# THE
# OBSERVER'S HANDBOOK
## FOR 1949

PUBLISHED BY

**The Royal Astronomical Society of Canada**

C. A. CHANT, EDITOR
F. S. HOGG, ASSISTANT EDITOR
DAVID DUNLAP OBSERVATORY

FORTY-FIRST YEAR OF PUBLICATION

TORONTO
3 WILLCOCKS STREET
PRINTED FOR THE SOCIETY
BY THE UNIVERSITY OF TORONTO PRESS
1948

## THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Society was incorporated in 1890 as The Astronomical and Physical Society of Toronto, assuming its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London, Windsor, and Guelph, Ontario; Winnipeg, Man.; Saskatoon, Sask.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as over 1,100 members of these Canadian Centres, there are nearly 500 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list of our publications. The Society publishes a monthly "Journal" and a yearly "Observer's Handbook". Single copies of the Journal are 50 cents, and of the Handbook, 40 cents.

Membership is open to anyone interested in astronomy. Annual dues, $3.00; life membership, $40.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 3 Willcocks St., Toronto.

## JULIAN CALENDAR, 1949

J.D. 2,430,000 plus the following:

| | | | | | |
|---|---|---|---|---|---|
| Jan. 1 | 2918 | May 1 | 3038 | Sep. 1 | 3161 |
| Feb. 1 | 2949 | Jun. 1 | 3069 | Oct. 1 | 3191 |
| Mar. 1 | 2977 | Jul. 1 | 3099 | Nov. 1 | 3222 |
| Apr. 1 | 3008 | Aug. 1 | 3130 | Dec. 1 | 3252 |

The Julian Day commences at noon. Thus J.D. 2,432,918 = Jan. 1.5 G.C.T.

## 1949 CALENDAR 1949

| | JANUARY | FEBRUARY | MARCH | APRIL |
|---|---|---|---|---|
| Sun. | 2 9 16 23 30 | .. 6 13 20 27 | .. 6 13 20 27 | .. 3 10 17 24 |
| Mon. | 3 10 17 24 31 | .. 7 14 21 28 | . 7 14 21 28 | .. 4 11 18 25 |
| Tues. | 4 11 18 25 ... | 1 8 15 22 .... | 1 8 15 22 29 | .. 5 12 19 26 |
| Wed. | 5 12 19 26 .... | 2 9 16 23 .... | 2 9 16 23 30 | .. 6 13 20 27 |
| Thur. | 6 13 20 27 .... | 3 10 17 24 .. | 3 10 17 24 31 | .. 7 14 21 28 |
| Fri. | 7 14 21 28 .... | 4 11 18 25 ... | 4 11 18 25 ... | 1 8 15 22 29 |
| Sat. | 1 8 15 22 29 ... | 5 12 19 26 .. | 5 12 19 26 .. | 2 9 16 23 30 |

| | MAY | JUNE | JULY | AUGUST |
|---|---|---|---|---|
| Sun. | 1 8 15 22 29 | .. 5 12 19 26 | 3 10 17 24 31 | .. 7 14 21 28 |
| Mon. | 2 9 16 23 30 | .. 6 13 20 27 | 4 11 18 25 .... | 1 8 15 22 29 |
| Tues. | 3 10 17 24 31 | .. 7 14 21 28 | 5 12 19 26 .... | 2 9 16 23 30 |
| Wed. | 4 11 18 25 .... | 1 8 15 22 29 | 6 13 20 27 .... | 3 10 17 24 31 |
| Thur. | 5 12 19 26 .... | 2 9 16 23 30 | 7 14 21 28 .... | 4 11 18 25 .... |
| Fri. | 6 13 20 27 ... | 3 10 17 24 .... | 1 8 15 22 29 ... | 5 12 19 26 .... |
| Sat. | 7 14 21 28 ... | 4 11 18 25 | 2 9 16 23 30 | 6 13 20 27 .... |

| | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER |
|---|---|---|---|---|
| Sun. | .. 4 11 18 25 | 2 9 16 23 30 | .. 6 13 20 27 | .. 4 11 18 25 |
| Mon. | .. 5 12 19 26 | 3 10 17 24 31 | .. 7 14 21 28 | .. 5 12 19 26 |
| Tues. | .. 6 13 20 27 | 4 11 18 25 .... | 1 8 15 22 29 | .. 6 13 20 27 |
| Wed. | .. 7 14 21 28 | 5 12 19 26 .... | 2 9 16 23 30 | .. 7 14 21 28 |
| Thur. | 1 8 15 22 29 | 6 13 20 27 .... | 3 10 17 24 | 1 8 15 22 29 |
| Fri. | 2 9 16 23 30 | 7 14 21 28 .... | 4 11 18 25 | 2 9 16 23 30 |
| Sat. | 3 10 17 24 .... | 1 8 15 22 29 .... | 5 12 19 26 .... | 3 10 17 24 31 |

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## CONTENTS



## TABLES IN RECENT OBSERVER'S HANDBOOKS



PRINTED IN CANADA

# PREFACE

The HANDBOOK for 1949 is the 41st issue. During the past decade its circulation has increased from 1500 to 5500. This year, for the second time, some advertisements of astronomical accessories are inserted. The Officers of the Society appreciate this assistance at the present time of financial difficulty. With regret the price has been raised to 40 cents.

Four circular star maps 9 inches in diameter at a price of one cent each, and a set of four maps plotted on equatorial co-ordinates at a price of ten cents, are obtainable from the Director of University Extension, University of Toronto, Toronto 5.

Celestial distances given herein are based on the standard value of 8″.80 for the sun's parallax, not on the more recent value 8″.790 determined by Sir Harold Jones. Among the alterations and additions this year are:

1. *Algol.* Olin J. Egger's epoch 2432520.6303 and period 2.86731525d., as published in the *Astrophysical Journal*, 1948.
2. *Standard Time Zones.* A new map including all of the U.S.A.
3. *Sunrise, sunset; moonrise, moonset.* The tables now include a wider range of latitude, taking in the southern states.
4. *Sun-spots.* A table of solar rotation numbers for observers of sun-spots, and an ephemeris for physical observations of the sun.

Dr. F. S. Hogg, the Assistant Editor, as in recent years, assumed the responsibility of preparing this volume and to him the chief credit of its success is due; but sincere thanks are tendered to all those names mentioned in the book. Our deep indebtedness to the British *Nautical Almanac* and the *American Ephemeris* is thankfully acknowledged.

C. A. CHANT.

David Dunlap Observatory,
Richmond Hill, Ont., November, 1948.

# ANNIVERSARIES AND FESTIVALS 1949

| | | | |
|---|---|---|---|
| New Year's Day | Sat. | Jan. | 1 |
| Epiphany | Thu. | Jan. | 6 |
| Septuagesima Sunday | | Feb. | 13 |
| Quinquagesima (Shrove Sunday) | | Feb. | 27 |
| St. David | Tue. | Mar. | 1 |
| Ash Wednesday | | Mar. | 2 |
| St. Patrick | Thu. | Mar. | 17 |
| Palm Sunday | | Apr. | 10 |
| Good Friday | | Apr. | 15 |
| Easter Sunday | | Apr. | 17 |
| St. George | Sat. | Apr. | 23 |
| Rogation Sunday | | May | 22 |
| Empire Day (Victoria Day) | Tue. | May | 24 |
| Ascension Day | Thu. | May | 26 |
| Birthday of the Queen Mother, Mary (1867) | Thu. | May | 26 |
| Pentecost (Whit Sunday) | | Jun. | 5 |
| Trinity Sunday | | Jun. | 12 |
| Corpus Christi | Thu. | Jun. | 16 |
| St. John Baptist (Midsummer Day) | Fri. | Jun. | 24 |
| Dominion Day | Fri. | Jul. | 1 |
| Birthday of Queen Elizabeth (1900) | Thu. | Aug. | 4 |
| Labour Day | Mon. | Sep. | 5 |
| Hebrew New Year (Rosh Hashanah) | Sat. | Sep. | 24 |
| St. Michael (Michaelmas Day) | Thu. | Sep. | 29 |
| All Saints' Day | Tue. | Nov. | 1 |
| Remembrance Day | Fri. | Nov. | 11 |
| First Sunday in Advent | | Nov. | 27 |
| St. Andrew | Wed. | Nov. | 30 |
| Accession of King George VI (1936) | Sun. | Dec. | 11 |
| Birthday of King George VI (1895) | Wed. | Dec. | 14 |
| Christmas Day | Sun. | Dec. | 25 |

Thanksgiving Day, Date set by Proclamation

# SYMBOLS AND ABBREVIATIONS

## SIGNS OF THE ZODIAC

| | | |
|---|---|---|
| ♈ Aries........ 0° | ♌ Leo........120° | ♐ Sagittarius...240° |
| ♉ Taurus ......30° | ♍ Virgo......150° | ♑ Capricornus..270° |
| ♊ Gemini ......60° | ♎ Libra......180° | ♒ Aquarius....300° |
| ♋ Cancer.......90° | ♏ Scorpio ....210° | ♓ Pisces.......330° |

## SUN, MOON AND PLANETS

| | | |
|---|---|---|
| ☉ The Sun. | ☾ The Moon generally. | ♃ Jupiter. |
| ● New Moon. | ☿ Mercury. | ♄ Saturn. |
| ☉ Full Moon. | ♀ Venus. | ♅ or ♅ Uranus. |
| ☽ First Quarter | ⊕ Earth. | ♆ Neptune. |
| ☾ Last Quarter. | ♂ Mars. | ♇ Pluto |

## ASPECTS AND ABBREVIATIONS

☌ Conjunction, or having the same Longitude or Right Ascension.
☍ Opposition, or differing 180° in Longitude or Right Ascension.
□ Quadrature, or differing 90° in Longitude or Right Ascension.
☊ Ascending Node; ☋ Descending Node.
$\alpha$ or A.R., Right Ascension; $\delta$ Declination.
h, m, s, Hours, Minutes, Seconds of Time.
° ′ ″, Degrees, Minutes, Seconds of Arc.

## THE GREEK ALPHABET

| | | | | | |
|---|---|---|---|---|---|
| Α, α, | Alpha. | Ι, ι, | Iota. | Ρ, ρ, | Rho. |
| Β, β, | Beta. | Κ, κ, | Kappa. | Σ, σ, ς, | Sigma. |
| Γ, γ, | Gamma. | Λ, λ, | Lambda. | Τ, τ, | Tau. |
| Δ, δ, | Delta. | Μ, μ, | Mu. | Υ, υ, | Upsilon. |
| Ε, ε, | Epsilon. | Ν, ν, | Nu. | Φ, φ, | Phi. |
| Ζ, ζ, | Zeta. | Ξ, ξ, | Xi. | Χ, χ, | Chi. |
| Η, η, | Eta. | Ο, ο, | Omicron. | Ψ, ψ, | Psi. |
| Θ, θ, ϑ, | Theta. | Π, π, | Pi. | Ω, ω, | Omega. |

## THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 31, 33, etc.), O represents the disc of the planet, d signifies that the satellite is on the disc, * signifies that the satellite is behind the disc or in the shadow. Configurations are for an inverting telescope.

# THE CONSTELLATIONS

## Latin and English Names with Abbreviations

| | | |
|---|---|---|
| Andromeda, (*Chained Maiden*) | And | Andr |
| Antlia, *Air Pump* | Ant | Antl |
| Apus, *Bird of Paradise* | Aps | Apus |
| Aquarius, *Water-bearer* | Aqr | Aqar |
| Aquila, *Eagle* | Aql | Aqil |
| Ara, *Altar* | Ara | Arae |
| Aries, *Ram* | Ari | Arie |
| Auriga, (*Charioteer*) | Aur | Auri |
| Bootes, (*Herdsman*) | Boo | Boot |
| Caelum, *Chisel* | Cae | Cael |
| Camelopardalis, *Giraffe* | Cam | Caml |
| Cancer, *Crab* | Cnc | Canc |
| Canes Venatici, *Hunting Dogs* | CVn | CVen |
| Canis Major, *Greater Dog* | CMa | CMaj |
| Canis Minor, *Lesser Dog* | CMi | CMin |
| Capricornus, *Sea-goat* | Cap | Capr |
| Carina, *Keel* | Car | Cari |
| Cassiopeia, (*Lady in Chair*) | Cas | Cass |
| Centaurus, *Centaur* | Cen | Cent |
| Cepheus, (*King*) | Cep | Ceph |
| Cetus, *Whale* | Cet | Ceti |
| Chamaeleon, *Chamaeleon* | Cha | Cham |
| Circinus, *Compasses* | Cir | Circ |
| Columba, *Dove* | Col | Colm |
| Coma Berenices, *Berenice's Hair* | Com | Coma |
| Corona Australis, *Southern Crown* | CrA | CorA |
| Corona Borealis, *Northern Crown* | CrB | CorB |
| Corvus, *Crow* | Crv | Corv |
| Crater, *Cup* | Crt | Crat |
| Crux, (*Southern*) *Cross* | Cru | Cruc |
| Cygnus, *Swan* | Cyg | Cygn |
| Delphinus, *Dolphin* | Del | Dlph |
| Dorado, *Swordfish* | Dor | Dora |
| Draco, *Dragon* | Dra | Drac |
| Equuleus, *Little Horse* | Equ | Equl |
| Eridanus, *River Eridanus* | Eri | Erid |
| Fornax, *Furnace* | For | Forn |
| Gemini, *Twins* | Gem | Gemi |
| Grus, *Crane* | Gru | Grus |
| Hercules, (*Kneeling Giant*) | Her | Herc |
| Horologium, *Clock* | Hor | Horo |
| Hydra, *Water-snake* | Hya | Hyda |
| Hydrus, *Sea-serpent* | Hyi | Hydi |
| Indus, *Indian* | Ind | Indi |
| Lacerta, *Lizard* | Lac | Lacr |

