 | ·8 | ·8 | ·7 | ·7 | ·6 |
| **Oct.** | 0·8 | 0·8 | 0·9 | 0·9 | 0·9 | 0·9 | 0·9 | 0·9 | 0·9 | 0·9 | 0·8 | 0·8 |
| **Nov.** | ·6 | ·7 | ·8 | ·8 | ·9 | ·9 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 |
| **Dec.** | 0·5 | 0·6 | 0·6 | 0·7 | 0·8 | 0·8 | 0·9 | 1·0 | 1·0 | 1·0 | 1·0 | 1·0 |
| Lat. | AZIMUTH | | | | | | | | | | | |
| ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| **0** | 0·2 | 0·3 | 0·4 | 0·5 | 0·5 | 0·6 | 0·6 | 0·6 | 0·6 | 0·6 | 0·6 | 0·5 |
| **20** | 0·2 | 0·3 | 0·4 | 0·5 | 0·6 | 0·6 | 0·7 | 0·7 | 0·7 | 0·6 | 0·6 | 0·5 |
| **40** | 0·3 | 0·4 | 0·5 | 0·6 | 0·7 | 0·8 | 0·8 | 0·8 | 0·8 | 0·8 | 0·7 | 0·6 |
| **50** | 0·3 | 0·5 | 0·6 | 0·7 | 0·8 | 0·9 | 1·0 | 1·0 | 1·0 | 0·9 | 0·9 | 0·8 |
| **55** | 0·4 | 0·5 | 0·7 | 0·8 | 0·9 | 1·0 | 1·1 | 1·1 | 1·1 | 1·0 | 1·0 | 0·9 |
| **60** | 0·4 | 0·6 | 0·8 | 0·9 | 1·1 | 1·2 | 1·2 | 1·3 | 1·3 | 1·2 | 1·1 | 1·0 |
| **65** | 0·5 | 0·7 | 0·9 | 1·1 | 1·3 | 1·4 | 1·5 | 1·5 | 1·5 | 1·4 | 1·3 | 1·2 |

Latitude = Apparent altitude (corrected for refraction) $-1° + a_0 + a_1 + a_2$

The table is entered with LHA Aries to determine the column to be used; each column refers to a range of 10°. $a_0$ is taken, with mental interpolation, from the upper table with the units of LHA Aries in degrees as argument; $a_1$, $a_2$ are taken, without interpolation, from the second and third tables with arguments latitude and month respectively. $a_0$, $a_1$, $a_2$, are always positive. The final table gives the azimuth of *Polaris*.

# CONVERSION OF ARC TO TIME

| 0°–59° | | 60°–119° | | 120°–179° | | 180°–239° | | 240°–299° | | 300°–359° | | | 0′.00 | 0′.25 | 0′.50 | 0′.75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ° | h m | ′ | m s | m s | m s | m s |
| 0 | 0 00 | 60 | 4 00 | 120 | 8 00 | 180 | 12 00 | 240 | 16 00 | 300 | 20 00 | 0 | 0 00 | 0 01 | 0 02 | 0 03 |
| 1 | 0 04 | 61 | 4 04 | 121 | 8 04 | 181 | 12 04 | 241 | 16 04 | 301 | 20 04 | 1 | 0 04 | 0 05 | 0 06 | 0 07 |
| 2 | 0 08 | 62 | 4 08 | 122 | 8 08 | 182 | 12 08 | 242 | 16 08 | 302 | 20 08 | 2 | 0 08 | 0 09 | 0 10 | 0 11 |
| 3 | 0 12 | 63 | 4 12 | 123 | 8 12 | 183 | 12 12 | 243 | 16 12 | 303 | 20 12 | 3 | 0 12 | 0 13 | 0 14 | 0 15 |
| 4 | 0 16 | 64 | 4 16 | 124 | 8 16 | 184 | 12 16 | 244 | 16 16 | 304 | 20 16 | 4 | 0 16 | 0 17 | 0 18 | 0 19 |
| 5 | 0 20 | 65 | 4 20 | 125 | 8 20 | 185 | 12 20 | 245 | 16 20 | 305 | 20 20 | 5 | 0 20 | 0 21 | 0 22 | 0 23 |
| 6 | 0 24 | 66 | 4 24 | 126 | 8 24 | 186 | 12 24 | 246 | 16 24 | 306 | 20 24 | 6 | 0 24 | 0 25 | 0 26 | 0 27 |
| 7 | 0 28 | 67 | 4 28 | 127 | 8 28 | 187 | 12 28 | 247 | 16 28 | 307 | 20 28 | 7 | 0 28 | 0 29 | 0 30 | 0 31 |
| 8 | 0 32 | 68 | 4 32 | 128 | 8 32 | 188 | 12 32 | 248 | 16 32 | 308 | 20 32 | 8 | 0 32 | 0 33 | 0 34 | 0 35 |
| 9 | 0 36 | 69 | 4 36 | 129 | 8 36 | 189 | 12 36 | 249 | 16 36 | 309 | 20 36 | 9 | 0 36 | 0 37 | 0 38 | 0 39 |
| 10 | 0 40 | 70 | 4 40 | 130 | 8 40 | 190 | 12 40 | 250 | 16 40 | 310 | 20 40 | 10 | 0 40 | 0 41 | 0 42 | 0 43 |
| 11 | 0 44 | 71 | 4 44 | 131 | 8 44 | 191 | 12 44 | 251 | 16 44 | 311 | 20 44 | 11 | 0 44 | 0 45 | 0 46 | 0 47 |
| 12 | 0 48 | 72 | 4 48 | 132 | 8 48 | 192 | 12 48 | 252 | 16 48 | 312 | 20 48 | 12 | 0 48 | 0 49 | 0 50 | 0 51 |
| 13 | 0 52 | 73 | 4 52 | 133 | 8 52 | 193 | 12 52 | 253 | 16 52 | 313 | 20 52 | 13 | 0 52 | 0 53 | 0 54 | 0 55 |
| 14 | 0 56 | 74 | 4 56 | 134 | 8 56 | 194 | 12 56 | 254 | 16 56 | 314 | 20 56 | 14 | 0 56 | 0 57 | 0 58 | 0 59 |
| 15 | 1 00 | 75 | 5 00 | 135 | 9 00 | 195 | 13 00 | 255 | 17 00 | 315 | 21 00 | 15 | 1 00 | 1 01 | 1 02 | 1 03 |
| 16 | 1 04 | 76 | 5 04 | 136 | 9 04 | 196 | 13 04 | 256 | 17 04 | 316 | 21 04 | 16 | 1 04 | 1 05 | 1 06 | 1 07 |
| 17 | 1 08 | 77 | 5 08 | 137 | 9 08 | 197 | 13 08 | 257 | 17 08 | 317 | 21 08 | 17 | 1 08 | 1 09 | 1 10 | 1 11 |
| 18 | 1 12 | 78 | 5 12 | 138 | 9 12 | 198 | 13 12 | 258 | 17 12 | 318 | 21 12 | 18 | 1 12 | 1 13 | 1 14 | 1 15 |
| 19 | 1 16 | 79 | 5 16 | 139 | 9 16 | 199 | 13 16 | 259 | 17 16 | 319 | 21 16 | 19 | 1 16 | 1 17 | 1 18 | 1 19 |
| 20 | 1 20 | 80 | 5 20 | 140 | 9 20 | 200 | 13 20 | 260 | 17 20 | 320 | 21 20 | 20 | 1 20 | 1 21 | 1 22 | 1 23 |
| 21 | 1 24 | 81 | 5 24 | 141 | 9 24 | 201 | 13 24 | 261 | 17 24 | 321 | 21 24 | 21 | 1 24 | 1 25 | 1 26 | 1 27 |
| 22 | 1 28 | 82 | 5 28 | 142 | 9 28 | 202 | 13 28 | 262 | 17 28 | 322 | 21 28 | 22 | 1 28 | 1 29 | 1 30 | 1 31 |
| 23 | 1 32 | 83 | 5 32 | 143 | 9 32 | 203 | 13 32 | 263 | 17 32 | 323 | 21 32 | 23 | 1 32 | 1 33 | 1 34 | 1 35 |
| 24 | 1 36 | 84 | 5 36 | 144 | 9 36 | 204 | 13 36 | 264 | 17 36 | 324 | 21 36 | 24 | 1 36 | 1 37 | 1 38 | 1 39 |
| 25 | 1 40 | 85 | 5 40 | 145 | 9 40 | 205 | 13 40 | 265 | 17 40 | 325 | 21 40 | 25 | 1 40 | 1 41 | 1 42 | 1 43 |
| 26 | 1 44 | 86 | 5 44 | 146 | 9 44 | 206 | 13 44 | 266 | 17 44 | 326 | 21 44 | 26 | 1 44 | 1 45 | 1 46 | 1 47 |
| 27 | 1 48 | 87 | 5 48 | 147 | 9 48 | 207 | 13 48 | 267 | 17 48 | 327 | 21 48 | 27 | 1 48 | 1 49 | 1 50 | 1 51 |
| 28 | 1 52 | 88 | 5 52 | 148 | 9 52 | 208 | 13 52 | 268 | 17 52 | 328 | 21 52 | 28 | 1 52 | 1 53 | 1 54 | 1 55 |
| 29 | 1 56 | 89 | 5 56 | 149 | 9 56 | 209 | 13 56 | 269 | 17 56 | 329 | 21 56 | 29 | 1 56 | 1 57 | 1 58 | 1 59 |
| 30 | 2 00 | 90 | 6 00 | 150 | 10 00 | 210 | 14 00 | 270 | 18 00 | 330 | 22 00 | 30 | 2 00 | 2 01 | 2 02 | 2 03 |
| 31 | 2 04 | 91 | 6 04 | 151 | 10 04 | 211 | 14 04 | 271 | 18 04 | 331 | 22 04 | 31 | 2 04 | 2 05 | 2 06 | 2 07 |
| 32 | 2 08 | 92 | 6 08 | 152 | 10 08 | 212 | 14 08 | 272 | 18 08 | 332 | 22 08 | 32 | 2 08 | 2 09 | 2 10 | 2 11 |
| 33 | 2 12 | 93 | 6 12 | 153 | 10 12 | 213 | 14 12 | 273 | 18 12 | 333 | 22 12 | 33 | 2 12 | 2 13 | 2 14 | 2 15 |
| 34 | 2 16 | 94 | 6 16 | 154 | 10 16 | 214 | 14 16 | 274 | 18 16 | 334 | 22 16 | 34 | 2 16 | 2 17 | 2 18 | 2 19 |
| 35 | 2 20 | 95 | 6 20 | 155 | 10 20 | 215 | 14 20 | 275 | 18 20 | 335 | 22 20 | 35 | 2 20 | 2 21 | 2 22 | 2 23 |
| 36 | 2 24 | 96 | 6 24 | 156 | 10 24 | 216 | 14 24 | 276 | 18 24 | 336 | 22 24 | 36 | 2 24 | 2 25 | 2 26 | 2 27 |
| 37 | 2 28 | 97 | 6 28 | 157 | 10 28 | 217 | 14 28 | 277 | 18 28 | 337 | 22 28 | 37 | 2 28 | 2 29 | 2 30 | 2 31 |
| 38 | 2 32 | 98 | 6 32 | 158 | 10 32 | 218 | 14 32 | 278 | 18 32 | 338 | 22 32 | 38 | 2 32 | 2 33 | 2 34 | 2 35 |
| 39 | 2 36 | 99 | 6 36 | 159 | 10 36 | 219 | 14 36 | 279 | 18 36 | 339 | 22 36 | 39 | 2 36 | 2 37 | 2 38 | 2 39 |
| 40 | 2 40 | 100 | 6 40 | 160 | 10 40 | 220 | 14 40 | 280 | 18 40 | 340 | 22 40 | 40 | 2 40 | 2 41 | 2 42 | 2 43 |
| 41 | 2 44 | 101 | 6 44 | 161 | 10 44 | 221 | 14 44 | 281 | 18 44 | 341 | 22 44 | 41 | 2 44 | 2 45 | 2 46 | 2 47 |
| 42 | 2 48 | 102 | 6 48 | 162 | 10 48 | 222 | 14 48 | 282 | 18 48 | 342 | 22 48 | 42 | 2 48 | 2 49 | 2 50 | 2 51 |
| 43 | 2 52 | 103 | 6 52 | 163 | 10 52 | 223 | 14 52 | 283 | 18 52 | 343 | 22 52 | 43 | 2 52 | 2 53 | 2 54 | 2 55 |
| 44 | 2 56 | 104 | 6 56 | 164 | 10 56 | 224 | 14 56 | 284 | 18 56 | 344 | 22 56 | 44 | 2 56 | 2 57 | 2 58 | 2 59 |
| 45 | 3 00 | 105 | 7 00 | 165 | 11 00 | 225 | 15 00 | 285 | 19 00 | 345 | 23 00 | 45 | 3 00 | 3 01 | 3 02 | 3 03 |
| 46 | 3 04 | 106 | 7 04 | 166 | 11 04 | 226 | 15 04 | 286 | 19 04 | 346 | 23 04 | 46 | 3 04 | 3 05 | 3 06 | 3 07 |
| 47 | 3 08 | 107 | 7 08 | 167 | 11 08 | 227 | 15 08 | 287 | 19 08 | 347 | 23 08 | 47 | 3 08 | 3 09 | 3 10 | 3 11 |
| 48 | 3 12 | 108 | 7 12 | 168 | 11 12 | 228 | 15 12 | 288 | 19 12 | 348 | 23 12 | 48 | 3 12 | 3 13 | 3 14 | 3 15 |
| 49 | 3 16 | 109 | 7 16 | 169 | 11 16 | 229 | 15 16 | 289 | 19 16 | 349 | 23 16 | 49 | 3 16 | 3 17 | 3 18 | 3 19 |
| 50 | 3 20 | 110 | 7 20 | 170 | 11 20 | 230 | 15 20 | 290 | 19 20 | 350 | 23 20 | 50 | 3 20 | 3 21 | 3 22 | 3 23 |
| 51 | 3 24 | 111 | 7 24 | 171 | 11 24 | 231 | 15 24 | 291 | 19 24 | 351 | 23 24 | 51 | 3 24 | 3 25 | 3 26 | 3 27 |
| 52 | 3 28 | 112 | 7 28 | 172 | 11 28 | 232 | 15 28 | 292 | 19 28 | 352 | 23 28 | 52 | 3 28 | 3 29 | 3 30 | 3 31 |
| 53 | 3 32 | 113 | 7 32 | 173 | 11 32 | 233 | 15 32 | 293 | 19 32 | 353 | 23 32 | 53 | 3 32 | 3 33 | 3 34 | 3 35 |
| 54 | 3 36 | 114 | 7 36 | 174 | 11 36 | 234 | 15 36 | 294 | 19 36 | 354 | 23 36 | 54 | 3 36 | 3 37 | 3 38 | 3 39 |
| 55 | 3 40 | 115 | 7 40 | 175 | 11 40 | 235 | 15 40 | 295 | 19 40 | 355 | 23 40 | 55 | 3 40 | 3 41 | 3 42 | 3 43 |
| 56 | 3 44 | 116 | 7 44 | 176 | 11 44 | 236 | 15 44 | 296 | 19 44 | 356 | 23 44 | 56 | 3 44 | 3 45 | 3 46 | 3 47 |
| 57 | 3 48 | 117 | 7 48 | 177 | 11 48 | 237 | 15 48 | 297 | 19 48 | 357 | 23 48 | 57 | 3 48 | 3 49 | 3 50 | 3 51 |
| 58 | 3 52 | 118 | 7 52 | 178 | 11 52 | 238 | 15 52 | 298 | 19 52 | 358 | 23 52 | 58 | 3 52 | 3 53 | 3 54 | 3 55 |
| 59 | 3 56 | 119 | 7 56 | 179 | 11 56 | 239 | 15 56 | 299 | 19 56 | 359 | 23 56 | 59 | 3 56 | 3 57 | 3 58 | 3 59 |

The above table is for converting expressions in arc to their equivalent in time; its main use in this Almanac is for the conversion of longitude for application to LMT (*added* if *west*, *subtracted* if *east*) to give UT or vice versa, particularly in the case of sunrise, sunset, etc.

## 24^m INCREMENTS AND CORRECTIONS

| 24^m | SUN PLANETS | ARIES | MOON | v or d | Corr^n | v or d | Corr^n | v or d | Corr^n |
|---|---|---|---|---|---|---|---|---|---|
| s | ° ′ | ° ′ | ° ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| 00 | 6 00·0 | 6 01·0 | 5 43·6 | 0·0 | 0·0 | 6·0 | 2·5 | 12·0 | 4·9 |
| 01 | 6 00·3 | 6 01·2 | 5 43·8 | 0·1 | 0·0 | 6·1 | 2·5 | 12·1 | 4·9 |
| 02 | 6 00·5 | 6 01·5 | 5 44·1 | 0·2 | 0·1 | 6·2 | 2·5 | 12·2 | 5·0 |
| 03 | 6 00·8 | 6 01·7 | 5 44·3 | 0·3 | 0·1 | 6·3 | 2·6 | 12·3 | 5·0 |
| 04 | 6 01·0 | 6 02·0 | 5 44·6 | 0·4 | 0·2 | 6·4 | 2·6 | 12·4 | 5·1 |
| 05 | 6 01·3 | 6 02·2 | 5 44·8 | 0·5 | 0·2 | 6·5 | 2·7 | 12·5 | 5·1 |
| 06 | 6 01·5 | 6 02·5 | 5 45·0 | 0·6 | 0·2 | 6·6 | 2·7 | 12·6 | 5·1 |
| 07 | 6 01·8 | 6 02·7 | 5 45·3 | 0·7 | 0·3 | 6·7 | 2·7 | 12·7 | 5·2 |
| 08 | 6 02·0 | 6 03·0 | 5 45·5 | 0·8 | 0·3 | 6·8 | 2·8 | 12·8 | 5·2 |
| 09 | 6 02·3 | 6 03·2 | 5 45·7 | 0·9 | 0·4 | 6·9 | 2·8 | 12·9 | 5·3 |
| 10 | 6 02·5 | 6 03·5 | 5 46·0 | 1·0 | 0·4 | 7·0 | 2·9 | 13·0 | 5·3 |
| 11 | 6 02·8 | 6 03·7 | 5 46·2 | 1·1 | 0·4 | 7·1 | 2·9 | 13·1 | 5·3 |
| 12 | 6 03·0 | 6 04·0 | 5 46·5 | 1·2 | 0·5 | 7·2 | 2·9 | 13·2 | 5·4 |
| 13 | 6 03·3 | 6 04·2 | 5 46·7 | 1·3 | 0·5 | 7·3 | 3·0 | 13·3 | 5·4 |
| 14 | 6 03·5 | 6 04·5 | 5 46·9 | 1·4 | 0·6 | 7·4 | 3·0 | 13·4 | 5·5 |
| 15 | 6 03·8 | 6 04·7 | 5 47·2 | 1·5 | 0·6 | 7·5 | 3·1 | 13·5 | 5·5 |
| 16 | 6 04·0 | 6 05·0 | 5 47·4 | 1·6 | 0·7 | 7·6 | 3·1 | 13·6 | 5·6 |
| 17 | 6 04·3 | 6 05·2 | 5 47·7 | 1·7 | 0·7 | 7·7 | 3·1 | 13·7 | 5·6 |
| 18 | 6 04·5 | 6 05·5 | 5 47·9 | 1·8 | 0·7 | 7·8 | 3·2 | 13·8 | 5·6 |
| 19 | 6 04·8 | 6 05·7 | 5 48·1 | 1·9 | 0·8 | 7·9 | 3·2 | 13·9 | 5·7 |
| 20 | 6 05·0 | 6 06·0 | 5 48·4 | 2·0 | 0·8 | 8·0 | 3·3 | 14·0 | 5·7 |
| 21 | 6 05·3 | 6 06·3 | 5 48·6 | 2·1 | 0·9 | 8·1 | 3·3 | 14·1 | 5·8 |
| 22 | 6 05·5 | 6 06·5 | 5 48·8 | 2·2 | 0·9 | 8·2 | 3·3 | 14·2 | 5·8 |
| 23 | 6 05·8 | 6 06·8 | 5 49·1 | 2·3 | 0·9 | 8·3 | 3·4 | 14·3 | 5·8 |
| 24 | 6 06·0 | 6 07·0 | 5 49·3 | 2·4 | 1·0 | 8·4 | 3·4 | 14·4 | 5·9 |
| 25 | 6 06·3 | 6 07·3 | 5 49·6 | 2·5 | 1·0 | 8·5 | 3·5 | 14·5 | 5·9 |
| 26 | 6 06·5 | 6 07·5 | 5 49·8 | 2·6 | 1·1 | 8·6 | 3·5 | 14·6 | 6·0 |
| 27 | 6 06·8 | 6 07·8 | 5 50·0 | 2·7 | 1·1 | 8·7 | 3·6 | 14·7 | 6·0 |
| 28 | 6 07·0 | 6 08·0 | 5 50·3 | 2·8 | 1·1 | 8·8 | 3·6 | 14·8 | 6·0 |
| 29 | 6 07·3 | 6 08·3 | 5 50·5 | 2·9 | 1·2 | 8·9 | 3·6 | 14·9 | 6·1 |
| 30 | 6 07·5 | 6 08·5 | 5 50·8 | 3·0 | 1·2 | 9·0 | 3·7 | 15·0 | 6·1 |
| 31 | 6 07·8 | 6 08·8 | 5 51·0 | 3·1 | 1·3 | 9·1 | 3·7 | 15·1 | 6·2 |
| 32 | 6 08·0 | 6 09·0 | 5 51·2 | 3·2 | 1·3 | 9·2 | 3·8 | 15·2 | 6·2 |
| 33 | 6 08·3 | 6 09·3 | 5 51·5 | 3·3 | 1·3 | 9·3 | 3·8 | 15·3 | 6·2 |
| 34 | 6 08·5 | 6 09·5 | 5 51·7 | 3·4 | 1·4 | 9·4 | 3·8 | 15·4 | 6·3 |
| 35 | 6 08·8 | 6 09·8 | 5 52·0 | 3·5 | 1·4 | 9·5 | 3·9 | 15·5 | 6·3 |
| 36 | 6 09·0 | 6 10·0 | 5 52·2 | 3·6 | 1·5 | 9·6 | 3·9 | 15·6 | 6·4 |
| 37 | 6 09·3 | 6 10·3 | 5 52·4 | 3·7 | 1·5 | 9·7 | 4·0 | 15·7 | 6·4 |
| 38 | 6 09·5 | 6 10·5 | 5 52·7 | 3·8 | 1·6 | 9·8 | 4·0 | 15·8 | 6·5 |
| 39 | 6 09·8 | 6 10·8 | 5 52·9 | 3·9 | 1·6 | 9·9 | 4·0 | 15·9 | 6·5 |
| 40 | 6 10·0 | 6 11·0 | 5 53·1 | 4·0 | 1·6 | 10·0 | 4·1 | 16·0 | 6·5 |
| 41 | 6 10·3 | 6 11·3 | 5 53·4 | 4·1 | 1·7 | 10·1 | 4·1 | 16·1 | 6·6 |
| 42 | 6 10·5 | 6 11·5 | 5 53·6 | 4·2 | 1·7 | 10·2 | 4·2 | 16·2 | 6·6 |
| 43 | 6 10·8 | 6 11·8 | 5 53·9 | 4·3 | 1·8 | 10·3 | 4·2 | 16·3 | 6·7 |
| 44 | 6 11·0 | 6 12·0 | 5 54·1 | 4·4 | 1·8 | 10·4 | 4·2 | 16·4 | 6·7 |
| 45 | 6 11·3 | 6 12·3 | 5 54·3 | 4·5 | 1·8 | 10·5 | 4·3 | 16·5 | 6·7 |
| 46 | 6 11·5 | 6 12·5 | 5 54·6 | 4·6 | 1·9 | 10·6 | 4·3 | 16·6 | 6·8 |
| 47 | 6 11·8 | 6 12·8 | 5 54·8 | 4·7 | 1·9 | 10·7 | 4·4 | 16·7 | 6·8 |
| 48 | 6 12·0 | 6 13·0 | 5 55·1 | 4·8 | 2·0 | 10·8 | 4·4 | 16·8 | 6·9 |
| 49 | 6 12·3 | 6 13·3 | 5 55·3 | 4·9 | 2·0 | 10·9 | 4·5 | 16·9 | 6·9 |
| 50 | 6 12·5 | 6 13·5 | 5 55·5 | 5·0 | 2·0 | 11·0 | 4·5 | 17·0 | 6·9 |
| 51 | 6 12·8 | 6 13·8 | 5 55·8 | 5·1 | 2·1 | 11·1 | 4·5 | 17·1 | 7·0 |
| 52 | 6 13·0 | 6 14·0 | 5 56·0 | 5·2 | 2·1 | 11·2 | 4·6 | 17·2 | 7·0 |
| 53 | 6 13·3 | 6 14·3 | 5 56·2 | 5·3 | 2·2 | 11·3 | 4·6 | 17·3 | 7·1 |
| 54 | 6 13·5 | 6 14·5 | 5 56·5 | 5·4 | 2·2 | 11·4 | 4·7 | 17·4 | 7·1 |
| 55 | 6 13·8 | 6 14·8 | 5 56·7 | 5·5 | 2·2 | 11·5 | 4·7 | 17·5 | 7·1 |
| 56 | 6 14·0 | 6 15·0 | 5 57·0 | 5·6 | 2·3 | 11·6 | 4·7 | 17·6 | 7·2 |
| 57 | 6 14·3 | 6 15·3 | 5 57·2 | 5·7 | 2·3 | 11·7 | 4·8 | 17·7 | 7·2 |
| 58 | 6 14·5 | 6 15·5 | 5 57·4 | 5·8 | 2·4 | 11·8 | 4·8 | 17·8 | 7·3 |
| 59 | 6 14·8 | 6 15·8 | 5 57·7 | 5·9 | 2·4 | 11·9 | 4·9 | 17·9 | 7·3 |
| 60 | 6 15·0 | 6 16·0 | 5 57·9 | 6·0 | 2·5 | 12·0 | 4·9 | 18·0 | 7·4 |

## 25^m

| 25^m | SUN PLANETS | ARIES | MOON | v or d | Corr^n | v or d | Corr^n | v or d | Corr^n |
|---|---|---|---|---|---|---|---|---|---|
| s | ° ′ | ° ′ | ° ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| 00 | 6 15·0 | 6 16·0 | 5 57·9 | 0·0 | 0·0 | 6·0 | 2·6 | 12·0 | 5·1 |
| 01 | 6 15·3 | 6 16·3 | 5 58·2 | 0·1 | 0·0 | 6·1 | 2·6 | 12·1 | 5·1 |
| 02 | 6 15·5 | 6 16·5 | 5 58·4 | 0·2 | 0·1 | 6·2 | 2·6 | 12·2 | 5·2 |
| 03 | 6 15·8 | 6 16·8 | 5 58·6 | 0·3 | 0·1 | 6·3 | 2·7 | 12·3 | 5·2 |
| 04 | 6 16·0 | 6 17·0 | 5 58·9 | 0·4 | 0·2 | 6·4 | 2·7 | 12·4 | 5·3 |
| 05 | 6 16·3 | 6 17·3 | 5 59·1 | 0·5 | 0·2 | 6·5 | 2·8 | 12·5 | 5·3 |
| 06 | 6 16·5 | 6 17·5 | 5 59·3 | 0·6 | 0·3 | 6·6 | 2·8 | 12·6 | 5·4 |
| 07 | 6 16·8 | 6 17·8 | 5 59·6 | 0·7 | 0·3 | 6·7 | 2·8 | 12·7 | 5·4 |
| 08 | 6 17·0 | 6 18·0 | 5 59·8 | 0·8 | 0·3 | 6·8 | 2·9 | 12·8 | 5·4 |
| 09 | 6 17·3 | 6 18·3 | 6 00·1 | 0·9 | 0·4 | 6·9 | 2·9 | 12·9 | 5·5 |
| 10 | 6 17·5 | 6 18·5 | 6 00·3 | 1·0 | 0·4 | 7·0 | 3·0 | 13·0 | 5·5 |
| 11 | 6 17·8 | 6 18·8 | 6 00·5 | 1·1 | 0·5 | 7·1 | 3·0 | 13·1 | 5·6 |
| 12 | 6 18·0 | 6 19·0 | 6 00·8 | 1·2 | 0·5 | 7·2 | 3·1 | 13·2 | 5·6 |
| 13 | 6 18·3 | 6 19·3 | 6 01·0 | 1·3 | 0·6 | 7·3 | 3·1 | 13·3 | 5·7 |
| 14 | 6 18·5 | 6 19·5 | 6 01·3 | 1·4 | 0·6 | 7·4 | 3·1 | 13·4 | 5·7 |
| 15 | 6 18·8 | 6 19·8 | 6 01·5 | 1·5 | 0·6 | 7·5 | 3·2 | 13·5 | 5·7 |
| 16 | 6 19·0 | 6 20·0 | 6 01·7 | 1·6 | 0·7 | 7·6 | 3·2 | 13·6 | 5·8 |
| 17 | 6 19·3 | 6 20·3 | 6 02·0 | 1·7 | 0·7 | 7·7 | 3·3 | 13·7 | 5·8 |
| 18 | 6 19·5 | 6 20·5 | 6 02·2 | 1·8 | 0·8 | 7·8 | 3·3 | 13·8 | 5·9 |
| 19 | 6 19·8 | 6 20·8 | 6 02·5 | 1·9 | 0·8 | 7·9 | 3·4 | 13·9 | 5·9 |
| 20 | 6 20·0 | 6 21·0 | 6 02·7 | 2·0 | 0·9 | 8·0 | 3·4 | 14·0 | 6·0 |
| 21 | 6 20·3 | 6 21·3 | 6 02·9 | 2·1 | 0·9 | 8·1 | 3·4 | 14·1 | 6·0 |
| 22 | 6 20·5 | 6 21·5 | 6 03·2 | 2·2 | 0·9 | 8·2 | 3·5 | 14·2 | 6·0 |
| 23 | 6 20·8 | 6 21·8 | 6 03·4 | 2·3 | 1·0 | 8·3 | 3·5 | 14·3 | 6·1 |
| 24 | 6 21·0 | 6 22·0 | 6 03·6 | 2·4 | 1·0 | 8·4 | 3·6 | 14·4 | 6·1 |
| 25 | 6 21·3 | 6 22·3 | 6 03·9 | 2·5 | 1·1 | 8·5 | 3·6 | 14·5 | 6·2 |
| 26 | 6 21·5 | 6 22·5 | 6 04·1 | 2·6 | 1·1 | 8·6 | 3·7 | 14·6 | 6·2 |
| 27 | 6 21·8 | 6 22·8 | 6 04·4 | 2·7 | 1·1 | 8·7 | 3·7 | 14·7 | 6·2 |
| 28 | 6 22·0 | 6 23·0 | 6 04·6 | 2·8 | 1·2 | 8·8 | 3·7 | 14·8 | 6·3 |
| 29 | 6 22·3 | 6 23·3 | 6 04·8 | 2·9 | 1·2 | 8·9 | 3·8 | 14·9 | 6·3 |
| 30 | 6 22·5 | 6 23·5 | 6 05·1 | 3·0 | 1·3 | 9·0 | 3·8 | 15·0 | 6·4 |
| 31 | 6 22·8 | 6 23·8 | 6 05·3 | 3·1 | 1·3 | 9·1 | 3·9 | 15·1 | 6·4 |
| 32 | 6 23·0 | 6 24·0 | 6 05·6 | 3·2 | 1·4 | 9·2 | 3·9 | 15·2 | 6·5 |
| 33 | 6 23·3 | 6 24·3 | 6 05·8 | 3·3 | 1·4 | 9·3 | 4·0 | 15·3 | 6·5 |
| 34 | 6 23·5 | 6 24·5 | 6 06·0 | 3·4 | 1·4 | 9·4 | 4·0 | 15·4 | 6·5 |
| 35 | 6 23·8 | 6 24·8 | 6 06·3 | 3·5 | 1·5 | 9·5 | 4·0 | 15·5 | 6·6 |
| 36 | 6 24·0 | 6 25·1 | 6 06·5 | 3·6 | 1·5 | 9·6 | 4·1 | 15·6 | 6·6 |
| 37 | 6 24·3 | 6 25·3 | 6 06·7 | 3·7 | 1·6 | 9·7 | 4·1 | 15·7 | 6·7 |
| 38 | 6 24·5 | 6 25·6 | 6 07·0 | 3·8 | 1·6 | 9·8 | 4·2 | 15·8 | 6·7 |
| 39 | 6 24·8 | 6 25·8 | 6 07·2 | 3·9 | 1·7 | 9·9 | 4·2 | 15·9 | 6·8 |
| 40 | 6 25·0 | 6 26·1 | 6 07·5 | 4·0 | 1·7 | 10·0 | 4·3 | 16·0 | 6·8 |
| 41 | 6 25·3 | 6 26·3 | 6 07·7 | 4·1 | 1·7 | 10·1 | 4·3 | 16·1 | 6·8 |
| 42 | 6 25·5 | 6 26·6 | 6 07·9 | 4·2 | 1·8 | 10·2 | 4·3 | 16·2 | 6·9 |
| 43 | 6 25·8 | 6 26·8 | 6 08·2 | 4·3 | 1·8 | 10·3 | 4·4 | 16·3 | 6·9 |
| 44 | 6 26·0 | 6 27·1 | 6 08·4 | 4·4 | 1·9 | 10·4 | 4·4 | 16·4 | 7·0 |
| 45 | 6 26·3 | 6 27·3 | 6 08·7 | 4·5 | 1·9 | 10·5 | 4·5 | 16·5 | 7·0 |
| 46 | 6 26·5 | 6 27·6 | 6 08·9 | 4·6 | 2·0 | 10·6 | 4·5 | 16·6 | 7·1 |
| 47 | 6 26·8 | 6 27·8 | 6 09·1 | 4·7 | 2·0 | 10·7 | 4·5 | 16·7 | 7·1 |
| 48 | 6 27·0 | 6 28·1 | 6 09·4 | 4·8 | 2·0 | 10·8 | 4·6 | 16·8 | 7·1 |
| 49 | 6 27·3 | 6 28·3 | 6 09·6 | 4·9 | 2·1 | 10·9 | 4·6 | 16·9 | 7·2 |
| 50 | 6 27·5 | 6 28·6 | 6 09·8 | 5·0 | 2·1 | 11·0 | 4·7 | 17·0 | 7·2 |
| 51 | 6 27·8 | 6 28·8 | 6 10·1 | 5·1 | 2·2 | 11·1 | 4·7 | 17·1 | 7·3 |
| 52 | 6 28·0 | 6 29·1 | 6 10·3 | 5·2 | 2·2 | 11·2 | 4·8 | 17·2 | 7·3 |
| 53 | 6 28·3 | 6 29·3 | 6 10·6 | 5·3 | 2·3 | 11·3 | 4·8 | 17·3 | 7·4 |
| 54 | 6 28·5 | 6 29·6 | 6 10·8 | 5·4 | 2·3 | 11·4 | 4·8 | 17·4 | 7·4 |
| 55 | 6 28·8 | 6 29·8 | 6 11·0 | 5·5 | 2·3 | 11·5 | 4·9 | 17·5 | 7·4 |
| 56 | 6 29·0 | 6 30·1 | 6 11·3 | 5·6 | 2·4 | 11·6 | 4·9 | 17·6 | 7·5 |
| 57 | 6 29·3 | 6 30·3 | 6 11·5 | 5·7 | 2·4 | 11·7 | 5·0 | 17·7 | 7·5 |
| 58 | 6 29·5 | 6 30·6 | 6 11·8 | 5·8 | 2·5 | 11·8 | 5·0 | 17·8 | 7·6 |
| 59 | 6 29·8 | 6 30·8 | 6 12·0 | 5·9 | 2·5 | 11·9 | 5·1 | 17·9 | 7·6 |
| 60 | 6 30·0 | 6 31·1 | 6 12·2 | 6·0 | 2·6 | 12·0 | 5·1 | 18·0 | 7·7 |

# TABLES FOR INTERPOLATING SUNRISE, MOONRISE, ETC.

## TABLE I—FOR LATITUDE

| Tabular Interval 10° | 5° | 2° | Difference between the times for consecutive latitudes $5^m$ | $10^m$ | $15^m$ | $20^m$ | $25^m$ | $30^m$ | $35^m$ | $40^m$ | $45^m$ | $50^m$ | $55^m$ | $60^m$ | $1^h05^m$ | $1^h10^m$ | $1^h15^m$ | $1^h20^m$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° ′ | ° ′ | ° ′ | m | m | m | m | m | m | m | m | m | m | m | m | h m | h m | h m | h m |
| **0 30** | **0 15** | **0 06** | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 0 02 | 0 02 | 0 02 | 0 02 |
| **1 00** | **0 30** | **0 12** | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 | 4 | 4 | 5 | 05 | 05 | 05 | 05 |
| **1 30** | **0 45** | **0 18** | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 7 | 7 | 07 | 07 | 07 | 07 |
| **2 00** | **1 00** | **0 24** | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 10 | 10 | 10 | 10 |
| **2 30** | **1 15** | **0 30** | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 9 | 10 | 11 | 12 | 12 | 13 | 13 | 13 |
| **3 00** | **1 30** | **0 36** | 1 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 0 15 | 0 15 | 0 16 | 0 16 |
| **3 30** | **1 45** | **0 42** | 2 | 3 | 5 | 7 | 8 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 18 | 19 | 19 |
| **4 00** | **2 00** | **0 48** | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 21 | 22 | 22 |
| **4 30** | **2 15** | **0 54** | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 16 | 18 | 19 | 21 | 22 | 23 | 24 | 25 | 26 |
| **5 00** | **2 30** | **1 00** | 2 | 5 | 7 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 23 | 25 | 26 | 27 | 28 | 29 |
| **5 30** | **2 45** | **1 06** | 3 | 5 | 8 | 11 | 13 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 0 29 | 0 30 | 0 31 | 0 32 |
| **6 00** | **3 00** | **1 12** | 3 | 6 | 9 | 12 | 14 | 17 | 20 | 22 | 24 | 26 | 29 | 31 | 32 | 33 | 34 | 36 |
| **6 30** | **3 15** | **1 18** | 3 | 6 | 10 | 13 | 16 | 19 | 22 | 24 | 26 | 29 | 31 | 34 | 36 | 37 | 38 | 40 |
| **7 00** | **3 30** | **1 24** | 3 | 7 | 10 | 14 | 17 | 20 | 23 | 26 | 29 | 31 | 34 | 37 | 39 | 41 | 42 | 44 |
| **7 30** | **3 45** | **1 30** | 4 | 7 | 11 | 15 | 18 | 22 | 25 | 28 | 31 | 34 | 37 | 40 | 43 | 44 | 46 | 48 |
| **8 00** | **4 00** | **1 36** | 4 | 8 | 12 | 16 | 20 | 23 | 27 | 30 | 34 | 37 | 41 | 44 | 0 47 | 0 48 | 0 51 | 0 53 |
| **8 30** | **4 15** | **1 42** | 4 | 8 | 13 | 17 | 21 | 25 | 29 | 33 | 36 | 40 | 44 | 48 | 0 51 | 0 53 | 0 56 | 0 58 |
| **9 00** | **4 30** | **1 48** | 4 | 9 | 13 | 18 | 22 | 27 | 31 | 35 | 39 | 43 | 47 | 52 | 0 55 | 0 58 | 1 01 | 1 04 |
| **9 30** | **4 45** | **1 54** | 5 | 9 | 14 | 19 | 24 | 28 | 33 | 38 | 42 | 47 | 51 | 56 | 1 00 | 1 04 | 1 08 | 1 12 |
| **10 00** | **5 00** | **2 00** | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 1 05 | 1 10 | 1 15 | 1 20 |

Table I is for interpolating the LMT of sunrise, twilight, moonrise, etc., for latitude. It is to be entered, in the appropriate column on the left, with the difference between true latitude and the nearest tabular latitude which is *less* than the true latitude; and with the argument at the top which is the nearest value of the difference between the times for the tabular latitude and the next higher one; the correction so obtained is applied to the time for the tabular latitude; the sign of the correction can be seen by inspection. It is to be noted that the interpolation is not linear, so that when using this table it is essential to take out the tabular phenomenon for the latitude *less* than the true latitude.

## TABLE II—FOR LONGITUDE

| Long. East or West | Difference between the times for given date and preceding date (for east longitude) or for given date and following date (for west longitude) $10^m$ | $20^m$ | $30^m$ | $40^m$ | $50^m$ | $60^m$ | $1^h +$ $10^m$ | $1^h +$ $20^m$ | $1^h +$ $30^m$ | $1^h +$ $40^m$ | $1^h +$ $50^m$ | $1^h +$ $60^m$ | $2^h10^m$ | $2^h20^m$ | $2^h30^m$ | $2^h40^m$ | $2^h50^m$ | $3^h00^m$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ° | m | m | m | m | m | m | m | m | m | m | m | m | h m | h m | h m | h m | h m | h m |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 00 | 0 00 | 0 00 | 0 00 | 0 00 | 0 00 |
| **10** | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 04 | 04 | 04 | 04 | 05 | 05 |
| **20** | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 6 | 7 | 07 | 08 | 08 | 09 | 09 | 10 |
| **30** | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 | 9 | 10 | 11 | 12 | 12 | 13 | 14 | 15 |
| **40** | 1 | 2 | 3 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 16 | 17 | 18 | 19 | 20 |
| **50** | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 | 14 | 15 | 17 | 0 18 | 0 19 | 0 21 | 0 22 | 0 24 | 0 25 |
| **60** | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 | 17 | 18 | 20 | 22 | 23 | 25 | 27 | 28 | 30 |
| **70** | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 17 | 19 | 21 | 23 | 25 | 27 | 29 | 31 | 33 | 35 |
| **80** | 2 | 4 | 7 | 9 | 11 | 13 | 16 | 18 | 20 | 22 | 24 | 27 | 29 | 31 | 33 | 36 | 38 | 40 |
| **90** | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 20 | 22 | 25 | 27 | 30 | 32 | 35 | 37 | 40 | 42 | 45 |
| **100** | 3 | 6 | 8 | 11 | 14 | 17 | 19 | 22 | 25 | 28 | 31 | 33 | 0 36 | 0 39 | 0 42 | 0 44 | 0 47 | 0 50 |
| **110** | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 31 | 34 | 37 | 40 | 43 | 46 | 49 | 0 52 | 0 55 |
| **120** | 3 | 7 | 10 | 13 | 17 | 20 | 23 | 27 | 30 | 33 | 37 | 40 | 43 | 47 | 50 | 53 | 0 57 | 1 00 |
| **130** | 4 | 7 | 11 | 14 | 18 | 22 | 25 | 29 | 32 | 36 | 40 | 43 | 47 | 51 | 54 | 0 58 | 1 01 | 1 05 |
| **140** | 4 | 8 | 12 | 16 | 19 | 23 | 27 | 31 | 35 | 39 | 43 | 47 | 51 | 54 | 0 58 | 1 02 | 1 06 | 1 10 |
| **150** | 4 | 8 | 13 | 17 | 21 | 25 | 29 | 33 | 38 | 42 | 46 | 50 | 0 54 | 0 58 | 1 03 | 1 07 | 1 11 | 1 15 |
| **160** | 4 | 9 | 13 | 18 | 22 | 27 | 31 | 36 | 40 | 44 | 49 | 53 | 0 58 | 1 02 | 1 07 | 1 11 | 1 16 | 1 20 |
| **170** | 5 | 9 | 14 | 19 | 24 | 28 | 33 | 38 | 42 | 47 | 52 | 57 | 1 01 | 1 06 | 1 11 | 1 16 | 1 20 | 1 25 |
| **180** | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 1 05 | 1 10 | 1 15 | 1 20 | 1 25 | 1 30 |

Table II is for interpolating the LMT of moonrise, moonset and the Moon's meridian passage for longitude. It is entered with longitude and with the difference between the times for the given date and for the preceding date (in east longitudes) or following date (in west longitudes). The correction is normally *added* for west longitudes and *subtracted* for east longitudes, but if, as occasionally happens, the times become earlier each day instead of later, the signs of the corrections must be reversed.

# INDEX TO SELECTED STARS, 2024

| Name | No | Mag | SHA | Dec |
|---|---|---|---|---|
| | | | ° | ° |
| *Acamar* | **7** | 3·2 | 315 | S 40 |
| *Achernar* | **5** | 0·5 | 335 | S 57 |
| *Acrux* | **30** | 1·3 | 173 | S 63 |
| *Adhara* | **19** | 1·5 | 255 | S 29 |
| *Aldebaran* | **10** | 0·9 | 291 | N 17 |
| *Alioth* | **32** | 1·8 | 166 | N 56 |
| *Alkaid* | **34** | 1·9 | 153 | N 49 |
| *Alnair* | **55** | 1·7 | 28 | S 47 |
| *Alnilam* | **15** | 1·7 | 276 | S 1 |
| *Alphard* | **25** | 2·0 | 218 | S 9 |
| *Alphecca* | **41** | 2·2 | 126 | N 27 |
| *Alpheratz* | **1** | 2·1 | 358 | N 29 |
| *Altair* | **51** | 0·8 | 62 | N 9 |
| *Ankaa* | **2** | 2·4 | 353 | S 42 |
| *Antares* | **42** | 1·0 | 112 | S 26 |
| *Arcturus* | **37** | 0·0 | 146 | N 19 |
| *Atria* | **43** | 1·9 | 107 | S 69 |
| *Avior* | **22** | 1·9 | 234 | S 60 |
| *Bellatrix* | **13** | 1·6 | 278 | N 6 |
| *Betelgeuse* | **16** | Var.* | 271 | N 7 |
| *Canopus* | **17** | −0·7 | 264 | S 53 |
| *Capella* | **12** | 0·1 | 280 | N 46 |
| *Deneb* | **53** | 1·3 | 49 | N 45 |
| *Denebola* | **28** | 2·1 | 182 | N 14 |
| *Diphda* | **4** | 2·0 | 349 | S 18 |
| *Dubhe* | **27** | 1·8 | 194 | N 62 |
| *Elnath* | **14** | 1·7 | 278 | N 29 |
| *Eltanin* | **47** | 2·2 | 91 | N 51 |
| *Enif* | **54** | 2·4 | 34 | N 10 |
| *Fomalhaut* | **56** | 1·2 | 15 | S 29 |
| *Gacrux* | **31** | 1·6 | 172 | S 57 |
| *Gienah* | **29** | 2·6 | 176 | S 18 |
| *Hadar* | **35** | 0·6 | 149 | S 60 |
| *Hamal* | **6** | 2·0 | 328 | N 24 |
| *Kaus Australis* | **48** | 1·9 | 84 | S 34 |
| *Kochab* | **40** | 2·1 | 137 | N 74 |
| *Markab* | **57** | 2·5 | 14 | N 15 |
| *Menkar* | **8** | 2·5 | 314 | N 4 |
| *Menkent* | **36** | 2·1 | 148 | S 36 |
| *Miaplacidus* | **24** | 1·7 | 222 | S 70 |
| *Mirfak* | **9** | 1·8 | 308 | N 50 |
| *Nunki* | **50** | 2·0 | 76 | S 26 |
| *Peacock* | **52** | 1·9 | 53 | S 57 |
| *Pollux* | **21** | 1·1 | 243 | N 28 |
| *Procyon* | **20** | 0·4 | 245 | N 5 |
| *Rasalhague* | **46** | 2·1 | 96 | N 13 |
| *Regulus* | **26** | 1·4 | 208 | N 12 |
| *Rigel* | **11** | 0·1 | 281 | S 8 |
| *Rigil Kentaurus* | **38** | −0·3 | 140 | S 61 |
| *Sabik* | **44** | 2·4 | 102 | S 16 |
| *Schedar* | **3** | 2·2 | 350 | N 57 |
| *Shaula* | **45** | 1·6 | 96 | S 37 |
| *Sirius* | **18** | −1·5 | 258 | S 17 |
| *Spica* | **33** | 1·0 | 158 | S 11 |
| *Suhail* | **23** | 2·2 | 223 | S 44 |
| *Vega* | **49** | 0·0 | 81 | N 39 |
| *Zubenelgenubi* | **39** | 2·8 | 137 | S 16 |

| No | Name | Mag | SHA | Dec |
|---|---|---|---|---|
| | | | ° | ° |
| **1** | *Alpheratz* | 2·1 | 358 | N 29 |
| **2** | *Ankaa* | 2·4 | 353 | S 42 |
| **3** | *Schedar* | 2·2 | 350 | N 57 |
| **4** | *Diphda* | 2·0 | 349 | S 18 |
| **5** | *Achernar* | 0·5 | 335 | S 57 |
| **6** | *Hamal* | 2·0 | 328 | N 24 |
| **7** | *Acamar* | 3·2 | 315 | S 40 |
| **8** | *Menkar* | 2·5 | 314 | N 4 |
| **9** | *Mirfak* | 1·8 | 308 | N 50 |
| **10** | *Aldebaran* | 0·9 | 291 | N 17 |
| **11** | *Rigel* | 0·1 | 281 | S 8 |
| **12** | *Capella* | 0·1 | 280 | N 46 |
| **13** | *Bellatrix* | 1·6 | 278 | N 6 |
| **14** | *Elnath* | 1·7 | 278 | N 29 |
| **15** | *Alnilam* | 1·7 | 276 | S 1 |
| **16** | *Betelgeuse* | Var.* | 271 | N 7 |
| **17** | *Canopus* | −0·7 | 264 | S 53 |
| **18** | *Sirius* | −1·5 | 258 | S 17 |
| **19** | *Adhara* | 1·5 | 255 | S 29 |
| **20** | *Procyon* | 0·4 | 245 | N 5 |
| **21** | *Pollux* | 1·1 | 243 | N 28 |
| **22** | *Avior* | 1·9 | 234 | S 60 |
| **23** | *Suhail* | 2·2 | 223 | S 44 |
| **24** | *Miaplacidus* | 1·7 | 222 | S 70 |
| **25** | *Alphard* | 2·0 | 218 | S 9 |
| **26** | *Regulus* | 1·4 | 208 | N 12 |
| **27** | *Dubhe* | 1·8 | 194 | N 62 |
| **28** | *Denebola* | 2·1 | 182 | N 14 |
| **29** | *Gienah* | 2·6 | 176 | S 18 |
| **30** | *Acrux* | 1·3 | 173 | S 63 |
| **31** | *Gacrux* | 1·6 | 172 | S 57 |
| **32** | *Alioth* | 1·8 | 166 | N 56 |
| **33** | *Spica* | 1·0 | 158 | S 11 |
| **34** | *Alkaid* | 1·9 | 153 | N 49 |
| **35** | *Hadar* | 0·6 | 149 | S 60 |
| **36** | *Menkent* | 2·1 | 148 | S 36 |
| **37** | *Arcturus* | 0·0 | 146 | N 19 |
| **38** | *Rigil Kentaurus* | −0·3 | 140 | S 61 |
| **39** | *Zubenelgenubi* | 2·8 | 137 | S 16 |
| **40** | *Kochab* | 2·1 | 137 | N 74 |
| **41** | *Alphecca* | 2·2 | 126 | N 27 |
| **42** | *Antares* | 1·0 | 112 | S 26 |
| **43** | *Atria* | 1·9 | 107 | S 69 |
| **44** | *Sabik* | 2·4 | 102 | S 16 |
| **45** | *Shaula* | 1·6 | 96 | S 37 |
| **46** | *Rasalhague* | 2·1 | 96 | N 13 |
| **47** | *Eltanin* | 2·2 | 91 | N 51 |
| **48** | *Kaus Australis* | 1·9 | 84 | S 34 |
| **49** | *Vega* | 0·0 | 81 | N 39 |
| **50** | *Nunki* | 2·0 | 76 | S 26 |
| **51** | *Altair* | 0·8 | 62 | N 9 |
| **52** | *Peacock* | 1·9 | 53 | S 57 |
| **53** | *Deneb* | 1·3 | 49 | N 45 |
| **54** | *Enif* | 2·4 | 34 | N 10 |
| **55** | *Alnair* | 1·7 | 28 | S 47 |
| **56** | *Fomalhaut* | 1·2 | 15 | S 29 |
| **57** | *Markab* | 2·5 | 14 | N 15 |

*0·1 — 1·2

# ALTITUDE CORRECTION TABLES 0°–35°— MOON

| App. Alt. | 0°–4° Corrⁿ | 5°–9° Corrⁿ | 10°–14° Corrⁿ | 15°–19° Corrⁿ | 20°–24° Corrⁿ | 25°–29° Corrⁿ | 30°–34° Corrⁿ | App. Alt. |
|---|---|---|---|---|---|---|---|---|
| ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ′ |
| 00 | 0 34·5 | 5 58·2 | 10 62·1 | 15 62·8 | 20 62·2 | 25 60·8 | 30 58·9 | 00 |
| 10 | 36·5 | 58·5 | 62·2 | 62·8 | 62·2 | 60·8 | 58·8 | 10 |
| 20 | 38·3 | 58·7 | 62·2 | 62·8 | 62·1 | 60·7 | 58·8 | 20 |
| 30 | 40·0 | 58·9 | 62·3 | 62·8 | 62·1 | 60·7 | 58·7 | 30 |
| 40 | 41·5 | 59·1 | 62·3 | 62·8 | 62·0 | 60·6 | 58·6 | 40 |
| 50 | 42·9 | 59·3 | 62·4 | 62·7 | 62·0 | 60·6 | 58·5 | 50 |
| 00 | 1 44·2 | 6 59·5 | 11 62·4 | 16 62·7 | 21 62·0 | 26 60·5 | 31 58·5 | 00 |
| 10 | 45·4 | 59·7 | 62·4 | 62·7 | 61·9 | 60·4 | 58·4 | 10 |
| 20 | 46·5 | 59·9 | 62·5 | 62·7 | 61·9 | 60·4 | 58·3 | 20 |
| 30 | 47·5 | 60·0 | 62·5 | 62·7 | 61·9 | 60·3 | 58·2 | 30 |
| 40 | 48·4 | 60·2 | 62·5 | 62·7 | 61·8 | 60·3 | 58·2 | 40 |
| 50 | 49·3 | 60·3 | 62·6 | 62·7 | 61·8 | 60·2 | 58·1 | 50 |
| 00 | 2 50·1 | 7 60·5 | 12 62·6 | 17 62·7 | 22 61·7 | 27 60·1 | 32 58·0 | 00 |
| 10 | 50·8 | 60·6 | 62·6 | 62·6 | 61·7 | 60·1 | 57·9 | 10 |
| 20 | 51·5 | 60·7 | 62·6 | 62·6 | 61·6 | 60·0 | 57·8 | 20 |
| 30 | 52·2 | 60·9 | 62·7 | 62·6 | 61·6 | 59·9 | 57·8 | 30 |
| 40 | 52·8 | 61·0 | 62·7 | 62·6 | 61·6 | 59·9 | 57·7 | 40 |
| 50 | 53·4 | 61·1 | 62·7 | 62·6 | 61·5 | 59·8 | 57·6 | 50 |
| 00 | 3 53·9 | 8 61·2 | 13 62·7 | 18 62·5 | 23 61·5 | 28 59·7 | 33 57·5 | 00 |
| 10 | 54·4 | 61·3 | 62·7 | 62·5 | 61·4 | 59·7 | 57·4 | 10 |
| 20 | 54·9 | 61·4 | 62·7 | 62·5 | 61·4 | 59·6 | 57·4 | 20 |
| 30 | 55·3 | 61·5 | 62·8 | 62·5 | 61·3 | 59·5 | 57·3 | 30 |
| 40 | 55·7 | 61·6 | 62·8 | 62·4 | 61·3 | 59·5 | 57·2 | 40 |
| 50 | 56·1 | 61·6 | 62·8 | 62·4 | 61·2 | 59·4 | 57·1 | 50 |
| 00 | 4 56·4 | 9 61·7 | 14 62·8 | 19 62·4 | 24 61·2 | 29 59·3 | 34 57·0 | 00 |
| 10 | 56·8 | 61·8 | 62·8 | 62·4 | 61·1 | 59·3 | 56·9 | 10 |
| 20 | 57·1 | 61·9 | 62·8 | 62·3 | 61·1 | 59·2 | 56·9 | 20 |
| 30 | 57·4 | 61·9 | 62·8 | 62·3 | 61·0 | 59·1 | 56·8 | 30 |
| 40 | 57·7 | 62·0 | 62·8 | 62·3 | 61·0 | 59·1 | 56·7 | 40 |
| 50 | 58·0 | 62·1 | 62·8 | 62·2 | 60·9 | 59·0 | 56·6 | 50 |

| HP | L | U | L | U | L | U | L | U | L | U | L | U | L | U | HP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| 54·0 | 0·3 | 0·9 | 0·3 | 0·9 | 0·4 | 1·0 | 0·5 | 1·1 | 0·6 | 1·2 | 0·7 | 1·3 | 0·9 | 1·5 | 54·0 |
| 54·3 | 0·7 | 1·1 | 0·7 | 1·2 | 0·8 | 1·2 | 0·8 | 1·3 | 0·9 | 1·4 | 1·1 | 1·5 | 1·2 | 1·7 | 54·3 |
| 54·6 | 1·1 | 1·4 | 1·1 | 1·4 | 1·1 | 1·4 | 1·2 | 1·5 | 1·3 | 1·6 | 1·4 | 1·7 | 1·5 | 1·8 | 54·6 |
| 54·9 | 1·4 | 1·6 | 1·5 | 1·6 | 1·5 | 1·6 | 1·6 | 1·7 | 1·6 | 1·8 | 1·8 | 1·9 | 1·9 | 2·0 | 54·9 |
| 55·2 | 1·8 | 1·8 | 1·8 | 1·8 | 1·9 | 1·8 | 1·9 | 1·9 | 2·0 | 2·0 | 2·1 | 2·1 | 2·2 | 2·2 | 55·2 |
| 55·5 | 2·2 | 2·0 | 2·2 | 2·0 | 2·3 | 2·1 | 2·3 | 2·1 | 2·4 | 2·2 | 2·4 | 2·3 | 2·5 | 2·4 | 55·5 |
| 55·8 | 2·6 | 2·2 | 2·6 | 2·2 | 2·6 | 2·3 | 2·7 | 2·3 | 2·7 | 2·4 | 2·8 | 2·4 | 2·9 | 2·5 | 55·8 |
| 56·1 | 3·0 | 2·4 | 3·0 | 2·5 | 3·0 | 2·5 | 3·0 | 2·5 | 3·1 | 2·6 | 3·1 | 2·6 | 3·2 | 2·7 | 56·1 |
| 56·4 | 3·3 | 2·7 | 3·4 | 2·7 | 3·4 | 2·7 | 3·4 | 2·7 | 3·4 | 2·8 | 3·5 | 2·8 | 3·5 | 2·9 | 56·4 |
| 56·7 | 3·7 | 2·9 | 3·7 | 2·9 | 3·8 | 2·9 | 3·8 | 2·9 | 3·8 | 3·0 | 3·8 | 3·0 | 3·9 | 3·0 | 56·7 |
| 57·0 | 4·1 | 3·1 | 4·1 | 3·1 | 4·1 | 3·1 | 4·1 | 3·1 | 4·2 | 3·2 | 4·2 | 3·2 | 4·2 | 3·2 | 57·0 |
| 57·3 | 4·5 | 3·3 | 4·5 | 3·3 | 4·5 | 3·3 | 4·5 | 3·3 | 4·5 | 3·3 | 4·5 | 3·4 | 4·6 | 3·4 | 57·3 |
| 57·6 | 4·9 | 3·5 | 4·9 | 3·5 | 4·9 | 3·5 | 4·9 | 3·5 | 4·9 | 3·5 | 4·9 | 3·5 | 4·9 | 3·6 | 57·6 |
| 57·9 | 5·3 | 3·8 | 5·3 | 3·8 | 5·2 | 3·8 | 5·2 | 3·7 | 5·2 | 3·7 | 5·2 | 3·7 | 5·2 | 3·7 | 57·9 |
| 58·2 | 5·6 | 4·0 | 5·6 | 4·0 | 5·6 | 4·0 | 5·6 | 4·0 | 5·6 | 3·9 | 5·6 | 3·9 | 5·6 | 3·9 | 58·2 |
| 58·5 | 6·0 | 4·2 | 6·0 | 4·2 | 6·0 | 4·2 | 6·0 | 4·2 | 6·0 | 4·1 | 5·9 | 4·1 | 5·9 | 4·1 | 58·5 |
| 58·8 | 6·4 | 4·4 | 6·4 | 4·4 | 6·4 | 4·4 | 6·3 | 4·4 | 6·3 | 4·3 | 6·3 | 4·3 | 6·2 | 4·2 | 58·8 |
| 59·1 | 6·8 | 4·6 | 6·8 | 4·6 | 6·7 | 4·6 | 6·7 | 4·6 | 6·7 | 4·5 | 6·6 | 4·5 | 6·6 | 4·4 | 59·1 |
| 59·4 | 7·2 | 4·8 | 7·1 | 4·8 | 7·1 | 4·8 | 7·1 | 4·8 | 7·0 | 4·7 | 7·0 | 4·7 | 6·9 | 4·6 | 59·4 |
| 59·7 | 7·5 | 5·1 | 7·5 | 5·0 | 7·5 | 5·0 | 7·5 | 5·0 | 7·4 | 4·9 | 7·3 | 4·8 | 7·2 | 4·8 | 59·7 |
| 60·0 | 7·9 | 5·3 | 7·9 | 5·3 | 7·9 | 5·2 | 7·8 | 5·2 | 7·8 | 5·1 | 7·7 | 5·0 | 7·6 | 4·9 | 60·0 |
| 60·3 | 8·3 | 5·5 | 8·3 | 5·5 | 8·2 | 5·4 | 8·2 | 5·4 | 8·1 | 5·3 | 8·0 | 5·2 | 7·9 | 5·1 | 60·3 |
| 60·6 | 8·7 | 5·7 | 8·7 | 5·7 | 8·6 | 5·7 | 8·6 | 5·6 | 8·5 | 5·5 | 8·4 | 5·4 | 8·2 | 5·3 | 60·6 |
| 60·9 | 9·1 | 5·9 | 9·0 | 5·9 | 9·0 | 5·9 | 8·9 | 5·8 | 8·8 | 5·7 | 8·7 | 5·6 | 8·6 | 5·4 | 60·9 |
| 61·2 | 9·5 | 6·2 | 9·4 | 6·1 | 9·4 | 6·1 | 9·3 | 6·0 | 9·2 | 5·9 | 9·1 | 5·8 | 8·9 | 5·6 | 61·2 |
| 61·5 | 9·8 | 6·4 | 9·8 | 6·3 | 9·7 | 6·3 | 9·7 | 6·2 | 9·5 | 6·1 | 9·4 | 5·9 | 9·2 | 5·8 | 61·5 |

## DIP

| Ht. of Eye | Corrⁿ | Ht. of Eye | Ht. of Eye | Corrⁿ | Ht. of Eye |
|---|---|---|---|---|---|
| m | ′ | ft. | m | ′ | ft. |
| 2·4 | | 8·0 | 9·5 | | 31·5 |
| | −2·8 | | | −5·5 | |
| 2·6 | | 8·6 | 9·9 | | 32·7 |
| | −2·9 | | | −5·6 | |
| 2·8 | | 9·2 | 10·3 | | 33·9 |
| | −3·0 | | | −5·7 | |
| 3·0 | | 9·8 | 10·6 | | 35·1 |
| | −3·1 | | | −5·8 | |
| 3·2 | | 10·5 | 11·0 | | 36·3 |
| | −3·2 | | | −5·9 | |
| 3·4 | | 11·2 | 11·4 | | 37·6 |
| | −3·3 | | | −6·0 | |
| 3·6 | | 11·9 | 11·8 | | 38·9 |
| | −3·4 | | | −6·1 | |
| 3·8 | | 12·6 | 12·2 | | 40·1 |
| | −3·5 | | | −6·2 | |
| 4·0 | | 13·3 | 12·6 | | 41·5 |
| | −3·6 | | | −6·3 | |
| 4·3 | | 14·1 | 13·0 | | 42·8 |
| | −3·7 | | | −6·4 | |
| 4·5 | | 14·9 | 13·4 | | 44·2 |
| | −3·8 | | | −6·5 | |
| 4·7 | | 15·7 | 13·8 | | 45·5 |
| | −3·9 | | | −6·6 | |
| 5·0 | | 16·5 | 14·2 | | 46·9 |
| | −4·0 | | | −6·7 | |
| 5·2 | | 17·4 | 14·7 | | 48·4 |
| | −4·1 | | | −6·8 | |
| 5·5 | | 18·3 | 15·1 | | 49·8 |
| | −4·2 | | | −6·9 | |
| 5·8 | | 19·1 | 15·5 | | 51·3 |
| | −4·3 | | | −7·0 | |
| 6·1 | | 20·1 | 16·0 | | 52·8 |
| | −4·4 | | | −7·1 | |
| 6·3 | | 21·0 | 16·5 | | 54·3 |
| | −4·5 | | | −7·2 | |
| 6·6 | | 22·0 | 16·9 | | 55·8 |
| | −4·6 | | | −7·3 | |
| 6·9 | | 22·9 | 17·4 | | 57·4 |
| | −4·7 | | | −7·4 | |
| 7·2 | | 23·9 | 17·9 | | 58·9 |
| | −4·8 | | | −7·5 | |
| 7·5 | | 24·9 | 18·4 | | 60·5 |
| | −4·9 | | | −7·6 | |
| 7·9 | | 26·0 | 18·8 | | 62·1 |
| | −5·0 | | | −7·7 | |
| 8·2 | | 27·1 | 19·3 | | 63·8 |
| | −5·1 | | | −7·8 | |
| 8·5 | | 28·1 | 19·8 | | 65·4 |
| | −5·2 | | | −7·9 | |
| 8·8 | | 29·2 | 20·4 | | 67·1 |
| | −5·3 | | | −8·0 | |
| 9·2 | | 30·4 | 20·9 | | 68·8 |
| | −5·4 | | | −8·1 | |
| 9·5 | | 31·5 | 21·4 | | 70·5 |

## MOON CORRECTION TABLE

The correction is in two parts; the first correction is taken from the upper part of the table with argument apparent altitude, and the second from the lower part, with argument HP, in the same column as that from which the first correction was taken. Separate corrections are given in the lower part for lower (L) and upper(U) limbs. All corrections are to be **added** to apparent altitude, *but 30′ is to be subtracted from the altitude of the upper limb*.