| | | |
|---|---|---|
| Leo, *Lion* | Leo | Leon |
| Leo Minor, *Lesser Lion* | LMi | LMin |
| Lepus, *Hare* | Lep | Leps |
| Libra, *Scales* | Lib | Libr |
| Lupus, *Wolf* | Lup | Lupi |
| Lynx, *Lynx* | Lyn | Lync |
| Lyra, *Lyre* | Lyr | Lyra |
| Mensa, *Table* (*Mountain*) | Men | Mens |
| Microscopium, *Microscope* | Mic | Micr |
| Monoceros, *Unicorn* | Mon | Mono |
| Musca, *Fly* | Mus | Musc |
| Norma, *Square* | Nor | Norm |
| Octans, *Octant* | Oct | Octn |
| Ophiuchus, *Serpent-bearer* | Oph | Ophi |
| Orion, (*Hunter*) | Ori | Orio |
| Pavo, *Peacock* | Pav | Pavo |
| Pegasus, (*Winged Horse*) | Peg | Pegs |
| Perseus, (*Champion*) | Per | Pers |
| Phoenix, *Phoenix* | Phe | Phoe |
| Pictor, *Painter* | Pic | Pict |
| Pisces, *Fishes* | Psc | Pisc |
| Piscis Australis, *Southern Fish* | PsA | PscA |
| Puppis, *Poop* | Pup | Pupp |
| Pyxis, *Compass* | Pyx | Pyxi |
| Reticulum, *Net* | Ret | Reti |
| Sagitta, *Arrow* | Sge | Sgte |
| Sagittarius, *Archer* | Sgr | Sgtr |
| Scorpius, *Scorpion* | Scr | Scor |
| Sculptor, *Sculptor* | Scl | Scul |
| Scutum, *Shield* | Sct | Scut |
| Serpens, *Serpent* | Ser | Serp |
| Sextans, *Sextant* | Sex | Sext |
| Taurus, *Bull* | Tau | Taur |
| Telescopium, *Telescope* | Tel | Tele |
| Triangulum, *Triangle* | Tri | Tria |
| Triangulum Australe, *Southern Triangle* | TrA | TrAu |
| Tucana, *Toucan* | Tuc | Tucn |
| Ursa Major, *Greater Bear* | UMa | UMaj |
| Ursa Minor, *Lesser Bear* | UMi | UMin |
| Vela, *Sails* | Vel | Velr |
| Virgo, *Virgin* | Vir | Virg |
| Volans, *Flying Fish* | Vol | Voln |
| Vulpecula, *Fox* | Vul | Vulp |

The 4-letter abbreviations are intended to be used in cases where a maximum saving of space is not necessary.

# MISCELLANEOUS ASTRONOMICAL DATA

**Units of Length**

| | | | |
|---|---|---|---|
| 1 Angstrom unit | $= 10^{-8}$ cm. | | |
| 1 micron | $= 10^{-4}$ cm. | | |
| 1 meter | $= 10^{2}$ cm. | $= 3.28084$ feet | |
| 1 kilometer | $= 10^{5}$ cm. | $= 0.62137$ miles | |
| 1 mile | $= 1.60935 \times 10^{5}$ cm. | $= 1.60935$ km. | |
| 1 astronomical unit | $= 1.49504 \times 10^{13}$ cm. | $= 92,897,416$ miles | |
| 1 light year | $= 9.463 \times 10^{17}$ cm. | $= 5.880 \times 10^{12}$ miles | $= 0.3069$ parsecs |
| 1 parsec | $= 30.84 \times 10^{17}$ cm. | $= 19.16 \times 10^{12}$ miles | $= 3.259$ l.y. |
| 1 megaparsec | $= 30.84 \times 10^{23}$ cm. | $= 19.16 \times 10^{18}$ miles | $= 3.259 \times 10^{6}$ l.y. |

**Units of Time**

Sidereal day $=$ 23*h* 56*m* 04.09*s* of mean solar time
Mean solar day $=$ 24*h* 03*m* 56.56*s* of sidereal time
Synodical month $=$ 29*d* 12*h* 44*m*; sidereal month $=$ 27*d* 07*h* 43*m*
Tropical year (ordinary) $=$ 365*d* 05*h* 48*m* 46*s*
Sidereal year $=$ 365*d* 06*h* 09*m* 10*s*
Eclipse year $=$ 346*d* 14*h* 53*m*

**The Earth**

Equatorial radius, $a = 3963.35$ miles; flattening, $c = (a-b)/a = 1/297.0$
Polar radius, $b = 3950.01$ miles
1° of latitude $= 69.057 - 0.349 \cos 2\phi$ miles (at latitude $\phi$)
1° of longitude $= 69.232 \cos \phi - 0.0584 \cos 3\phi$ miles
Mass of earth $= 6.6 \times 10^{21}$ tons; velocity of escape from $\oplus = 6.94$ miles/sec.

**Earth's Orbital Motion**

Solar parallax $=$ 8.″80; constant of aberration $=$ 20.″47
Annual general precession $=$ 50.″26; obliquity of ecliptic $=$ 23° 26′ 50″ (1939)
Orbital velocity $=$ 18.5 miles/sec.; parabolic velocity at $\oplus$ $=$ 26.2 miles/sec.

**Solar Motion**

Solar apex, R.A. 18*h* 04*m*; Dec. + 31°
Solar velocity $=$ 12.2 miles/sec.

**The Galactic System**

North pole of galactic plane R.A. 12*h* 40*m*, Dec. + 28° (1900)
Centre, 325° galactic longitude, $=$ R.A. 17*h* 24*m*, Dec. −30°
Distance to centre $=$ 10,000 parsecs; diameter $=$ 30,000 parsecs.
Rotational velocity (at sun) $=$ 262 km./sec.
Rotational period (at sun) $= 2.2 \times 10^{8}$ years
Mass $= 2 \times 10^{11}$ solar masses

**Extragalactic Nebulae**

Red shift $=$ +530 km./sec./megaparsec $=$ +101 miles /sec./million l.y.

**Radiation Constants**

Velocity of light $=$ 299,774 km./sec. $=$ 186,271 miles/sec.
Solar constant $=$ 1.93 gram calories/square cm./minute
Light ratio for one magnitude $=$ 2.512; log ratio $=$ 0.4000
Radiation from a star of zero apparent magnitude $= 3 \times 10^{-6}$ meter candles
Total energy emitted by a star of zero absolute magnitude $= 5 \times 10^{25}$ horsepower

**Miscellaneous**

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.035 \times 10^{-28}$ gm.; mass of the proton $= 1.662 \times 10^{-24}$ gm
Planck's constant, $h = 6.55 \times 10^{-27}$ erg. sec.
Loschmidt's number $= 2.705 \times 10^{19}$ molecules/cu. cm. of gas at N.T.P.
Absolute temperature $= T^\circ\,K = T^\circ C + 273^\circ = 5/9\,(T^\circ\,F + 459^\circ)$

| | |
|---|---|
| 1 radian $=$ 57°.2958 | $\pi = 3.141,592,653,6$ |
| $=$ 3437′.75 | No. of square degrees in the sky |
| $=$ 206,265″ | $=$ 41,253 |

# 1949 EPHEMERIS OF THE SUN AT 0h GREENWICH CIVIL TIME

| Date 1949 | Apparent R.A. | Corr. to Sun-dial | Apparent Dec. |
|---|---|---|---|
| | h m s | m s | ° ′ |
| Jan. 1 | 18 44 37 | +03 22 | −23 03.1 |
| 4 | 18 57 51 | +04 47 | −22 46.9 |
| 7 | 19 11 02 | +06 07 | −22 26.6 |
| 10 | 19 24 07 | +07 23 | −22 02.4 |
| 13 | 19 37 08 | +08 34 | −21 34.3 |
| 16 | 19 50 03 | +09 40 | −21 02.4 |
| 19 | 20 02 52 | +10 39 | −20 27.0 |
| 22 | 20 15 34 | +11 32 | −19 48.0 |
| 25 | 20 28 10 | +12 18 | −19 05.8 |
| 28 | 20 40 39 | +12 57 | −18 20.3 |
| 31 | 20 53 01 | +13 29 | −17 31.9 |
| Feb. 3 | 21 05 15 | +13 53 | −16 40.7 |
| 6 | 21 17 21 | +14 10 | −15 46.9 |
| 9 | 21 29 20 | +14 20 | −14 50.6 |
| 12 | 21 41 12 | +14 22 | −13 52.2 |
| 15 | 21 52 57 | +14 17 | −12 51.7 |
| 18 | 22 04 36 | +14 06 | −11 49.3 |
| 21 | 22 16 08 | +13 49 | −10 45.2 |
| 24 | 22 27 35 | +13 26 | −09 39.6 |
| 27 | 22 38 56 | +12 57 | −08 32.7 |
| Mar. 2 | 22 50 12 | +12 24 | −07 24.6 |
| 5 | 23 01 24 | +11 46 | −06 15.6 |
| 8 | 23 12 32 | +11 04 | −05 05.8 |
| 11 | 23 23 36 | +10 19 | −03 55.5 |
| 14 | 23 34 37 | +09 30 | −02 44.7 |
| 17 | 23 45 35 | +08 39 | −01 33.7 |
| 20 | 23 56 32 | +07 46 | −00 22.5 |
| 23 | 00 07 28 | +06 52 | +00 48.5 |
| 26 | 00 18 23 | +05 57 | +01 59.4 |
| 29 | 00 29 18 | +05 03 | +03 09.9 |
| Apr. 1 | 00 40 13 | +04 08 | +04 19.8 |
| 4 | 00 51 09 | +03 15 | +05 29.1 |
| 7 | 01 02 07 | +02 22 | +06 37.4 |
| 10 | 01 13 06 | +01 32 | +07 44.7 |
| 13 | 01 24 07 | +00 44 | +08 50.8 |
| 16 | 01 35 11 | −00 02 | +09 55.6 |
| 19 | 01 46 19 | −00 44 | +10 59.0 |
| 22 | 01 57 30 | −01 22 | +12 00.7 |
| 25 | 02 08 46 | −01 57 | +13 00.6 |
| 28 | 02 20 05 | −02 27 | +13 58.7 |
| May 1 | 02 31 30 | −02 52 | +14 54.7 |
| 4 | 02 42 59 | −03 13 | +15 48.4 |
| 7 | 02 54 33 | −03 28 | +16 39.8 |
| 10 | 03 06 11 | −03 39 | +17 28.7 |
| 13 | 03 17 55 | −03 45 | +18 14.9 |
| 16 | 03 29 44 | −03 46 | +18 58.4 |
| 19 | 03 41 38 | −03 41 | +19 39.0 |
| 22 | 03 53 38 | −03 31 | +20 16.6 |
| 25 | 04 05 42 | −03 17 | +20 51.1 |
| 28 | 04 17 51 | −02 58 | +21 22.4 |
| 31 | 04 30 04 | −02 34 | +21 50.4 |
| Jun. 3 | 04 42 21 | −02 07 | +22 14.9 |
| 6 | 04 54 41 | −01 37 | +22 35.9 |
| 9 | 05 07 04 | −01 04 | +22 53.4 |
| 12 | 05 19 29 | −00 28 | +23 07.3 |
| 15 | 05 31 55 | +00 09 | +23 17.5 |
| 18 | 05 44 23 | +00 47 | +23 24.0 |
| 21 | 05 56 52 | +01 26 | +23 26.8 |
| 24 | 06 09 21 | +02 05 | +23 25.8 |
| 27 | 06 21 49 | +02 44 | +23 21.2 |
| 30 | 06 34 16 | +03 21 | +23 12.9 |

| Date 1949 | Apparent R.A. | Corr. to Sun-dial | Apparent Dec. |
|---|---|---|---|
| | h m s | m s | ° ′ |
| Jul. 3 | 06 46 41 | +03 56 | +23 00.9 |
| 6 | 06 59 03 | +04 28 | +22 45.3 |
| 9 | 07 11 21 | +04 57 | +22 26.1 |
| 12 | 07 23 36 | +05 22 | +22 03.4 |
| 15 | 07 35 47 | +05 44 | +21 37.4 |
| 18 | 07 47 54 | +06 01 | +21 08.0 |
| 21 | 07 59 56 | +06 13 | +20 35.5 |
| 24 | 08 11 53 | +06 21 | +19 59.7 |
| 27 | 08 23 45 | +06 23 | +19 21.0 |
| 30 | 08 35 32 | +06 20 | +18 39.4 |
| Aug. 2 | 08 47 13 | +06 11 | +17 55.0 |
| 5 | 08 58 48 | +05 57 | +17 08.1 |
| 8 | 09 10 18 | +05 37 | +16 18.6 |
| 11 | 09 21 43 | +05 12 | +15 26.8 |
| 14 | 09 33 02 | +04 42 | +14 32.7 |
| 17 | 09 44 17 | +04 07 | +13 36.6 |
| 20 | 09 55 27 | +03 28 | +12 38.5 |
| 23 | 10 06 33 | +02 44 | +11 38.6 |
| 26 | 10 17 35 | +01 56 | +10 37.0 |
| 29 | 10 28 33 | +01 05 | +09 33.9 |
| Sep. 1 | 10 39 28 | +00 10 | +08 29.4 |
| 4 | 10 50 20 | −00 47 | +07 23.8 |
| 7 | 11 01 10 | −01 47 | +06 17.0 |
| 10 | 11 11 58 | −02 49 | +05 09.4 |
| 13 | 11 22 45 | −03 52 | +04 00.9 |
| 16 | 11 33 30 | −04 56 | +02 51.8 |
| 19 | 11 44 16 | −06 00 | +01 42.2 |
| 22 | 11 55 03 | −07 03 | +00 32.2 |
| 25 | 12 05 50 | −08 06 | −00 37.9 |
| 28 | 12 16 38 | −09 07 | −01 48.1 |
| Oct. 1 | 12 27 28 | −10 06 | −02 58.2 |
| 4 | 12 38 21 | −11 04 | −04 07.9 |
| 7 | 12 49 16 | −11 58 | −05 17.2 |
| 10 | 13 00 15 | −12 48 | −06 25.9 |
| 13 | 13 11 19 | −13 35 | −07 33.8 |
| 16 | 13 22 27 | −14 16 | −08 40.9 |
| 19 | 13 33 40 | −14 53 | −09 46.8 |
| 22 | 13 44 59 | −15 24 | −10 51.5 |
| 25 | 13 56 24 | −15 48 | −11 54.7 |
| 28 | 14 07 55 | −16 07 | −12 56.2 |
| 31 | 14 19 33 | −16 19 | −13 56.0 |
| Nov. 3 | 14 31 17 | −16 24 | −14 53.7 |
| 6 | 14 43 09 | −16 21 | −15 49.2 |
| 9 | 14 55 09 | −16 12 | −16 42.4 |
| 12 | 15 07 16 | −15 54 | −17 33.0 |
| 15 | 15 19 31 | −15 29 | −18 20.9 |
| 18 | 15 31 53 | −14 56 | −19 06.0 |
| 21 | 15 44 24 | −14 15 | −19 48.0 |
| 24 | 15 57 01 | −13 28 | −20 26.7 |
| 27 | 16 09 46 | −12 33 | −21 02.0 |
| 30 | 16 22 36 | −11 32 | −21 33.7 |
| Dec. 3 | 16 35 33 | −10 25 | −22 01.8 |
| 6 | 16 48 35 | −09 12 | −22 26.0 |
| 9 | 17 01 42 | −07 55 | −22 46.3 |
| 12 | 17 14 53 | −06 33 | −23 02.6 |
| 15 | 17 28 08 | −05 08 | −23 14.8 |
| 18 | 17 41 26 | −03 41 | −23 22.8 |
| 21 | 17 54 45 | −02 11 | −23 26.6 |
| 24 | 18 08 04 | −00 41 | −23 26.1 |
| 27 | 18 21 24 | +00 48 | −23 21.4 |
| 30 | 18 34 41 | +02 17 | −23 12.5 |

## SOLAR AND SIDEREAL TIME

In practical astronomy three different kinds of time are used, while in ordinary life we use a fourth.

1. *Apparent Time*—By apparent noon is meant the moment when the sun is on the meridian, and apparent time is measured by the distance in degrees that the sun is east or west of the meridian. Apparent time is given by the sun-dial.

2. *Mean Time*—The interval between apparent noon on two successive days is not constant, and a clock cannot be constructed to keep apparent time. For this reason *mean time* is used. The length of a mean day is the average of all the apparent days throughout the year. The *real sun* moves about the ecliptic in one year; an imaginary *mean sun* is considered as moving uniformly around the celestial equator in one year. The difference between the times that the real sun and the mean sun cross the meridian is the *equation of time.* Or, in general, *Apparent Time—Mean Time = Equation of Time.* This is the same as *Correction to Sun-dial* on page 7, with the sign reversed.

3. *Sidereal Time*—This is time as determined from the stars. It is sidereal noon when the Vernal Equinox or First of Aries is on the meridian. In accurate time-keeping the moment when a star is on the meridian is observed and the corresponding mean time is then computed with the assistance of the Nautical Almanac. When a telescope is mounted equatorially the position of a body in the sky is located by means of the sidereal time.

4. *Standard Time*—In everyday life we use still another kind of time. A moment's thought will show that in general two places will not have the same mean time; indeed, difference in longitude between two places is determined from their difference in time. But in travelling it is very inconvenient to have the time varying from station to station. For the purpose of facilitating transportation the system of *Standard Time* was introduced in 1883. Within a certain belt approximately 15° wide, all the clocks show the same time, and in passing from one belt to the next the hands of the clock are moved forward or backward one hour.

In Canada we have six standard time belts, as follows;—60th meridian or Atlantic Time, 4h. slower than Greenwich; 75th meridian or Eastern Time, 5h.; 90th meridian or Central Time, 6h.; 105th meridian or Mountain Time, 7h.; 120th meridian or Pacific Time, 8h.; and 135th meridian or Yukon Time, 9h. slower than Greenwich.

The boundaries of the time belts are shown on the map on page 9.

*Daylight Saving Time* is the standard time of the next zone eastward. It is adopted in many places between certain specified dates during the summer.

# MAP OF STANDARD TIME ZONES

## TIMES OF SUNRISE AND SUNSET

In the tables on pages 11 to 16 are given the times of sunrise and sunset for places in latitudes 32°, 36°, 40°, 44°, 46°, 48°, 50°, and 52°. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean to Standard Time for the cities and towns named.

The time of sunrise and sunset at a given place, in local mean time, varies from day to day, and depends principally upon the declination of the sun. Variations in the equation of time, the apparent diameter of the sun and atmospheric refraction at the points of sunrise and sunset also affect the final result. These quantities, as well as the solar declination, do not have precisely the same values on corresponding days from year to year, and so the table gives only approximately average values. The times are for the rising and setting of the upper limb of the sun, and are corrected for refraction. It must also be remembered that these times are computed for the sea horizon, which is only approximately realised on land surfaces.

### *The Standard Times for Any Station*

In order to find the time of sunrise and sunset for any place on any day, first from the list below find the approximate latitude of the place and the correction, in minutes, which follows the name. Then find in the monthly table the local time of sunrise and sunset for the proper latitude, on the desired day, and apply the correction to get the Standard Time.

**CANADIAN CITIES AND TOWNS**

| | Lat. | Cor. | | Lat. | Cor. |
|---|---|---|---|---|---|
| Belleville | 44 | + 09 | Peterborough | 44 | + 13 |
| Brandon | 50 | + 40 | Port Arthur | 48 | + 57 |
| Brantford | 43 | + 21 | Prince Albert | 53 | + 03 |
| Calgary | 51 | + 36 | Prince Rupert | 54 | + 41 |
| Charlottetown | 46 | + 13 | Quebec | 47 | − 15 |
| Chatham | 42 | + 29 | Regina | 50 | − 02 |
| Cornwall | 45 | − 01 | St. Catharines | 43 | + 17 |
| Dawson | 64 | + 18 | St. Hyacinthe | 46 | − 09 |
| Edmonton | 54 | + 34 | St. John, N.B. | 45 | + 24 |
| Fort William | 48 | + 57 | St. John's, Nfld. | 48 | 00 |
| Fredericton | 46 | + 26 | St. Thomas | 43 | + 25 |
| Galt | 43 | + 21 | Sarnia | 43 | + 30 |
| Glace Bay | 46 | 00 | Saskatoon | 52 | + 07 |
| Granby | 45 | − 09 | Sault Ste. Marie | 47 | + 37 |
| Guelph | 44 | + 21 | Shawinigan Falls | 47 | − 09 |
| Halifax | 45 | + 15 | Sherbrooke | 45 | − 13 |
| Hamilton | 43 | + 19 | Stratford | 43 | + 24 |
| Hull | 45 | + 03 | Sudbury | 47 | + 24 |
| Kingston | 44 | + 06 | Sydney | 46 | + 01 |
| Kitchener | 43 | + 22 | Timmins | 48 | + 26 |
| London | 43 | + 25 | Toronto | 44 | + 18 |
| Medicine Hat | 50 | + 23 | Three Rivers | 46 | − 10 |
| Moncton | 46 | + 19 | Trail | 49 | − 09 |
| Montreal | 45 | − 06 | Truro | 45 | + 13 |
| Moose Jaw | 50 | + 02 | Vancouver | 49 | + 12 |
| Niagara Falls | 43 | + 16 | Victoria | 48 | + 14 |
| North Bay | 46 | + 18 | Windsor | 42 | + 32 |
| Oshawa | 44 | + 15 | Winnipeg | 50 | + 29 |
| Ottawa | 45 | + 03 | Woodstock | 43 | + 23 |
| Owen Sound | 45 | + 24 | Yellowknife | 63 | + 37 |

**AMERICAN CITIES**

| | Lat. | Cor. |
|---|---|---|
| Atlanta | 34 | + 37 |
| Baltimore | 39 | + 06 |
| Birmingham | 34 | − 13 |
| Boston | 42 | − 16 |
| Buffalo | 43 | + 15 |
| Chicago | 42 | − 10 |
| Cincinnati | 39 | + 38 |
| Cleveland | 42 | + 26 |
| Dallas | 33 | + 27 |
| Denver | 40 | 00 |
| Detroit | 42 | + 32 |
| Fairbanks | 65 | − 10 |
| Indianapolis | 40 | − 15 |
| Juneau | 58 | − 02 |
| Kansas City | 39 | + 18 |
| Los Angeles | 34 | − 07 |
| Louisville | 38 | − 17 |
| Memphis | 35 | 00 |
| Milwaukee | 43 | − 09 |
| Minneapolis | 45 | + 13 |
| New Orleans | 30 | 00 |
| New York | 41 | − 04 |
| Omaha | 41 | + 24 |
| Philadelphia | 40 | + 01 |
| Pittsburgh | 40 | + 20 |
| Portland | 46 | + 11 |
| St. Louis | 39 | + 01 |
| San Francisco | 38 | + 10 |
| Seattle | 48 | + 09 |
| Washington | 39 | + 08 |

*Example*—Find the time of sunrise at Owen Sound, on February 12.

In the above list Owen Sound is under "45°", and the correction is + 24 min. On page 11 the time of sunrise on February 12 for latitude 45° is 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