For corrections for pressure and temperature see page A4.

For bubble sextant observations ignore dip, take the mean of upper and lower limb corrections and subtract 15′ from the altitude.

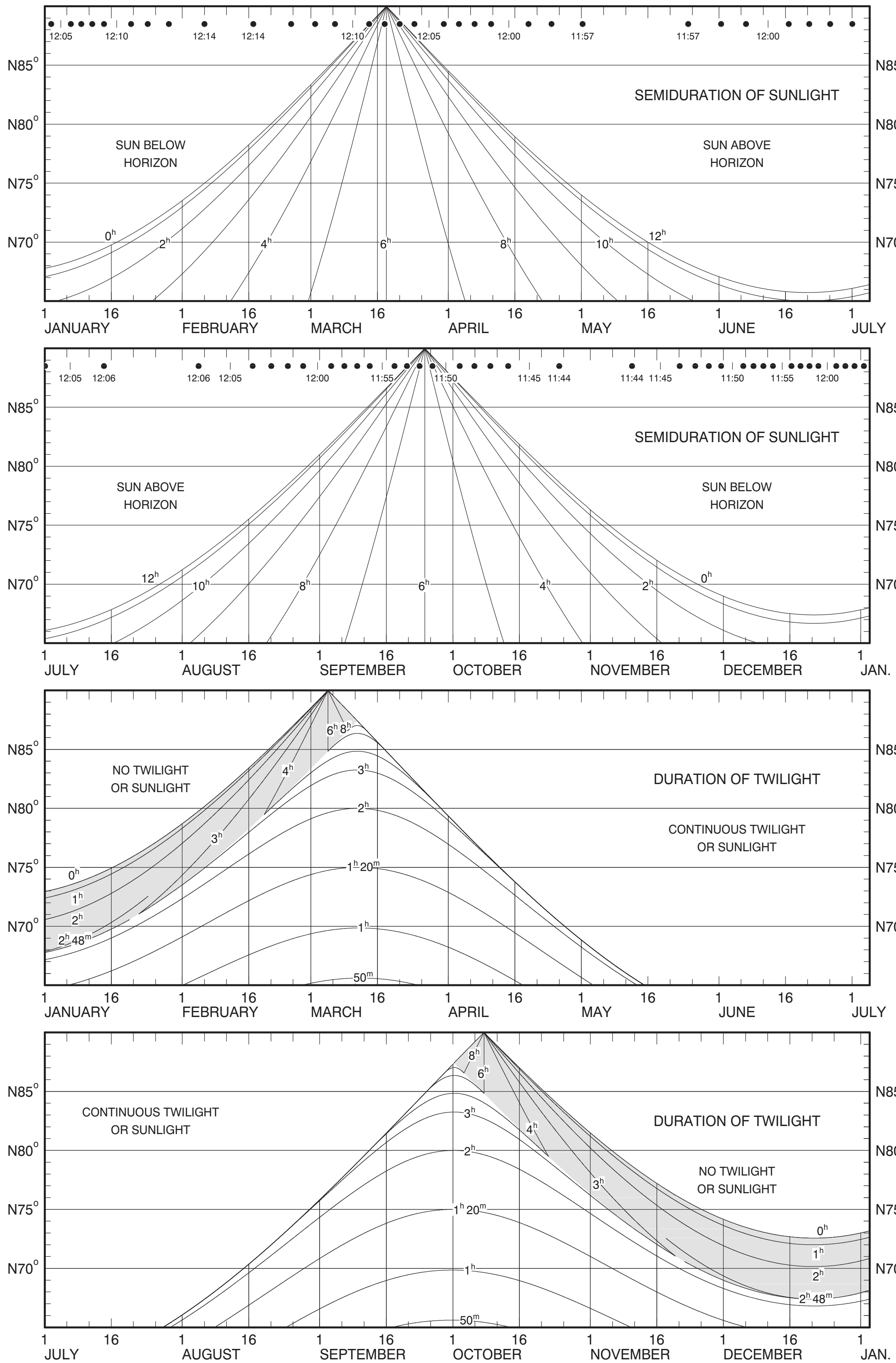
App. Alt. = Apparent altitude = Sextant altitude corrected for index error and dip.

# ALTITUDE CORRECTION TABLES 35°–90°— MOON

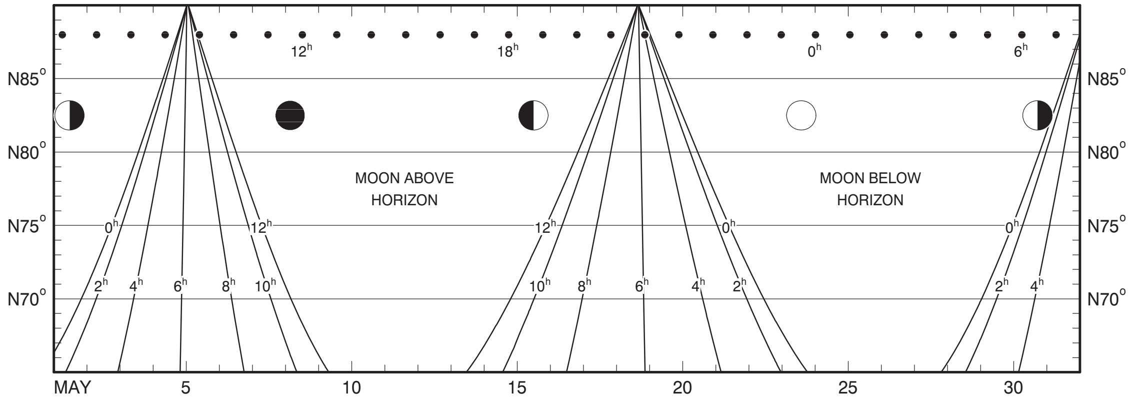
| App. Alt. | 35°–39° Corrn | 40°–44° Corrn | 45°–49° Corrn | 50°–54° Corrn | 55°–59° Corrn | 60°–64° Corrn | 65°–69° Corrn | 70°–74° Corrn | 75°–79° Corrn | 80°–84° Corrn | 85°–89° Corrn | App. Alt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ° ′ | ′ |
| **00** | 35 56·5 | 40 53·7 | 45 50·5 | 50 46·9 | 55 43·1 | 60 38·9 | 65 34·6 | 70 30·0 | 75 25·3 | 80 20·5 | 85 15·6 | **00** |
| **10** | 56·4 | 53·6 | 50·4 | 46·8 | 42·9 | 38·8 | 34·4 | 29·9 | 25·2 | 20·4 | 15·5 | **10** |
| **20** | 56·3 | 53·5 | 50·2 | 46·7 | 42·8 | 38·7 | 34·3 | 29·7 | 25·0 | 20·2 | 15·3 | **20** |
| **30** | 56·2 | 53·4 | 50·1 | 46·5 | 42·7 | 38·5 | 34·1 | 29·6 | 24·9 | 20·0 | 15·1 | **30** |
| **40** | 56·2 | 53·3 | 50·0 | 46·4 | 42·5 | 38·4 | 34·0 | 29·4 | 24·7 | 19·9 | 15·0 | **40** |
| **50** | 56·1 | 53·2 | 49·9 | 46·3 | 42·4 | 38·2 | 33·8 | 29·3 | 24·5 | 19·7 | 14·8 | **50** |
| **00** | 36 56·0 | 41 53·1 | 46 49·8 | 51 46·2 | 56 42·3 | 61 38·1 | 66 33·7 | 71 29·1 | 76 24·4 | 81 19·6 | 86 14·6 | **00** |
| **10** | 55·9 | 53·0 | 49·7 | 46·0 | 42·1 | 37·9 | 33·5 | 29·0 | 24·2 | 19·4 | 14·5 | **10** |
| **20** | 55·8 | 52·9 | 49·5 | 45·9 | 42·0 | 37·8 | 33·4 | 28·8 | 24·1 | 19·2 | 14·3 | **20** |
| **30** | 55·7 | 52·8 | 49·4 | 45·8 | 41·9 | 37·7 | 33·2 | 28·7 | 23·9 | 19·1 | 14·2 | **30** |
| **40** | 55·6 | 52·6 | 49·3 | 45·7 | 41·7 | 37·5 | 33·1 | 28·5 | 23·8 | 18·9 | 14·0 | **40** |
| **50** | 55·5 | 52·5 | 49·2 | 45·5 | 41·6 | 37·4 | 32·9 | 28·3 | 23·6 | 18·7 | 13·8 | **50** |
| **00** | 37 55·4 | 42 52·4 | 47 49·1 | 52 45·4 | 57 41·4 | 62 37·2 | 67 32·8 | 72 28·2 | 77 23·4 | 82 18·6 | 87 13·7 | **00** |
| **10** | 55·3 | 52·3 | 49·0 | 45·3 | 41·3 | 37·1 | 32·6 | 28·0 | 23·3 | 18·4 | 13·5 | **10** |
| **20** | 55·2 | 52·2 | 48·8 | 45·2 | 41·2 | 36·9 | 32·5 | 27·9 | 23·1 | 18·2 | 13·3 | **20** |
| **30** | 55·1 | 52·1 | 48·7 | 45·0 | 41·0 | 36·8 | 32·3 | 27·7 | 22·9 | 18·1 | 13·2 | **30** |
| **40** | 55·0 | 52·0 | 48·6 | 44·9 | 40·9 | 36·6 | 32·2 | 27·6 | 22·8 | 17·9 | 13·0 | **40** |
| **50** | 55·0 | 51·9 | 48·5 | 44·8 | 40·8 | 36·5 | 32·0 | 27·4 | 22·6 | 17·8 | 12·8 | **50** |
| **00** | 38 54·9 | 43 51·8 | 48 48·4 | 53 44·6 | 58 40·6 | 63 36·4 | 68 31·9 | 73 27·2 | 78 22·5 | 83 17·6 | 88 12·7 | **00** |
| **10** | 54·8 | 51·7 | 48·3 | 44·5 | 40·5 | 36·2 | 31·7 | 27·1 | 22·3 | 17·4 | 12·5 | **10** |
| **20** | 54·7 | 51·6 | 48·1 | 44·4 | 40·3 | 36·1 | 31·6 | 26·9 | 22·1 | 17·3 | 12·3 | **20** |
| **30** | 54·6 | 51·5 | 48·0 | 44·2 | 40·2 | 35·9 | 31·4 | 26·8 | 22·0 | 17·1 | 12·2 | **30** |
| **40** | 54·5 | 51·4 | 47·9 | 44·1 | 40·1 | 35·8 | 31·3 | 26·6 | 21·8 | 16·9 | 12·0 | **40** |
| **50** | 54·4 | 51·2 | 47·8 | 44·0 | 39·9 | 35·6 | 31·1 | 26·5 | 21·7 | 16·8 | 11·8 | **50** |
| **00** | 39 54·3 | 44 51·1 | 49 47·7 | 54 43·9 | 59 39·8 | 64 35·5 | 69 31·0 | 74 26·3 | 79 21·5 | 84 16·6 | 89 11·7 | **00** |
| **10** | 54·2 | 51·0 | 47·5 | 43·7 | 39·6 | 35·3 | 30·8 | 26·1 | 21·3 | 16·4 | 11·5 | **10** |
| **20** | 54·1 | 50·9 | 47·4 | 43·6 | 39·5 | 35·2 | 30·7 | 26·0 | 21·2 | 16·3 | 11·4 | **20** |
| **30** | 54·0 | 50·8 | 47·3 | 43·5 | 39·4 | 35·0 | 30·5 | 25·8 | 21·0 | 16·1 | 11·2 | **30** |
| **40** | 53·9 | 50·7 | 47·2 | 43·3 | 39·2 | 34·9 | 30·4 | 25·7 | 20·9 | 16·0 | 11·0 | **40** |
| **50** | 53·8 | 50·6 | 47·0 | 43·2 | 39·1 | 34·7 | 30·2 | 25·5 | 20·7 | 15·8 | 10·9 | **50** |

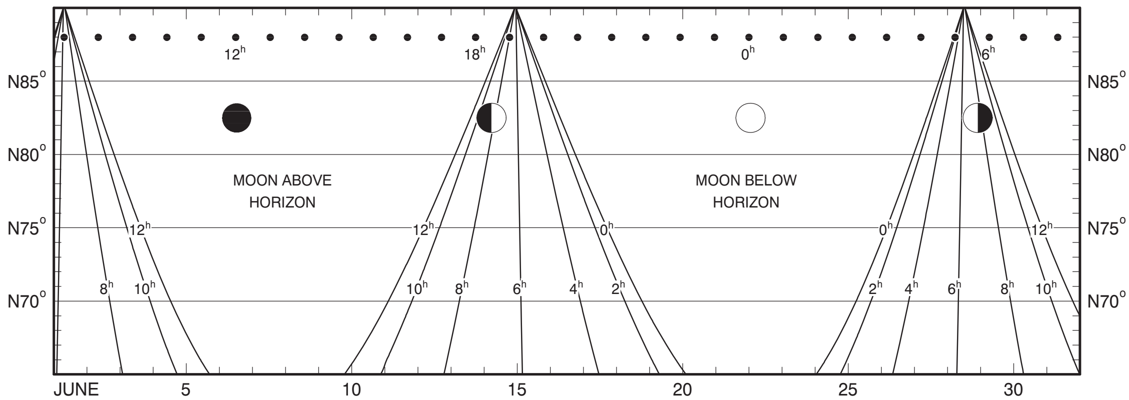
| HP | L | U | L | U | L | U | L | U | L | U | L | U | L | U | L | U | L | U | L | U | L | U | HP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ | ′ |
| **54·0** | 1·1 | 1·7 | 1·3 | 1·9 | 1·5 | 2·1 | 1·7 | 2·4 | 2·0 | 2·6 | 2·3 | 2·9 | 2·6 | 3·2 | 2·9 | 3·5 | 3·2 | 3·8 | 3·5 | 4·1 | 3·8 | 4·5 | **54·0** |
| **54·3** | 1·4 | 1·8 | 1·6 | 2·0 | 1·8 | 2·2 | 2·0 | 2·5 | 2·2 | 2·7 | 2·5 | 3·0 | 2·8 | 3·2 | 3·1 | 3·5 | 3·3 | 3·8 | 3·6 | 4·1 | 3·9 | 4·4 | **54·3** |
| **54·6** | 1·7 | 2·0 | 1·9 | 2·2 | 2·1 | 2·4 | 2·3 | 2·6 | 2·5 | 2·8 | 2·7 | 3·0 | 3·0 | 3·3 | 3·2 | 3·5 | 3·5 | 3·8 | 3·8 | 4·0 | 4·0 | 4·3 | **54·6** |
| **54·9** | 2·0 | 2·2 | 2·2 | 2·3 | 2·3 | 2·5 | 2·5 | 2·7 | 2·7 | 2·9 | 2·9 | 3·1 | 3·2 | 3·3 | 3·4 | 3·5 | 3·6 | 3·8 | 3·9 | 4·0 | 4·1 | 4·3 | **54·9** |
| **55·2** | 2·3 | 2·3 | 2·5 | 2·4 | 2·6 | 2·6 | 2·8 | 2·8 | 3·0 | 2·9 | 3·2 | 3·1 | 3·4 | 3·3 | 3·6 | 3·5 | 3·8 | 3·7 | 4·0 | 4·0 | 4·2 | 4·2 | **55·2** |
| **55·5** | 2·7 | 2·5 | 2·8 | 2·6 | 2·9 | 2·7 | 3·1 | 2·9 | 3·2 | 3·0 | 3·4 | 3·2 | 3·6 | 3·4 | 3·7 | 3·5 | 3·9 | 3·7 | 4·1 | 3·9 | 4·3 | 4·1 | **55·5** |
| **55·8** | 3·0 | 2·6 | 3·1 | 2·7 | 3·2 | 2·8 | 3·3 | 3·0 | 3·5 | 3·1 | 3·6 | 3·3 | 3·8 | 3·4 | 3·9 | 3·6 | 4·1 | 3·7 | 4·2 | 3·9 | 4·4 | 4·0 | **55·8** |
| **56·1** | 3·3 | 2·8 | 3·4 | 2·9 | 3·5 | 3·0 | 3·6 | 3·1 | 3·7 | 3·2 | 3·8 | 3·3 | 4·0 | 3·4 | 4·1 | 3·6 | 4·2 | 3·7 | 4·4 | 3·8 | 4·5 | 4·0 | **56·1** |
| **56·4** | 3·6 | 2·9 | 3·7 | 3·0 | 3·8 | 3·1 | 3·9 | 3·2 | 3·9 | 3·3 | 4·0 | 3·4 | 4·1 | 3·5 | 4·3 | 3·6 | 4·4 | 3·7 | 4·5 | 3·8 | 4·6 | 3·9 | **56·4** |
| **56·7** | 3·9 | 3·1 | 4·0 | 3·1 | 4·1 | 3·2 | 4·1 | 3·3 | 4·2 | 3·3 | 4·3 | 3·4 | 4·3 | 3·5 | 4·4 | 3·6 | 4·5 | 3·7 | 4·6 | 3·8 | 4·7 | 3·8 | **56·7** |
| **57·0** | 4·3 | 3·2 | 4·3 | 3·3 | 4·3 | 3·3 | 4·4 | 3·4 | 4·4 | 3·4 | 4·5 | 3·5 | 4·5 | 3·5 | 4·6 | 3·6 | 4·7 | 3·6 | 4·7 | 3·7 | 4·8 | 3·8 | **57·0** |
| **57·3** | 4·6 | 3·4 | 4·6 | 3·4 | 4·6 | 3·4 | 4·6 | 3·5 | 4·7 | 3·5 | 4·7 | 3·5 | 4·7 | 3·6 | 4·8 | 3·6 | 4·8 | 3·6 | 4·8 | 3·7 | 4·9 | 3·7 | **57·3** |
| **57·6** | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 4·9 | 3·6 | 5·0 | 3·6 | 5·0 | 3·6 | 5·0 | 3·6 | **57·6** |
| **57·9** | 5·2 | 3·7 | 5·2 | 3·7 | 5·2 | 3·7 | 5·2 | 3·7 | 5·2 | 3·7 | 5·1 | 3·6 | 5·1 | 3·6 | 5·1 | 3·6 | 5·1 | 3·6 | 5·1 | 3·6 | 5·1 | 3·6 | **57·9** |
| **58·2** | 5·5 | 3·9 | 5·5 | 3·8 | 5·5 | 3·8 | 5·4 | 3·8 | 5·4 | 3·7 | 5·4 | 3·7 | 5·3 | 3·7 | 5·3 | 3·6 | 5·2 | 3·6 | 5·2 | 3·5 | 5·2 | 3·5 | **58·2** |
| **58·5** | 5·9 | 4·0 | 5·8 | 4·0 | 5·8 | 3·9 | 5·7 | 3·9 | 5·6 | 3·8 | 5·6 | 3·8 | 5·5 | 3·7 | 5·5 | 3·6 | 5·4 | 3·6 | 5·3 | 3·5 | 5·3 | 3·4 | **58·5** |
| **58·8** | 6·2 | 4·2 | 6·1 | 4·1 | 6·0 | 4·1 | 6·0 | 4·0 | 5·9 | 3·9 | 5·8 | 3·8 | 5·7 | 3·7 | 5·6 | 3·6 | 5·5 | 3·5 | 5·4 | 3·5 | 5·3 | 3·4 | **58·8** |
| **59·1** | 6·5 | 4·3 | 6·4 | 4·3 | 6·3 | 4·2 | 6·2 | 4·1 | 6·1 | 4·0 | 6·0 | 3·9 | 5·9 | 3·8 | 5·8 | 3·6 | 5·7 | 3·5 | 5·6 | 3·4 | 5·4 | 3·3 | **59·1** |
| **59·4** | 6·8 | 4·5 | 6·7 | 4·4 | 6·6 | 4·3 | 6·5 | 4·2 | 6·4 | 4·1 | 6·2 | 3·9 | 6·1 | 3·8 | 6·0 | 3·7 | 5·8 | 3·5 | 5·7 | 3·4 | 5·5 | 3·2 | **59·4** |
| **59·7** | 7·1 | 4·7 | 7·0 | 4·5 | 6·9 | 4·4 | 6·8 | 4·3 | 6·6 | 4·1 | 6·5 | 4·0 | 6·3 | 3·8 | 6·1 | 3·7 | 6·0 | 3·5 | 5·8 | 3·3 | 5·6 | 3·2 | **59·7** |
| **60·0** | 7·5 | 4·8 | 7·3 | 4·7 | 7·2 | 4·5 | 7·0 | 4·4 | 6·9 | 4·2 | 6·7 | 4·0 | 6·5 | 3·9 | 6·3 | 3·7 | 6·1 | 3·5 | 5·9 | 3·3 | 5·7 | 3·1 | **60·0** |
| **60·3** | 7·8 | 5·0 | 7·6 | 4·8 | 7·5 | 4·7 | 7·3 | 4·5 | 7·1 | 4·3 | 6·9 | 4·1 | 6·7 | 3·9 | 6·5 | 3·7 | 6·3 | 3·5 | 6·0 | 3·2 | 5·8 | 3·0 | **60·3** |
| **60·6** | 8·1 | 5·1 | 7·9 | 5·0 | 7·7 | 4·8 | 7·6 | 4·6 | 7·3 | 4·4 | 7·1 | 4·2 | 6·9 | 3·9 | 6·7 | 3·7 | 6·4 | 3·4 | 6·2 | 3·2 | 5·9 | 2·9 | **60·6** |
| **60·9** | 8·4 | 5·3 | 8·2 | 5·1 | 8·0 | 4·9 | 7·8 | 4·7 | 7·6 | 4·5 | 7·3 | 4·2 | 7·1 | 4·0 | 6·8 | 3·7 | 6·6 | 3·4 | 6·3 | 3·2 | 6·0 | 2·9 | **60·9** |
| **61·2** | 8·7 | 5·4 | 8·5 | 5·2 | 8·3 | 5·0 | 8·1 | 4·8 | 7·8 | 4·5 | 7·6 | 4·3 | 7·3 | 4·0 | 7·0 | 3·7 | 6·7 | 3·4 | 6·4 | 3·1 | 6·1 | 2·8 | **61·2** |
| **61·5** | 9·1 | 5·6 | 8·8 | 5·4 | 8·6 | 5·1 | 8·3 | 4·9 | 8·1 | 4·6 | 7·8 | 4·3 | 7·5 | 4·0 | 7·2 | 3·7 | 6·9 | 3·4 | 6·5 | 3·1 | 6·2 | 2·7 | **61·5** |

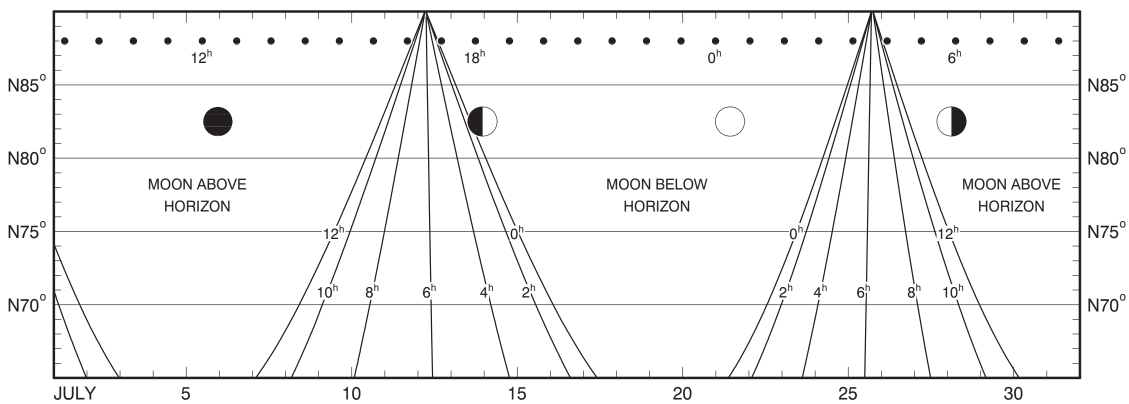
# SEMIDURATION OF SUNLIGHT AND TWILIGHT

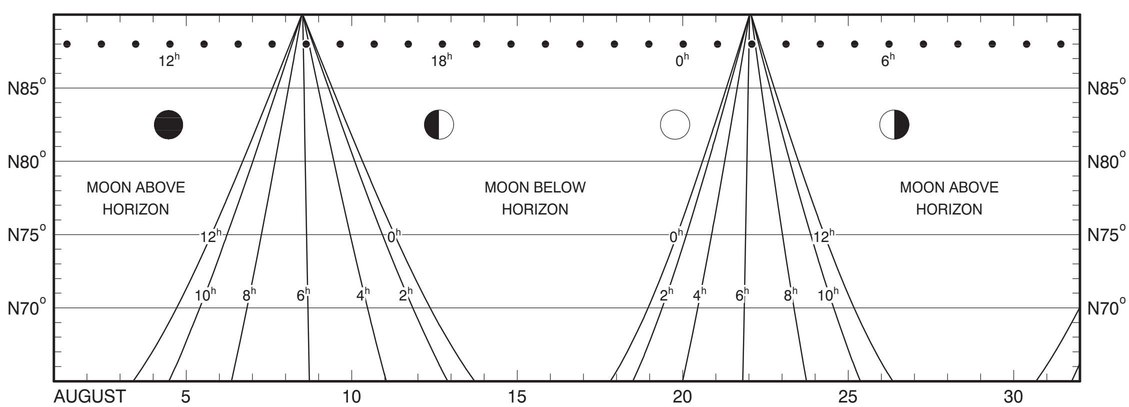


# SEMIDURATION OF MOONLIGHT



# APPENDIX F

# MEASUREMENT ON THE EARTH

## F1. The Earth

The Earth is approximately an **oblate spheroid** (a sphere flattened at the poles). Approximations of its dimensions and the amount of flattening are given in Appendix C. However, for many navigational purposes, the earth is assumed to be a sphere, without intolerable error.

The **axis of rotation** or **polar axis** of the Earth is the line connecting the North Pole and the South Pole.

## F2. Circles of the earth

A **great circle** is the line of intersection of a sphere and a plane through the center of the sphere. This is the largest circle that can be drawn on a sphere. The shortest line on the surface of a sphere between two points on that surface is part of a great circle. On the spheroidal Earth the shortest line is called a **geodesic**. A great circle is a near enough approximation of a geodesic for most problems of navigation.

A **small circle** is the line of intersection of a sphere and a plane which does not pass through the center of the sphere.

A **meridian** is a great circle through the geographical poles of the Earth. Hence, all meridians meet at the poles, and their planes intersect each other in a line, the **polar axis** (Figure F2a). The term **meridian** is usually applied to the **upper branch** only, that half from pole to pole which passes through a given point. The other half is called the **lower branch**.

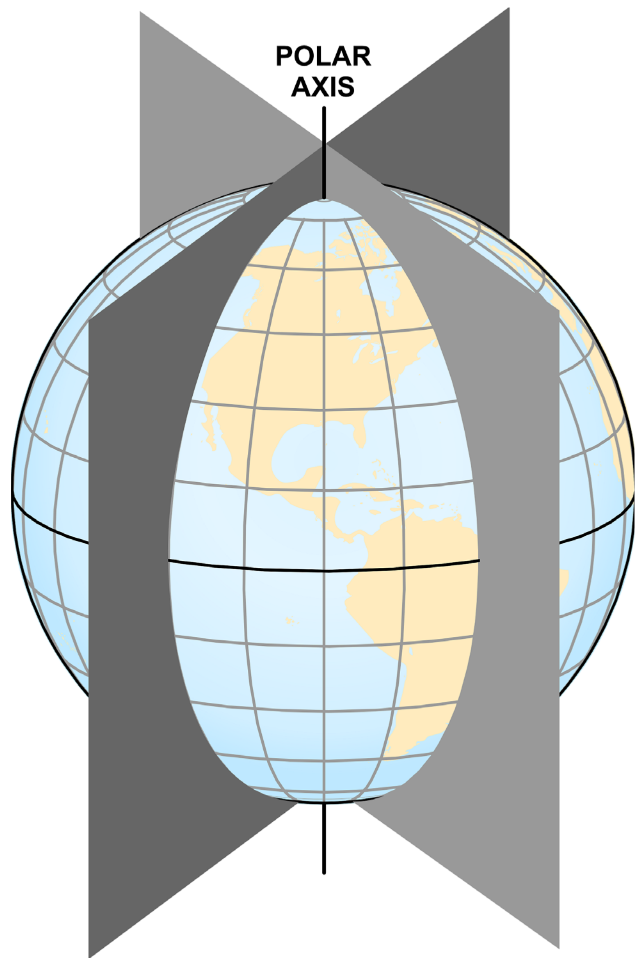



*Figure F2a. The planes of the meridians meet at the polar axis.*

The **prime meridian** is that meridian used as the origin for measurement of longitude (Figure F2b). The prime meridian used almost universally is that through the original position of the British Royal Observatory at Greenwich, near London.

The **equator** is the terrestrial great circle whose plane is perpendicular to the polar axis (Figure F2c). It is midway between the poles.

A **parallel** or **parallel of latitude** is a circle on the surface of the Earth, parallel to the plane of the equator (Figure F2d). It connects all points of equal latitude. The equator, a great circle, is a limiting case connecting points of 0° latitude. The poles, single points at latitude 90°, are the other limiting case. All other parallels are small circles.

## F3. Position on the Earth

A position on the surface of the earth (except at either of the poles) may be defined by two magnitudes called **coordinates**. Those customarily used are *latitude* and *longitude*. A position may also be expressed in relation to known geographical positions.

**Latitude** (L, lat.) is angular distance from the equator, measured northward or southward along meridian from 0° at the equator to 90° at the poles (Figure F2b). It is designated *north* (N) or *south* (S) to indicate tho direction of measurement.

The **difference of latitude (*l*, DLat.)** between two places is the angular length of arc of any meridian between their parallels (Figure F2b). It is the numerical difference of the latitudes if the places are on the same side of the equator; it is the sum of the latitudes if the places are on opposite


*Figure F2b. Circles and coordinates on the Earth. All parallels except the equator are small circles; the equator and meridians are great circles.*

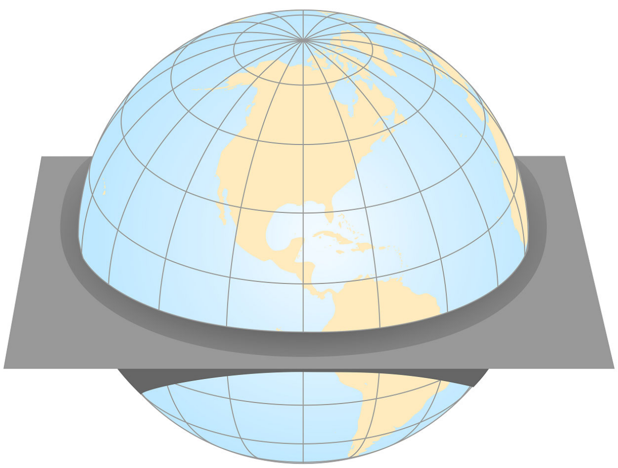


*Figure F2c. The equator is a great circle midway between the poles.*

sides of the equator. It may be designated north (N) or south (S) when appropriate.

The middle or **mid-latitude (Lm)** between two places on the same side of the equator is half the sum of their latitudes. Mid-latitude is labeled N or S to indicate whether it is north or south of the equator. The expression may refer to the mid-latitude of two places on opposite sides of the equator. In this case, it is equal to half the difference between the two latitudes and takes the name of the place farthest from the equator. When the places are on opposite sides of the equator, two mid latitudes arc generally used, the average of each latitude and 0°.

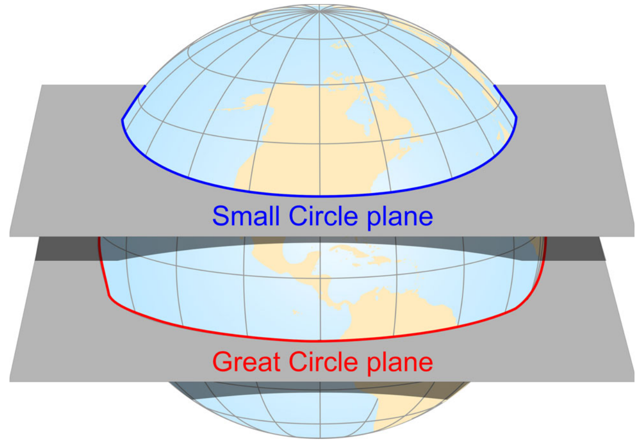



*Figure F2d. Parallel of latitude is parallel to the equator.*

**Longitude** (λ, **long**.) is the arc of a parallel or the angle at the pole between the prime meridian and the meridian of a point on the Earth, measured eastward or westward from the prime meridian through 180° (Figure F2b). It is designated *east* (E) or *west* (W) to indicate the direction of measurement.

The **difference of longitude (DLo)** between two places is the shorter arc of the parallel or the smaller angle at the pole between the meridians of the two places. If both places are on the same side (east or west) of Greenwich, DLo is the numerical difference of the longitudes of the two places; if on opposite sides, DLo is the numerical sum unless this exceeds 180°, when it is 360° minus the sum. The distance between two meridians at any parallel of latitude, expressed in distance units, usually nautical miles, is called **departure (p, Dep.)**. It represents distance made good east or west as a craft proceeds from one point to another. Its numerical value between any two meridians decreases with increased latitude, while DLo is numerically the same at any latitude. Either DLo or p may be designated *east* (E) or *west* (W) when appropriate.

### F4. Distance on the Earth

**Distance** (**D**, **Dist.**) is the spatial separation of two points, and is expressed as the length of a line joining them. On the surface of the Earth it is usually stated in miles. Navigators customarily use the **nautical mile** (**mi.**, **NM**) of 1852 meters exactly. This was the value suggested by the International Hydrographic Bureau in 1929, and since adopted by most maritime nations. It is often called the **International Nautical Mile** to distinguish it from slightly different values used by some countries. On July l, 1959, the United States adopted the exact relationship of 1 yard-0.9144 meter. The length of the International Nautical Mile is consequently equal to 6,076.11549 feet (approximately).

For most navigational purposes nautical mile is considered the length of one minute of latitude, or of any great circle of the earth, regardless of location. On the

World Geodetic System ellipsoid of 1972, the length of 1 minute of latitude varies from about 6,046 feet at the equator to approximately 6,108 feet at the poles. A **geographical mile** is the length of 1 minute of the equator, or about 6,087 feet.

The land or **statute mile** (**mi.**, **St M**) of 5,280 feet is commonly used for navigation on rivers and lake, notably the Great Lakes of North America.

The nautical mile is about 38/33 or approximately 1.15 statute miles. A conversion table for nautical and statute miles is given in Table 9.

Distance, as customarily used by the navigator, refers to the length of the rhumb line connecting two places. This is a line making the same oblique angle with all meridians. Meridians and parallels (including the equator) which also maintain constant true directions, may be considered special cases of the rhumb line. Any other rhumb line spirals toward the pole, forming a **loxodromic curve** or **loxodrome** (Figure F4), Distance along the great circle connecting two points is customarily designated **great circle distance**.

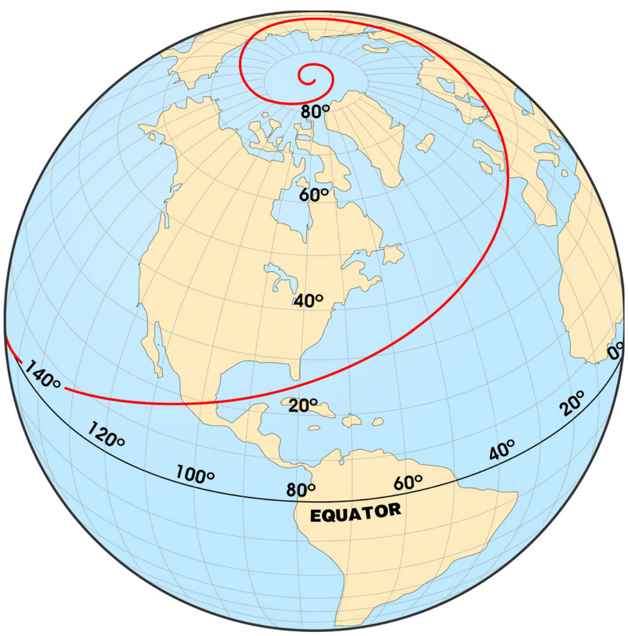



*Figure F4. A rhumb line or loxodrome.*

## F5. Speed

**Speed** (S) is rate of motion, or distance per unit of time. A **knot** (kn.), the unit of speed commonly used in navigation, is a rate of one nautical mile per hour. The expression "knots per hour" refers to acceleration, not speed.

Sometimes the expression speed of advance (SOA) is used to indicate the speed intended to be made along the track (Section F6), and speed over ground (SOG) is used to indicate the speed along the actual path. Speed made good (SMG) is the speed along the course made good.

## F6. Direction on the Earth

**Direction** is the position of one point relative to another. Navigators express direction as the angular difference in degrees from a reference direction, usually north or the ship's head.

**Course (C, Cn)** is the horizontal direction in which a vessel is intended to be steered, expressed as angular distance from 000°, at north, clockwise through 360°. Strictly used, the term applies to direction through the water, not the direction intended to be made good over the ground. The course is often designated as **true**, **magnetic**, **compass**, or **grid** according to the reference direction.

**Track made good (TMG)** is the single resultant direction from the point of departure to point of arrival at any given time. The use of this term is preferred to the use of the misnomer "course made good." **Course of advance (COA)** is the direction intended to be made good over the ground, and **course over ground (COG)** is the direction between a vessel's last fix and an estimated position. A **course line** is a line drawn on a chart extending in the direction of a course. It is sometimes convenient to express a course as an angle from either north or south, through 90° or 180°. In this case it is designated **course angle (C)** and should be properly labeled to indicate the origin (prefix) and direction of measurement (suffix). Thus, C N35°E = Cn 035° (000° + 35°), C N155°W = Cn 205° (360° - 155°), C S47°E = Cn 133° (180° - 47°). But Cn 260° may be either C N100°W or C S80°W, depending upon the conditions of the problem.

**Track (TR)** is the intended horizontal direction of travel with respect to the Earth. The terms intended track and trackline are used to indicate the path of intended travel. See Figure F6a. The track consists of one or a series of course lines, from the point of departure to the destination, along which one intends to proceed. A great circle which a vessel intends to follow is called a **great-circle track**, though it consists of a series of straight lines approximating a great circle.

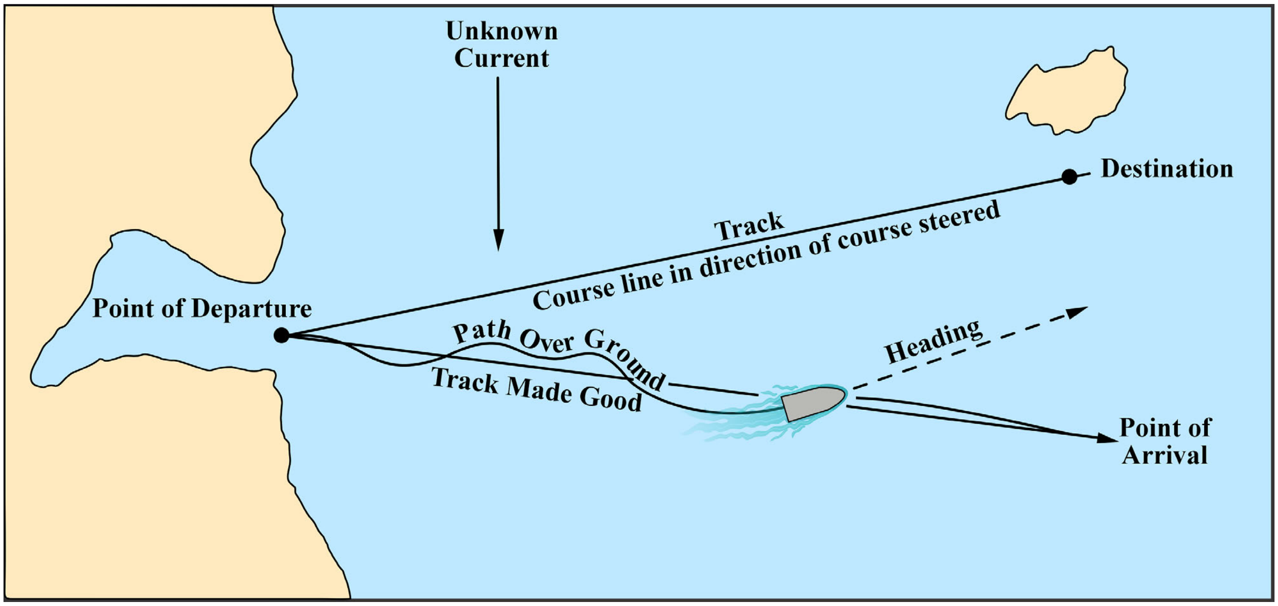



*Figure F6a. Course line, track, track made good, and heading.*

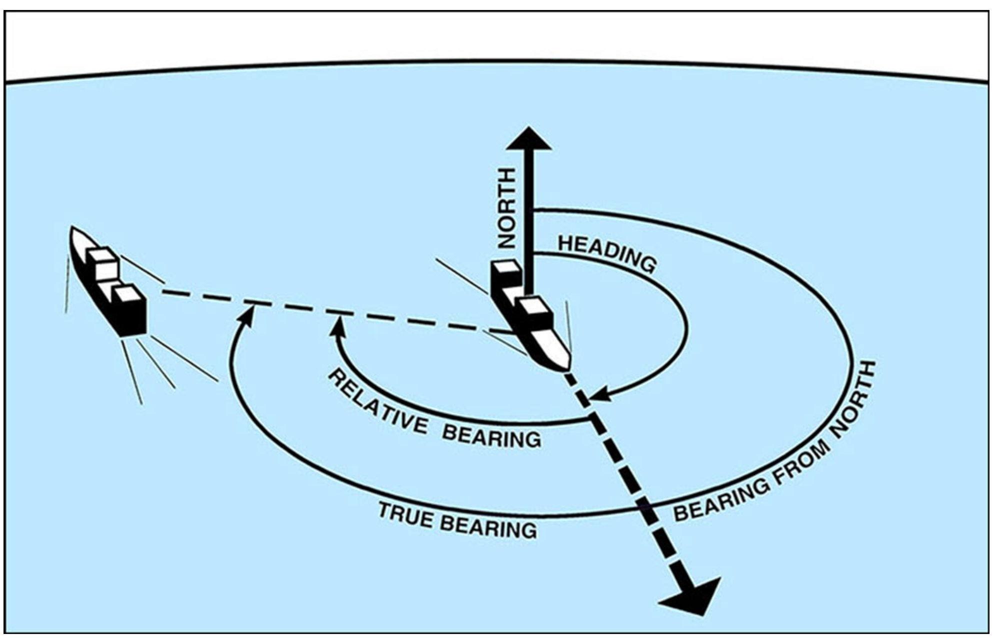



*Figure F6b. Relative Bearing*

**Heading (Hdg., SH)** is the direction in which a vessel is pointed at any given moment, expressed as angular distance from 000° clockwise through 360°. It is easy to confuse heading and course. Heading constantly changes as a vessel yaws back and forth across the course due to sea, wind, and steering error.

**Bearing (B, Brg.)** is the direction of one terrestrial point from another, expressed as angular distance from 000° (North) clockwise through 360°. When measured through 90° or 180° from either north or south, it is called bearing angle (B). Bearing and azimuth are sometimes used interchangeably, but the latter more accurately refers to the horizontal direction of a point on the celestial sphere from a point on the Earth.

A relative bearing is measured relative to the ship's heading from 000° (dead ahead) clockwise through 360°. However, it is sometimes conveniently measured right or left from 000° at the ship's head through 180°. This is particularly true when using Table 18, Distance of an Object by Two Bearings.

To convert a relative bearing to a true bearing, add the true heading. See Figure F6b.

True Bearing = Relative Bearing + True Heading.

Thus, if another vessel bears 127° relative from a ship whose heading is 150°, the bearing from north is 127°+150°=277°. If the total exceeds 360°, subtract this amount.

To convert a bearing from north to a relative bearing, subtract the heading:

Relative Bearing = True Bearing - True Heading.

Thus, a lightship which bears 241° from north bears relative from a ship whose heading is 137°. If the heading is larger than the true bearing, add 360° to the true bearing before subtracting.

## F7. Grid Direction

Because of the rapid convergence of the meridians in polar regions, the true direction of an oblique line near the pole may vary considerably over relatively few miles. The meridians are radial lines meeting at the poles, instead of being parallel, as they appear on the familiar Mercator chart.

Near the pole the convenience of parallel meridians is attained by means of a **polar grid**. On the chart a number of lines are printed parallel to a selected reference meridian, usually that of Greenwich. On transverse Mercator charts the fictitious meridians may serve this purpose. Any straight line on the chart makes the same angle with all grid lines. On the transverse Mercator projection it is therefore a **fictitious rhumb line**. On any polar projection it is a close approximation to a great circle. If north along the reference meridian is selected as the reference direction, all parallel grid lines can be considered extending in the same direction. The constant direction relative to the grid lines is called **grid direction**. North along the Greenwich meridian is usually taken as grid north in both the Northern and Southern Hemispheres.

The value of grid directions is indicated in Figure F7. In this figure *A* and *B* are 400 miles apart. The true bearing of *B* from *A* is 023°, yet at *B* this bearing line, if continued, extends in true direction 163°, a change of 140° in 400 miles. The grid direction at any point along the bearing line is 103°.

When north along the Greenwich meridian is used as grid north, interconversion between grid and true directions is quite simple. Let *G* represent a grid direction, *T* the corresponding true direction, λ is longitude and *W* is the Western Hemisphere. Then for the Arctic,

$$G = T + \lambda W$$

That is, in the Western Hemisphere, in the Arctic, grid direction is found by adding the longitude to the true direction. From this it follows that,

$$T = G - \lambda W$$

and in the Eastern Hemisphere,

$$G = T - \lambda E$$
$$T = G + \lambda E$$

In the Southern Hemisphere the signs (+ or -) of the longitude are reversed in all formulas.

If a magnetic compass is used to follow a grid direction, variation and convergency can be combined into a single correction called **grid variation** or **grivation**. It is customary to show lines of equal grivation on polar charts rather than lines of equal variation. **Isogrivs** are lines of equal grivation.

With one modification the grid system of direction can be used in any latitude. Meridians 1° apart make an angle of 1° with each other where they meet at the pole. The **convergency** is one, and the 360° of longitude cover all 360° around the pole. At the equator the meridians are parallel and the convergency is zero. Between these two limits the convergency has some value between zero and one. On a sphere it is equal to the sine of the latitude. For practical navigation this relationship can be used on the spheroidal earth. On a simple conic or Lambert conformal chart a constant convergency is used over the entire chart, and is known as the **constant of the cone**. On a simple conic projection it is equal to the sine of the standard parallel. On a Lambert conformal projection it is equal (approximately) to the sine of the latitude midway between the two standard parallels. When convergency is printed on the chart, it is generally adjusted for ellipticity of the earth. If *K* is the constant of the cone,

$$K = \sin\tfrac{1}{2}(L_1 + L_2) \text{ approx.},$$

where $L_1$ and $L_2$ are the latitudes of the two standard parallels. On such a chart, grid navigation is conducted as explained above, except that in each of the formulas the longitude is multiplied by *K*:

$$G = T + K\lambda W$$
$$T = G - K\lambda W$$
$$G = T - K\lambda E$$
$$T = G + K\lambda E$$

Thus, a straight line on such a chart changes its true direction, not by 1° for each degree of longitude, but by K°. As in higher latitudes, convergency and variation can be combined.

In using grid navigation one should keep clearly in mind the fact that the grid lines are parallel *on the chart*. Since distortion varies on charts of different projections, and on charts of conic projections having different standard parallels, *the grid direction between any two given points is not the same on all charts*. For operations which are to be coordinated by means of grid directions, *it is important that*

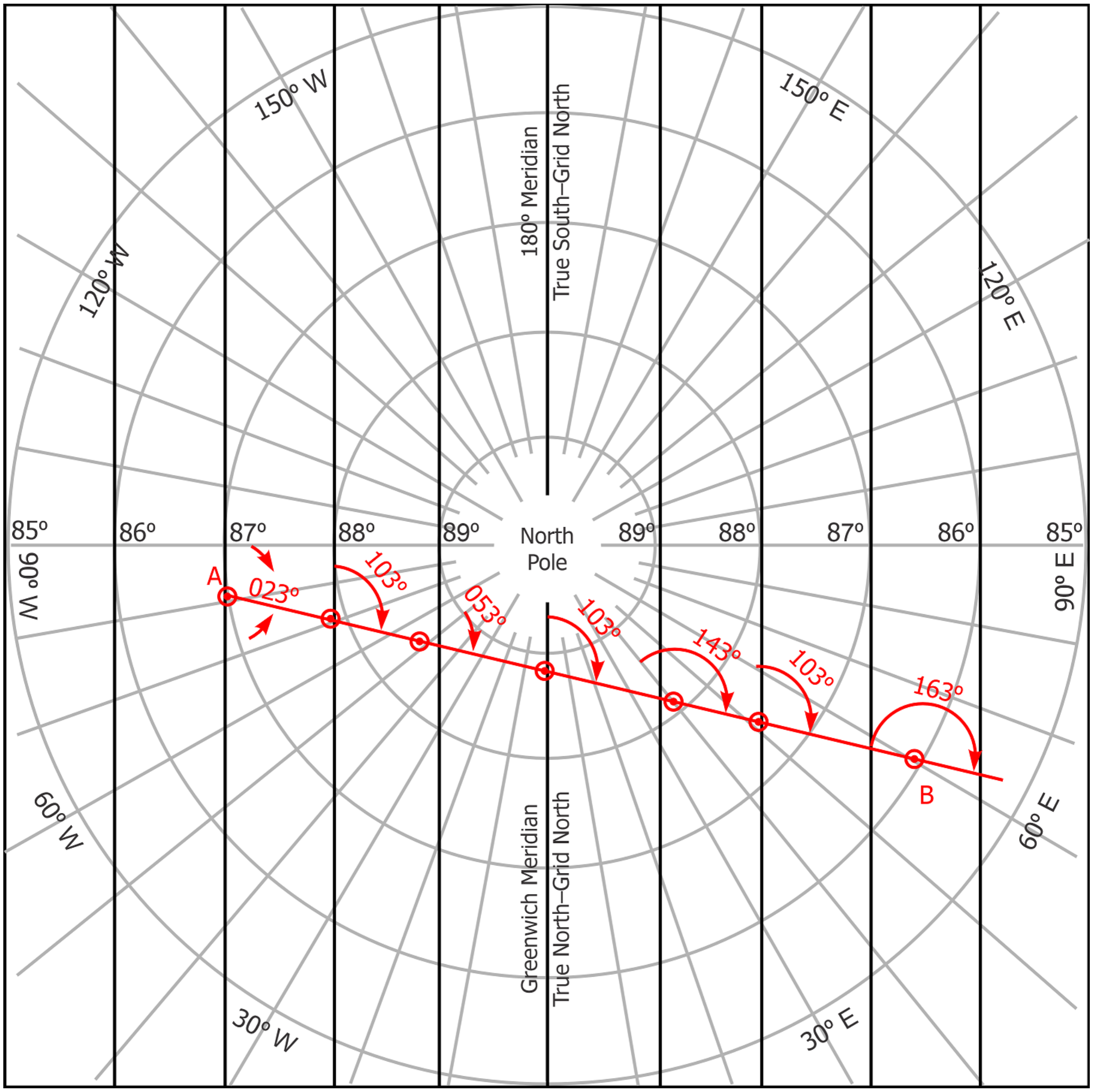



*Figure F7. Polar grid navigation.*

*all charts showing the grid be on a single graticule*.

For more information on polar navigation see Volume 1 Chapter 34.

## F8. Problems

**F3.** Point A: lat. 37°21.4'N, λ 143°18.8'W; Point B: lat. 43°04.1'N, λ 11°47.3'E; Point C: lat. 63°24.4'S, λ 132°06.9'E; Point D: lat. 2°36.6'S, λ 168°01.2'W.

**Required:** (1) The difference of latitude between A and B, between A and C, and between C and D. (2) The difference of longitude between A and B, between A and C, and between B and C.

**Answer:** (1) $l_{AB}$ 5°42.7'N, $l_{AC}$ 100°45.8'S, $l_{CD}$ 60°47.8'N; (2) $DLo_{AB}$ 155°06.1'E, $DLo_{AC}$ 84°34.3'W, $DLo_{BC}$ 120°19.6'E.

**F4a.** The distance between points E and F is 258.4 nautical miles.

**Required:** The distance in statute miles between points E and F (1) by proportion, using the ratio given in Section F4; (2) by conversion factor, using the value given in Section F4; (3) by *Table 9*.

**Answer:** (1) 297.6 St M, (2) 297.2 St M, (3) 297.4 St M.

**F4b.** The distance between points G and H is 83.3 statute miles.

**Required:** The distance in nautical miles between points G and H (1) by proportion, using the ratio given in Section F4; (2) by conversion factor, using the value given in Section F4; (3) by *Table 9*.

**Answer:** (1) 72.3 M, (2) 72.4 M, (3) 72.4 M.

**F5a.** A ship is steaming at 18.5 knots.

**Required:** The speed in statute miles per hour.

**Answer:** 21.3 mph.

**F5b.** A motorboat is traveling at 30 statute miles per hour.

**Required:** The speed in knots.

**Answer:** 26 kn.

**F6a.** Convert the following course angles to courses: (1) N127°W, (2) S3°W, (3) N99°E, (4) S171°E.

**Answer:** (1) Cn 233°, (2) Cn 183°, (3) Cn 099°, (4) Cn 009°.

**F6b.** Convert the following courses to course angles, giving the two possible answers of each: (1) 153°, (2) 257°.

**Answer:** (1) N153°E or S27°E, (2) N103°W or S77°W.

**F6c.** A ship is on course 151°. The following relative bearings are observed: (1) 006°, (2) 109°, (3) 255°, (4) broad on the port bow.

**Required:** The bearings from north.

**Answer:** (1) 157°, (2) 260°, (3) 046°, (4) 106°.

**F6d.** A ship is on course 244°. The following bearings from north are observed:(1) 041°, (2) 188°, (3) 332°.

**Required:** The relative bearings.

**Answer:** (1) 157°, (2) 304°, (3) 088°.

**F6e.** The captain of a ship on course 055° wishes to change course when a certain lighthouse is broad on the starboard beam.

**Required:** The bearing from north when the course is to be changed.

**Answer:** 145°.

**F7a.** Convert the following true directions to grid directions using (1) a convergency of one, (2) a convergency of 0.866. (Give answers to nearest whole degree.)

**Required:**

| True | Latitude | Longitude |
|---|---|---|
| 157° | N | 27° W |
| 353° | N | 114° E |
| 118° | S | 63° E |
| 042° | S | 147° W |

**Answer:** (1) 184°, 239°, 181°, 255°; (2) 180°, 254° 173°, 275°.

**F7b.** Convert the following grid directions to true directions using (1) a convergency of 0.629, (2) a convergency of one.

**Required:**

| Grid | Latitude | Longitude |
|---|---|---|
| 003° | N | 174° W |
| 148° | N | 9° E |
| 317° | S | 64° E |
| 256° | S | 155° W |

**Answer:** (1) 254°, 154°, 357°, 159°; (2) 189°, 157°, 021°, 101°.

# APPENDIX G

# MEASUREMENT ON THE CELESTIAL SPHERE

## G1. The Celestial Sphere

A glimpse of the sky on a clear night is sufficient to enable an observer to imagine that all of the heavenly bodies are located on the inner surface of a sphere (Figure G1a) of infinite radius with the Earth at its center. This imaginary dome is called the **celestial sphere** (Figure G1b) whose north and south **celestial poles** are located by the extension of the Earth's axis and whose **celestial equator** (sometimes called **equinoctial**) is formed by projecting the plane of the Earth's equator to the celestial sphere. A **celestial meridian** is formed by the intersection of the plane of a terrestrial meridian, extended, and the celestial sphere. It is the arc of a great circle through the poles of the celestial sphere.

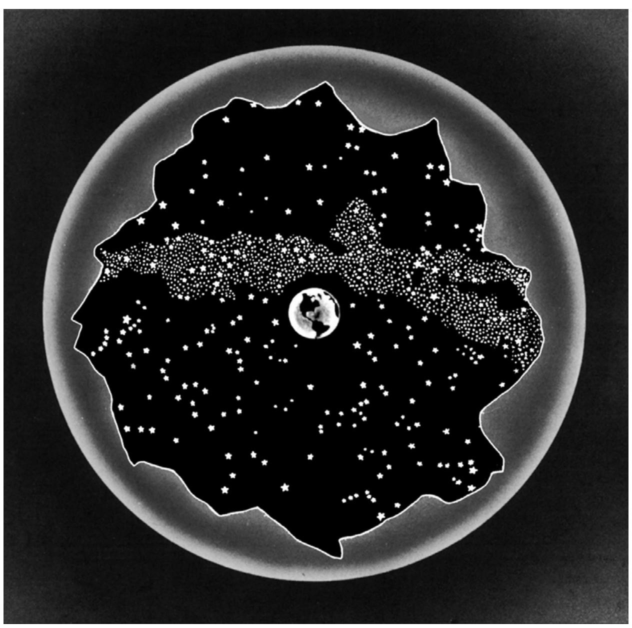


*Figure G1a. The celestial sphere.*

The point on the celestial sphere vertically overhead of an observer is the **zenith** and the point on the opposite side of the sphere, vertically below, is the **nadir**. The zenith and nadir are the extremities of a diameter of the celestial sphere through the observer and the common center of the Earth and the celestial sphere. The arc of a celestial meridian between the poles is called the **upper branch** if it contains the zenith, and the **lower branch** if it contains the nadir. The upper branch is frequently used in navigation and references to a celestial meridian are understood to mean only its upper branch unless otherwise stated. Celestial meridians take the names, of their terrestrial counterparts.

An **hour circle** is a great circle through the celestial poles and a point or body on the celestial sphere. It is similar to a celestial meridian, but moves with the celestial sphere as it rotates about the Earth, while a celestial meridian remains fixed with respect to the Earth.

The location of a body along its hour circle is defined by the body's angular distance from the celestial equator. This distance, called **declination**, is measured north or south of the celestial equator in degrees, from 0° through 90°, similar to latitude on the Earth.

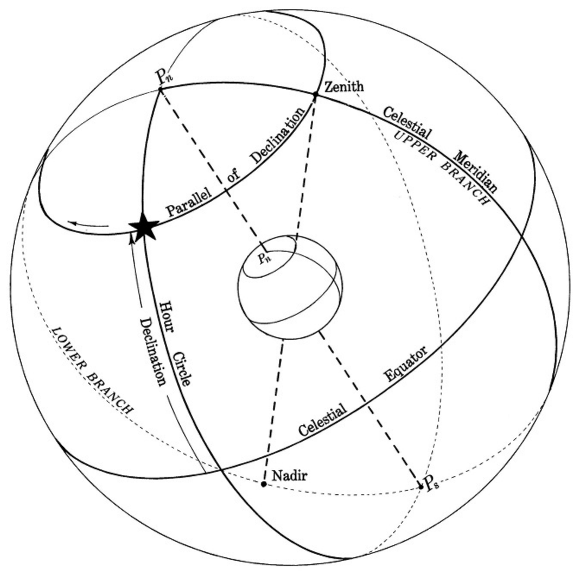



*Figure G1b. Elements of the celestial sphere.*

A circle parallel to the celestial equator is called a **parallel of declination**, since it connects all points of equal declination. It is similar to a parallel of latitude on the Earth. The path of a celestial body during its daily apparent revolution around the Earth is called its **diurnal circle**. It is not actually a circle if a body changes its declination. Since the declination of all navigational bodies is continually changing, the bodies are describing flat spherical spirals as they circle the Earth. However, since the change is relatively slow, a diurnal circle and a parallel of declination are usually considered identical.

A point on the celestial sphere may be identified at the intersection of its parallel of declination and its hour circle. The parallel of declination is identified by the declination.

Two basic methods of locating the hour circle are in use. Its angular distance west of a reference hour circle through a point on the celestial sphere called the **vernal**

**equinox** or **first point of Aries** ( ♈ ) is called **sidereal hour angle** (**SHA**, Figure G1c). This angle measured eastward from the vernal equinox is called **right ascension**, and is usually expressed in time units.

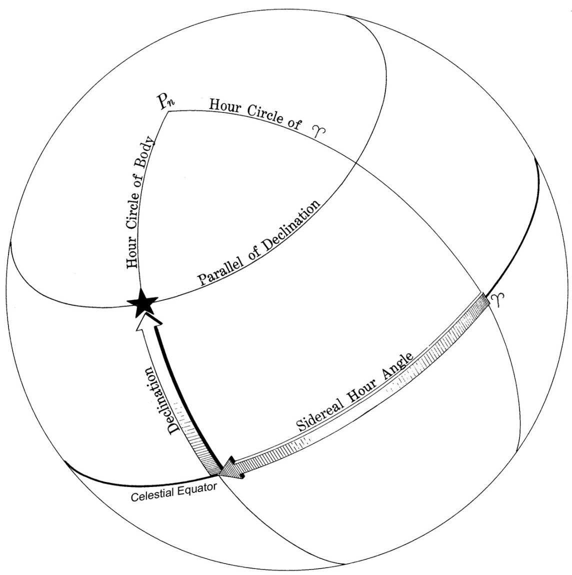



*Figure G1c. A point on the celestial sphere can be located by its declination and sidereal hour angle.*

The second method of locating the hour circle is to indicate its angular distance west of a celestial meridian (Figure G1d). If the **Greenwich celestial meridian** is used as the reference, the angular distance is called **Greenwich hour angle** (**GHA**), and if the meridian of the observer, it is called **local hour angle** (**LHA**). It is sometimes more convenient to measure LHA either eastward or westward, as longitude is measured on the Earth, in which case it is called **meridian angle** (**t**). These coordinates are discussed further in Section G4.

A point on the celestial sphere may also be located by means of **altitude** and **azimuth**, coordinates based upon the horizon as the primary great circle, instead of the celestial equator. This system is discussed in Section G6.

Two additional systems used by astronomers are based upon the ecliptic (Section G2) and the galactic equator (the approximate mid great circle of the galaxy). The coordinates of the ecliptic system are **celestial latitude** and **celestial longitude** and those of the galactic system are **galactic latitude** and **galactic longitude**.

## G2. Apparent Motion of Celestial Bodies

To a terrestrial observer the Earth seems to be stationary and the various celestial bodies appear to be in continual motion. It is this **apparent motion**, or motion relative to the Earth, that concerns the navigator primarily.

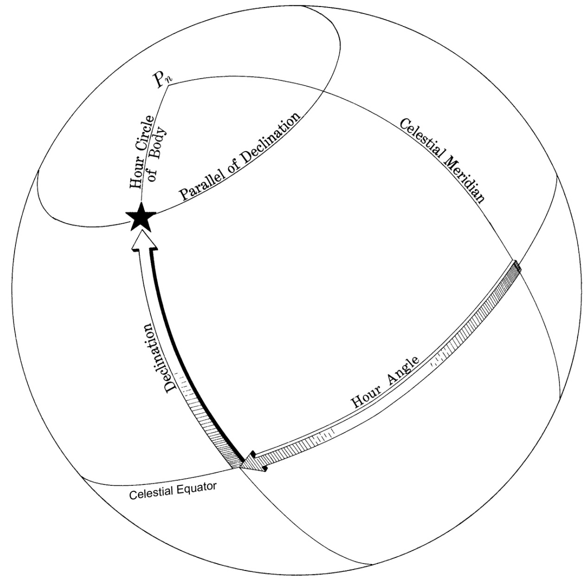



*Figure G1d. A point on the celestial sphere can be located by its declination and hour angle.*

The daily motion of the various bodies due to the rotation of the Earth is the most conspicuous movement. Even a casual observer, however, soon notes that the various celestial bodies do not maintain the same positions relative to each other. That is, while the celestial sphere appears to rotate about its axis, making one revolution about the apparently stationary Earth each day, the various celestial bodies are changing their positions on the sphere.

If the rotation of the Earth on its axis could be stopped, so that the daily apparent rotation of the celestial sphere would cease, the motions of the various bodies relative to each other would be more apparent. The stars would appear almost stationary. This is why they are sometimes called “fixed stars.” They form a nearly stationary background which serves as a convenient reference for other motions.

The Sun would appear to move eastward about 1 ° per day, completing its trip around the celestial sphere in 1 year. The motion is not along the celestial equator, but along another great circle, called the **ecliptic**, which is inclined to the celestial equator at an angle of about 23°27' (Figure G2). This great circle lies in the plane of the Earth's orbit around the Sun, since it is this *actual* motion that causes the *apparent* motion of the Sun.

The Moon would appear to make one trip around the celestial sphere each month, following closely the path of the Sun. The planets would appear to move erratically, but keeping close to the ecliptic.

The two points at which the ecliptic crosses the celestial equator are called **equinoxes** (meaning “equal nights”), since days and nights are of equal length when the Sun is at these points. The Sun is at one of these points ( ♈ ) about March 21. This is called the **vernal** (spring) **equinox**, **first**

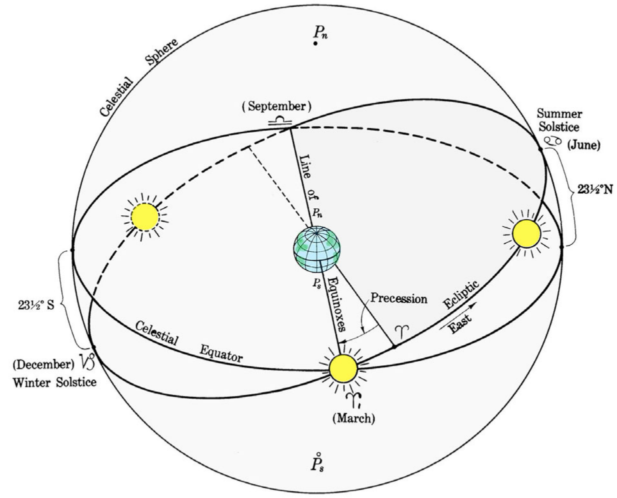



*Figure G2. Elements of the ecliptic, along which the Sun appears to move during 1 year.*

**point of Aries**, or **March equinox**.

Since the Sun is on the celestial equator at this time, its declination is 0°. As it continues eastward, it arrives about June 21 at one of the points of maximum separation of the ecliptic and celestial equator. This is called the **summer solstice**, sometimes called **June solstice**. At this time the declination of the Sun reaches its maximum value of about 23°27'N, and since the ecliptic and celestial equator are parallel at this point, the change in declination of the Sun is momentarily zero, increasing slowly on each side of this point. Hence, the name solstice, meaning "Sun standing still".