| DATE | | Latitude 32° Sunrise | Latitude 32° Sunset | Latitude 36° Sunrise | Latitude 36° Sunset | Latitude 40° Sunrise | Latitude 40° Sunset | Latitude 44° Sunrise | Latitude 44° Sunset | Latitude 46° Sunrise | Latitude 46° Sunset | Latitude 48° Sunrise | Latitude 48° Sunset | Latitude 50° Sunrise | Latitude 50° Sunset | Latitude 52° Sunrise | Latitude 52° Sunset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |
| January | **1** | 7 01 | 5 07 | 7 11 | 4 57 | 7 22 | 4 45 | 7 35 | 4 32 | 7 42 | 4 25 | 7 50 | 4 17 | 7 59 | 4 08 | 8 08 | 3 59 |
| | **3** | 7 01 | 5 08 | 7 11 | 4 58 | 7 23 | 4 47 | 7 35 | 4 34 | 7 42 | 4 26 | 7 50 | 4 19 | 7 59 | 4 10 | 8 08 | 4 01 |
| | **5** | 7 01 | 5 10 | 7 12 | 5 00 | 7 23 | 4 49 | 7 35 | 4 36 | 7 42 | 4 29 | 7 50 | 4 22 | 7 58 | 4 13 | 8 07 | 4 03 |
| | **7** | 7 02 | 5 11 | 7 11 | 5 02 | 7 22 | 4 50 | 7 35 | 4 38 | 7 42 | 4 31 | 7 49 | 4 23 | 7 58 | 4 15 | 8 06 | 4 06 |
| | **9** | 7 02 | 5 13 | 7 11 | 5 04 | 7 22 | 4 52 | 7 34 | 4 40 | 7 41 | 4 33 | 7 49 | 4 26 | 7 57 | 4 18 | 8 05 | 4 08 |
| | **11** | 7 02 | 5 15 | 7 11 | 5 06 | 7 22 | 4 54 | 7 34 | 4 42 | 7 40 | 4 36 | 7 48 | 4 28 | 7 56 | 4 20 | 8 05 | 4 11 |
| | **13** | 7 01 | 5 16 | 7 11 | 5 08 | 7 21 | 4 56 | 7 33 | 4 45 | 7 39 | 4 39 | 7 47 | 4 31 | 7 55 | 4 23 | 8 03 | 4 14 |
| | **15** | 7 01 | 5 18 | 7 10 | 5 10 | 7 20 | 4 58 | 7 32 | 4 48 | 7 38 | 4 41 | 7 45 | 4 34 | 7 54 | 4 26 | 8 01 | 4 18 |
| | **17** | 7 01 | 5 20 | 7 10 | 5 12 | 7 20 | 5 00 | 7 30 | 4 50 | 7 37 | 4 44 | 7 44 | 4 37 | 7 52 | 4 29 | 7 59 | 4 21 |
| | **19** | 7 00 | 5 22 | 7 09 | 5 14 | 7 19 | 5 02 | 7 29 | 4 53 | 7 35 | 4 46 | 7 42 | 4 39 | 7 50 | 4 32 | 7 57 | 4 24 |
| | **21** | 6 59 | 5 24 | 7 08 | 5 15 | 7 18 | 5 05 | 7 28 | 4 55 | 7 34 | 4 48 | 7 40 | 4 42 | 7 48 | 4 35 | 7 56 | 4 27 |
| | **23** | 6 59 | 5 26 | 7 07 | 5 17 | 7 15 | 5 08 | 7 26 | 4 57 | 7 32 | 4 51 | 7 39 | 4 45 | 7 46 | 4 38 | 7 54 | 4 31 |
| | **25** | 6 58 | 5 27 | 7 06 | 5 19 | 7 14 | 5 10 | 7 26 | 5 00 | 7 31 | 4 54 | 7 37 | 4 48 | 7 44 | 4 41 | 7 51 | 4 35 |
| | **27** | 6 57 | 5 29 | 7 05 | 5 21 | 7 12 | 5 13 | 7 24 | 5 02 | 7 29 | 4 57 | 7 35 | 4 51 | 7 42 | 4 45 | 7 48 | 4 38 |
| | **29** | 6 56 | 5 31 | 7 04 | 5 23 | 7 11 | 5 15 | 7 22 | 5 05 | 7 27 | 5 00 | 7 33 | 4 54 | 7 39 | 4 48 | 7 46 | 4 42 |
| | **31** | 6 55 | 5 33 | 7 02 | 5 25 | 7 10 | 5 17 | 7 19 | 5 08 | 7 24 | 5 03 | 7 30 | 4 57 | 7 36 | 4 51 | 7 43 | 4 45 |
| February | **2** | 6 53 | 5 35 | 7 00 | 5 27 | 7 08 | 5 20 | 7 17 | 5 11 | 7 22 | 5 06 | 7 27 | 5 00 | 7 33 | 4 55 | 7 39 | 4 49 |
| | **4** | 6 52 | 5 37 | 6 59 | 5 29 | 7 06 | 5 22 | 7 15 | 5 13 | 7 20 | 5 09 | 7 25 | 5 04 | 7 30 | 4 58 | 7 35 | 4 53 |
| | **6** | 6 50 | 5 38 | 6 57 | 5 32 | 7 04 | 5 25 | 7 13 | 5 16 | 7 18 | 5 11 | 7 22 | 5 07 | 7 27 | 5 02 | 7 32 | 4 56 |
| | **8** | 6 49 | 5 40 | 6 55 | 5 34 | 7 02 | 5 27 | 7 10 | 5 19 | 7 15 | 5 14 | 7 20 | 5 10 | 7 24 | 5 05 | 7 29 | 5 00 |
| | **10** | 6 47 | 5 42 | 6 53 | 5 36 | 7 00 | 5 29 | 7 08 | 5 22 | 7 13 | 5 17 | 7 17 | 5 13 | 7 21 | 5 08 | 7 25 | 5 03 |
| | **12** | 6 45 | 5 44 | 6 51 | 5 38 | 6 59 | 5 31 | 7 05 | 5 24 | 7 09 | 5 20 | 7 14 | 5 16 | 7 17 | 5 12 | 7 21 | 5 07 |
| | **14** | 6 44 | 5 45 | 6 49 | 5 40 | 6 55 | 5 34 | 7 03 | 5 27 | 7 06 | 5 23 | 7 10 | 5 19 | 7 14 | 5 15 | 7 18 | 5 10 |
| | **16** | 6 42 | 5 47 | 6 47 | 5 42 | 6 53 | 5 36 | 7 00 | 5 30 | 7 02 | 5 26 | 7 06 | 5 23 | 7 10 | 5 19 | 7 14 | 5 14 |
| | **18** | 6 40 | 5 49 | 6 45 | 5 44 | 6 50 | 5 39 | 6 57 | 5 33 | 6 59 | 5 29 | 7 03 | 5 26 | 7 07 | 5 22 | 7 11 | 5 18 |
| | **20** | 6 38 | 5 50 | 6 43 | 5 46 | 6 48 | 5 41 | 6 54 | 5 35 | 6 56 | 5 32 | 6 59 | 5 29 | 7 03 | 5 26 | 7 07 | 5 22 |
| | **22** | 6 36 | 5 52 | 6 40 | 5 48 | 6 45 | 5 43 | 6 50 | 5 38 | 6 53 | 5 35 | 6 56 | 5 32 | 6 59 | 5 29 | 7 02 | 5 26 |
| | **24** | 6 33 | 5 54 | 6 38 | 5 50 | 6 42 | 5 45 | 6 47 | 5 40 | 6 49 | 5 38 | 6 52 | 5 35 | 6 55 | 5 32 | 6 58 | 5 30 |
| | **26** | 6 31 | 5 55 | 6 35 | 5 52 | 6 39 | 5 47 | 6 44 | 5 43 | 6 46 | 5 41 | 6 49 | 5 38 | 6 51 | 5 36 | 6 53 | 5 33 |
| | **28** | 6 29 | 5 57 | 6 33 | 5 54 | 6 36 | 5 49 | 6 40 | 5 46 | 6 43 | 5 44 | 6 45 | 5 41 | 6 47 | 5 39 | 6 49 | 5 31 |

| Month | DATE | Latitude 32° Sunrise | Latitude 32° Sunset | Latitude 36° Sunrise | Latitude 36° Sunset | Latitude 40° Sunrise | Latitude 40° Sunset | Latitude 44° Sunrise | Latitude 44° Sunset | Latitude 46° Sunrise | Latitude 46° Sunset | Latitude 48° Sunrise | Latitude 48° Sunset | Latitude 50° Sunrise | Latitude 50° Sunset | Latitude 52° Sunrise | Latitude 52° Sunset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |
| March | **2** | 6 27 | 5 58 | 6 30 | 5 55 | 6 33 | 5 52 | 6 37 | 5 48 | 6 39 | 5 46 | 6 41 | 5 44 | 6 43 | 5 42 | 6 46 | 5 40 |
| | **4** | 6 24 | 6 00 | 6 27 | 5 57 | 6 30 | 5 54 | 6 34 | 5 51 | 6 36 | 5 49 | 6 37 | 5 47 | 6 39 | 5 46 | 6 41 | 5 44 |
| | **6** | 6 22 | 6 01 | 6 24 | 5 59 | 6 27 | 5 57 | 6 30 | 5 54 | 6 32 | 5 52 | 6 33 | 5 51 | 6 35 | 5 49 | 6 37 | 5 47 |
| | **8** | 6 19 | 6 03 | 6 22 | 6 01 | 6 24 | 5 59 | 6 26 | 5 56 | 6 28 | 5 55 | 6 29 | 5 54 | 6 31 | 5 53 | 6 32 | 5 51 |
| | **10** | 6 17 | 6 04 | 6 19 | 6 03 | 6 21 | 6 01 | 6 23 | 5 59 | 6 24 | 5 58 | 6 25 | 5 57 | 6 26 | 5 56 | 6 28 | 5 55 |
| | **12** | 6 14 | 6 06 | 6 17 | 6 04 | 6 18 | 6 03 | 6 19 | 6 02 | 6 20 | 6 01 | 6 21 | 6 00 | 6 22 | 5 59 | 6 23 | 5 58 |
| | **14** | 6 12 | 6 07 | 6 14 | 6 06 | 6 15 | 6 05 | 6 15 | 6 04 | 6 16 | 6 03 | 6 17 | 6 03 | 6 18 | 6 02 | 6 19 | 6 02 |
| | **16** | 6 09 | 6 09 | 6 11 | 6 07 | 6 12 | 6 07 | 6 12 | 6 07 | 6 13 | 6 06 | 6 13 | 6 06 | 6 14 | 6 05 | 6 14 | 6 05 |
| | **18** | 6 07 | 6 10 | 6 08 | 6 10 | 6 08 | 6 09 | 6 08 | 6 09 | 6 09 | 6 09 | 6 09 | 6 09 | 6 10 | 6 09 | 6 10 | 6 09 |
| | **20** | 6 04 | 6 11 | 6 06 | 6 11 | 6 05 | 6 11 | 6 05 | 6 11 | 6 05 | 6 11 | 6 05 | 6 12 | 6 05 | 6 12 | 6 05 | 6 12 |
| | **22** | 6 02 | 6 13 | 6 03 | 6 13 | 6 02 | 6 13 | 6 02 | 6 14 | 6 02 | 6 14 | 6 01 | 6 15 | 6 01 | 6 15 | 6 00 | 6 15 |
| | **24** | 5 59 | 6 14 | 6 00 | 6 15 | 5 59 | 6 15 | 5 58 | 6 16 | 5 58 | 6 16 | 5 57 | 6 18 | 5 57 | 6 18 | 5 55 | 6 19 |
| | **26** | 5 57 | 6 16 | 5 57 | 6 16 | 5 56 | 6 17 | 5 55 | 6 19 | 5 54 | 6 19 | 5 53 | 6 20 | 5 52 | 6 21 | 5 51 | 6 22 |
| | **28** | 5 54 | 6 17 | 5 54 | 6 18 | 5 52 | 6 19 | 5 51 | 6 21 | 5 50 | 6 22 | 5 49 | 6 23 | 5 48 | 6 24 | 5 46 | 6 26 |
| | **30** | 5 51 | 6 18 | 5 51 | 6 19 | 5 49 | 6 21 | 5 48 | 6 23 | 5 46 | 6 24 | 5 45 | 6 25 | 5 43 | 6 27 | 5 41 | 6 29 |
| April | **1** | 5 49 | 6 20 | 5 48 | 6 21 | 5 46 | 6 23 | 5 44 | 6 25 | 5 42 | 6 27 | 5 41 | 6 28 | 5 39 | 6 30 | 5 37 | 6 32 |
| | **3** | 5 46 | 6 21 | 5 45 | 6 22 | 5 43 | 6 25 | 5 40 | 6 28 | 5 38 | 6 29 | 5 37 | 6 31 | 5 35 | 6 33 | 5 32 | 6 36 |
| | **5** | 5 44 | 6 22 | 5 42 | 6 24 | 5 40 | 6 27 | 5 37 | 6 30 | 5 35 | 6 33 | 5 32 | 6 34 | 5 30 | 6 36 | 5 28 | 6 39 |
| | **7** | 5 41 | 6 24 | 5 40 | 6 26 | 5 36 | 6 29 | 5 33 | 6 33 | 5 31 | 6 35 | 5 28 | 6 37 | 5 26 | 6 40 | 5 23 | 6 43 |
| | **9** | 5 39 | 6 25 | 5 37 | 6 28 | 5 33 | 6 31 | 5 29 | 6 35 | 5 27 | 6 38 | 5 24 | 6 40 | 5 21 | 6 43 | 5 19 | 6 46 |
| | **11** | 5 36 | 6 26 | 5 34 | 6 29 | 5 30 | 6 33 | 5 25 | 6 38 | 5 23 | 6 40 | 5 20 | 6 43 | 5 17 | 6 46 | 5 14 | 6 49 |
| | **13** | 5 34 | 6 28 | 5 32 | 6 31 | 5 27 | 6 35 | 5 22 | 6 40 | 5 19 | 6 43 | 5 16 | 6 46 | 5 13 | 6 49 | 5 10 | 6 52 |
| | **15** | 5 32 | 6 29 | 5 29 | 6 32 | 5 24 | 6 38 | 5 19 | 6 43 | 5 16 | 6 46 | 5 13 | 6 49 | 5 09 | 6 52 | 5 06 | 6 56 |
| | **17** | 5 29 | 6 30 | 5 26 | 6 35 | 5 21 | 6 40 | 5 15 | 6 45 | 5 12 | 6 48 | 5 09 | 6 52 | 5 05 | 6 56 | 5 01 | 6 59 |
| | **19** | 5 27 | 6 32 | 5 24 | 6 37 | 5 18 | 6 42 | 5 12 | 6 48 | 5 09 | 6 51 | 5 05 | 6 55 | 5 01 | 6 59 | 4 56 | 7 02 |
| | **21** | 5 25 | 6 33 | 5 21 | 6 38 | 5 15 | 6 44 | 5 09 | 6 50 | 5 05 | 6 54 | 5 01 | 6 58 | 4 57 | 7 02 | 4 52 | 7 06 |
| | **23** | 5 23 | 6 35 | 5 18 | 6 40 | 5 12 | 6 46 | 5 06 | 6 53 | 5 02 | 6 56 | 4 58 | 7 01 | 4 53 | 7 05 | 4 48 | 7 09 |
| | **25** | 5 20 | 6 36 | 5 16 | 6 41 | 5 09 | 6 48 | 5 02 | 6 55 | 4 58 | 6 59 | 4 54 | 7 03 | 4 49 | 7 08 | 4 44 | 7 13 |
| | **27** | 5 18 | 6 37 | 5 13 | 6 43 | 5 07 | 6 50 | 4 59 | 6 57 | 4 55 | 7 01 | 4 51 | 7 06 | 4 45 | 7 11 | 4 40 | 7 16 |
| | **29** | 5 16 | 6 39 | 5 11 | 6 44 | 5 04 | 6 52 | 4 56 | 7 00 | 4 52 | 7 04 | 4 47 | 7 08 | 4 42 | 7 14 | 4 36 | 7 20 |