Continuing on, the Sun arrives at the **autumnal** or **September equinox** about September 23, when the declination is again 0° and the days and nights are again of equal length. In another 3 months it arrives at the **winter** or **December solstice** about December 22, when the declination is again maximum, but on the opposite side of the celestial equator. By March 21 it has arrived back at the vernal equinox, completing the cycle.

The terms *equinox* and *solstice* refer both to the points indicated and the times at which the Sun is at these points.

### G3. Coordinated Systems

Various systems of coordinates on the celestial sphere, all of them similar to the familiar latitude and longitude on the Earth, were discussed briefly in the Section G1. Of these, the navigator is usually concerned with only the celestial equator system and the horizon system. The former is but an extension to the celestial sphere of the geographical system of the Earth. The latter is a similar system in which the horizon replaces the celestial equator as the primary great circle, and the zenith and nadir are the poles. These two systems are the almost constant companions of the celestial navigator.

### G4. The Celestial Equator System of Coordinates

The familiar graticule of latitude and longitude lines, expanded until it reaches the celestial sphere, forms the basis of the **celestial equator system** of coordinates. On the celestial sphere latitude becomes declination, while longitude becomes sidereal hour angle (SHA), measured from the vernal equinox.

**Declination** (**d**) is angular distance north or south of the celestial equator (d in Figure G4a). It is measured along an hour circle, from 0° at the celestial equator through 90° at the celestial poles, and is labeled N or S to indicate the direction of measurement. All points having the same declination lie along a parallel of declination.

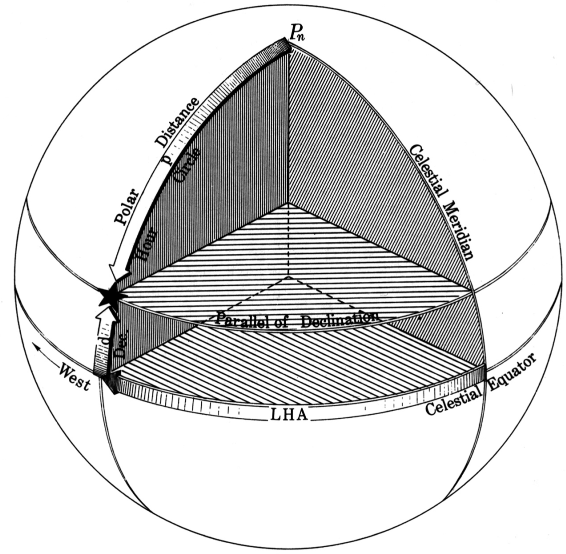



*Figure G4a. The celestial equator system of coordinates, showing measurements of declination, polar distance, and local hour angle.*

**Polar distance** (**p**) is angular distance from a celestial pole, or the arc of an hour circle between the celestial pole and a point on the celestial sphere. It is measured along an hour circle and may vary from 0° to 180°, since either pole may be used as the origin of measurement. It is usually considered the complement of declination, though it may be either 90° – d or 90° + d, depending upon the pole used. See Figure G4a.

**Local hour angle** (**LHA**) is angular distance west of the local celestial meridian, or the arc of the celestial equator between the upper branch of the local celestial meridian and the hour circle through a point on the celestial sphere, measured westward from the local celestial meridian, through 360°. It is also the similar arc of the parallel of declination and the angle at the celestial pole, similarly measured. If the Greenwich (0°) meridian is used as the reference, instead of the local meridian, the expression **Greenwich hour angle** (**GHA**) is applied. It is sometimes convenient to measure the arc or angle in either an easterly or westerly direction from the local meridian, through 180°, when it is called **meridian angle** (**t**) and labeled E or W to indicate the direction of measurement. All bodies or other points having the same hour angle lie along the same hour circle.

The **time diagram,** shown in Figure G4b, illustrates the relationship between the various hour angles and meridian angle. The circle is the celestial equator as seen from above the South Pole, with the upper branch of the observer's meridian ($P_SM$) at the top. The radius $P_SG$ is the Greenwich meridian; $P_S$ ♈ is the hour circle of the vernal equinox. The Sun's hour circle is to the east of the observer's meridian; the Moon's hour circle is to the west of the observer's meridian. Note that when LHA is less than 180°, it is numerically the same and is labeled W, but that when LHA is greater than 180°, t = 360° – LHA and is labeled E. In Figure G4b arc GM is the longitude, which in this case is west. The relationships shown apply equally to other arrangements of radii, except for relative magnitudes of the quantities involved.

The line where Earth and sky appear to meet is called the **visible** or **apparent horizon**. On land this is usually an irregular line unless the terrain is level. At sea the visible horizon appears very regular and is often very sharp. However, its position relative to the celestial sphere depends primarily upon (1) the refractive index of the air and (2) the height of the observer's eye above the surface.

Figure G5 shows a cross section of the Earth and celestial sphere through the position of an observer at *A* above the surface of the Earth. A straight line through *A* and the center of the Earth *O* is the vertical of the observer, and contains his zenith (Z) and nadir (Na). A plane perpendicular to the true vertical is a horizontal plane, and its intersection with the celestial sphere is a horizon. It is the **celestial horizon** if the plane passes through the center of the Earth, the **geoidal horizon** if it is tangent to the Earth, and the **sensible horizon** if it passes through the eye of the observer at *A*. Since the radius of the Earth is considered negligible with respect to that of the celestial sphere, these horizons become superimposed, and most measurements are referred only to the celestial horizon. This is sometimes called the **rational horizon** from the Latin word **"**ratio,**"** reckoning.

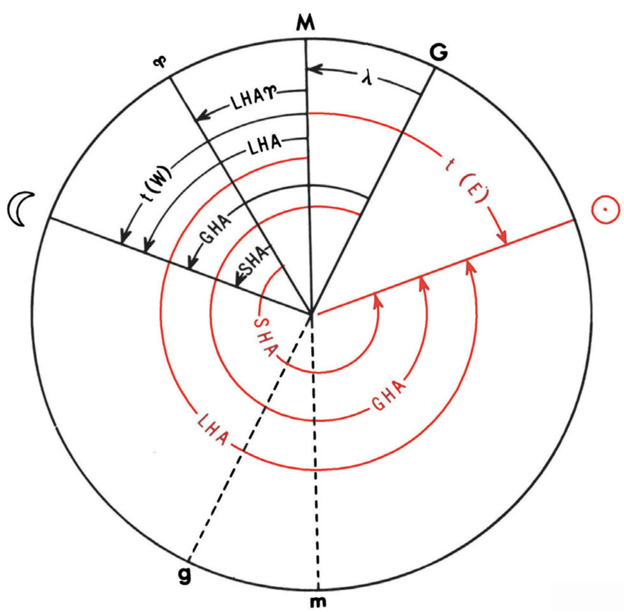



*Figure G4b. Time diagram.*

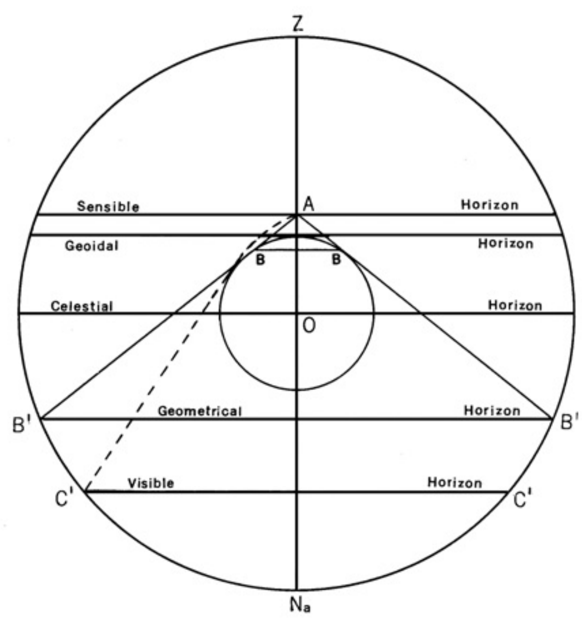



*Figure G5. The horizon used in navigation.*

## G5. The Horizons

The second set of celestial coordinates with which the navigator is directly concerned is based upon the horizon as the primary great circle. However, since several different horizons are defined, these should be thoroughly understood before proceeding with a consideration of the horizon system of coordinates.

If the eye of the observer is at the surface of the Earth, his visible horizon coincides with the plane of the geoidal horizon; but when elevated above the surface, as at *A*, his eye becomes the vertex of a cone which, neglecting refraction, is tangent to the Earth at the small circle *BB*, and which intersects the celestial sphere in *B′ B′*, the **geometrical horizon**. This expression is sometimes, but less appropriately, applied to the celestial horizon.

Refraction causes the visible horizon *C′ C′* to appear above, but is actually slightly below, the geometrical horizon as shown in Figure G5.

For any elevation above the surface, the celestial horizon is usually above the geometrical and visible horizons, the difference increasing as elevation increases. It is thus possible to observe a body which is above the visible horizon but below the celestial horizon. That is, the body's altitude is negative and its zenith distance is greater than 90°.

### G6. The Horizon System of Coordinates

This system is based upon the celestial horizon as the primary great circle and a series of secondary vertical circles which are great circles through the zenith and nadir of the observer and hence perpendicular to his or her horizon. Thus, the celestial horizon is similar to the equator, and the vertical circles are similar to meridians, but with one important difference. The celestial horizon and vertical circles are dependent upon the position of the observer and hence move with changes in position, while the primary and secondary great circles of both the geographical and celestial equator systems are independent of the observer. The horizon and celestial equator systems coincide for an observer at the geographical pole of the Earth and are mutually perpendicular for an observer on the equator. At all other places the two are oblique.

The **celestial** or **local meridian** passes through the observer's zenith, nadir, and poles of the celestial equator system of coordinates. As such, it passes through north and south on the observer's horizon. One of these poles (having the same name, N or S, as the latitude) is above the horizon and is called the **elevated pole**. The other, called the **depressed pole**, is below the horizon. In the horizon system it is called the principal vertical circle. The vertical circle through the east and west points of the horizon, and hence perpendicular to the principal vertical circle, is called the **prime vertical circle**, or simply the **prime vertical**.

As shown in Figure G6, altitude is angular distance above the horizon. It is measured along a vertical circle, from 0° at the horizon through 90° at the zenith. Altitude measured from the visible horizon may exceed 90° because of the dip of the horizon, as shown in Figure G6. Altitude is nominally a positive value, however, angular distance below the celestial horizon, called negative altitude, is provided for by including certain negative altitudes in some tables for use in celestial navigation. All points having the same altitude lie along a **parallel of altitude** or **almucantar**.

**Zenith distance** (z) is angular distance from the zenith, or the arc of a vertical circle between the zenith and a point on the celestial sphere. It is measured along a vertical circle from 0° through 180°. It is usually considered the complement of altitude. For a body measured with respect to the celestial horizon z = 90°-h, and for a body below the celestial horizon z = 90°-(-h), or z = 90°+h.

The horizontal direction of a point on the celestial sphere, or the bearing of the geographical position, is called **azimuth** or **azimuth angle** depending upon the method of measurement. In both methods it is an arc of the horizon (or parallel of altitude). It is true azimuth (Zn) if measured east from north on the horizon through 360°, and azimuth angle (Z) if measured either direction along the horizon through 180°, starting at the north for an observer in north latitudes and the south in south latitudes.

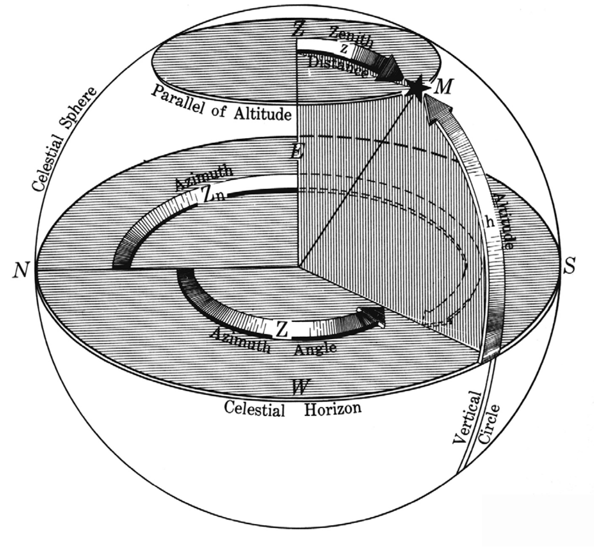



*Figure G6. The horizon system of coordinates, showing measurement of altitude, zenith distance, azimuth, and azimuth angle.*

### G7. Diagram on the Plane of the Celestial Meridians

From a point outside the celestial sphere (if this were possible) and over the celestial equator, at such a distance that the view would be orthographic, the great circle appearing as the outer limit would be a **celestial meridian**. Other celestial meridians would appear as ellipses. The celestial equator would appear as a diameter 90° from the poles, and parallels of declination as straight lines parallel to the equator.

A number of useful relationships can be demonstrated by drawing a diagram on the plane of the celestial meridian showing this orthographic view. Arcs of circles can be substituted for the ellipses without destroying the basic relationships. Refer to Figure G7a. In the lower diagram the circle represents the celestial meridian, *QQ′* the celestial equator, *Pn* and *Ps* the north and south celestial poles, respectively. If a star has a declination of 30 °N, an angle of 30° can be measured from the celestial equator, as shown. It could be measured either to the right or left, and would have been toward the south pole if the declination had been south. The parallel of declination is a line through this point and parallel to the celestial equator. The star is somewhere on this line (actually a circle viewed on edge).

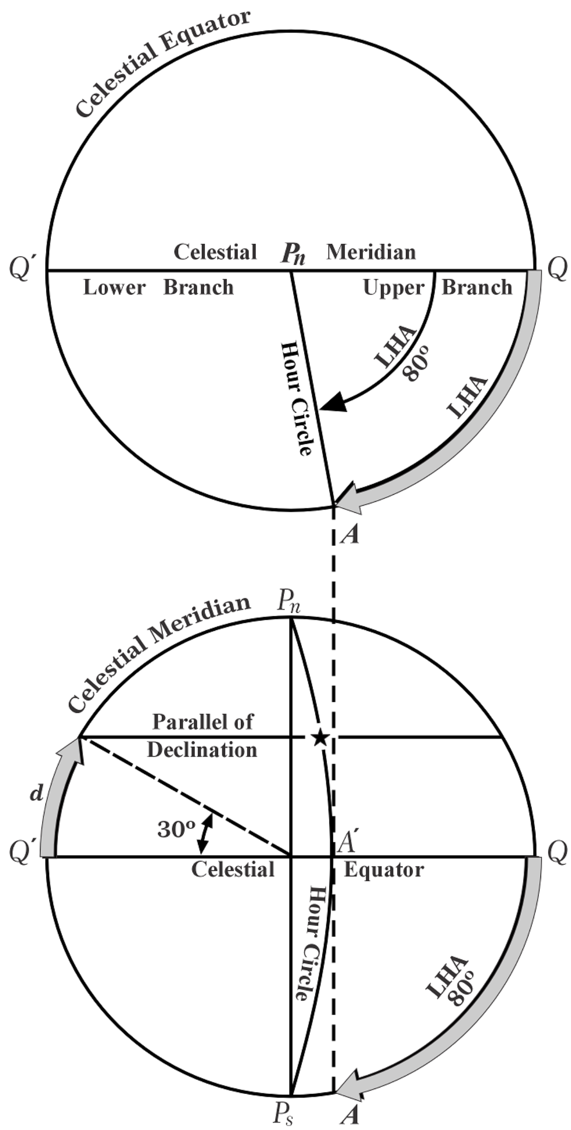



*Figure G7a. Measurement of celestial equator system of coordinates.*

To locate the hour circle, draw the upper diagram so that *Pn* is directly above *Pn* of the lower figure (in line with the polar axis *Pn Ps*), and the circle is of the same diameter as that of the lower figure. This is the plan view, looking down on the celestial sphere from the top. The circle is the celestial equator. Since the view is from above the *north* celestial pole, west is clockwise. The diameter *QQ′* is the celestial meridian shown as a circle in the lower diagram. If the right half is considered the upper branch, local hour angle is measured clockwise from this line to the hour circle, as shown. In this case the LHA is 80°. The intersection of the hour circle and celestial equator, point *A*, can be projected down to the lower diagram (point *A′*) by a straight line parallel to the polar axis. The elliptical hour circle can be represented approximately by an arc of a circle through *A′*, *Pn*, *Ps*. The center of this circle is somewhere along the celestial equator line *QQ′*, extended if necessary. It is usually found by trial and error. The intersection of the hour circle and parallel of declination locates the star.

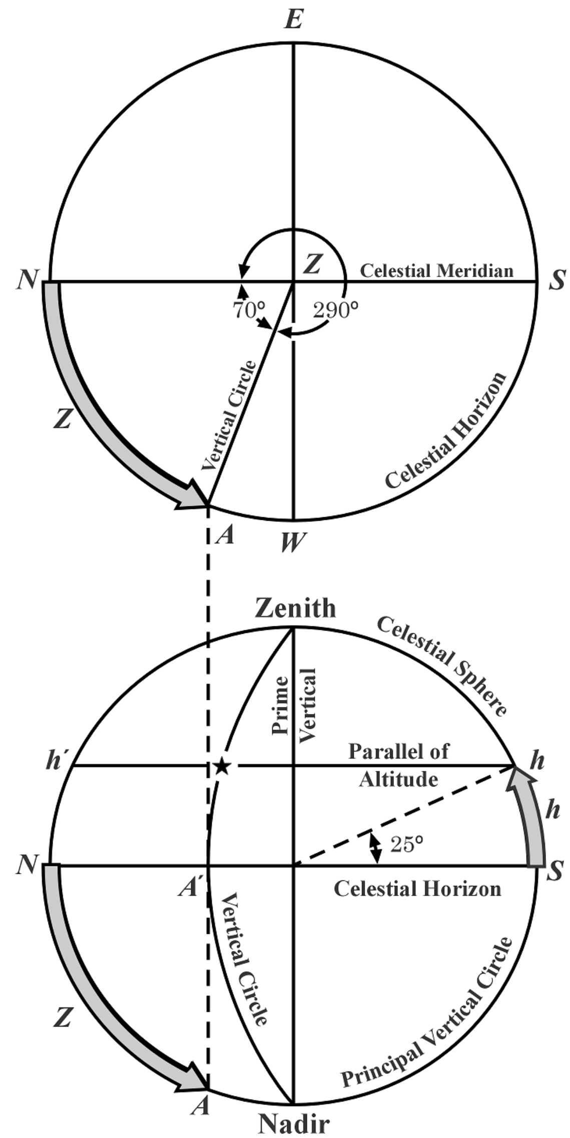



*Figure G7b. Measurement of horizon system of coordinates.*

Since the upper diagram serves only to locate point *A′* in the lower diagram, the two can be combined. That is, the LHA arc can be drawn in the lower diagram, as shown, and point *A* projected *upward* to *A′*. In practice, the upper diagram is not drawn, being shown here for illustrative purposes only.

In this example the star is on that half of the sphere toward the observer, or the *western* part. If LHA had been greater than 180°, the body would have been on the *eastern* or “back” side.

From the east or west point over the celestial horizon, the orthographic view of the horizon system of coordinates would be similar to that of the celestial equator system from a point over the celestial equator (Figure G7a), since the celestial meridian is also the principal vertical circle. The horizon would appear as a diameter, parallels of altitude as straight lines parallel to the horizon, the zenith and nadir as poles 90° from the horizon, and vertical circles as ellipses through the zenith and nadir, except for the principal vertical circle, which would appear as a circle, and the prime vertical, which would appear as a diameter perpendicular to the horizon.

A celestial body can be located by altitude and azimuth in a manner similar to that used with the celestial equator system. If the altitude is 25°, this angle is measured from the horizon toward the zenith and the parallel of altitude is drawn as a straight line parallel to the horizon, as shown at *hh′* in the lower diagram of Figure G7b. The plan view from above the zenith is shown in the upper diagram. If north is taken at the left, as shown, azimuths are measured clockwise from this point. In the figure the azimuth is 290° and the azimuth angle is N 70° W. The vertical circle is located by measuring either arc. Point *A* thus located can be projected vertically downward to *A′* on the horizon of the lower diagram, and the vertical circle represented approximately by the arc of a circle through *A′* and the zenith and nadir. The center of this circle is on *NS*, extended if necessary. The body is at the intersection of the parallel of altitude and the vertical circle. Since the upper diagram serves only to locate *A′* on the lower diagram, the two can be combined, point *A* located on the lower diagram and projected upward to *A′*, as shown. Since the body of the example has an azimuth greater than 180°, it is on the western or "front" side of the diagram.

Since the celestial meridian appears the same in both the celestial equator and horizon systems, the two diagrams can be combined and, if properly oriented, a body can be located by one set of coordinates, and the coordinates of the other system can be determined by measurement.

Refer to Figure G7c. By convention, the zenith is shown at the top and the north point of the horizon at the left. The west point on the horizon is at the center, and the east point directly behind it. In the figure the latitude is 37°N. Therefore, the zenith is 37° north of the celestial equator. Since the zenith is established at the top of the diagram, the equator can be found by measuring an arc of 37° toward the south, along the celestial meridian. If the declination is 30°N and the LHA is 80°, the body can be located as described above.

The altitude and azimuth can be determined by the reverse process to that described above. Draw a line *hh′* through the body and parallel to the horizon, *NS*. The altitude, 25°, is found by measurement, as shown. Draw the arc of a circle through the body, the zenith, and nadir. From *A′*, the intersection of this arc with the horizon, draw a vertical line intersecting the circle at *A*. The azimuth N 70° W, is found by measurement, as shown. The prefix N is applied

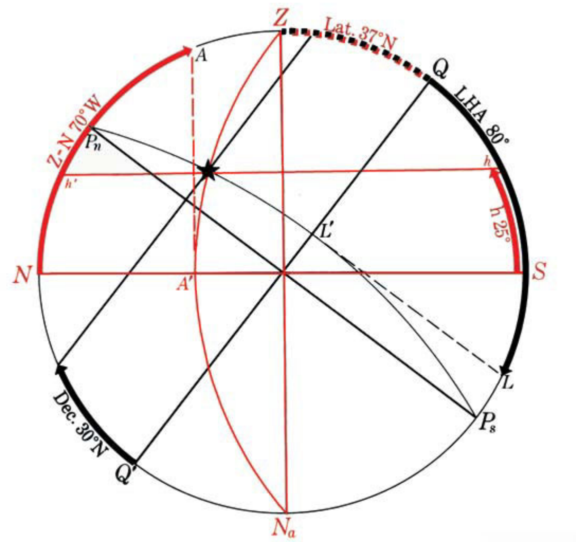



*Figure G7c. Diagram on the plane of the celestial meridian.*

to agree with the latitude. The body is left (*north*) of *ZNa*, the prime vertical circle. The suffix W applies because the LHA, 80°, shows that the body is west of the meridian.

If altitude and azimuth are given, the body is located as described above. The parallel of declination is then drawn parallel to *QQ′*, the celestial equator, and the declination determined by measurement. Point *L′* is located by drawing the arc of a circle through *Pn*, the star, and *Ps*. From *L′* a line is drawn perpendicular to *QQ′*, locating *L*. The meridian angle is then found by measurement. The declination is known to be north because the body is between the celestial equator and the north celestial pole. The meridian angle is west to agree with the azimuth angle, and hence LHA is numerically the same.

Since *QQ′* and *PnPs* are perpendicular, and *ZNa* and *NS* are also perpendicular, arc *NPn* is equal to arc *ZQ*. That is, *the altitude of the elevated pole is equal to the declination of the zenith, which is equal to the latitude*. This relationship is the basis of the method of determining latitude by an observation of Polaris.

The diagram on the plane of the celestial meridian is useful in approximating a number of relationships.

## G8. The Navigational Triangle

A triangle formed by arcs of great circles of a sphere is called a **spherical triangle**. A spherical triangle on the celestial sphere is called a **celestial triangle**. The spherical triangle of particular significance to navigators is called the **navigational triangle**, formed by arcs of a celestial meridian, an hour circle, and a vertical circle. Its vertices are the elevated pole, the zenith, and a point on the celestial sphere (usually a celestial body). The terrestrial counterpart is also called a navigational triangle, being formed by arcs of two meridians and the great circle connecting two places on the Earth, one on each meridian. The vertices are the two places and a pole. In great-circle sailing these places are the point of departure and the destination. In celestial navigation they are the **assumed position** (**AP**) of the observer and the **geographical position** (**GP**) of the body (the point on the Earth's surface having the body in its zenith). The GP of the Sun is sometimes called the **subsolar point**, that of the Moon the **sublunar point**, that of a satellite (either natural or artificial) the **subsatellite point**, and that of a star its **substellar** or **subastral point**. When used to solve a celestial observation, either the celestial or terrestrial triangle may be called the **astronomical triangle**.

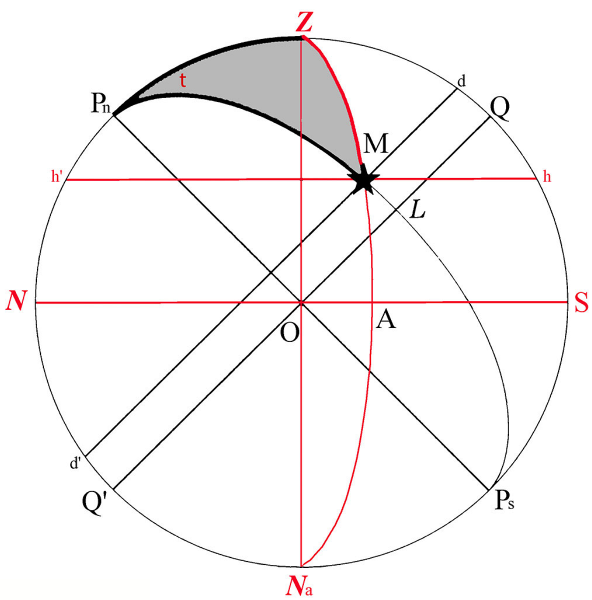



*Figure G8a. The navigational triangle.*

The navigational triangle is shown in Figure G8a on a diagram on the plane of the celestial meridian. The Earth is at the center, *O*. The star is at *M*, *dd'* is its parallel of declination, and *hh'* is its altitude circle.

In the Figure G8a, arc *QZ* of the celestial meridian is the latitude of the observer, and *PnZ*, one side of the triangle, is the **colatitude**. Arc *AM* of the vertical circle is the altitude of the body, and side *ZM* of the triangle is the zenith distance, or **coaltitude**. Arc *LM* of the hour circle is the declination of the body, and side *PnM* of the triangle is the polar distance, or **codeclination**.

The angle at the elevated pole, *ZPnM*, having the hour circle and the celestial meridian as sides, is the meridian angle, *t*. The angle at the zenith, *PnZM*, having the vertical circle and that arc of the celestial meridian, which includes the elevated pole, as sides, is the azimuth angle. The angle at the celestial body, *ZMPn*, having the hour circle and the vertical circle as sides, is the **parallactic angle** (*q*) (sometimes called the *position angle*), which is not generally used by the navigator.

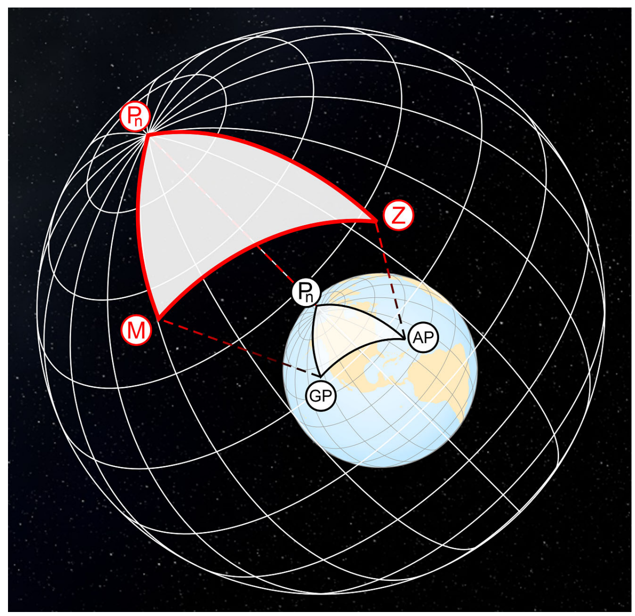



*Figure G8b. The navigational triangle in perspective.*

# APPENDIX H: EXTRACTS FROM 2020 TIDE TABLES



## New York (The Battery), New York, 2020

Times and Heights of High and Low Waters

### January

| Day | Time (h m) | Height (ft) | Height (cm) |
|---|---|---|---|
| 1 W | 0034 | 3.8 | 116 |
| | 0624 | 0.9 | 27 |
| | 1239 | 4.1 | 125 |
| | 1901 | 0.5 | 15 |
| 2 Th ◐ | 0119 | 3.7 | 113 |
| | 0726 | 1.1 | 34 |
| | 1324 | 3.9 | 119 |
| | 1953 | 0.6 | 18 |
| 3 F | 0204 | 3.8 | 116 |
| | 0830 | 1.1 | 34 |
| | 1411 | 3.7 | 113 |
| | 2045 | 0.6 | 18 |
| 4 Sa | 0250 | 3.8 | 116 |
| | 0928 | 0.9 | 27 |
| | 1503 | 3.6 | 110 |
| | 2133 | 0.5 | 15 |
| 5 Su | 0339 | 4.0 | 122 |
| | 1021 | 0.7 | 21 |
| | 1600 | 3.5 | 107 |
| | 2219 | 0.4 | 12 |
| 6 M | 0429 | 4.2 | 128 |
| | 1110 | 0.5 | 15 |
| | 1657 | 3.6 | 110 |
| | 2304 | 0.2 | 6 |
| 7 Tu | 0516 | 4.5 | 137 |
| | 1158 | 0.2 | 6 |
| | 1748 | 3.8 | 116 |
| | 2350 | 0.1 | 3 |
| 8 W | 0600 | 4.8 | 146 |
| | 1245 | -0.1 | -3 |
| | 1834 | 3.9 | 119 |
| 9 Th | 0037 | -0.1 | -3 |
| | 0641 | 5.0 | 152 |
| | 1332 | -0.4 | -12 |
| | 1917 | 4.1 | 125 |
| 10 F ○ | 0125 | -0.3 | -9 |
| | 0723 | 5.3 | 162 |
| | 1418 | -0.6 | -18 |
| | 2000 | 4.3 | 131 |
| 11 Sa | 0213 | -0.5 | -15 |
| | 0806 | 5.4 | 165 |
| | 1504 | -0.8 | -24 |
| | 2046 | 4.4 | 134 |
| 12 Su | 0300 | -0.6 | -18 |
| | 0853 | 5.4 | 165 |
| | 1549 | -0.8 | -24 |
| | 2137 | 4.4 | 134 |
| 13 M | 0348 | -0.6 | -18 |
| | 0944 | 5.3 | 162 |
| | 1635 | -0.8 | -24 |
| | 2233 | 4.5 | 137 |
| 14 Tu | 0438 | -0.5 | -15 |
| | 1041 | 5.2 | 158 |
| | 1723 | -0.7 | -21 |
| | 2330 | 4.6 | 140 |
| 15 W | 0533 | -0.3 | -9 |
| | 1139 | 4.9 | 149 |
| | 1816 | -0.5 | -15 |
| 16 Th | 0027 | 4.6 | 140 |
| | 0637 | 0.0 | 0 |
| | 1236 | 4.7 | 143 |
| | 1915 | -0.4 | -12 |
| 17 F ◑ | 0123 | 4.7 | 143 |
| | 0747 | 0.1 | 3 |
| | 1335 | 4.4 | 134 |
| | 2016 | -0.3 | -9 |
| 18 Sa | 0220 | 4.7 | 143 |
| | 0855 | 0.1 | 3 |
| | 1436 | 4.1 | 125 |
| | 2116 | -0.2 | -6 |
| 19 Su | 0321 | 4.7 | 143 |
| | 0958 | 0.0 | 0 |
| | 1543 | 4.0 | 122 |
| | 2212 | -0.2 | -6 |
| 20 M | 0424 | 4.8 | 146 |
| | 1056 | -0.1 | -3 |
| | 1650 | 3.9 | 119 |
| | 2306 | -0.2 | -6 |
| 21 Tu | 0523 | 4.9 | 149 |
| | 1150 | -0.3 | -9 |
| | 1750 | 4.0 | 122 |
| | 2358 | -0.2 | -6 |
| 22 W | 0616 | 5.0 | 152 |
| | 1241 | -0.4 | -12 |
| | 1842 | 4.1 | 125 |
| 23 Th | 0048 | -0.2 | -6 |
| | 0703 | 5.1 | 155 |
| | 1330 | -0.5 | -15 |
| | 1929 | 4.2 | 128 |
| 24 F ● | 0136 | -0.2 | -6 |
| | 0746 | 5.1 | 155 |
| | 1415 | -0.5 | -15 |
| | 2013 | 4.2 | 128 |
| 25 Sa | 0221 | -0.2 | -6 |
| | 0828 | 5.0 | 152 |
| | 1458 | -0.5 | -15 |
| | 2057 | 4.2 | 128 |
| 26 Su | 0304 | -0.1 | -3 |
| | 0909 | 4.9 | 149 |
| | 1537 | -0.4 | -12 |
| | 2140 | 4.2 | 128 |
| 27 M | 0344 | 0.0 | 0 |
| | 0951 | 4.7 | 143 |
| | 1615 | -0.3 | -9 |
| | 2224 | 4.1 | 125 |
| 28 Tu | 0423 | 0.2 | 6 |
| | 1033 | 4.5 | 137 |
| | 1651 | -0.1 | -3 |
| | 2306 | 4.0 | 122 |
| 29 W | 0501 | 0.4 | 12 |
| | 1115 | 4.3 | 131 |
| | 1726 | 0.1 | 3 |
| | 2347 | 3.9 | 119 |
| 30 Th | 0541 | 0.6 | 18 |
| | 1156 | 4.0 | 122 |
| | 1801 | 0.4 | 12 |
| 31 F | 0026 | 3.9 | 119 |
| | 0630 | 0.9 | 27 |
| | 1237 | 3.8 | 116 |
| | 1840 | 0.5 | 15 |