| | DATE | Latitude 32° | | Latitude 36° | | Latitude 40° | | Latitude 44° | | Latitude 46° | | Latitude 48° | | Latitude 50° | | Latitude 52° | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset | Sunrise | Sunset |
| | | 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 |
| May | **1** | 5 14 | 6 40 | 5 09 | 6 46 | 5 02 | 6 53 | 4 53 | 7 02 | 4 49 | 7 06 | 4 44 | 7 11 | 4 38 | 7 17 | 4 32 | 7 23 |
| | **3** | 5 13 | 6 42 | 5 07 | 6 48 | 4 59 | 6 56 | 4 50 | 7 04 | 4 46 | 7 09 | 4 40 | 7 14 | 4 34 | 7 20 | 4 28 | 7 26 |
| | **5** | 5 11 | 6 43 | 5 05 | 6 49 | 4 56 | 6 58 | 4 47 | 7 07 | 4 43 | 7 11 | 4 37 | 7 17 | 4 31 | 7 23 | 4 25 | 7 29 |
| | **7** | 5 09 | 6 46 | 5 03 | 6 51 | 4 54 | 7 00 | 4 44 | 7 09 | 4 40 | 7 14 | 4 34 | 7 20 | 4 27 | 7 26 | 4 21 | 7 32 |
| | **9** | 5 07 | 6 47 | 5 01 | 6 52 | 4 51 | 7 02 | 4 42 | 7 11 | 4 37 | 7 16 | 4 31 | 7 22 | 4 24 | 7 29 | 4 17 | 7 36 |
| | **11** | 5 06 | 6 47 | 4 59 | 6 54 | 4 49 | 7 04 | 4 39 | 7 14 | 4 34 | 7 19 | 4 28 | 7 25 | 4 21 | 7 32 | 4 14 | 7 39 |
| | **13** | 5 04 | 6 49 | 4 57 | 6 56 | 4 47 | 7 06 | 4 37 | 7 16 | 4 31 | 7 21 | 4 25 | 7 28 | 4 18 | 7 35 | 4 11 | 7 42 |
| | **15** | 5 03 | 6 50 | 4 55 | 6 57 | 4 45 | 7 08 | 4 35 | 7 18 | 4 28 | 7 24 | 4 22 | 7 30 | 4 15 | 7 38 | 4 07 | 7 45 |
| | **17** | 5 02 | 6 51 | 4 53 | 6 59 | 4 44 | 7 10 | 4 33 | 7 20 | 4 26 | 7 26 | 4 20 | 7 33 | 4 13 | 7 40 | 4 04 | 7 48 |
| | **19** | 5 00 | 6 53 | 4 51 | 7 01 | 4 42 | 7 11 | 4 31 | 7 22 | 4 24 | 7 28 | 4 17 | 7 35 | 4 10 | 7 43 | 4 01 | 7 52 |
| | **21** | 4 59 | 6 54 | 4 50 | 7 03 | 4 40 | 7 13 | 4 29 | 7 24 | 4 22 | 7 31 | 4 15 | 7 38 | 4 07 | 7 46 | 3 58 | 7 55 |
| | **23** | 4 58 | 6 56 | 4 49 | 7 04 | 4 39 | 7 15 | 4 27 | 7 26 | 4 20 | 7 33 | 4 13 | 7 40 | 4 05 | 7 48 | 3 55 | 7 57 |
| | **25** | 4 57 | 6 57 | 4 48 | 7 05 | 4 37 | 7 16 | 4 25 | 7 28 | 4 18 | 7 35 | 4 11 | 7 43 | 4 03 | 7 51 | 3 53 | 8 00 |
| | **27** | 4 56 | 6 58 | 4 47 | 7 07 | 4 36 | 7 18 | 4 24 | 7 30 | 4 16 | 7 37 | 4 09 | 7 45 | 4 01 | 7 53 | 3 51 | 8 03 |
| | **29** | 4 56 | 6 59 | 4 46 | 7 08 | 4 35 | 7 20 | 4 22 | 7 32 | 4 15 | 7 39 | 4 07 | 7 47 | 3 59 | 7 56 | 3 49 | 8 05 |
| | **31** | 4 55 | 7 00 | 4 45 | 7 10 | 4 34 | 7 21 | 4 21 | 7 34 | 4 14 | 7 41 | 4 06 | 7 49 | 3 57 | 7 58 | 3 47 | 8 08 |
| June | **2** | 4 54 | 7 02 | 4 45 | 7 11 | 4 33 | 7 23 | 4 20 | 7 35 | 4 13 | 7 43 | 4 05 | 7 51 | 3 56 | 8 00 | 3 45 | 8 10 |
| | **4** | 4 54 | 7 03 | 4 44 | 7 12 | 4 33 | 7 24 | 4 19 | 7 37 | 4 12 | 7 44 | 4 04 | 7 53 | 3 55 | 8 02 | 3 44 | 8 12 |
| | **6** | 4 54 | 7 04 | 4 44 | 7 13 | 4 32 | 7 25 | 4 18 | 7 38 | 4 11 | 7 46 | 4 02 | 7 54 | 3 53 | 8 04 | 3 42 | 8 14 |
| | **8** | 4 53 | 7 05 | 4 43 | 7 14 | 4 31 | 7 26 | 4 17 | 7 40 | 4 10 | 7 47 | 4 02 | 7 56 | 3 52 | 8 05 | 3 41 | 8 16 |
| | **10** | 4 53 | 7 05 | 4 43 | 7 16 | 4 31 | 7 27 | 4 17 | 7 41 | 4 09 | 7 49 | 4 01 | 7 57 | 3 51 | 8 07 | 3 40 | 8 18 |
| | **12** | 4 53 | 7 06 | 4 43 | 7 16 | 4 31 | 7 28 | 4 17 | 7 42 | 4 09 | 7 50 | 4 01 | 7 58 | 3 51 | 8 08 | 3 40 | 8 19 |
| | **14** | 4 53 | 7 07 | 4 43 | 7 17 | 4 31 | 7 29 | 4 17 | 43 | 4 08 | 7 51 | 4 00 | 7 59 | 3 50 | 8 09 | 3 39 | 8 20 |
| | **16** | 4 54 | 7 08 | 4 43 | 7 18 | 4 31 | 7 30 | 17 | 7 44 | 4 08 | 7 52 | 4 00 | 8 00 | 3 50 | 8 10 | 3 39 | 8 21 |
| | **18** | 4 54 | 7 09 | 4 43 | 7 19 | 4 31 | 7 31 | 4 17 | 7 45 | 4 08 | 7 53 | 4 00 | 8 01 | 3 50 | 8 11 | 3 39 | 8 22 |
| | **20** | 4 54 | 7 09 | 4 43 | 7 19 | 4 31 | 7 31 | 4 17 | 7 45 | 4 08 | 7 54 | 4 00 | 8 02 | 3 50 | 8 12 | 3 39 | 8 23 |
| | **22** | 4 54 | 7 09 | 4 44 | 7 20 | 4 31 | 7 32 | 4 17 | 7 46 | 4 08 | 7 55 | 4 01 | 8 03 | 3 50 | 8 12 | 3 39 | 8 23 |
| | **24** | 4 55 | 7 10 | 4 44 | 7 20 | 4 32 | 7 32 | 4 18 | 7 46 | 4 09 | 7 55 | 4 01 | 8 03 | 3 51 | 8 13 | 3 40 | 8 24 |
| | **26** | 4 56 | 7 10 | 4 44 | 7 21 | 4 32 | 7 33 | 4 18 | 7 47 | 4 10 | 7 55 | 4 02 | 8 03 | 3 52 | 8 13 | 3 41 | 8 24 |
| | **28** | 4 56 | 7 10 | 4 45 | 7 21 | 4 33 | 7 33 | 4 19 | 7 47 | 4 11 | 7 55 | 4 03 | 8 03 | 3 53 | 8 13 | 3 42 | 8 24 |
| | **30** | 4 57 | 7 10 | 4 46 | 7 21 | 4 34 | 7 33 | 4 20 | 7 47 | 4 12 | 7 55 | 4 04 | 8 03 | 3 54 | 8 13 | 3 43 | 8 24 |

| DATE | | Latitude 32° Sunrise | Latitude 32° Sunset | Latitude 36° Sunrise | Latitude 36° Sunset | Latitude 40° Sunrise | Latitude 40° Sunset | Latitude 44° Sunrise | Latitude 44° Sunset | Latitude 46° Sunrise | Latitude 46° Sunset | Latitude 48° Sunrise | Latitude 48° Sunset | Latitude 50° Sunrise | Latitude 50° Sunset | Latitude 52° Sunrise | Latitude 52° Sunset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |
| July | 2 | 4 58 | 7 10 | 4 47 | 7 20 | 4 35 | 7 33 | 4 21 | 7 47 | 4 13 | 7 54 | 4 05 | 8 03 | 3 55 | 8 13 | 3 44 | 8 23 |
| | 4 | 4 59 | 7 10 | 4 48 | 7 20 | 4 36 | 7 33 | 4 22 | 7 46 | 4 14 | 7 54 | 4 06 | 8 02 | 3 56 | 8 12 | 3 46 | 8 22 |
| | 6 | 5 00 | 7 10 | 4 49 | 7 19 | 4 37 | 7 32 | 4 23 | 7 46 | 4 15 | 7 53 | 4 07 | 8 01 | 3 58 | 8 11 | 3 47 | 8 21 |
| | 8 | 5 01 | 7 09 | 4 50 | 7 19 | 4 38 | 7 31 | 4 25 | 7 45 | 4 17 | 7 52 | 4 09 | 8 00 | 3 59 | 8 10 | 3 49 | 8 20 |
| | 10 | 5 02 | 7 09 | 4 51 | 7 18 | 4 39 | 7 30 | 4 26 | 7 44 | 4 18 | 7 51 | 4 10 | 7 59 | 4 01 | 8 08 | 3 51 | 8 18 |
| | 12 | 5 03 | 7 08 | 4 52 | 7 18 | 4 41 | 7 30 | 4 28 | 7 43 | 4 20 | 7 50 | 4 12 | 7 58 | 4 03 | 8 07 | 3 53 | 8 17 |
| | 14 | 5 04 | 7 08 | 4 53 | 7 18 | 4 42 | 7 29 | 4 29 | 7 42 | 4 22 | 7 49 | 4 14 | 7 57 | 4 05 | 8 06 | 3 55 | 8 15 |
| | 16 | 5 05 | 7 07 | 4 55 | 7 17 | 4 44 | 7 28 | 4 31 | 7 40 | 4 24 | 7 47 | 4 16 | 7 56 | 4 07 | 8 04 | 3 58 | 8 13 |
| | 18 | 5 06 | 7 06 | 4 56 | 7 16 | 4 45 | 7 26 | 4 32 | 7 39 | 4 26 | 7 46 | 4 18 | 7 54 | 4 10 | 8 02 | 4 00 | 8 11 |
| | 20 | 5 07 | 7 05 | 4 57 | 7 15 | 4 47 | 7 25 | 4 34 | 7 38 | 4 28 | 7 44 | 4 20 | 7 52 | 4 12 | 8 00 | 4 03 | 8 09 |
| | 22 | 5 08 | 7 04 | 4 59 | 7 13 | 4 48 | 7 23 | 4 36 | 7 36 | 4 30 | 7 42 | 4 22 | 7 50 | 4 14 | 7 58 | 4 06 | 8 07 |
| | 24 | 5 10 | 7 03 | 5 00 | 7 12 | 4 50 | 7 22 | 4 38 | 7 34 | 4 32 | 7 40 | 4 25 | 7 48 | 4 17 | 7 55 | 4 08 | 8 04 |
| | 26 | 5 11 | 7 01 | 5 02 | 7 11 | 4 52 | 7 20 | 4 40 | 7 32 | 4 34 | 7 38 | 4 27 | 7 45 | 4 19 | 7 53 | 4 11 | 8 01 |
| | 28 | 5 12 | 7 00 | 5 03 | 7 09 | 4 53 | 7 18 | 4 42 | 7 30 | 4 37 | 7 36 | 4 30 | 7 43 | 4 22 | 7 50 | 4 14 | 7 58 |
| | 30 | 5 14 | 6 59 | 5 05 | 7 07 | 4 55 | 7 17 | 4 44 | 7 27 | 4 39 | 7 33 | 4 32 | 7 40 | 4 25 | 7 47 | 4 17 | 7 55 |
| August | 1 | 5 15 | 6 57 | 5 06 | 7 05 | 4 57 | 7 15 | 4 46 | 7 25 | 4 41 | 7 31 | 4 35 | 7 38 | 4 28 | 7 44 | 4 21 | 7 52 |
| | 3 | 5 16 | 6 56 | 5 08 | 7 04 | 4 59 | 7 12 | 4 48 | 7 22 | 4 43 | 7 28 | 4 37 | 7 35 | 4 31 | 7 41 | 4 24 | 7 49 |
| | 5 | 5 18 | 6 54 | 5 09 | 7 02 | 5 01 | 7 11 | 4 50 | 7 20 | 4 45 | 7 26 | 4 40 | 7 31 | 4 33 | 7 37 | 4 27 | 7 45 |
| | 7 | 5 19 | 6 52 | 5 11 | 7 00 | 5 02 | 7 08 | 4 53 | 7 17 | 4 48 | 7 23 | 4 42 | 7 28 | 4 36 | 7 34 | 4 30 | 7 41 |
| | 9 | 5 20 | 6 50 | 5 12 | 6 58 | 5 04 | 7 06 | 4 55 | 7 15 | 4 50 | 7 20 | 4 45 | 7 25 | 4 39 | 7 31 | 4 33 | 7 37 |
| | 11 | 5 22 | 6 48 | 5 14 | 6 56 | 5 06 | 7 03 | 4 58 | 7 12 | 4 53 | 7 17 | 4 48 | 7 22 | 4 42 | 7 27 | 4 36 | 7 34 |
| | 13 | 5 23 | 6 46 | 5 15 | 6 53 | 5 08 | 7 01 | 5 00 | 7 09 | 4 55 | 7 13 | 4 50 | 7 18 | 4 45 | 7 24 | 4 39 | 7 30 |
| | 15 | 5 24 | 6 44 | 5 17 | 6 51 | 5 10 | 6 58 | 5 02 | 7 06 | 4 58 | 7 10 | 4 53 | 7 15 | 4 48 | 7 20 | 4 42 | 7 26 |
| | 17 | 5 26 | 6 42 | 5 19 | 6 49 | 5 12 | 6 55 | 5 05 | 7 03 | 5 00 | 7 07 | 4 56 | 7 11 | 4 51 | 7 16 | 4 46 | 7 21 |
| | 19 | 5 27 | 6 39 | 5 20 | 6 46 | 5 14 | 6 52 | 5 07 | 6 59 | 5 03 | 7 03 | 4 59 | 7 07 | 4 54 | 7 12 | 4 49 | 7 17 |
| | 21 | 5 28 | 6 38 | 5 22 | 6 43 | 5 16 | 6 49 | 5 09 | 6 56 | 5 05 | 7 00 | 5 01 | 7 04 | 4 57 | 7 08 | 4 52 | 7 13 |
| | 23 | 5 29 | 6 35 | 5 23 | 6 41 | 5 18 | 6 46 | 5 11 | 6 53 | 5 08 | 6 56 | 5 04 | 7 00 | 5 00 | 7 04 | 4 56 | 7 09 |
| | 25 | 5 31 | 6 33 | 5 25 | 6 38 | 5 20 | 6 43 | 5 14 | 6 50 | 5 11 | 6 53 | 5 07 | 6 57 | 5 03 | 7 00 | 4 59 | 7 05 |
| | 27 | 5 31 | 6 32 | 5 26 | 6 35 | 5 22 | 6 40 | 5 16 | 6 47 | 5 13 | 6 49 | 5 09 | 6 53 | 5 06 | 6 56 | 5 02 | 7 00 |
| | 29 | 5 33 | 6 28 | 5 28 | 6 33 | 5 24 | 6 37 | 5 18 | 6 43 | 5 15 | 6 45 | 5 12 | 6 49 | 5 09 | 6 52 | 5 05 | 6 56 |
| | 31 | 5 34 | 6 26 | 5 30 | 6 30 | 5 25 | 6 34 | 5 20 | 6 40 | 5 18 | 6 42 | 5 15 | 6 45 | 5 12 | 6 48 | 5 09 | 6 51 |

| DATE | | Latitude 32° Sunrise | Latitude 32° Sunset | Latitude 36° Sunrise | Latitude 36° Sunset | Latitude 40° Sunrise | Latitude 40° Sunset | Latitude 44° Sunrise | Latitude 44° Sunset | Latitude 46° Sunrise | Latitude 46° Sunset | Latitude 48° Sunrise | Latitude 48° Sunset | Latitude 50° Sunrise | Latitude 50° Sunset | Latitude 52° Sunrise | Latitude 52° Sunset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |
| September | **2** | 5 35 | 6 23 | 5 31 | 6 27 | 5 27 | 6 31 | 5 23 | 6 36 | 5 20 | 6 38 | 5 18 | 6 41 | 5 15 | 6 44 | 5 12 | 6 47 |
| | **4** | 5 36 | 6 22 | 5 33 | 6 24 | 5 29 | 6 28 | 5 25 | 6 32 | 5 23 | 6 34 | 5 20 | 6 37 | 5 18 | 6 40 | 5 15 | 6 41 |
| | **6** | 5 38 | 6 19 | 5 34 | 6 22 | 5 31 | 6 25 | 5 27 | 6 28 | 5 25 | 6 31 | 5 23 | 6 33 | 5 21 | 6 35 | 5 19 | 6 37 |
| | **8** | 5 39 | 6 17 | 5 36 | 6 19 | 5 33 | 6 22 | 5 30 | 6 25 | 5 28 | 6 27 | 5 26 | 6 29 | 5 24 | 6 31 | 5 22 | 6 33 |
| | **10** | 5 41 | 6 13 | 5 38 | 6 16 | 5 35 | 6 18 | 5 32 | 6 21 | 5 31 | 6 23 | 5 29 | 6 25 | 5 27 | 6 27 | 5 25 | 6 28 |
| | **12** | 5 42 | 6 10 | 5 39 | 6 13 | 5 37 | 6 15 | 5 34 | 6 17 | 5 33 | 6 19 | 5 31 | 6 21 | 5 30 | 6 22 | 5 28 | 6 23 |
| | **14** | 5 43 | 6 09 | 5 41 | 6 10 | 5 39 | 6 12 | 5 36 | 6 14 | 5 35 | 6 15 | 5 34 | 6 16 | 5 33 | 6 18 | 5 31 | 6 19 |
| | **16** | 5 44 | 6 05 | 5 42 | 6 07 | 5 41 | 6 08 | 5 39 | 6 10 | 5 38 | 6 11 | 5 37 | 6 12 | 5 36 | 6 13 | 5 34 | 6 14 |
| | **18** | 5 46 | 6 02 | 5 44 | 6 04 | 5 43 | 6 05 | 5 41 | 6 07 | 5 41 | 6 07 | 5 40 | 6 08 | 5 39 | 6 09 | 5 38 | 6 10 |
| | **20** | 5 46 | 6 01 | 5 46 | 6 01 | 5 45 | 6 02 | 5 44 | 6 03 | 5 44 | 6 03 | 5 43 | 6 04 | 5 42 | 6 05 | 5 41 | 6 05 |
| | **22** | 5 48 | 5 57 | 5 47 | 5 58 | 5 47 | 5 58 | 5 46 | 5 59 | 5 46 | 5 59 | 5 45 | 6 00 | 5 45 | 6 00 | 5 44 | 6 00 |
| | **24** | 5 49 | 5 56 | 5 49 | 5 55 | 5 49 | 5 55 | 5 48 | 5 55 | 5 48 | 5 55 | 5 48 | 5 56 | 5 48 | 5 56 | 5 47 | 5 56 |
| | **26** | 5 51 | 5 52 | 5 51 | 5 52 | 5 51 | 5 52 | 5 51 | 5 52 | 5 51 | 5 52 | 5 51 | 5 51 | 5 51 | 5 51 | 5 51 | 5 51 |
| | **28** | 5 52 | 5 49 | 5 52 | 5 49 | 5 52 | 5 49 | 5 53 | 5 48 | 5 53 | 5 48 | 5 54 | 5 47 | 5 54 | 5 47 | 5 54 | 5 46 |
| | **30** | 5 54 | 5 46 | 5 53 | 5 46 | 5 54 | 5 46 | 5 55 | 5 44 | 5 56 | 5 44 | 5 57 | 5 43 | 5 57 | 5 43 | 5 57 | 5 42 |
| October | **2** | 5 54 | 5 44 | 5 55 | 5 44 | 5 56 | 5 43 | 5 57 | 5 41 | 5 58 | 5 40 | 5 59 | 5 39 | 6 00 | 5 38 | 6 00 | 5 37 |
| | **4** | 5 56 | 5 41 | 5 56 | 5 41 | 5 58 | 5 40 | 5 59 | 5 37 | 6 01 | 5 36 | 6 02 | 5 35 | 6 03 | 5 34 | 6 04 | 5 32 |
| | **6** | 5 57 | 5 39 | 5 58 | 5 38 | 6 00 | 5 36 | 6 02 | 5 34 | 6 03 | 5 32 | 6 04 | 5 31 | 6 06 | 5 29 | 6 07 | 5 28 |
| | **8** | 5 58 | 5 36 | 5 59 | 5 35 | 6 02 | 5 33 | 6 04 | 5 30 | 6 06 | 5 28 | 6 07 | 5 27 | 6 09 | 5 25 | 6 11 | 5 23 |
| | **10** | 6 00 | 5 34 | 6 01 | 5 32 | 6 04 | 5 30 | 6 07 | 5 27 | 6 08 | 5 25 | 6 10 | 5 23 | 6 12 | 5 21 | 6 14 | 5 19 |
| | **12** | 6 00 | 5 33 | 6 03 | 5 30 | 6 06 | 5 27 | 6 09 | 5 24 | 6 11 | 5 21 | 6 13 | 5 19 | 6 15 | 5 17 | 6 17 | 5 15 |
| | **14** | 6 03 | 5 29 | 6 04 | 5 27 | 6 08 | 5 24 | 6 11 | 5 20 | 6 14 | 5 18 | 6 16 | 5 15 | 6 19 | 5 13 | 6 21 | 5 10 |
| | **16** | 6 04 | 5 27 | 6 06 | 5 25 | 6 10 | 5 21 | 6 14 | 5 17 | 6 17 | 5 14 | 6 19 | 5 11 | 6 22 | 5 09 | 6 25 | 5 06 |
| | **18** | 6 05 | 5 25 | 6 08 | 5 22 | 6 12 | 5 18 | 6 17 | 5 13 | 6 19 | 5 11 | 6 22 | 5 08 | 6 25 | 5 05 | 6 28 | 5 02 |
| | **20** | 6 07 | 5 22 | 6 10 | 5 19 | 6 15 | 5 15 | 6 20 | 5 10 | 6 22 | 5 07 | 6 25 | 5 04 | 6 28 | 5 01 | 6 32 | 4 58 |
| | **22** | 6 09 | 5 20 | 6 12 | 5 17 | 6 17 | 5 12 | 6 22 | 5 07 | 6 25 | 5 04 | 6 28 | 5 00 | 6 31 | 4 57 | 6 35 | 4 54 |
| | **24** | 6 10 | 5 18 | 6 14 | 5 14 | 6 19 | 5 09 | 6 25 | 5 04 | 6 28 | 5 00 | 6 31 | 4 57 | 6 35 | 4 53 | 6 39 | 4 50 |
| | **26** | 6 12 | 5 16 | 6 16 | 5 12 | 6 21 | 5 06 | 6 27 | 5 01 | 6 31 | 4 57 | 6 35 | 4 53 | 6 38 | 4 49 | 6 43 | 4 46 |
| | **28** | 6 13 | 5 14 | 6 18 | 5 09 | 6 24 | 5 03 | 6 30 | 4 57 | 6 34 | 4 53 | 6 38 | 4 49 | 6 42 | 4 45 | 6 47 | 4 42 |
| | **30** | 6 15 | 5 12 | 6 20 | 5 07 | 6 26 | 5 00 | 6 33 | 4 55 | 6 37 | 4 50 | 6 41 | 4 46 | 6 45 | 4 42 | 6 50 | 4 38 |