### February

| Day | Time (h m) | Height (ft) | Height (cm) |
|---|---|---|---|
| 1 Sa ◐ | 0103 | 3.9 | 119 |
| | 0735 | 1.0 | 30 |
| | 1320 | 3.6 | 110 |
| | 1931 | 0.7 | 21 |
| 2 Su | 0142 | 3.9 | 119 |
| | 0843 | 1.0 | 30 |
| | 1408 | 3.4 | 104 |
| | 2034 | 0.7 | 21 |
| 3 M | 0228 | 4.0 | 122 |
| | 0943 | 0.8 | 24 |
| | 1506 | 3.4 | 104 |
| | 2134 | 0.6 | 18 |
| 4 Tu | 0324 | 4.1 | 125 |
| | 1037 | 0.6 | 18 |
| | 1612 | 3.5 | 107 |
| | 2228 | 0.4 | 12 |
| 5 W | 0427 | 4.4 | 134 |
| | 1128 | 0.3 | 9 |
| | 1714 | 3.7 | 113 |
| | 2321 | 0.2 | 6 |
| 6 Th | 0526 | 4.7 | 143 |
| | 1218 | -0.1 | -3 |
| | 1808 | 4.0 | 122 |
| 7 F | 0013 | -0.1 | -3 |
| | 0618 | 5.0 | 152 |
| | 1307 | -0.4 | -12 |
| | 1855 | 4.3 | 131 |
| 8 Sa | 0105 | -0.5 | -15 |
| | 0706 | 5.3 | 162 |
| | 1355 | -0.7 | -21 |
| | 1942 | 4.6 | 140 |
| 9 Su ○ | 0157 | -0.7 | -21 |
| | 0753 | 5.5 | 168 |
| | 1441 | -1.0 | -30 |
| | 2029 | 4.8 | 146 |
| 10 M | 0247 | -0.9 | -27 |
| | 0841 | 5.6 | 171 |
| | 1527 | -1.1 | -34 |
| | 2118 | 5.0 | 152 |
| 11 Tu | 0336 | -0.9 | -27 |
| | 0932 | 5.5 | 168 |
| | 1612 | -1.1 | -34 |
| | 2212 | 5.0 | 152 |
| 12 W | 0426 | -0.8 | -24 |
| | 1026 | 5.3 | 162 |
| | 1659 | -0.9 | -27 |
| | 2307 | 5.1 | 155 |
| 13 Th | 0519 | -0.6 | -18 |
| | 1123 | 5.0 | 152 |
| | 1748 | -0.6 | -18 |
| 14 F | 0002 | 5.0 | 152 |
| | 0619 | -0.2 | -6 |
| | 1220 | 4.6 | 140 |
| | 1844 | -0.3 | -9 |
| 15 Sa ◑ | 0058 | 4.9 | 149 |
| | 0725 | 0.0 | 0 |
| | 1318 | 4.3 | 131 |
| | 1947 | 0.0 | 0 |
| 16 Su | 0155 | 4.8 | 146 |
| | 0834 | 0.2 | 6 |
| | 1420 | 4.0 | 122 |
| | 2051 | 0.2 | 6 |
| 17 M | 0256 | 4.7 | 143 |
| | 0939 | 0.2 | 6 |
| | 1527 | 3.8 | 116 |
| | 2152 | 0.2 | 6 |
| 18 Tu | 0401 | 4.6 | 140 |
| | 1037 | 0.1 | 3 |
| | 1635 | 3.8 | 116 |
| | 2248 | 0.2 | 6 |
| 19 W | 0505 | 4.6 | 140 |
| | 1131 | 0.0 | 0 |
| | 1737 | 3.9 | 119 |
| | 2341 | 0.1 | 3 |
| 20 Th | 0600 | 4.7 | 143 |
| | 1221 | -0.1 | -3 |
| | 1828 | 4.1 | 125 |
| 21 F | 0030 | 0.1 | 3 |
| | 0647 | 4.9 | 149 |
| | 1307 | -0.2 | -6 |
| | 1913 | 4.3 | 131 |
| 22 Sa | 0117 | 0.0 | 0 |
| | 0729 | 4.9 | 149 |
| | 1351 | -0.3 | -9 |
| | 1954 | 4.4 | 134 |
| 23 Su ● | 0201 | -0.1 | -3 |
| | 0808 | 4.9 | 149 |
| | 1431 | -0.3 | -9 |
| | 2033 | 4.5 | 137 |
| 24 M | 0242 | -0.1 | -3 |
| | 0846 | 4.9 | 149 |
| | 1508 | -0.3 | -9 |
| | 2110 | 4.5 | 137 |
| 25 Tu | 0321 | 0.0 | 0 |
| | 0924 | 4.7 | 143 |
| | 1543 | -0.2 | -6 |
| | 2147 | 4.4 | 134 |
| 26 W | 0358 | 0.1 | 3 |
| | 1001 | 4.5 | 137 |
| | 1615 | 0.0 | 0 |
| | 2222 | 4.3 | 131 |
| 27 Th | 0434 | 0.3 | 9 |
| | 1038 | 4.3 | 131 |
| | 1644 | 0.2 | 6 |
| | 2255 | 4.3 | 131 |
| 28 F | 0509 | 0.5 | 15 |
| | 1116 | 4.1 | 125 |
| | 1709 | 0.4 | 12 |
| | 2326 | 4.2 | 128 |
| 29 Sa | 0545 | 0.7 | 21 |
| | 1155 | 3.8 | 116 |
| | 1735 | 0.6 | 18 |
| | 2359 | 4.2 | 128 |

### March

| Day | Time (h m) | Height (ft) | Height (cm) |
|---|---|---|---|
| 1 Su | 0635 | 0.9 | 27 |
| | 1236 | 3.7 | 113 |
| | 1812 | 0.8 | 24 |
| 2 M ◐ | 0039 | 4.2 | 128 |
| | 0752 | 1.0 | 30 |
| | 1324 | 3.5 | 107 |
| | 1915 | 0.9 | 27 |
| 3 Tu | 0129 | 4.2 | 128 |
| | 0904 | 0.9 | 27 |
| | 1422 | 3.5 | 107 |
| | 2048 | 0.9 | 27 |
| 4 W | 0229 | 4.3 | 131 |
| | 1004 | 0.7 | 21 |
| | 1532 | 3.6 | 110 |
| | 2158 | 0.7 | 21 |
| 5 Th | 0342 | 4.4 | 134 |
| | 1058 | 0.4 | 12 |
| | 1642 | 3.9 | 119 |
| | 2257 | 0.3 | 9 |
| 6 F | 0455 | 4.7 | 143 |
| | 1150 | 0.0 | 0 |
| | 1741 | 4.3 | 131 |
| | 2353 | -0.1 | -3 |
| 7 Sa | 0555 | 5.1 | 155 |
| | 1240 | -0.4 | -12 |
| | 1833 | 4.7 | 143 |
| 8 Su | 0047 | -0.5 | -15 |
| | 0648 | 5.5 | 168 |
| | 1329 | -0.7 | -21 |
| | 1921 | 5.1 | 155 |
| 9 M ○ | 0140 | -0.8 | -24 |
| | 0736 | 5.7 | 174 |
| | 1416 | -1.0 | -30 |
| | 2008 | 5.4 | 165 |
| 10 Tu | 0231 | -1.0 | -30 |
| | 0825 | 5.7 | 174 |
| | 1502 | -1.1 | -34 |
| | 2057 | 5.6 | 171 |
| 11 W | 0321 | -1.1 | -34 |
| | 0916 | 5.6 | 171 |
| | 1547 | -1.0 | -30 |
| | 2148 | 5.6 | 171 |
| 12 Th | 0411 | -0.9 | -27 |
| | 1009 | 5.3 | 162 |
| | 1633 | -0.8 | -24 |
| | 2241 | 5.6 | 171 |
| 13 F | 0503 | -0.7 | -21 |
| | 1106 | 5.0 | 152 |
| | 1722 | -0.5 | -15 |
| | 2337 | 5.4 | 165 |
| 14 Sa | 0600 | -0.3 | -9 |
| | 1204 | 4.6 | 140 |
| | 1816 | 0.0 | 0 |
| 15 Su | 0033 | 5.1 | 155 |
| | 0703 | 0.1 | 3 |
| | 1303 | 4.3 | 131 |
| | 1919 | 0.4 | 12 |
| 16 M ◑ | 0130 | 4.9 | 149 |
| | 0811 | 0.3 | 9 |
| | 1404 | 4.1 | 125 |
| | 2027 | 0.6 | 18 |
| 17 Tu | 0231 | 4.6 | 140 |
| | 0916 | 0.4 | 12 |
| | 1509 | 3.9 | 119 |
| | 2131 | 0.7 | 21 |
| 18 W | 0336 | 4.5 | 137 |
| | 1014 | 0.4 | 12 |
| | 1616 | 3.9 | 119 |
| | 2229 | 0.6 | 18 |
| 19 Th | 0441 | 4.5 | 137 |
| | 1107 | 0.3 | 9 |
| | 1716 | 4.1 | 125 |
| | 2321 | 0.5 | 15 |
| 20 F | 0537 | 4.6 | 140 |
| | 1155 | 0.2 | 6 |
| | 1807 | 4.3 | 131 |
| 21 Sa | 0010 | 0.4 | 12 |
| | 0625 | 4.7 | 143 |
| | 1239 | 0.1 | 3 |
| | 1850 | 4.5 | 137 |
| 22 Su | 0055 | 0.2 | 6 |
| | 0706 | 4.8 | 146 |
| | 1320 | 0.0 | 0 |
| | 1929 | 4.7 | 143 |
| 23 M | 0138 | 0.1 | 3 |
| | 0744 | 4.9 | 149 |
| | 1359 | -0.1 | -3 |
| | 2004 | 4.8 | 146 |
| 24 Tu ● | 0219 | 0.0 | 0 |
| | 0820 | 4.8 | 146 |
| | 1435 | -0.1 | -3 |
| | 2038 | 4.8 | 146 |
| 25 W | 0258 | 0.0 | 0 |
| | 0856 | 4.7 | 143 |
| | 1509 | 0.0 | 0 |
| | 2109 | 4.8 | 146 |
| 26 Th | 0335 | 0.1 | 3 |
| | 0931 | 4.5 | 137 |
| | 1540 | 0.2 | 6 |
| | 2137 | 4.7 | 143 |
| 27 F | 0410 | 0.2 | 6 |
| | 1006 | 4.3 | 131 |
| | 1608 | 0.3 | 9 |
| | 2203 | 4.7 | 143 |
| 28 Sa | 0445 | 0.4 | 12 |
| | 1043 | 4.1 | 125 |
| | 1632 | 0.5 | 15 |
| | 2232 | 4.6 | 140 |
| 29 Su | 0519 | 0.6 | 18 |
| | 1122 | 3.9 | 119 |
| | 1700 | 0.7 | 21 |
| | 2310 | 4.6 | 140 |
| 30 M | 0601 | 0.8 | 24 |
| | 1207 | 3.8 | 116 |
| | 1738 | 0.9 | 27 |
| | 2357 | 4.5 | 137 |
| 31 Tu | 0709 | 0.9 | 27 |
| | 1258 | 3.7 | 113 |
| | 1834 | 1.0 | 30 |

Time meridian 75° W. 0000 is midnight. 1200 is noon. Times are not adjusted for Daylight Saving Time.
Heights are referred to mean lower low water which is the chart datum of soundings.

## TABLE 2. – TIDAL DIFFERENCES AND OTHER CONSTANTS

| No. | PLACE | POSITION Latitude | POSITION Longitude | DIFFERENCES Time High Water | DIFFERENCES Time Low Water | DIFFERENCES Height High Water | DIFFERENCES Height Low Water | RANGES Mean | RANGES Spring | Mean Tide Level |
|---|---|---|---|---|---|---|---|---|---|---|
| | | North | West | h m | h m | ft | ft | ft | ft | ft |
| | NEW YORK<br>Long Island, south shore-cont.<br>Time meridian, 75° W | | | | on Sandy Hook, p.84 | | | | | |
| | *Hempstead Bay-cont.* | | | | | | | | | |
| 1305 | Freeport, Baldwin Bay | 40° 38.0' | 73° 35.2' | +0 37 | +0 55 | *0.64 | *0.65 | 3.0 | 3.6 | 1.6 |
| 1307 | Baldwin, Parsonage Cove | 40° 38.0' | 73° 37.0' | +0 10 | +0 20 | *0.93 | *0.95 | 4.35 | 5.08 | 2.36 |
| 1309 | Long Beach (Inside) | 40° 36' | 73° 39' | +0 18 | +0 02 | *0.84 | *0.85 | 3.9 | 4.7 | 2.1 |
| 1311 | Long Beach, Bridgewater Yacht Club | 40° 35.7' | 73° 39.3' | +0 06 | +0 08 | *0.94 | *0.89 | 4.43 | 5.14 | 2.39 |
| 1313 | Bay Park, Hewlett Bay | 40° 37.7' | 73° 40.1' | +0 20 | +0 25 | *0.99 | *1.00 | 4.63 | 5.33 | 2.51 |
| 1315 | Woodmere, Brosewere Bay | 40° 37' | 73° 42' | +0 34 | +0 50 | *0.84 | *0.85 | 3.9 | 4.7 | 2.1 |
| 1317 | East Rockaway Inlet, Atlantic Beach | 40° 35.6' | 73° 44.4' | -0 05 | -0 21 | *0.93 | *1.00 | 4.37 | 5.16 | 2.38 |
| | *Jamaica Bay* | | | | | | | | | |
| 1319 | Kingsborough, Sheepshead Bay | 40° 34.9' | 73° 56.0' | +0 05 | -0 03 | *1.05 | *1.11 | 4.92 | 5.82 | 2.67 |
| 1321 | Plumb Beach Channel | 40° 35.1' | 73° 55.5' | +0 02 | -0 03 | *1.05 | *1.05 | 4.9 | 5.9 | 2.6 |
| 1323 | Barren Island, Rockaway Inlet | 40° 34.7' | 73° 53.3' | -0 01 | -0 04 | *1.07 | *1.05 | 5.0 | 6.0 | 2.7 |
| 1325 | Beach Channel (bridge) | 40° 35' | 73° 49' | +0 37 | +0 24 | *1.09 | *1.10 | 5.1 | 6.2 | 2.7 |
| 1327 | Motts Basin | 40° 37.0' | 73° 45.5' | +0 39 | +0 48 | *1.16 | *1.15 | 5.4 | 6.5 | 2.9 |
| 1329 | Norton Point, Hook Creek | 40° 38.1' | 73° 44.8' | +0 38 | +0 45 | *1.16 | *1.16 | 5.4 | 6.5 | 2.9 |
| 1331 | J.F.K. International Airport | 40° 37.4' | 73° 47.0' | +0 25 | +0 45 | *1.14 | *1.15 | 5.3 | 6.4 | 2.8 |
| 1333 | North Channel Bridge, Grassy Bay | 40° 38.7' | 73° 50.2' | +0 21 | +0 27 | *1.18 | *1.16 | 5.56 | 6.42 | 3.01 |
| 1335 | Canarsie | 40° 37.8' | 73° 53.1' | +0 27 | +0 08 | *1.12 | *1.10 | 5.2 | 6.3 | 2.8 |
| 1337 | Mill Basin | 40° 37' | 73° 55' | +0 28 | +0 04 | *1.12 | *1.10 | 5.2 | 6.3 | 2.8 |
| | NEW YORK and NEW JERSEY<br>New York Harbor | | | | | | | | | |
| 1339 | Coney Island | 40° 34' | 73° 59' | -0 04 | -0 17 | *1.01 | *1.00 | 4.7 | 5.7 | 2.5 |
| 1341 | Norton Point, Gravesend Bay | 40° 35.4' | 73° 59.9' | -0 01 | +0 03 | *1.02 | *1.15 | 4.7 | 5.7 | 2.6 |
| 1343 | Fort Wadsworth, The Narrows | 40° 36.4' | 74° 03.3' | +0 06 | +0 06 | *0.98 | *1.05 | 4.8 | 5.4 | 2.5 |
| 1345 | Fort Hamilton, The Narrows | 40° 36.5' | 74° 02.1' | +0 02 | +0 07 | *1.01 | *1.00 | 4.7 | 5.7 | 2.5 |
| 1347 | U.S. Coast Guard Station, Staten Island | 40° 36.7' | 74° 03.6' | +0 12 | +0 11 | *0.96 | *1.05 | 4.47 | 5.35 | 2.43 |
| | | | | | on New York, p.72 | | | | | |
| 1349 | St. George, Staten Island | 40° 38.6' | 74° 04.4' | -0 17 | -0 15 | *0.99 | *0.99 | 4.5 | 5.4 | 2.4 |
| 1351 | Gowanus Bay | 40° 39.9' | 74° 00.8' | -0 18 | -0 12 | *1.03 | *0.95 | 4.7 | 5.7 | 2.6 |
| 1353 | NEW YORK (The Battery) | 40° 42.0' | 74° 00.9' | | *Daily Predictions* | | | 4.53 | 5.50 | 2.47 |
| | Hudson River <8> | | | | | | | | | |
| 1355 | Weehawken, Union City, N.J. | 40° 45.9' | 74° 01.1' | +0 13 | +0 15 | *0.96 | *0.96 | 4.37 | 5.29 | 2.41 |
| 1357 | Edgewater, N.J. | 40° 48.8' | 73° 58.7' | +0 31 | +0 28 | *0.93 | *0.93 | 4.24 | 5.13 | 2.33 |
| 1359 | Dyckman Street, Ferry Slip, N.Y. | 40° 52.0' | 73° 56.0' | +0 51 | +0 44 | *0.88 | *0.81 | 3.98 | 4.66 | 2.16 |
| 1361 | Spuyten Duyvil Creek ent., N.Y. | 40° 52.7' | 73° 55.5' | +0 52 | +0 48 | *0.84 | *0.84 | 3.85 | 4.66 | 2.20 |
| 1363 | Riverdale, N.Y. | 40° 54.2' | 73° 54.9' | +0 48 | +0 49 | *0.85 | *0.85 | 3.86 | 4.67 | 2.13 |
| 1365 | Alpine, N.J. | 40° 56.7' | 73° 55.1' | +1 05 | +1 02 | *0.83 | *0.90 | 3.75 | 4.54 | 2.06 |
| 1367 | Tarrytown | 41° 04.7' | 73° 52.2' | +1 49 | +1 57 | *0.70 | *0.70 | 3.2 | 3.7 | 1.8 |
| 1369 | Haverstraw | 41° 13.1' | 73° 57.8' | +2 15 | +2 42 | *0.72 | *0.81 | 3.23 | 3.91 | 1.78 |
| 1371 | Peekskill | 41° 17' | 73° 56' | +2 28 | +3 03 | *0.64 | *0.64 | 2.9 | 3.4 | 1.8 |
| 1373 | Newburgh | 41° 30.0' | 74° 00.4' | +3 46 | +4 03 | *0.62 | *0.64 | 2.8 | 3.2 | 1.5 |
| 1375 | Beacon | 41° 30.3' | 73° 58.2' | +3 37 | +3 49 | *0.70 | *0.90 | 3.13 | 3.68 | 1.75 |
| 1377 | New Hamburg | 41° 35' | 73° 57' | +4 04 | +4 28 | *0.64 | *0.64 | 2.9 | 3.3 | 1.6 |
| 1379 | Poughkeepsie | 41° 42' | 73° 57' | +4 34 | +4 46 | *0.68 | *0.68 | 3.1 | 3.5 | 1.7 |
| 1381 | Hyde Park | 41° 47.2' | 73° 57.8' | +5 00 | +5 12 | *0.70 | *0.68 | 3.2 | 3.6 | 1.8 |
| 1383 | Kingston | 41° 55' | 73° 59' | +5 20 | +5 34 | *0.81 | *0.82 | 3.7 | 4.2 | 2.0 |
| 1385 | Turkey Point | 42° 00.8' | 73° 56.3' | +5 29 | +5 47 | *0.87 | *1.00 | 3.90 | 4.50 | 2.17 |
| 1387 | Tivoli | 42° 04' | 73° 56' | +5 50 | +6 04 | *0.86 | *0.86 | 3.9 | 4.4 | 1.9 |
| 1389 | Hudson | 42° 15' | 73° 48' | +6 58 | +7 12 | *0.88 | *0.86 | 4.0 | 4.4 | 2.2 |
| | | | | | on Albany, p.80 | | | | | |
| 1391 | Castleton | 42° 32' | 73° 46' | -0 17 | -0 29 | -0.2 | +0.1 | 4.3 | 4.7 | 2.2 |
| 1393 | ALBANY | 42° 39.0' | 73° 44.8' | | *Daily predictions* | | | 4.6 | 5.0 | 2.5 |
| 1395 | Troy | 42° 44' | 73° 42' | +0 08 | +0 10 | *1.00 | *1.00 | 4.7 | 5.1 | 2.3 |
| | The Kills and Newark Bay | | | | on New York, p.72 | | | | | |
| | *Kill Van Kull* | | | | | | | | | |
| 1397 | Constable Hook | 40° 39.3' | 74° 05.2' | -0 18 | -0 08 | *1.02 | *1.02 | 4.63 | 5.60 | 2.54 |
| 1399 | BAYONNE BRIDGE, STATEN ISLAND | 40° 38.4' | 74° 08.8' | | *Daily predictions, p.76* | | | 4.98 | 5.52 | 2.70 |
| 1401 | Port Elizabeth | 40° 40.4' | 74° 08.4' | -0 02 | +0 13 | *1.11 | *0.95 | 5.05 | 6.11 | 2.73 |
| 1403 | Port Newark Terminal | 40° 41' | 74° 08' | +0 03 | +0 21 | *1.12 | *1.12 | 5.1 | 6.1 | 2.7 |
| | *Passaic River* | | | | | | | | | |
| 1405 | Point No Point | 40° 43.9' | 74° 07.0' | +0 00 | +0 22 | *1.15 | *1.04 | 5.21 | 6.30 | 2.83 |
| 1407 | Belleville | 40° 47.2' | 74° 08.8' | +0 09 | +0 49 | *1.23 | *1.19 | 5.60 | 6.78 | 3.08 |
| 1409 | East Rutherford | 40° 50.8' | 74° 07.2' | +0 09 | +1 06 | *1.29 | *1.29 | 5.87 | 7.10 | 3.20 |
| 1411 | Garfield | 40° 52.1' | 74° 06.7' | +0 08 | - - - | - - - | - - - | - - | - - | - - |
| | *Hackensack River* | | | | | | | | | |
| 1413 | Kearny Point | 40° 43.7' | 74° 06.2' | +0 11 | +0 22 | *1.15 | *1.14 | 5.21 | 6.30 | 2.85 |
| 1415 | Amtrak RR. swing bridge | 40° 45.1' | 74° 05.8' | +0 33 | +0 39 | *1.16 | *1.10 | 5.27 | 6.38 | 2.87 |
| 1417 | Fish Creek, Berrys Creek | 40° 47.6' | 74° 05.5' | +1 02 | +1 00 | *1.16 | *1.00 | 5.31 | 6.43 | 2.86 |
| 1419 | Carlstadt, Garretts Reach | 40° 48.4' | 74° 03.6' | +0 59 | +0 45 | *1.26 | *1.29 | 5.71 | 6.29 | 3.12 |
| 1421 | North Secaucus, Garretts Reach | 40° 48.4' | 74° 02.6' | +0 57 | +0 57 | *1.23 | *1.23 | 5.61 | 6.79 | 3.06 |
| 1423 | Mill Creek, 0.8 n.mi. above entrance | 40° 47.9' | 74° 03.0' | +1 34 | - - - | - - - | - - - | - - | - - | - - |
| 1425 | Cromakill Creek, N.J. Turnpike | 40° 48.2' | 74° 02.0' | +1 00 | - - - | - - - | - - - | - - | - - | - - |

Endnotes can be found at the end of table 2.

# TABLE 3.—HEIGHT OF TIDE AT ANY TIME

| Duration of rise or fall, see footnote | Time from the nearest high water or low water | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* | *h. m.* |
| **4 10** | 0 08 | 0 16 | 0 24 | 0 32 | 0 40 | 0 48 | 0 56 | 1 04 | 1 12 | 1 20 | 1 28 | 1 36 | 1 44 | 1 52 | 2 00 |
| **4 20** | 0 09 | 0 17 | 0 26 | 0 35 | 0 43 | 0 52 | 1 01 | 1 09 | 1 18 | 1 27 | 1 35 | 1 44 | 1 53 | 2 01 | 2 10 |
| **4 40** | 0 09 | 0 19 | 0 28 | 0 37 | 0 47 | 0 56 | 1 05 | 1 15 | 1 24 | 1 33 | 1 43 | 1 52 | 2 01 | 2 11 | 2 20 |
| **5 00** | 0 10 | 0 20 | 0 30 | 0 40 | 0 50 | 1 00 | 1 10 | 1 20 | 1 30 | 1 40 | 1 50 | 2 00 | 2 10 | 2 20 | 2 30 |
| **5 20** | 0 11 | 0 21 | 0 32 | 0 43 | 0 53 | 1 04 | 1 15 | 1 25 | 1 36 | 1 47 | 1 57 | 2 08 | 2 19 | 2 29 | 2 40 |
| **5 40** | 0 11 | 0 23 | 0 34 | 0 45 | 0 57 | 1 08 | 1 19 | 1 31 | 1 42 | 1 53 | 2 05 | 2 16 | 2 27 | 2 39 | 2 50 |
| **6 00** | 0 12 | 0 24 | 0 36 | 0 48 | 1 00 | 1 12 | 1 24 | 1 36 | 1 48 | 2 00 | 2 12 | 2 24 | 2 36 | 2 48 | 3 00 |
| **6 20** | 0 13 | 0 25 | 0 38 | 0 51 | 1 03 | 1 16 | 1 29 | 1 41 | 1 54 | 2 07 | 2 19 | 2 32 | 2 45 | 2 57 | 3 10 |
| **6 40** | 0 13 | 0 27 | 0 40 | 0 53 | 1 07 | 1 20 | 1 33 | 1 47 | 2 00 | 2 13 | 2 27 | 2 40 | 2 53 | 3 07 | 3 20 |
| **7 00** | 0 14 | 0 28 | 0 42 | 0 56 | 1 10 | 1 24 | 1 38 | 1 52 | 2 06 | 2 20 | 2 34 | 2 48 | 3 02 | 3 16 | 3 30 |
| **7 20** | 0 15 | 0 29 | 0 44 | 0 59 | 1 13 | 1 28 | 1 43 | 1 57 | 2 12 | 2 27 | 2 41 | 2 56 | 3 11 | 3 25 | 3 40 |
| **7 40** | 0 15 | 0 31 | 0 46 | 1 01 | 1 17 | 1 32 | 1 47 | 2 03 | 2 18 | 2 33 | 2 49 | 3 04 | 3 19 | 3 35 | 3 50 |
| **8 00** | 0 16 | 0 32 | 0 48 | 1 04 | 1 20 | 1 36 | 1 52 | 2 08 | 2 24 | 2 40 | 2 56 | 3 12 | 3 28 | 3 44 | 4 00 |
| **8 20** | 0 17 | 0 33 | 0 50 | 1 07 | 1 23 | 1 40 | 1 57 | 2 13 | 2 30 | 2 47 | 3 03 | 3 20 | 3 37 | 3 53 | 4 10 |
| **8 40** | 0 17 | 0 35 | 0 52 | 1 09 | 1 27 | 1 44 | 2 01 | 2 19 | 2 36 | 2 53 | 3 11 | 3 28 | 3 45 | 4 03 | 4 20 |
| **9 00** | 0 18 | 0 36 | 0 54 | 1 12 | 1 30 | 1 48 | 2 06 | 2 24 | 2 42 | 3 00 | 3 18 | 3 36 | 3 54 | 4 12 | 4 30 |
| **9 20** | 0 19 | 0 37 | 0 56 | 1 15 | 1 33 | 1 52 | 2 11 | 2 29 | 2 48 | 3 07 | 3 25 | 3 44 | 4 03 | 4 21 | 4 40 |
| **9 40** | 0 19 | 0 39 | 0 58 | 1 17 | 1 37 | 1 56 | 2 15 | 2 35 | 2 54 | 3 13 | 3 33 | 3 52 | 4 11 | 4 31 | 4 50 |
| **10 00** | 0 20 | 0 40 | 1 00 | 1 20 | 1 40 | 2 00 | 2 20 | 2 40 | 3 00 | 3 20 | 3 40 | 4 00 | 4 20 | 4 40 | 5 00 |
| **10 20** | 0 21 | 0 41 | 1 02 | 1 23 | 1 43 | 2 04 | 2 25 | 2 45 | 3 06 | 3 27 | 3 47 | 4 08 | 4 29 | 4 49 | 5 10 |
| **10 40** | 0 21 | 0 43 | 1 04 | 1 25 | 1 47 | 2 08 | 2 29 | 2 51 | 3 12 | 3 33 | 3 55 | 4 16 | 4 37 | 4 59 | 5 20 |

| Range of tide, see footnote | Correction to height | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* | *Ft.* |
| **0.5** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| **1.0** | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 |
| **1.5** | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| **2.0** | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| **2.5** | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 | 1.2 |
| **3.0** | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.5 |
| **3.5** | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 |
| **4.0** | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| **4.5** | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.9 | 1.1 | 1.3 | 1.6 | 1.8 | 2.0 | 2.2 |
| **5.0** | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 1.0 | 1.2 | 1.5 | 1.7 | 2.0 | 2.2 | 2.5 |
| **5.5** | 0.0 | 0.1 | 0.1 | 0.2 | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 | 1.4 | 1.6 | 1.9 | 2.2 | 2.5 | 2.8 |
| **6.0** | 0.0 | 0.1 | 0.1 | 0.3 | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0 |
| **6.5** | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 | 0.8 | 1.1 | 1.3 | 1.6 | 1.9 | 2.2 | 2.6 | 2.9 | 3.2 |
| **7.0** | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.7 | 0.9 | 1.2 | 1.4 | 1.8 | 2.1 | 2.4 | 2.8 | 3.1 | 3.5 |
| **7.5** | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.7 | 1.0 | 1.2 | 1.5 | 1.9 | 2.2 | 2.6 | 3.0 | 3.4 | 3.8 |
| **8.0** | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.8 | 1.0 | 1.3 | 1.6 | 2.0 | 2.4 | 2.8 | 3.2 | 3.6 | 4.0 |
| **8.5** | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 0.8 | 1.1 | 1.4 | 1.8 | 2.1 | 2.5 | 2.9 | 3.4 | 3.8 | 4.2 |
| **9.0** | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 0.9 | 1.2 | 1.5 | 1.9 | 2.2 | 2.7 | 3.1 | 3.6 | 4.0 | 4.5 |
| **9.5** | 0.0 | 0.1 | 0.2 | 0.4 | 0.6 | 0.9 | 1.2 | 1.6 | 2.0 | 2.4 | 2.8 | 3.3 | 3.8 | 4.3 | 4.8 |
| **10.0** | 0.0 | 0.1 | 0.2 | 0.4 | 0.7 | 1.0 | 1.3 | 1.7 | 2.1 | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
| **10.5** | 0.0 | 0.1 | 0.3 | 0.5 | 0.7 | 1.0 | 1.3 | 1.7 | 2.2 | 2.6 | 3.1 | 3.6 | 4.2 | 4.7 | 5.2 |
| **11.0** | 0.0 | 0.1 | 0.3 | 0.5 | 0.7 | 1.1 | 1.4 | 1.7 | 2.3 | 2.8 | 3.3 | 3.8 | 4.4 | 4.9 | 5.5 |
| **11.5** | 0.0 | 0.1 | 0.3 | 0.5 | 0.8 | 1.1 | 1.5 | 1.8 | 2.3 | 2.9 | 3.4 | 4.0 | 4.6 | 5.1 | 5.8 |
| **12.0** | 0.0 | 0.1 | 0.3 | 0.5 | 0.8 | 1.1 | 1.5 | 1.9 | 2.5 | 3.0 | 3.6 | 4.1 | 4.8 | 5.4 | 6.0 |
| **12.5** | 0.0 | 0.1 | 0.3 | 0.5 | 0.8 | 1.2 | 2.6 | 1.9 | 2.6 | 3.1 | 3.7 | 4.3 | 5.0 | 5.6 | 6.2 |
| **13.0** | 0.0 | 0.1 | 0.3 | 0.6 | 0.9 | 1.2 | 1.7 | 2.2 | 2.7 | 3.2 | 3.9 | 4.5 | 5.1 | 5.8 | 6.5 |
| **13.5** | 0.0 | 0.1 | 0.3 | 0.6 | 0.9 | 1.3 | 1.7 | 2.2 | 2.8 | 3.4 | 4.0 | 4.7 | 5.3 | 6.0 | 6.8 |
| **14.0** | 0.0 | 0.2 | 0.3 | 0.6 | 0.9 | 1.3 | 1.8 | 2.3 | 2.9 | 3.5 | 4.2 | 4.8 | 5.5 | 6.3 | 7.0 |
| **14.5** | 0.0 | 0.2 | 0.4 | 0.6 | 1.0 | 1.4 | 1.9 | 2.4 | 3.0 | 3.6 | 4.3 | 5.0 | 5.7 | 6.5 | 7.2 |
| **15.0** | 0.0 | 0.2 | 0.4 | 0.6 | 1.0 | 1.4 | 1.9 | 2.5 | 3.1 | 3.8 | 4.4 | 5.2 | 5.9 | 6.7 | 7.5 |
| **15.5** | 0.0 | 0.2 | 0.4 | 0.7 | 1.0 | 1.5 | 2.0 | 2.6 | 3.2 | 3.9 | 4.6 | 5.4 | 6.1 | 6.9 | 7.8 |
| **16.0** | 0.0 | 0.2 | 0.4 | 0.7 | 1.1 | 1.5 | 2.1 | 2.6 | 3.3 | 4.0 | 4.7 | 5.5 | 6.3 | 7.2 | 8.0 |
| **16.5** | 0.0 | 0.2 | 0.4 | 0.7 | 1.1 | 1.6 | 2.1 | 2.7 | 3.4 | 4.1 | 4.9 | 5.7 | 6.5 | 7.4 | 8.2 |
| **17.0** | 0.0 | 0.2 | 0.4 | 0.7 | 1.1 | 1.6 | 2.2 | 2.8 | 3.5 | 4.2 | 5.0 | 5.9 | 6.7 | 7.6 | 8.5 |
| **17.5** | 0.0 | 0.2 | 0.4 | 0.8 | 1.2 | 1.7 | 2.2 | 2.9 | 3.6 | 4.4 | 5.2 | 6.0 | 6.9 | 7.8 | 8.8 |
| **18.0** | 0.0 | 0.2 | 0.4 | 0.8 | 1.2 | 1.7 | 2.3 | 3.0 | 3.7 | 4.5 | 5.3 | 6.2 | 7.1 | 8.1 | 9.0 |
| **18.5** | 0.1 | 0.2 | 0.5 | 0.8 | 1.2 | 1.8 | 2.4 | 3.1 | 3.8 | 4.6 | 5.5 | 6.4 | 7.3 | 8.3 | 9.2 |
| **19.0** | 0.1 | 0.2 | 0.5 | 0.8 | 1.3 | 1.8 | 2.4 | 3.1 | 3.9 | 4.8 | 5.6 | 6.6 | 7.5 | 8.5 | 9.5 |
| **19.5** | 0.1 | 0.2 | 0.5 | 0.8 | 1.3 | 1.9 | 2.5 | 3.2 | 4.0 | 4.9 | 5.8 | 6.7 | 7.7 | 8.7 | 9.8 |
| **20.0** | 0.1 | 0.2 | 0.5 | 0.9 | 1.3 | 1.9 | 2.6 | 3.3 | 4.1 | 5.0 | 5.9 | 6.9 | 7.9 | 9.0 | 10.0 |

Obtain from the predictions the high water and low water, one of which is before and the other after the time for which the height is required. The difference between the times of occurrence of these tides is the duration of rise or fall, and the difference between their heights is the range of tide for the above table. Find the difference between the nearest high or low water and the time for which the height is required.