| DATE | | Latitude 32° Sunrise | Latitude 32° Sunset | Latitude 36° Sunrise | Latitude 36° Sunset | Latitude 40° Sunrise | Latitude 40° Sunset | Latitude 44° Sunrise | Latitude 44° Sunset | Latitude 46° Sunrise | Latitude 46° Sunset | Latitude 48° Sunrise | Latitude 48° Sunset | Latitude 50° Sunrise | Latitude 50° Sunset | Latitude 52° Sunrise | Latitude 52° Sunset |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 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 |
| November | **1** | 6 16 | 5 10 | 6 22 | 5 05 | 6 28 | 4 58 | 6 35 | 4 52 | 6 39 | 4 47 | 6 44 | 4 43 | 6 48 | 4 39 | 6 53 | 4 34 |
| | **3** | 6 18 | 5 09 | 6 24 | 5 03 | 6 31 | 4 55 | 6 38 | 4 49 | 6 42 | 4 44 | 6 47 | 4 40 | 6 52 | 4 35 | 6 57 | 4 30 |
| | **5** | 6 20 | 5 07 | 6 26 | 5 01 | 6 33 | 4 53 | 6 41 | 4 46 | 6 45 | 4 41 | 6 50 | 4 37 | 6 55 | 4 32 | 7 00 | 4 27 |
| | **7** | 6 22 | 5 06 | 6 27 | 4 59 | 6 35 | 4 51 | 6 43 | 4 43 | 6 48 | 4 38 | 6 53 | 4 34 | 6 58 | 4 28 | 7 04 | 4 23 |
| | **9** | 6 23 | 5 04 | 6 29 | 4 57 | 6 37 | 4 49 | 6 46 | 4 41 | 6 51 | 4 36 | 6 56 | 4 31 | 7 01 | 4 25 | 7 07 | 4 19 |
| | **11** | 6 25 | 5 03 | 6 31 | 4 56 | 6 39 | 4 47 | 6 48 | 4 39 | 6 53 | 4 33 | 6 59 | 4 29 | 7 04 | 4 22 | 7 11 | 4 16 |
| | **13** | 6 27 | 5 02 | 6 33 | 4 54 | 6 42 | 4 45 | 6 51 | 4 37 | 6 56 | 4 31 | 7 02 | 4 26 | 7 08 | 4 20 | 7 14 | 4 13 |
| | **15** | 6 29 | 5 01 | 6 35 | 4 52 | 6 44 | 4 44 | 6 54 | 4 35 | 6 59 | 4 29 | 7 05 | 4 24 | 7 11 | 4 17 | 7 18 | 4 10 |
| | **17** | 6 30 | 4 59 | 6 37 | 4 51 | 6 47 | 4 42 | 6 57 | 4 32 | 7 02 | 4 27 | 7 08 | 4 21 | 7 15 | 4 14 | 7 22 | 4 07 |
| | **19** | 6 32 | 4 59 | 6 39 | 4 50 | 6 49 | 4 41 | 6 59 | 4 31 | 7 04 | 4 25 | 7 10 | 4 19 | 7 18 | 4 12 | 7 25 | 4 04 |
| | **21** | 6 34 | 4 58 | 6 41 | 4 49 | 6 51 | 4 39 | 7 01 | 4 29 | 7 07 | 4 23 | 7 13 | 4 17 | 7 21 | 4 10 | 7 28 | 4 02 |
| | **23** | 6 36 | 4 57 | 6 43 | 4 48 | 6 54 | 4 38 | 7 04 | 4 28 | 7 10 | 4 21 | 7 16 | 4 15 | 7 24 | 4 08 | 7 31 | 4 00 |
| | **25** | 6 37 | 4 57 | 6 45 | 4 48 | 6 56 | 4 37 | 7 06 | 4 27 | 7 12 | 4 20 | 7 19 | 4 14 | 7 27 | 4 06 | 7 35 | 3 58 |
| | **27** | 6 39 | 4 56 | 6 47 | 4 47 | 6 58 | 4 36 | 7 09 | 4 25 | 7 15 | 4 19 | 7 22 | 4 12 | 7 30 | 4 04 | 7 38 | 3 56 |
| | **29** | 6 41 | 4 56 | 6 48 | 4 47 | 6 59 | 4 36 | 7 11 | 4 24 | 7 18 | 4 18 | 7 25 | 4 11 | 7 33 | 4 03 | 7 41 | 3 55 |
| December | **1** | 6 43 | 4 55 | 6 50 | 4 47 | 7 01 | 4 35 | 7 13 | 4 23 | 7 20 | 4 17 | 7 27 | 4 10 | 7 36 | 4 02 | 7 44 | 3 54 |
| | **3** | 6 44 | 4 55 | 6 52 | 4 46 | 7 03 | 4 35 | 7 15 | 4 23 | 7 22 | 4 16 | 7 30 | 4 09 | 7 38 | 4 01 | 7 47 | 3 52 |
| | **5** | 6 46 | 4 55 | 6 54 | 4 46 | 7 05 | 4 35 | 7 18 | 4 23 | 7 25 | 4 15 | 7 32 | 4 08 | 7 41 | 4 00 | 7 49 | 3 51 |
| | **7** | 6 47 | 4 56 | 6 56 | 4 46 | 7 07 | 4 35 | 7 20 | 4 22 | 7 27 | 4 15 | 7 35 | 4 07 | 7 43 | 3 59 | 7 52 | 3 50 |
| | **9** | 6 49 | 4 56 | 6 57 | 4 46 | 7 09 | 4 35 | 7 22 | 4 22 | 7 29 | 4 15 | 7 37 | 4 07 | 7 45 | 3 59 | 7 54 | 3 50 |
| | **11** | 6 50 | 4 56 | 6 59 | 4 46 | 7 10 | 4 35 | 7 24 | 4 22 | 7 31 | 4 15 | 7 39 | 4 07 | 7 48 | 3 58 | 7 57 | 3 49 |
| | **13** | 6 52 | 4 57 | 7 01 | 4 47 | 7 12 | 4 35 | 7 25 | 4 22 | 7 32 | 4 15 | 7 40 | 4 07 | 7 50 | 3 58 | 7 59 | 3 49 |
| | **15** | 6 53 | 4 57 | 7 02 | 4 47 | 7 14 | 4 36 | 7 27 | 4 23 | 7 34 | 4 16 | 7 42 | 4 07 | 7 51 | 3 59 | 8 01 | 3 49 |
| | **17** | 6 54 | 4 58 | 7 04 | 4 48 | 7 16 | 4 36 | 7 29 | 4 23 | 7 36 | 4 16 | 7 44 | 4 08 | 7 53 | 3 59 | 8 03 | 3 49 |
| | **19** | 6 55 | 4 59 | 7 05 | 4 49 | 7 17 | 4 37 | 7 30 | 4 24 | 7 37 | 4 17 | 7 45 | 4 08 | 7 54 | 4 00 | 8 04 | 3 49 |
| | **21** | 6 56 | 4 59 | 7 06 | 4 50 | 7 18 | 4 38 | 7 31 | 4 25 | 7 38 | 4 18 | 7 46 | 4 09 | 7 55 | 4 01 | 8 05 | 3 50 |
| | **23** | 6 57 | 5 01 | 7 07 | 4 51 | 7 19 | 4 39 | 7 32 | 4 26 | 7 39 | 4 19 | 7 47 | 4 10 | 7 56 | 4 02 | 8 06 | 3 51 |
| | **25** | 6 58 | 5 02 | 7 08 | 4 52 | 7 20 | 4 40 | 7 33 | 4 27 | 7 40 | 4 20 | 7 48 | 4 11 | 7 57 | 4 03 | 8 07 | 3 52 |
| | **27** | 6 59 | 5 03 | 7 09 | 4 53 | 7 21 | 4 41 | 7 34 | 4 28 | 7 41 | 4 21 | 7 49 | 4 13 | 7 58 | 4 04 | 8 08 | 3 54 |
| | **29** | 7 00 | 5 04 | 7 09 | 4 54 | 7 21 | 4 42 | 7 34 | 4 30 | 7 41 | 4 22 | 7 50 | 4 14 | 7 58 | 4 06 | 8 08 | 3 56 |
| | **31** | 7 00 | 5 06 | 7 10 | 4 56 | 7 22 | 4 44 | 7 35 | 4 31 | 7 42 | 4 24 | 7 50 | 4 16 | 7 59 | 4 07 | 8 08 | 3 58 |

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

| | Latitude 35° | | Latitude 40° | | Latitude 45° | | Latitude 50° | | Latitude 52° | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Morn. | Eve. | Morn. | Eve. | Morn. | Eve. | Morn. | Eve. | Morn. | Eve. |
| Jan. 1 | 5 38 | 6 29 | 5 45 | 6 22 | 5 52 | 6 15 | 6 00 | 6 07 | 6 04 | 6 04 |
| 11 | 5 39 | 6 37 | 5 45 | 6 31 | 5 52 | 6 24 | 5 59 | 6 17 | 6 02 | 6 14 |
| 21 | 5 38 | 6 45 | 5 43 | 6 40 | 5 48 | 6 35 | 5 54 | 6 30 | 5 56 | 6 28 |
| 31 | 5 34 | 6 54 | 5 38 | 6 50 | 5 41 | 6 47 | 5 45 | 6 44 | 5 46 | 6 42 |
| Feb. 10 | 5 27 | 7 03 | 5 29 | 7 01 | 5 31 | 7 00 | 5 32 | 6 59 | 5 32 | 6 58 |
| 20 | 5 17 | 7 12 | 5 17 | 7 12 | 5 18 | 7 12 | 5 15 | 7 14 | 5 14 | 7 15 |
| Mar. 2 | 5 06 | 7 20 | 5 04 | 7 22 | 5 02 | 7 26 | 4 56 | 7 30 | 4 54 | 7 33 |
| 12 | 4 52 | 7 29 | 4 48 | 7 33 | 4 43 | 7 39 | 4 35 | 7 47 | 4 31 | 7 51 |
| 22 | 4 38 | 7 38 | 4 31 | 7 45 | 4 23 | 7 54 | 4 11 | 8 06 | 4 05 | 8 11 |
| Apr. 1 | 4 23 | 7 47 | 4 13 | 7 57 | 4 01 | 8 09 | 3 46 | 8 25 | 3 38 | 8 33 |
| 11 | 4 07 | 7 57 | 3 55 | 8 09 | 3 39 | 8 25 | 3 19 | 8 46 | 3 08 | 8 57 |
| 21 | 3 51 | 8 07 | 3 36 | 8 23 | 3 17 | 8 43 | 2 50 | 9 10 | 2 36 | 9 25 |
| May 1 | 3 37 | 8 19 | 3 18 | 8 37 | 2 54 | 9 02 | 2 20 | 9 37 | 2 01 | 9 57 |
| 11 | 3 23 | 8 30 | 3 02 | 8 52 | 2 33 | 9 22 | 1 48 | 10 08 | 1 20 | 10 37 |
| 21 | 3 12 | 8 41 | 2 47 | 9 07 | 2 13 | 9 42 | 1 13 | 10 44 | 0 02 | —— |
| 31 | 3 04 | 8 51 | 2 36 | 9 20 | 1 56 | 10 01 | 0 23 | 11 42 | —— | —— |
| June 10 | 2 59 | 8 59 | 2 29 | 9 30 | 1 43 | 10 16 | —— | —— | —— | —— |
| 20 | 3 02 | 9 04 | 2 27 | 9 35 | 1 39 | 10 23 | —— | —— | —— | —— |
| 30 | 3 02 | 9 04 | 2 31 | 9 35 | 1 44 | 10 22 | —— | —— | —— | —— |
| July 10 | 3 09 | 9 01 | 2 39 | 9 30 | 1 56 | 10 13 | —— | —— | —— | —— |
| 20 | 3 18 | 8 54 | 2 51 | 9 20 | 2 14 | 9 57 | 1 04 | 11 04 | —— | —— |
| 30 | 3 28 | 8 43 | 3 05 | 9 06 | 2 33 | 9 38 | 1 43 | 10 26 | 1 07 | 11 00 |
| Aug. 9 | 3 39 | 8 30 | 3 20 | 8 50 | 2 52 | 9 16 | 2 15 | 9 53 | 1 53 | 10 15 |
| 19 | 3 50 | 8 16 | 3 34 | 8 32 | 3 12 | 8 53 | 2 42 | 9 23 | 2 26 | 9 38 |
| 29 | 4 00 | 8 00 | 3 47 | 8 14 | 3 29 | 8 31 | 3 06 | 8 53 | 2 54 | 9 05 |
| Sept. 8 | 4 10 | 7 44 | 3 59 | 7 55 | 3 46 | 8 08 | 3 28 | 8 26 | 3 19 | 8 34 |
| 18 | 4 19 | 7 28 | 4 11 | 7 36 | 4 01 | 7 46 | 3 47 | 8 00 | 3 40 | 8 07 |
| 28 | 4 28 | 7 13 | 4 22 | 7 18 | 4 15 | 7 25 | 4 05 | 7 35 | 4 01 | 7 39 |
| Oct. 8 | 4 35 | 6 59 | 4 32 | 7 02 | 4 28 | 7 06 | 4 22 | 7 12 | 4 18 | 7 15 |
| 18 | 4 43 | 6 46 | 4 42 | 6 47 | 4 40 | 6 49 | 4 37 | 6 51 | 4 36 | 6 53 |
| 28 | 4 51 | 6 36 | 4 52 | 6 34 | 4 53 | 6 34 | 4 53 | 6 34 | 4 52 | 6 34 |
| Nov. 7 | 5 00 | 6 27 | 5 02 | 6 24 | 5 05 | 6 21 | 5 07 | 6 19 | 5 08 | 6 18 |
| 17 | 5 08 | 6 21 | 5 12 | 6 17 | 5 17 | 6 12 | 5 21 | 6 07 | 5 23 | 6 06 |
| 27 | 5 16 | 6 18 | 5 22 | 6 13 | 5 28 | 6 06 | 5 34 | 6 00 | 5 37 | 5 57 |
| Dec. 7 | 5 24 | 6 18 | 5 31 | 6 12 | 5 38 | 6 04 | 5 45 | 5 57 | 5 48 | 5 54 |
| 17 | 5 31 | 6 21 | 5 38 | 6 14 | 5 45 | 6 06 | 5 53 | 5 58 | 5 57 | 5 55 |
| 27 | 5 36 | 6 26 | 5 43 | 6 19 | 5 51 | 6 11 | 5 59 | 6 03 | 6 02 | 6 00 |
| Jan. 1 | 5 38 | 6 29 | 5 45 | 6 22 | 5 52 | 6 15 | 6 00 | 6 07 | 6 03 | 6 04 |

The above table gives the local mean time of the beginning of morning twilight, and of the ending of evening twilight, for various latitudes. To obtain the corresponding standard time, the method used is the same as for correcting the sunrise and sunset tables, as described on page 10. The entry —— in the above table indicates that at such dates and latitudes, twilight lasts all night. This table, taken from the American Ephemeris, is computed for *astronomical* twilight, i.e., for the time at which the sun is 108° from the zenith (or 18° below the horizon).