Enter the table with the duration of rise or fall, printed in heavy-faced type, which most nearly agrees with the actual value, and on that horizontal line find the time from the nearest high or low water which agrees most nearly with the corresponding actual difference. The correction sought is in the column directly below, on the line with the range of tide.

When the nearest tide is high water, subtract the correction.

When the nearest tide is low, add the correction.

## The Narrows, New York Harbor, New York, 2020

F–Flood, Dir. 336° True  E–Ebb, Dir. 164° True

### January

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 W | 0223 | 0539 | 1.4E |
| | 0857 | 1155 | 1.3F |
| | 1434 | 1756 | 1.6E |
| | 2135 | | |
| 2 Th ◐ | | 0035 | 1.2F |
| | 0314 | 0642 | 1.4E |
| | 0955 | 1243 | 1.3F |
| | 1524 | 1852 | 1.6E |
| | 2220 | | |
| 3 F | | 0112 | 1.3F |
| | 0405 | 0739 | 1.5E |
| | 1049 | 1328 | 1.3F |
| | 1615 | 1943 | 1.6E |
| | 2302 | | |
| 4 Sa | | 0146 | 1.3F |
| | 0457 | 0832 | 1.6E |
| | 1141 | 1415 | 1.3F |
| | 1707 | 2032 | 1.7E |
| | 2343 | | |
| 5 Su | | 0226 | 1.4F |
| | 0547 | 0921 | 1.7E |
| | 1231 | 1508 | 1.3F |
| | 1758 | 2119 | 1.8E |
| 6 M | 0024 | 0311 | 1.5F |
| | 0634 | 1006 | 1.9E |
| | 1319 | 1602 | 1.3F |
| | 1846 | 2203 | 1.8E |
| 7 Tu | 0105 | 0357 | 1.7F |
| | 0718 | 1047 | 2.0E |
| | 1406 | 1649 | 1.4F |
| | 1933 | 2245 | 1.9E |
| 8 W | 0146 | 0441 | 1.9F |
| | 0759 | 1126 | 2.2E |
| | 1451 | 1730 | 1.5F |
| | 2018 | 2326 | 2.0E |
| 9 Th | 0229 | 0522 | 2.0F |
| | 0840 | 1205 | 2.2E |
| | 1534 | 1809 | 1.6F |
| | 2102 | | |
| 10 F ○ | | 0008 | 2.0E |
| | 0312 | 0603 | 2.1F |
| | 0921 | 1246 | 2.3E |
| | 1616 | 1849 | 1.6F |
| | 2147 | | |
| 11 Sa | | 0052 | 2.0E |
| | 0357 | 0647 | 2.1F |
| | 1004 | 1329 | 2.2E |
| | 1658 | 1933 | 1.6F |
| | 2233 | | |
| 12 Su | | 0140 | 1.9E |
| | 0443 | 0735 | 2.0F |
| | 1050 | 1413 | 2.2E |
| | 1743 | 2021 | 1.6F |
| | 2322 | | |
| 13 M | | 0228 | 1.9E |
| | 0534 | 0826 | 1.8F |
| | 1140 | 1457 | 2.1E |
| | 1831 | 2112 | 1.5F |
| 14 Tu | 0013 | 0315 | 1.8E |
| | 0630 | 0922 | 1.7F |
| | 1232 | 1542 | 2.0E |
| | 1923 | 2206 | 1.5F |
| 15 W | 0106 | 0405 | 1.8E |
| | 0732 | 1021 | 1.6F |
| | 1325 | 1631 | 1.8E |
| | 2017 | 2303 | 1.5F |
| 16 Th | 0200 | 0503 | 1.6E |
| | 0837 | 1122 | 1.4F |
| | 1418 | 1730 | 1.7E |
| | 2112 | 2359 | 1.5F |
| 17 F ◑ | 0255 | 0612 | 1.6E |
| | 0943 | 1221 | 1.3F |
| | 1512 | 1837 | 1.6E |
| | 2207 | | |
| 18 Sa | | 0052 | 1.5F |
| | 0354 | 0723 | 1.5E |
| | 1048 | 1318 | 1.2F |
| | 1610 | 1943 | 1.6E |
| | 2302 | | |
| 19 Su | | 0145 | 1.5F |
| | 0457 | 0831 | 1.6E |
| | 1151 | 1420 | 1.1F |
| | 1713 | 2045 | 1.6E |
| | 2356 | | |
| 20 M | | 0246 | 1.5F |
| | 0559 | 0932 | 1.6E |
| | 1252 | 1539 | 1.1F |
| | 1816 | 2143 | 1.6E |
| 21 Tu | 0050 | 0355 | 1.5F |
| | 0657 | 1026 | 1.7E |
| | 1351 | 1649 | 1.2F |
| | 1915 | 2236 | 1.7E |
| 22 W | 0142 | 0454 | 1.6F |
| | 0749 | 1114 | 1.8E |
| | 1445 | 1743 | 1.2F |
| | 2010 | 2324 | 1.7E |
| 23 Th | 0233 | 0541 | 1.6F |
| | 0836 | 1158 | 1.9E |
| | 1533 | 1829 | 1.3F |
| | 2100 | | |
| 24 F ● | | 0011 | 1.7E |
| | 0321 | 0622 | 1.6F |
| | 0920 | 1242 | 1.9E |
| | 1616 | 1913 | 1.3F |
| | 2146 | | |
| 25 Sa | | 0058 | 1.7E |
| | 0405 | 0702 | 1.6F |
| | 1003 | 1325 | 1.9E |
| | 1658 | 1955 | 1.3F |
| | 2231 | | |
| 26 Su | | 0145 | 1.6E |
| | 0449 | 0743 | 1.5F |
| | 1046 | 1407 | 1.9E |
| | 1739 | 2034 | 1.2F |
| | 2316 | | |
| 27 M | | 0229 | 1.6E |
| | 0534 | 0827 | 1.5F |
| | 1130 | 1448 | 1.8E |
| | 1821 | 2112 | 1.1F |
| 28 Tu | 0002 | 0312 | 1.5E |
| | 0622 | 0914 | 1.4F |
| | 1216 | 1527 | 1.8E |
| | 1904 | 2151 | 1.1F |
| 29 W | 0048 | 0355 | 1.5E |
| | 0714 | 1004 | 1.3F |
| | 1303 | 1608 | 1.7E |
| | 1947 | 2233 | 1.2F |
| 30 Th | 0133 | 0441 | 1.5E |
| | 0808 | 1056 | 1.3F |
| | 1348 | 1652 | 1.7E |
| | 2031 | 2317 | 1.2F |
| 31 F | 0219 | 0535 | 1.5E |
| | 0903 | 1146 | 1.3F |
| | 1434 | 1744 | 1.6E |
| | 2115 | | |

### February

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 Sa ◐ | | 0000 | 1.4F |
| | 0306 | 0635 | 1.5E |
| | 0959 | 1233 | 1.3F |
| | 1522 | 1839 | 1.6E |
| | 2201 | | |
| 2 Su | | 0043 | 1.5F |
| | 0357 | 0734 | 1.6E |
| | 1054 | 1321 | 1.3F |
| | 1614 | 1935 | 1.7E |
| | 2248 | | |
| 3 M | | 0128 | 1.6F |
| | 0451 | 0830 | 1.7E |
| | 1148 | 1413 | 1.3F |
| | 1711 | 2031 | 1.7E |
| | 2337 | | |
| 4 Tu | | 0218 | 1.7F |
| | 0546 | 0923 | 1.9E |
| | 1241 | 1512 | 1.3F |
| | 1808 | 2125 | 1.8E |
| 5 W | 0026 | 0313 | 1.8F |
| | 0639 | 1012 | 2.1E |
| | 1332 | 1613 | 1.5F |
| | 1903 | 2216 | 1.9E |
| 6 Th | 0116 | 0409 | 1.9F |
| | 0728 | 1057 | 2.2E |
| | 1421 | 1704 | 1.6F |
| | 1954 | 2304 | 2.1E |
| 7 F | 0206 | 0500 | 2.1F |
| | 0816 | 1141 | 2.4E |
| | 1507 | 1748 | 1.8F |
| | 2043 | 2350 | 2.2E |
| 8 Sa | 0256 | 0548 | 2.2F |
| | 0902 | 1224 | 2.4E |
| | 1551 | 1831 | 1.9F |
| | 2129 | | |
| 9 Su ○ | | 0037 | 2.2E |
| | 0345 | 0634 | 2.2F |
| | 0948 | 1310 | 2.4E |
| | 1634 | 1915 | 1.9F |
| | 2215 | | |
| 10 M | | 0126 | 2.2E |
| | 0434 | 0723 | 2.1F |
| | 1036 | 1355 | 2.3E |
| | 1718 | 2001 | 1.8F |
| | 2303 | | |
| 11 Tu | | 0214 | 2.2E |
| | 0525 | 0815 | 2.0F |
| | 1125 | 1441 | 2.2E |
| | 1804 | 2050 | 1.8F |
| | 2353 | | |
| 12 W | | 0302 | 2.1E |
| | 0619 | 0909 | 1.8F |
| | 1216 | 1526 | 2.1E |
| | 1854 | 2143 | 1.7F |
| 13 Th | 0046 | 0351 | 2.0E |
| | 0719 | 1007 | 1.6F |
| | 1308 | 1614 | 1.9E |
| | 1948 | 2240 | 1.6F |
| 14 F | 0141 | 0446 | 1.8E |
| | 0823 | 1109 | 1.5F |
| | 1400 | 1709 | 1.7E |
| | 2045 | 2339 | 1.6F |
| 15 Sa ◑ | 0236 | 0553 | 1.6E |
| | 0930 | 1212 | 1.3F |
| | 1455 | 1816 | 1.6E |
| | 2144 | | |
| 16 Su | | 0036 | 1.5F |
| | 0335 | 0708 | 1.5E |
| | 1039 | 1314 | 1.1F |
| | 1554 | 1927 | 1.5E |
| | 2245 | | |
| 17 M | | 0134 | 1.4F |
| | 0440 | 0822 | 1.5E |
| | 1145 | 1425 | 1.0F |
| | 1702 | 2037 | 1.4E |
| | 2345 | | |
| 18 Tu | | 0242 | 1.3F |
| | 0547 | 0929 | 1.5E |
| | 1249 | 1547 | 1.0F |
| | 1812 | 2141 | 1.4E |
| 19 W | 0044 | 0400 | 1.3F |
| | 0649 | 1026 | 1.6E |
| | 1350 | 1653 | 1.1F |
| | 1917 | 2236 | 1.5E |
| 20 Th | 0140 | 0500 | 1.4F |
| | 0743 | 1112 | 1.7E |
| | 1443 | 1745 | 1.2F |
| | 2012 | 2324 | 1.5E |
| 21 F | 0232 | 0548 | 1.5F |
| | 0829 | 1154 | 1.8E |
| | 1527 | 1830 | 1.3F |
| | 2058 | | |
| 22 Sa | | 0008 | 1.6E |
| | 0318 | 0627 | 1.5F |
| | 0909 | 1231 | 1.8E |
| | 1605 | 1908 | 1.3F |
| | 2137 | | |
| 23 Su ● | | 0049 | 1.6E |
| | 0358 | 0700 | 1.5F |
| | 0947 | 1307 | 1.8E |
| | 1638 | 1940 | 1.2F |
| | 2212 | | |
| 24 M | | 0128 | 1.6E |
| | 0435 | 0728 | 1.4F |
| | 1023 | 1341 | 1.7E |
| | 1708 | 1958 | 1.1F |
| | 2246 | | |
| 25 Tu | | 0205 | 1.6E |
| | 0511 | 0758 | 1.4F |
| | 1100 | 1415 | 1.7E |
| | 1737 | 2016 | 1.1F |
| | 2322 | | |
| 26 W | | 0239 | 1.6E |
| | 0549 | 0834 | 1.3F |
| | 1138 | 1447 | 1.7E |
| | 1809 | 2047 | 1.2F |
| 27 Th | 0001 | 0313 | 1.6E |
| | 0632 | 0916 | 1.3F |
| | 1219 | 1521 | 1.7E |
| | 1845 | 2127 | 1.3F |
| 28 F | 0043 | 0349 | 1.6E |
| | 0720 | 1002 | 1.3F |
| | 1302 | 1559 | 1.7E |
| | 1926 | 2213 | 1.4F |
| 29 Sa | 0127 | 0431 | 1.6E |
| | 0814 | 1054 | 1.3F |
| | 1347 | 1643 | 1.7E |
| | 2012 | 2303 | 1.5F |

### March

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 Su | 0214 | 0524 | 1.6E |
| | 0911 | 1147 | 1.3F |
| | 1435 | 1737 | 1.7E |
| | 2103 | 2355 | 1.6F |
| 2 M ◐ | 0304 | 0630 | 1.6E |
| | 1010 | 1239 | 1.3F |
| | 1529 | 1841 | 1.6E |
| | 2158 | | |
| 3 Tu | | 0046 | 1.7F |
| | 0400 | 0737 | 1.7E |
| | 1108 | 1333 | 1.3F |
| | 1630 | 1947 | 1.7E |
| | 2256 | | |
| 4 W | | 0139 | 1.7F |
| | 0500 | 0840 | 1.9E |
| | 1204 | 1431 | 1.4F |
| | 1734 | 2051 | 1.8E |
| | 2353 | | |
| 5 Th | | 0237 | 1.8F |
| | 0601 | 0937 | 2.1E |
| | 1258 | 1536 | 1.5F |
| | 1835 | 2150 | 1.9E |
| 6 F | 0050 | 0340 | 1.9F |
| | 0657 | 1028 | 2.3E |
| | 1349 | 1635 | 1.7F |
| | 1929 | 2242 | 2.2E |
| 7 Sa | 0146 | 0439 | 2.1F |
| | 0750 | 1114 | 2.4E |
| | 1437 | 1723 | 1.9F |
| | 2019 | 2330 | 2.3E |
| 8 Su | 0239 | 0530 | 2.2F |
| | 0840 | 1159 | 2.5E |
| | 1522 | 1807 | 2.1F |
| | 2106 | | |
| 9 M ○ | | 0018 | 2.5E |
| | 0329 | 0619 | 2.3F |
| | 0928 | 1245 | 2.5E |
| | 1605 | 1850 | 2.1F |
| | 2153 | | |
| 10 Tu | | 0106 | 2.5E |
| | 0419 | 0707 | 2.3F |
| | 1016 | 1331 | 2.5E |
| | 1648 | 1936 | 2.1F |
| | 2240 | | |
| 11 W | | 0154 | 2.5E |
| | 0509 | 0757 | 2.1F |
| | 1104 | 1418 | 2.4E |
| | 1734 | 2024 | 2.1F |
| | 2330 | | |
| 12 Th | | 0243 | 2.4E |
| | 0602 | 0851 | 1.9F |
| | 1154 | 1504 | 2.2E |
| | 1823 | 2117 | 1.9F |
| 13 F | 0023 | 0332 | 2.2E |
| | 0701 | 0948 | 1.7F |
| | 1247 | 1552 | 2.0E |
| | 1918 | 2214 | 1.8F |
| 14 Sa | 0119 | 0427 | 2.0E |
| | 0806 | 1054 | 1.5F |
| | 1341 | 1648 | 1.8E |
| | 2018 | 2317 | 1.6F |
| 15 Su | 0216 | 0533 | 1.7E |
| | 0916 | 1205 | 1.3F |
| | 1439 | 1757 | 1.6E |
| | 2123 | | |
| 16 M ◑ | | 0022 | 1.5F |
| | 0316 | 0653 | 1.6E |
| | 1027 | 1313 | 1.1F |
| | 1544 | 1916 | 1.4E |
| | 2230 | | |
| 17 Tu | | 0127 | 1.4F |
| | 0423 | 0812 | 1.5E |
| | 1136 | 1426 | 1.1F |
| | 1659 | 2032 | 1.4E |
| | 2336 | | |
| 18 W | | 0239 | 1.3F |
| | 0533 | 0922 | 1.6E |
| | 1240 | 1541 | 1.1F |
| | 1815 | 2140 | 1.4E |
| 19 Th | 0039 | 0354 | 1.3F |
| | 0639 | 1020 | 1.7E |
| | 1340 | 1644 | 1.2F |
| | 1919 | 2236 | 1.5E |
| 20 F | 0138 | 0454 | 1.4F |
| | 0734 | 1105 | 1.7E |
| | 1431 | 1735 | 1.3F |
| | 2010 | 2322 | 1.6E |
| 21 Sa | 0229 | 0541 | 1.4F |
| | 0819 | 1142 | 1.7E |
| | 1512 | 1817 | 1.3F |
| | 2050 | | |
| 22 Su | | 0001 | 1.6E |
| | 0311 | 0620 | 1.4F |
| | 0856 | 1214 | 1.7E |
| | 1544 | 1852 | 1.3F |
| | 2122 | | |
| 23 M | | 0036 | 1.6E |
| | 0347 | 0650 | 1.4F |
| | 0928 | 1243 | 1.7E |
| | 1610 | 1914 | 1.2F |
| | 2149 | | |
| 24 Tu ● | | 0108 | 1.6E |
| | 0419 | 0710 | 1.3F |
| | 0958 | 1311 | 1.7E |
| | 1632 | 1914 | 1.2F |
| | 2216 | | |
| 25 W | | 0138 | 1.6E |
| | 0449 | 0728 | 1.3F |
| | 1028 | 1339 | 1.7E |
| | 1653 | 1929 | 1.3F |
| | 2244 | | |
| 26 Th | | 0206 | 1.6E |
| | 0520 | 0757 | 1.3F |
| | 1100 | 1408 | 1.7E |
| | 1719 | 2000 | 1.4F |
| | 2318 | | |
| 27 F | | 0235 | 1.7E |
| | 0557 | 0835 | 1.3F |
| | 1137 | 1440 | 1.7E |
| | 1751 | 2041 | 1.5F |
| | 2357 | | |
| 28 Sa | | 0307 | 1.7E |
| | 0641 | 0920 | 1.2F |
| | 1219 | 1517 | 1.8E |
| | 1831 | 2127 | 1.5F |
| 29 Su | 0041 | 0345 | 1.7E |
| | 0733 | 1011 | 1.2F |
| | 1307 | 1559 | 1.7E |
| | 1920 | 2219 | 1.6F |
| 30 M | 0130 | 0430 | 1.7E |
| | 0830 | 1108 | 1.2F |
| | 1358 | 1650 | 1.6E |
| | 2015 | 2314 | 1.6F |
| 31 Tu | 0221 | 0530 | 1.7E |
| | 0931 | 1205 | 1.3F |
| | 1455 | 1754 | 1.6E |
| | 2116 | | |

Time meridian 75° W. 0000 is midnight. 1200 is noon. Times are not adjusted for Daylight Saving Time.

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# George Washington Bridge, Hudson River, 2020

F–Flood, Dir. 010° True E–Ebb, Dir. 203° True

## January

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 W | | 0134 | 1.3F |
| | 0401 | 0727 | 1.4E |
| | 1008 | 1334 | 1.2F |
| | 1553 | 1951 | 2.0E |
| | 2307 | | |
| 2 Th ◐ | | 0219 | 1.4F |
| | 0454 | 0833 | 1.4E |
| | 1113 | 1424 | 1.0F |
| | 1636 | 2043 | 1.9E |
| | 2342 | | |
| 3 F | | 0302 | 1.4F |
| | 0548 | 0929 | 1.5E |
| | 1214 | 1514 | 0.9F |
| | 1724 | 2129 | 1.9E |
| 4 Sa | 0017 | 0344 | 1.5F |
| | 0638 | 1017 | 1.7E |
| | 1309 | 1605 | 0.9F |
| | 1816 | 2211 | 2.0E |
| 5 Su | 0054 | 0423 | 1.6F |
| | 0724 | 1101 | 2.0E |
| | 1359 | 1656 | 1.0F |
| | 1911 | 2251 | 2.0E |
| 6 M | 0132 | 0500 | 1.7F |
| | 0805 | 1145 | 2.2E |
| | 1446 | 1746 | 1.1F |
| | 2003 | 2333 | 2.0E |
| 7 Tu | 0212 | 0534 | 1.9F |
| | 0845 | 1228 | 2.5E |
| | 1532 | 1831 | 1.2F |
| | 2052 | | |
| 8 W | | 0016 | 2.1E |
| | 0253 | 0606 | 2.1F |
| | 0926 | 1312 | 2.8E |
| | 1617 | 1912 | 1.3F |
| | 2140 | | |
| 9 Th | | 0100 | 2.2E |
| | 0335 | 0638 | 2.3F |
| | 1009 | 1355 | 3.0E |
| | 1701 | 1951 | 1.4F |
| | 2228 | | |
| 10 F ○ | | 0144 | 2.3E |
| | 0420 | 0715 | 2.6F |
| | 1056 | 1438 | 3.2E |
| | 1745 | 2030 | 1.5F |
| | 2316 | | |
| 11 Sa | | 0229 | 2.4E |
| | 0506 | 0755 | 2.7F |
| | 1144 | 1521 | 3.3E |
| | 1828 | 2114 | 1.5F |
| 12 Su | 0004 | 0315 | 2.5E |
| | 0554 | 0842 | 2.7F |
| | 1232 | 1604 | 3.4E |
| | 1912 | 2206 | 1.6F |
| 13 M | 0054 | 0402 | 2.6E |
| | 0646 | 0937 | 2.6F |
| | 1321 | 1648 | 3.3E |
| | 1959 | 2301 | 1.7F |
| 14 Tu | 0145 | 0451 | 2.6E |
| | 0741 | 1043 | 2.4F |
| | 1410 | 1734 | 3.1E |
| | 2048 | 2356 | 1.8F |
| 15 W | 0240 | 0546 | 2.5E |
| | 0843 | 1152 | 2.2F |
| | 1500 | 1827 | 2.9E |
| | 2141 | | |
| 16 Th | | 0050 | 1.9F |
| | 0338 | 0655 | 2.3E |
| | 0952 | 1258 | 1.9F |
| | 1552 | 1932 | 2.6E |
| | 2235 | | |
| 17 F ◑ | | 0146 | 2.0F |
| | 0440 | 0817 | 2.3E |
| | 1104 | 1404 | 1.7F |
| | 1649 | 2042 | 2.5E |
| | 2330 | | |
| 18 Sa | | 0244 | 2.1F |
| | 0547 | 0928 | 2.5E |
| | 1217 | 1511 | 1.5F |
| | 1750 | 2144 | 2.5E |
| 19 Su | 0024 | 0343 | 2.2F |
| | 0655 | 1030 | 2.6E |
| | 1330 | 1619 | 1.4F |
| | 1855 | 2240 | 2.5E |
| 20 M | 0118 | 0444 | 2.3F |
| | 0758 | 1128 | 2.8E |
| | 1440 | 1728 | 1.4F |
| | 1958 | 2335 | 2.4E |
| 21 Tu | 0212 | 0544 | 2.4F |
| | 0855 | 1224 | 3.0E |
| | 1546 | 1830 | 1.4F |
| | 2057 | | |
| 22 W | | 0029 | 2.4E |
| | 0303 | 0639 | 2.5F |
| | 0947 | 1317 | 3.1E |
| | 1645 | 1925 | 1.5F |
| | 2153 | | |
| 23 Th | | 0121 | 2.4E |
| | 0353 | 0728 | 2.5F |
| | 1037 | 1407 | 3.2E |
| | 1738 | 2016 | 1.5F |
| | 2247 | | |
| 24 F ● | | 0210 | 2.3E |
| | 0441 | 0814 | 2.4F |
| | 1123 | 1454 | 3.2E |
| | 1823 | 2106 | 1.5F |
| | 2338 | | |
| 25 Sa | | 0257 | 2.2E |
| | 0527 | 0901 | 2.3F |
| | 1206 | 1538 | 3.1E |
| | 1904 | 2157 | 1.5F |
| 26 Su | 0026 | 0342 | 2.1E |
| | 0611 | 0950 | 2.1F |
| | 1246 | 1618 | 2.9E |
| | 1941 | 2245 | 1.5F |
| 27 M | 0111 | 0425 | 2.0E |
| | 0656 | 1040 | 1.9F |
| | 1323 | 1656 | 2.7E |
| | 2015 | 2330 | 1.5F |
| 28 Tu | 0155 | 0506 | 1.9E |
| | 0743 | 1127 | 1.6F |
| | 1359 | 1731 | 2.5E |
| | 2049 | | |
| 29 W | | 0012 | 1.5F |
| | 0238 | 0547 | 1.7E |
| | 0834 | 1212 | 1.4F |
| | 1434 | 1804 | 2.3E |
| | 2124 | | |
| 30 Th | | 0051 | 1.5F |
| | 0322 | 0635 | 1.6E |
| | 0930 | 1256 | 1.2F |
| | 1511 | 1837 | 2.0E |
| | 2201 | | |
| 31 F | | 0130 | 1.4F |
| | 0406 | 0736 | 1.5E |
| | 1029 | 1342 | 1.0F |
| | 1552 | 1923 | 1.9E |
| | 2241 | | |

## February

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 Sa ◐ | | 0208 | 1.4F |
| | 0453 | 0840 | 1.5E |
| | 1127 | 1430 | 0.9F |
| | 1639 | 2024 | 1.8E |
| | 2322 | | |
| 2 Su | | 0245 | 1.5F |
| | 0541 | 0935 | 1.7E |
| | 1224 | 1521 | 0.9F |
| | 1733 | 2119 | 1.8E |
| 3 M | 0004 | 0321 | 1.5F |
| | 0631 | 1023 | 2.0E |
| | 1320 | 1615 | 0.9F |
| | 1833 | 2208 | 1.8E |
| 4 Tu | 0048 | 0359 | 1.7F |
| | 0721 | 1110 | 2.2E |
| | 1414 | 1711 | 1.0F |
| | 1931 | 2256 | 1.9E |
| 5 W | 0134 | 0442 | 1.9F |
| | 0810 | 1158 | 2.5E |
| | 1505 | 1803 | 1.2F |
| | 2025 | 2346 | 2.0E |
| 6 Th | 0221 | 0530 | 2.1F |
| | 0859 | 1246 | 2.8E |
| | 1553 | 1848 | 1.3F |
| | 2115 | | |
| 7 F | | 0036 | 2.2E |
| | 0310 | 0618 | 2.4F |
| | 0948 | 1333 | 3.1E |
| | 1638 | 1929 | 1.5F |
| | 2204 | | |
| 8 Sa | | 0126 | 2.4E |
| | 0401 | 0704 | 2.6F |
| | 1037 | 1418 | 3.3E |
| | 1721 | 2009 | 1.6F |
| | 2254 | | |
| 9 Su ○ | | 0215 | 2.6E |
| | 0452 | 0750 | 2.7F |
| | 1127 | 1503 | 3.4E |
| | 1803 | 2052 | 1.8F |
| | 2345 | | |
| 10 M | | 0303 | 2.8E |
| | 0543 | 0839 | 2.7F |
| | 1216 | 1546 | 3.4E |
| | 1845 | 2140 | 1.9F |
| 11 Tu | 0036 | 0352 | 2.9E |
| | 0636 | 0934 | 2.6F |
| | 1303 | 1629 | 3.3E |
| | 1929 | 2234 | 2.0F |
| 12 W | 0128 | 0441 | 2.9E |
| | 0732 | 1039 | 2.3F |
| | 1350 | 1713 | 3.1E |
| | 2016 | 2329 | 2.1F |
| 13 Th | 0221 | 0535 | 2.7E |
| | 0832 | 1143 | 2.1F |
| | 1438 | 1801 | 2.9E |
| | 2107 | | |
| 14 F | | 0023 | 2.1F |
| | 0317 | 0638 | 2.5E |
| | 0939 | 1245 | 1.8F |
| | 1528 | 1900 | 2.6E |
| | 2202 | | |
| 15 Sa ◑ | | 0119 | 2.1F |
| | 0417 | 0756 | 2.4E |
| | 1051 | 1349 | 1.5F |
| | 1623 | 2012 | 2.3E |
| | 2259 | | |
| 16 Su | | 0218 | 2.1F |
| | 0523 | 0909 | 2.4E |
| | 1207 | 1456 | 1.3F |
| | 1725 | 2120 | 2.2E |
| | 2356 | | |
| 17 M | | 0320 | 2.1F |
| | 0632 | 1012 | 2.5E |
| | 1324 | 1605 | 1.2F |
| | 1833 | 2220 | 2.2E |
| 18 Tu | 0054 | 0424 | 2.1F |
| | 0738 | 1110 | 2.7E |
| | 1437 | 1715 | 1.2F |
| | 1942 | 2316 | 2.2E |
| 19 W | 0151 | 0527 | 2.2F |
| | 0837 | 1205 | 2.8E |
| | 1540 | 1818 | 1.3F |
| | 2044 | | |
| 20 Th | | 0011 | 2.2E |
| | 0246 | 0624 | 2.2F |
| | 0929 | 1257 | 3.0E |
| | 1634 | 1911 | 1.4F |
| | 2140 | | |
| 21 F | | 0103 | 2.2E |
| | 0338 | 0714 | 2.3F |
| | 1016 | 1345 | 3.0E |
| | 1719 | 1958 | 1.5F |
| | 2231 | | |
| 22 Sa | | 0152 | 2.2E |
| | 0427 | 0759 | 2.2F |
| | 1100 | 1429 | 3.0E |
| | 1756 | 2042 | 1.6F |
| | 2318 | | |
| 23 Su ● | | 0238 | 2.3E |
| | 0514 | 0842 | 2.1F |
| | 1139 | 1510 | 3.0E |
| | 1827 | 2125 | 1.6F |
| 24 M | 0002 | 0321 | 2.3E |
| | 0557 | 0926 | 1.9F |
| | 1216 | 1547 | 2.8E |
| | 1854 | 2208 | 1.6F |
| 25 Tu | 0044 | 0401 | 2.2E |
| | 0639 | 1011 | 1.7F |
| | 1251 | 1620 | 2.7E |
| | 1921 | 2248 | 1.6F |
| 26 W | 0123 | 0438 | 2.1E |
| | 0721 | 1055 | 1.5F |
| | 1324 | 1649 | 2.5E |
| | 1951 | 2326 | 1.6F |
| 27 Th | 0201 | 0512 | 2.0E |
| | 0805 | 1137 | 1.3F |
| | 1359 | 1714 | 2.3E |
| | 2024 | | |
| 28 F | | 0000 | 1.5F |
| | 0239 | 0545 | 1.9E |
| | 0854 | 1218 | 1.2F |
| | 1436 | 1741 | 2.1E |
| | 2102 | | |
| 29 Sa | | 0031 | 1.5F |
| | 0318 | 0624 | 1.8E |
| | 0948 | 1301 | 1.0F |
| | 1518 | 1818 | 1.9E |
| | 2145 | | |

## March

| Day | Slack (h m) | Maximum (h m) | knots |
|---|---|---|---|
| 1 Su | | 0059 | 1.5F |
| | 0400 | 0726 | 1.7E |
| | 1046 | 1349 | 0.9F |
| | 1605 | 1910 | 1.7E |
| | 2231 | | |
| 2 M ◐ | | 0130 | 1.5F |
| | 0448 | 0845 | 1.8E |
| | 1146 | 1442 | 0.9F |
| | 1700 | 2021 | 1.7E |
| | 2319 | | |
| 3 Tu | | 0212 | 1.6F |
| | 0542 | 0945 | 2.1E |
| | 1246 | 1539 | 0.9F |
| | 1801 | 2130 | 1.7E |
| 4 W | 0010 | 0305 | 1.7F |
| | 0641 | 1038 | 2.3E |
| | 1343 | 1638 | 1.0F |
| | 1903 | 2228 | 1.8E |
| 5 Th | 0103 | 0404 | 1.9F |
| | 0739 | 1130 | 2.6E |
| | 1436 | 1734 | 1.2F |
| | 2001 | 2323 | 2.1E |
| 6 F | 0158 | 0507 | 2.1F |
| | 0835 | 1221 | 2.9E |
| | 1525 | 1823 | 1.4F |
| | 2054 | | |
| 7 Sa | | 0018 | 2.3E |
| | 0253 | 0605 | 2.4F |
| | 0927 | 1309 | 3.1E |
| | 1610 | 1906 | 1.7F |
| | 2145 | | |
| 8 Su | | 0111 | 2.6E |
| | 0348 | 0657 | 2.6F |
| | 1019 | 1356 | 3.3E |
| | 1652 | 1947 | 1.9F |
| | 2236 | | |
| 9 M ○ | | 0203 | 2.9E |
| | 0442 | 0746 | 2.6F |
| | 1108 | 1441 | 3.4E |
| | 1734 | 2028 | 2.1F |
| | 2327 | | |
| 10 Tu | | 0252 | 3.1E |
| | 0535 | 0835 | 2.6F |
| | 1157 | 1524 | 3.4E |
| | 1815 | 2114 | 2.3F |
| 11 W | 0019 | 0341 | 3.2E |
| | 0628 | 0929 | 2.4F |
| | 1243 | 1607 | 3.3E |
| | 1858 | 2206 | 2.3F |
| 12 Th | 0110 | 0431 | 3.1E |
| | 0723 | 1030 | 2.2F |
| | 1330 | 1651 | 3.1E |
| | 1944 | 2302 | 2.3F |
| 13 F | 0202 | 0523 | 2.9E |
| | 0822 | 1132 | 1.9F |
| | 1417 | 1737 | 2.7E |
| | 2035 | 2358 | 2.2F |
| 14 Sa | 0256 | 0622 | 2.7E |
| | 0928 | 1234 | 1.6F |
| | 1507 | 1832 | 2.4E |
| | 2130 | | |
| 15 Su | | 0055 | 2.1F |
| | 0354 | 0734 | 2.4E |
| | 1042 | 1337 | 1.4F |
| | 1602 | 1945 | 2.1E |
| | 2229 | | |
| 16 M ◑ | | 0155 | 2.0F |
| | 0457 | 0849 | 2.4E |
| | 1201 | 1443 | 1.2F |
| | 1705 | 2059 | 1.9E |
| | 2330 | | |
| 17 Tu | | 0259 | 1.9F |
| | 0605 | 0953 | 2.5E |
| | 1318 | 1552 | 1.1F |
| | 1818 | 2202 | 1.9E |
| 18 W | 0033 | 0403 | 1.9F |
| | 0713 | 1050 | 2.6E |
| | 1426 | 1659 | 1.2F |
| | 1931 | 2259 | 1.9E |
| 19 Th | 0134 | 0508 | 1.9F |
| | 0813 | 1143 | 2.7E |
| | 1522 | 1800 | 1.3F |
| | 2033 | 2353 | 2.0E |
| 20 F | 0233 | 0606 | 2.0F |
| | 0904 | 1232 | 2.8E |
| | 1607 | 1851 | 1.5F |
| | 2125 | | |
| 21 Sa | | 0044 | 2.1E |
| | 0327 | 0655 | 2.0F |
| | 0948 | 1318 | 2.8E |
| | 1644 | 1933 | 1.7F |
| | 2211 | | |
| 22 Su | | 0131 | 2.3E |
| | 0417 | 0739 | 2.0F |
| | 1028 | 1359 | 2.8E |
| | 1713 | 2012 | 1.8F |
| | 2254 | | |
| 23 M | | 0215 | 2.4E |
| | 0502 | 0819 | 1.9F |
| | 1106 | 1437 | 2.8E |
| | 1739 | 2048 | 1.8F |
| | 2334 | | |
| 24 Tu ● | | 0256 | 2.4E |
| | 0542 | 0859 | 1.8F |
| | 1141 | 1511 | 2.7E |
| | 1804 | 2123 | 1.8F |
| 25 W | 0011 | 0334 | 2.4E |
| | 0620 | 0939 | 1.6F |
| | 1216 | 1542 | 2.6E |
| | 1831 | 2157 | 1.8F |
| 26 Th | 0047 | 0408 | 2.4E |
| | 0658 | 1019 | 1.4F |
| | 1251 | 1608 | 2.4E |
| | 1901 | 2227 | 1.7F |
| 27 F | 0122 | 0438 | 2.3E |
| | 0738 | 1100 | 1.3F |
| | 1327 | 1634 | 2.3E |
| | 1934 | 2249 | 1.7F |
| 28 Sa | 0157 | 0507 | 2.2E |
| | 0822 | 1142 | 1.2F |
| | 1407 | 1704 | 2.2E |
| | 2012 | 2307 | 1.6F |
| 29 Su | 0234 | 0541 | 2.2E |
| | 0915 | 1226 | 1.1F |
| | 1450 | 1742 | 2.0E |
| | 2056 | 2341 | 1.7F |
| 30 M | 0316 | 0628 | 2.1E |
| | 1013 | 1315 | 1.0F |
| | 1539 | 1829 | 1.7E |
| | 2145 | | |
| 31 Tu | | 0028 | 1.7F |
| | 0405 | 0746 | 2.1E |
| | 1115 | 1410 | 1.0F |
| | 1633 | 1935 | 1.6E |
| | 2241 | | |

Time meridian 75° W. 0000 is midnight. 1200 is noon. Times are not adjusted for Daylight Saving Time.

## TABLE 2. – CURRENT DIFFERENCES AND OTHER CONSTANTS

| No. | PLACE | Meter Depth | POSITION Latitude | POSITION Longitude | TIME DIFFERENCES Min. before Flood | TIME DIFFERENCES Flood | TIME DIFFERENCES Min. before Ebb | TIME DIFFERENCES Ebb | SPEED RATIOS Flood | SPEED RATIOS Ebb | Minimum before Flood knots | Minimum before Flood Dir. | Maximum Flood knots | Maximum Flood Dir. | Minimum before Ebb knots | Minimum before Ebb Dir. | Maximum Ebb knots | Maximum Ebb Dir. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ft | North | West | h m | h m | h m | h m | | | knots | Dir. | knots | Dir. | knots | Dir. | knots | Dir. |
| | JAMAICA BAY<br>Time meridian, 75°W | | | | **on The Narrows, p.60** | | | | | | | | | | | | | |
| 1451 | Canarsie (midchannel, off pier) | | 40° 37.6' | 73° 53.0' | −1 44 | −1 39 | −1 26 | −2 13 | 0.3 | 0.4 | – – | – – | 0.5 | 045° | – – | – – | 0.7 | 222° |
| 1453 | Beach Channel (bridge) | | 40° 35.0' | 73° 49.0' | −1 38 | −1 14 | −1 05 | −1 32 | 1.2 | 1.1 | – – | – – | 1.9 | 062° | – – | – – | 2.0 | 225° |
| 1455 | Grass Hassock Channel | | 40° 36.6' | 73° 47.1' | −1 11 | −1 03 | −1 05 | −1 01 | 0.6 | 0.5 | – – | – – | 1.0 | 052° | – – | – – | 1.0 | 228° |
| | NEW YORK HARBOR ENTRANCE | | | | | | | | | | | | | | | | | |
| 1457 | Ambrose Channel | 15 | 40° 31.00' | 73° 58.48' | −0 47 | −1 11 | −0 33 | −0 14 | 1.0 | 0.9 | 0.1 | 025° | 1.6 | 303° | – – | – – | 1.7 | 123° |
| 1459 | Norton Point, WSW of | 16 | 40° 33.30' | 74° 01.30' | −0 03 | −1 02 | +0 18 | +0 20 | 0.6 | 0.7 | 0.3 | 263° | 1.0 | 341° | 0.1 | 071° | 1.2 | 166° |
| 1461 | THE NARROWS, midchannel | 17 | 40° 36.56' | 74° 02.77' | **Daily predictions** | | | | | | 0.2 | 064° | 1.6 | 336° | – – | – – | 1.9 | 164° |
| | ... do. | 30 | 40° 36.56' | 74° 02.77' | −0 23 | −0 07 | +0 13 | +0 14 | 1.1 | 0.9 | – – | – – | 1.7 | 332° | 0.1 | 246° | 1.7 | 160° |
| | ... do. | 43 | 40° 36.56' | 74° 02.77' | −0 44 | −0 11 | +0 17 | +0 00 | 1.2 | 0.9 | 0.1 | 244° | 1.8 | 332° | 0.1 | 244° | 1.6 | 156° |
| | ... do. | 63 | 40° 36.56' | 74° 02.77' | −1 10 | −0 31 | +0 10 | −0 13 | 1.1 | 0.7 | 0.1 | 240° | 1.7 | 331° | – – | – – | 1.3 | 147° |
| | NEW YORK HARBOR, Upper Bay | | | | | | | | | | | | | | | | | |
| 1463 | Bay Ridge, west of | 22 | 40° 37.54' | 74° 03.24' | −0 01 | +0 19 | +0 34 | +0 52 | 0.9 | 0.8 | 0.1 | 104° | 1.4 | 354° | – – | – – | 1.5 | 185° |
| 1465 | Bay Ridge Channel | 15 | 40° 39.18' | 74° 01.54' | −0 48 | −1 27 | −0 04 | −1 24 | 0.7 | 0.4 | – – | – – | 1.0 | 032° | 0.1 | 125° | 0.7 | 212° |
| | ... do. | 36 | 40° 39.18' | 74° 01.54' | −1 25 | −2 37 | −0 58 | −0 16 | 0.4 | 0.2 | – – | – – | 0.6 | 037° | – – | – – | 0.4 | 225° |
| 1467 | Red Hook Channel | | 40° 40.0' | 74° 01.2' | −0 53 | −0 45 | −0 16 | −0 37 | 0.6 | 0.4 | – – | – – | 1.0 | 353° | – – | – – | 0.7 | 170° |
| 1469 | Robbins Reef Light, east of | | 40° 39.45' | 74° 03.50' | +0 26 | +0 15 | −0 06 | +0 17 | 0.8 | 0.9 | – – | – – | 1.3 | 016° | – – | – – | 1.6 | 204° |
| 1471 | Red Hook, 1 mile west of | | 40° 40.5' | 74° 02.5' | +0 51 | +1 05 | +0 39 | +0 45 | 0.8 | 1.2 | – – | – – | 1.3 | 024° | – – | – – | 2.3 | 206° |
| 1473 | Statue of Liberty, east of | | 40° 41.4' | 74° 01.8' | +1 07 | +0 57 | +0 48 | +0 52 | 0.9 | 1.0 | – – | – – | 1.4 | 031° | – – | – – | 1.9 | 205° |
| | HUDSON RIVER, Midchannel <17> | | | | **on George Washington Bridge, p.64** | | | | | | | | | | | | | |
| 1475 | Hudson River entrance | 14 | 40° 42.30' | 74° 01.12' | −0 28 | −0 28 | −0 25 | +0 18 | 0.8 | 0.5 | 0.1 | 292° | 1.4 | 009° | – – | – – | 1.4 | 199° |
| 1477 | Grants Tomb | 18 | 40° 48.48' | 73° 58.06' | −0 13 | −0 22 | +0 11 | −0 33 | 1.0 | 0.7 | – – | – – | 1.8 | 025° | – – | – – | 1.8 | 208° |
| 1479 | GEORGE WASHINGTON BRIDGE | 14d | 40° 50.97' | 73° 56.99' | **Daily predictions** | | | | | | 0.3 | 288° | 1.8 | 010° | 0.1 | 289° | 2.5 | 203° |
| | ... do. | 40d | 40° 50.97' | 73° 56.99' | −0 35 | −0 38 | −0 04 | −0 19 | 1.0 | 0.8 | 0.2 | 285° | 1.7 | 012° | – – | – – | 1.9 | 198° |
| | ... do. | 63d | 40° 50.97' | 73° 56.99' | −0 56 | −0 40 | +0 04 | −0 36 | 0.7 | 0.4 | 0.1 | 266° | 1.3 | 355° | – – | – – | 1.1 | 177° |
| 1481 | Spuyten Duyvil | | 40° 53' | 73° 56' | −0 06 | +0 28 | +0 10 | +0 24 | 0.9 | 0.8 | – – | – – | 1.6 | 020° | – – | – – | 2.1 | 200° |
| 1483 | Riverdale | | 40° 54' | 73° 55' | +0 54 | +0 27 | +0 15 | +0 32 | 0.8 | 0.8 | – – | – – | 1.4 | 015° | – – | – – | 2.0 | 200° |
| 1485 | Mount St. Vincent College, SW of | 15 | 40° 54.42' | 73° 54.48' | +0 09 | +0 20 | +0 27 | +0 29 | 0.8 | 0.5 | – – | – – | 1.5 | 007° | – – | – – | 1.4 | 190° |
| 1487 | Dobbs Ferry | | 41° 01' | 73° 53' | +1 13 | +0 53 | +0 37 | +0 49 | 0.7 | 0.7 | – – | – – | 1.3 | 010° | – – | – – | 1.7 | 190° |
| 1489 | Tappan Zee Bridge | 5d | 41° 04.00' | 73° 52.90' | +1 12 | +0 55 | +0 52 | +1 06 | 0.6 | 0.8 | – – | – – | 1.1 | 356° | – – | – – | 1.9 | 175° |
| | ... do. | 16d | 41° 04.00' | 73° 52.90' | +0 50 | +0 29 | +1 04 | +1 05 | 0.7 | 0.7 | – – | – – | 1.2 | 354° | 0.1 | 265° | 1.6 | 174° |
| | ... do. | 35d | 41° 04.00' | 73° 52.90' | +0 14 | +0 05 | +0 51 | +0 54 | 0.5 | 0.4 | 0.1 | 265° | 0.8 | 349° | – – | – – | 0.9 | 178° |
| 1491 | Tarrytown | | 41° 05' | 73° 53' | +1 20 | +1 06 | +0 53 | +1 02 | 0.6 | 0.6 | – – | – – | 1.1 | 000° | – – | – – | 1.5 | 180° |
| 1493 | Ossining | | 41° 10' | 73° 54' | +1 33 | +1 22 | +1 16 | +1 19 | 0.5 | 0.5 | – – | – – | 0.9 | 320° | – – | – – | 1.3 | 140° |
| 1495 | Haverstraw | 4d | 41° 12.55' | 73° 57.07' | +2 29 | +2 11 | +1 58 | +2 01 | 0.4 | 0.6 | – – | – – | 0.8 | 348° | – – | – – | 1.5 | 165° |
| | ... do. | 12d | 41° 12.55' | 73° 57.07' | +2 04 | +2 10 | +2 14 | +1 45 | 0.5 | 0.4 | – – | – – | 1.0 | 345° | – – | – – | 1.1 | 166° |
| | ... do. | 20d | 41° 12.55' | 73° 57.07' | +1 26 | +1 46 | +2 14 | +1 31 | 0.5 | 0.3 | 0.1 | 076° | 0.8 | 344° | 0.1 | 073° | 0.7 | 162° |
| 1497 | Stony Point | 14d | 41° 14.49' | 73° 58.00' | +2 09 | +1 55 | +1 46 | +2 00 | 0.6 | 0.6 | 0.1 | 069° | 1.0 | 348° | – – | – – | 1.5 | 154° |
| | ... do. | 50d | 41° 14.49' | 73° 58.00' | +1 26 | +1 50 | +2 21 | +1 40 | 0.7 | 0.5 | – – | – – | 1.3 | 334° | 0.1 | 250° | 1.1 | 165° |
| | ... do. | 83d | 41° 14.49' | 73° 58.00' | +1 34 | +1 57 | +2 22 | +1 36 | 0.7 | 0.2 | – – | – – | 1.3 | 338° | – – | – – | 0.6 | 170° |
| 1499 | Peekskill | | 41° 17' | 73° 57' | +1 53 | +1 44 | +1 46 | +1 42 | 0.5 | 0.5 | – – | – – | 0.8 | 000° | – – | – – | 1.2 | 180° |
| 1501 | Bear Mountain Bridge | 13d | 41° 18.95' | 73° 59.03' | +2 18 | +1 32 | +1 40 | +2 02 | 0.4 | 0.6 | – – | – – | 0.6 | 000° | – – | – – | 1.4 | 180° |
| | ... do. | 52d | 41° 18.95' | 73° 59.03' | +1 58 | +1 46 | +2 02 | +2 05 | 0.6 | 0.5 | – – | – – | 1.0 | 343° | – – | – – | 1.2 | 167° |
| | ... do. | 88d | 41° 18.95' | 73° 59.03' | +1 34 | +1 38 | +2 07 | +2 07 | 0.6 | 0.4 | – – | – – | 1.0 | 339° | – – | – – | 0.9 | 161° |
| 1503 | Highland Falls | | 41° 22' | 73° 58' | +2 07 | +1 57 | +1 57 | +2 02 | 0.6 | 0.5 | – – | – – | 1.0 | 005° | – – | – – | 1.2 | 185° |
| 1505 | West Point, off Duck Island | | 41° 24' | 73° 57' | +2 15 | +2 07 | +2 04 | +2 04 | 0.6 | 0.4 | – – | – – | 1.0 | 010° | – – | – – | 1.1 | 190° |
| 1507 | Newburgh Beacon Bridge | 4d | 41° 31.00' | 73° 59.50' | +2 19 | +2 19 | +2 25 | +2 19 | 0.6 | 0.5 | – – | – – | 1.2 | 350° | – – | – – | 1.2 | 171° |
| | ... do. | 17d | 41° 31.00' | 73° 59.50' | +2 15 | +2 08 | +2 25 | +2 18 | 0.6 | 0.4 | – – | – – | 1.0 | 346° | – – | – – | 1.0 | 169° |
| | ... do. | 24d | 41° 31.00' | 73° 59.50' | +2 13 | +2 07 | +2 23 | +2 18 | 0.5 | 0.3 | – – | – – | 0.9 | 345° | – – | – – | 0.9 | 168° |
| 1509 | Roseton | 5d | 41° 33.75' | 73° 58.23' | +2 57 | +2 36 | +2 41 | +2 51 | 0.6 | 0.6 | 0.1 | 123° | 1.1 | 039° | 0.1 | 128° | 1.4 | 213° |
| | ... do. | 15d | 41° 33.75' | 73° 58.23' | +2 56 | +2 37 | +2 43 | +2 50 | 0.6 | 0.5 | – – | – – | 1.1 | 038° | 0.1 | 128° | 1.3 | 214° |
| | ... do. | 41d | 41° 33.75' | 73° 58.23' | +2 53 | +2 32 | +2 44 | +3 01 | 0.5 | 0.4 | – – | – – | 0.9 | 031° | – – | – – | 0.9 | 215° |

Endnotes can be found at the end of table 2.

# TABLE 3.—SPEED OF CURRENT AT ANY TIME

## TABLE A

| Interval between slack and desired time | Interval between slack and maximum current | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. m. 1 20 | h. m. 1 40 | h. m. 2 00 | h. m. 2 20 | h. m. 2 40 | h. m. 3 00 | h.m. 3 20 | h.m. 3 40 | h.m. 4 00 | h.m. 4 20 | h.m. 4 40 | h.m. 5 00 | h.m. 5 20 | h.m. 5 40 |
| h. m. | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots |
| 0 20 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 0 40 | 0.7 | 0.6 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 1 00 | 0.9 | 0.8 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| 1 20 | 1.0 | 1.0 | 0.9 | 0.8 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 |
| 1 40 | ---- | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 |
| 2 00 | ---- | ---- | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 |
| 2 20 | ---- | ---- | ---- | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 |
| 2 40 | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 |
| 3 00 | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 |
| 3 20 | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 |
| 3 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 4 00 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 |
| 4 20 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 |
| 4 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 |
| 5 00 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 |
| 5 20 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 |
| 5 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 |

## TABLE B

| Interval between slack and desired time | Interval between slack and maximum current | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | h. m. 1 20 | h. m. 1 40 | h. m. 2 00 | h. m. 2 20 | h. m. 2 40 | h. m. 3 00 | h. m. 3 20 | h. m. 3 40 | h. m. 4 00 | h. m. 4 20 | h. m. 4 40 | h. m. 5 00 | h. m. 5 20 | h. m. 5 40 |
| h. m. | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots | knots |
| 0 20 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 0 40 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| 1 00 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 |
| 1 20 | 1.0 | 1.0 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.5 |
| 1 40 | ---- | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 |
| 2 00 | ---- | ---- | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 |
| 2 20 | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 |
| 2 40 | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.7 |
| 3 00 | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 |
| 3 20 | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 |
| 3 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 |
| 4 00 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 |
| 4 20 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 | 0.9 |
| 4 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 | 1.0 |
| 5 00 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 | 1.0 |
| 5 20 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 | 1.0 |
| 5 40 | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | ---- | 1.0 |

**Use Table A** for all places except those listed below for Table B.
**Use Table B** for Cape Code Canal, Hell Gate, Chesapeake and Delaware Canal, and all stations in table 2 which are referred to them.

1. From predictions find the time of slack water and the time and velocity of maximum current (flood or ebb), one of which is immediately before and the other after the time for which the velocity is desired.
2. Find the interval of time between the above slack and maximum current, and enter the top of Table A or B with the interval which most nearly agrees with this value.
3. Find the interval of time between the above slack and the time desired, and enter the side of Table A or B with the interval which most nearly agrees with this value.
4. Find, in the Table, the factor corresponding to the above two intervals, and multiply the maximum velocity by this factor. The result will be the approximate velocity at the time desired.

# TABLE 4.—DURATION OF SLACK

The predicted times of slack water given in this publication indicate the instant of zero speed, which is only momentary. There is a period on each side of the slack water, however, during which the current is so weak that for practical purposes it may be considered negligible.

The following tables give, for various maximum currents, the approximate period of time during which weak currents not exceeding 0.1 to 0.5 knot will be encountered. This duration includes the last of the flood or ebb and the beginning of the following ebb or flood, that is, half of the duration will be before and half after the time of slack water.

Table A should be used for all places except those listed below for Table B.

Table B should be used for Cape Cod Canal, Hell Gate, Chesapeake and Delaware Canal, and all stations in Table 2 which are referred to them.

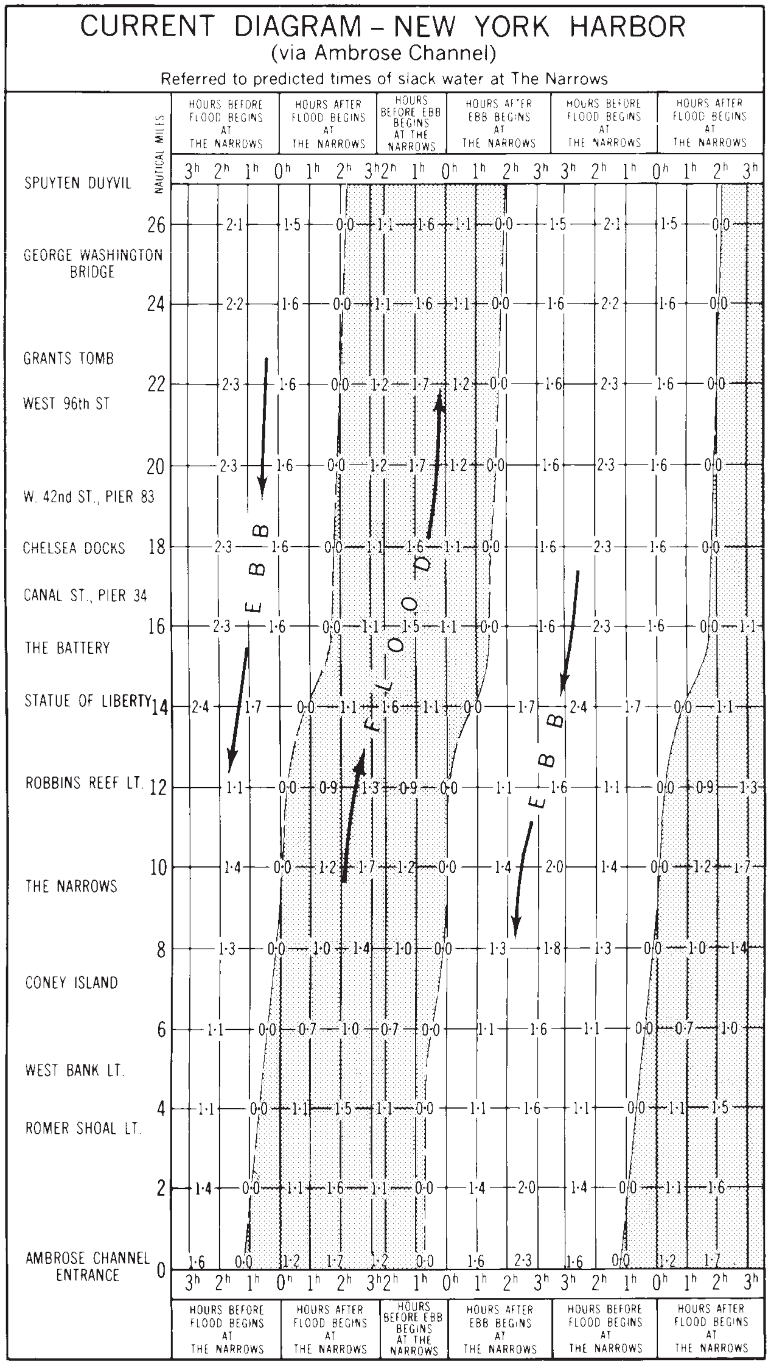
## Duration of weak current near time of slack water

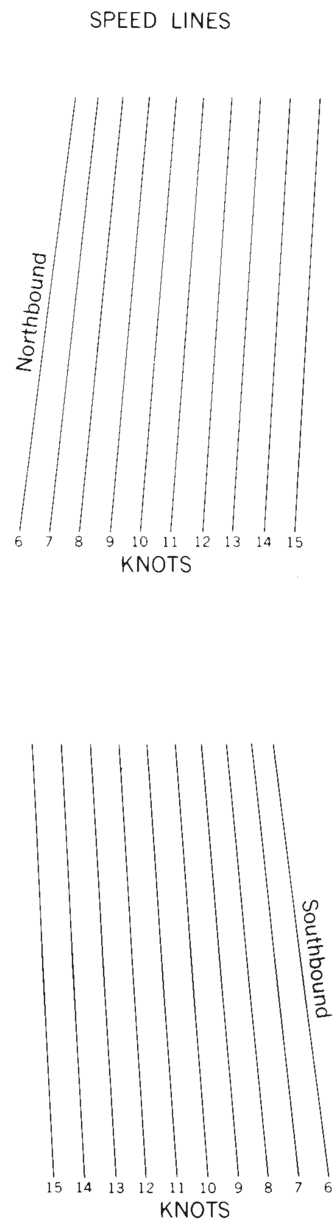
| Maximum | *Period with a speed not more than -* | | | | |
|---|---|---|---|---|---|
| *current* | *0.1 knot* | *0.2 knot* | *0.3 knot* | *0.4 knot* | *0.5 knot* |
| *Knots* | *Minutes* | *Minutes* | *Minutes* | *Minutes* | *Minutes* |
| 1.0 | 23 | 46 | 70 | 94 | 120 |
| 1.5 | 15 | 31 | 46 | 62 | 78 |
| 2.0 | 11 | 23 | 35 | 46 | 58 |
| 3.0 | 8 | 15 | 23 | 31 | 38 |
| 4.0 | 6 | 11 | 17 | 23 | 29 |
| 5.0 | 5 | 9 | 14 | 18 | 23 |
| 6.0 | 4 | 8 | 11 | 15 | 19 |
| 7.0 | 3 | 7 | 10 | 13 | 16 |
| 8.0 | 3 | 6 | 9 | 11 | 14 |
| 9.0 | 3 | 5 | 8 | 10 | 13 |
| 10.0 | 2 | 5 | 7 | 9 | 11 |

## TABLE B

| Maximum | *Period with a speed not more than -* | | | | |
|---|---|---|---|---|---|
| *current* | *0.1 knot* | *0.2 knot* | *0.3 knot* | *0.4 knot* | *0.5 knot* |
| *Knots* | *Minutes* | *Minutes* | *Minutes* | *Minutes* | *Minutes* |
| 1.0 | 13 | 28 | 46 | 66 | 89 |
| 1.5 | 8 | 18 | 28 | 39 | 52 |
| 2.0 | 6 | 13 | 20 | 28 | 36 |
| 3.0 | 4 | 8 | 13 | 18 | 22 |
| 4.0 | 3 | 6 | 9 | 13 | 17 |
| 5.0 | 3 | 5 | 8 | 10 | 13 |
| 6.0 | 2 | 4 | 6 | 8 | 11 |
| 7.0 | 2 | 4 | 5 | 7 | 9 |
| 8.0 | 2 | 3 | 5 | 6 | 8 |

When there is a difference between the speeds of the maximum flood and ebb preceding and following the slack for which the duration is desired, it will be sufficiently accurate for practical purposes to find a separate duration for each maximum speed and take the average of the two as the duration of the weak current.


CURRENT DIAGRAM – NEW YORK HARBOR
(via Ambrose Channel)
Referred to predicted times of slack water at The Narrows
HOURS BEFORE FLOOD BEGINS AT THE NARROWS
HOURS AFTER FLOOD BEGINS AT THE NARROWS
HOURS BEFORE EBB BEGINS AT THE NARROWS
HOURS AFTER EBB BEGINS AT THE NARROWS
NAUTICAL MILES
SPUYTEN DUYVIL
GEORGE WASHINGTON BRIDGE
GRANTS TOMB
WEST 96th ST
W. 42nd ST., PIER 83
CHELSEA DOCKS
CANAL ST., PIER 34
THE BATTERY
STATUE OF LIBERTY
ROBBINS REEF LT.
THE NARROWS
CONEY ISLAND
WEST BANK LT.
ROMER SHOAL LT.
AMBROSE CHANNEL ENTRANCE
EBB
FLOOD
EBB


SPEED LINES
Northbound
6 7 8 9 10 11 12 13 14 15
KNOTS
Southbound
15 14 13 12 11 10 9 8 7 6
KNOTS