# TIMES OF MOONRISE AND MOONSET, 1949. (Local Mean Time)

| DATE | Latitude 35° Moon Rise | | Latitude 40° Moon Rise | | Latitude 45° Moon Rise | | Latitude 50° Moon Rise | | Latitude 52° Moon Rise | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| **Jan.** | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| **1** | 09 07 | 19 09 | 09 23 | 18 55 | 09 40 | 18 38 | 10 03 | 18 16 | 10 14 | 18 07 |
| **2** | 09 42 | 20 10 | 09 55 | 19 59 | 10 09 | 19 46 | 10 26 | 19 30 | 10 34 | 19 21 |
| **3** | 10 11 | 21 09 | 10 21 | 21 01 | 10 31 | 20 51 | 10 44 | 20 40 | 10 50 | 20 35 |
| **4** | 10 37 | 22 06 | 10 43 | 22 01 | 10 50 | 21 55 | 10 58 | 21 49 | 11 02 | 21 47 |
| **5** | 11 01 | 23 01 | 11 04 | 23 00 | 11 07 | 22 58 | 11 11 | 22 57 | 11 12 | 22 56 |
| **6** | 11 24 | 23 57 | 11 23 | 23 59 | 11 23 | — — | 11 23 | — — | 11 22 | — — |
| **7** ☽ | 11 47 | — — | 11 44 | — — | 11 40 | 00 01 | 11 35 | 00 04 | 11 32 | 00 06 |
| **8** | 12 12 | 00 53 | 12 06 | 00 59 | 12 18 | 01 06 | 11 48 | 01 14 | 11 44 | 01 17 |
| **9** | 12 40 | 01 53 | 12 31 | 02 02 | 12 19 | 02 12 | 12 04 | 02 25 | 11 58 | 02 31 |
| **10** | 13 14 | 02 56 | 13 00 | 03 07 | 12 45 | 03 22 | 12 26 | 03 40 | 12 16 | 03 50 |
| **11** | 13 55 | 04 00 | 13 39 | 04 16 | 13 19 | 04 35 | 12 55 | 04 58 | 12 43 | 05 10 |
| **12** | 14 43 | 05 07 | 14 27 | 05 25 | 14 05 | 05 36 | 13 36 | 06 14 | 13 23 | 06 28 |
| **13** | 15 46 | 06 12 | 15 24 | 06 31 | 15 04 | 06 54 | 14 34 | 07 22 | 14 20 | 07 37 |
| **14** ○ | 16 55 | 07 12 | 16 36 | 07 29 | 16 15 | 07 51 | 15 48 | 08 18 | 15 45 | 08 32 |
| **15** | 18 08 | 08 02 | 17 53 | 08 18 | 17 35 | 08 36 | 17 14 | 08 59 | 17 03 | 09 10 |
| **16** | 19 23 | 08 45 | 19 12 | 08 57 | 18 59 | 09 11 | 18 44 | 09 29 | 18 36 | 09 36 |
| **17** | 20 36 | 09 22 | 20 30 | 09 30 | 20 22 | 09 40 | 20 13 | 09 51 | 20 09 | 09 56 |
| **18** | 21 48 | 09 54 | 21 45 | 09 58 | 21 42 | 10 03 | 21 38 | 10 08 | 21 37 | 10 12 |
| **19** | 22 57 | 10 24 | 22 58 | 10 24 | — — | 10 24 | — — | 10 24 | — — | 10 25 |
| **20** | — — | 10 52 | — — | 10 48 | 00 00 | 10 44 | 00 02 | 10 39 | 00 04 | 10 38 |
| **21** ☾ | 00 05 | 11 21 | 00 10 | 11 15 | 00 17 | 11 06 | 00 25 | 10 56 | 00 29 | 10 51 |
| **22** | 01 13 | 11 54 | 01 22 | 11 43 | 01 34 | 11 30 | 01 47 | 11 15 | 01 54 | 11 07 |
| **23** | 02 21 | 12 30 | 02 34 | 12 16 | 02 50 | 11 59 | 03 10 | 11 38 | 03 18 | 11 28 |
| **24** | 03 28 | 13 13 | 03 44 | 12 56 | 04 04 | 12 35 | 04 28 | 12 09 | 04 41 | 11 57 |
| **25** | 04 32 | 14 03 | 04 50 | 13 43 | 05 12 | 13 20 | 05 40 | 12 52 | 05 55 | 12 38 |
| **26** | 05 31 | 14 58 | 05 49 | 14 39 | 06 13 | 14 15 | 06 42 | 13 45 | 06 56 | 13 31 |
| **27** | 06 21 | 15 57 | 06 40 | 15 39 | 07 02 | 15 18 | 07 29 | 14 51 | 07 42 | 14 37 |
| **28** ● | 07 05 | 16 58 | 07 21 | 16 43 | 07 40 | 16 24 | 08 04 | 16 01 | 08 15 | 15 50 |
| **29** | 07 39 | 18 00 | 07 55 | 17 47 | 08 10 | 17 32 | 08 29 | 17 14 | 08 39 | 17 04 |
| **30** | 08 12 | 18 59 | 08 22 | 18 50 | 08 34 | 18 39 | 08 48 | 18 37 | 08 56 | 18 20 |
| **31** | 08 39 | 19 56 | 08 46 | 19 51 | 08 55 | 19 44 | 09 04 | 19 36 | 09 09 | 19 33 |
| **Feb.** | | | | | | | | | | |
| **1** | 09 04 | 20 53 | 09 07 | 20 50 | 09 12 | 20 47 | 09 17 | 20 44 | 09 19 | 20 43 |
| **2** | 09 27 | 21 48 | 09 27 | 21 49 | 09 28 | 21 50 | 09 29 | 21 51 | 09 29 | 21 52 |
| **3** | 09 50 | 22 44 | 09 47 | 22 49 | 09 44 | 22 53 | 09 41 | 22 59 | 09 39 | 23 02 |
| **4** | 10 13 | 23 42 | 10 08 | 23 49 | 10 01 | 23 58 | 09 53 | — — | 09 50 | — — |
| **5** | 10 39 | — — | 10 30 | — — | 10 20 | — — | 10 08 | 00 09 | 10 01 | 00 13 |
| **6** ☽ | 11 10 | 00 41 | 10 57 | 00 51 | 10 43 | 01 05 | 10 26 | 01 21 | 10 17 | 01 29 |
| **7** | 11 45 | 01 44 | 11 30 | 01 58 | 11 12 | 02 15 | 10 50 | 02 36 | 10 39 | 02 46 |
| **8** | 12 29 | 02 48 | 12 12 | 03 05 | 11 51 | 03 25 | 11 24 | 03 51 | 11 11 | 04 05 |
| **9** | 13 24 | 03 52 | 13 05 | 04 13 | 12 42 | 04 33 | 12 13 | 05 02 | 11 59 | 05 17 |
| **10** | 14 28 | 04 53 | 14 10 | 05 12 | 13 48 | 05 35 | 13 18 | 06 04 | 13 05 | 06 18 |
| **11** | 15 40 | 05 48 | 15 23 | 06 06 | 15 04 | 06 26 | 14 40 | 06 51 | 14 27 | 07 04 |
| **12** | 16 56 | 06 35 | 16 43 | 06 50 | 16 28 | 07 06 | 16 09 | 07 26 | 16 00 | 07 36 |
| **13** ○ | 18 13 | 07 15 | 18 04 | 07 26 | 17 54 | 07 38 | 17 42 | 07 51 | 17 35 | 07 59 |
| **14** | 19 28 | 07 50 | 19 23 | 07 57 | 19 18 | 08 04 | 19 12 | 08 12 | 19 09 | 08 15 |
| **15** | 20 38 | 08 22 | 20 40 | 08 23 | 20 40 | 08 26 | 20 40 | 08 28 | 20 41 | 08 30 |
| **16** | 21 51 | 08 52 | 21 55 | 08 49 | 22 00 | 08 47 | 22 07 | 08 44 | 22 10 | 08 43 |
| **17** | 23 02 | 09 22 | — — | 09 16 | 23 19 | 09 09 | 23 32 | 09 01 | 23 38 | 08 56 |
| **18** | — — | 09 54 | 00 00 | 09 44 | — — | 09 33 | — — | 09 18 | — — | 09 12 |
| **19** ☾ | 00 14 | 10 30 | 00 24 | 10 26 | 00 38 | 10 01 | 00 56 | 09 41 | 01 06 | 09 29 |
| **20** | 01 20 | 11 11 | 01 36 | 10 54 | 01 55 | 10 35 | 02 19 | 10 10 | 02 31 | 09 58 |
| **21** | 02 26 | 11 59 | 02 44 | 11 40 | 03 07 | 11 17 | 03 34 | 10 49 | 03 48 | 10 35 |
| **22** | 03 27 | 12 52 | 03 45 | 12 32 | 04 09 | 12 09 | 04 39 | 11 39 | 04 54 | 11 24 |
| **23** | 04 19 | 13 50 | 04 38 | 13 31 | 05 01 | 13 09 | 05 29 | 12 40 | 05 44 | 12 27 |
| **24** | 05 05 | 14 51 | 05 22 | 14 34 | 05 42 | 14 14 | 06 07 | 13 50 | 06 20 | 13 38 |
| **25** | 05 43 | 15 52 | 05 57 | 15 38 | 06 14 | 15 22 | 06 35 | 15 02 | 06 45 | 14 53 |
| **26** | 06 15 | 16 52 | 06 26 | 16 41 | 06 39 | 16 29 | 06 55 | 16 15 | 07 03 | 16 07 |
| **27** ● | 06 42 | 17 49 | 06 51 | 17 43 | 07 00 | 17 34 | 07 11 | 17 24 | 07 17 | 17 20 |
| **28** | 07 08 | 18 46 | 07 12 | 19 41 | 07 18 | 18 38 | 07 25 | 18 33 | 07 28 | 18 32 |

| DATE | | Latitude 35° Moon Rise | | Latitude 40° Moon Rise | | Latitude 45° Moon Rise | | Latitude 50° Moon Rise | | Latitude 52° Moon Rise | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| **Mar.** | | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| 1 | | 07 30 | 19 42 | 07 32 | 19 41 | 07 34 | 19 41 | 07 36 | 19 41 | 07 38 | 19 41 |
| 2 | | 07 53 | 20 37 | 07 52 | 20 40 | 07 50 | 20 44 | 07 48 | 20 48 | 07 47 | 20 51 |
| 3 | | 08 16 | 21 34 | 08 11 | 21 40 | 08 07 | 21 48 | 08 00 | 21 58 | 07 56 | 22 02 |
| 4 | | 08 41 | 22 32 | 08 33 | 22 42 | 08 24 | 22 54 | 08 13 | 23 08 | 08 08 | 23 16 |
| 5 | | 09 09 | 23 33 | 08 58 | 23 46 | 08 45 | — — | 08 29 | — — | 08 22 | — — |
| 6 | | 09 43 | — — | 09 28 | — — | 09 11 | 00 02 | 08 50 | 00 21 | 08 40 | 00 31 |
| 7 | ☽ | 10 22 | 00 36 | 10 05 | 00 52 | 09 45 | 01 11 | 09 19 | 01 35 | 09 07 | 01 48 |
| 8 | | 11 11 | 01 38 | 10 51 | 01 56 | 10 29 | 02 19 | 10 00 | 02 47 | 09 46 | 03 01 |
| 9 | | 12 09 | 02 39 | 11 49 | 02 58 | 11 26 | 03 22 | 10 56 | 03 51 | 10 42 | 04 06 |
| 10 | | 13 15 | 03 34 | 12 57 | 03 53 | 12 35 | 04 15 | 12 08 | 04 43 | 11 45 | 04 56 |
| 11 | | 14 27 | 04 24 | 14 12 | 04 40 | 13 54 | 04 58 | 13 33 | 05 22 | 13 22 | 05 34 |
| 12 | | 15 43 | 05 07 | 15 32 | 05 19 | 15 19 | 05 33 | 15 03 | 05 51 | 14 56 | 05 59 |
| 13 | | 16 59 | 05 34 | 16 51 | 05 52 | 16 44 | 06 02 | 16 35 | 06 13 | 16 31 | 06 18 |
| 14 | ○ | 18 13 | 06 16 | 18 10 | 06 21 | 18 08 | 06 26 | 18 06 | 06 31 | 18 04 | 06 34 |
| 15 | | 19 27 | 06 47 | 19 29 | 06 47 | 19 31 | 06 47 | 19 35 | 06 47 | 19 36 | 06 48 |
| 16 | | 20 41 | 07 18 | 20 47 | 07 14 | 20 55 | 07 09 | 21 05 | 07 04 | 21 08 | 07 01 |
| 17 | | 21 54 | 07 50 | 22 04 | 07 42 | 22 17 | 07 32 | 22 33 | 07 31 | 22 41 | 07 16 |
| 18 | | 23 06 | 08 26 | 23 20 | 08 13 | 23 38 | 07 59 | — — | 07 41 | — — | 07 34 |
| 19 | | — — | 09 06 | — — | 08 51 | — — | 08 32 | 00 00 | 08 09 | 00 11 | 07 57 |
| 20 | | 00 16 | 09 52 | 00 33 | 09 34 | 00 55 | 09 12 | 01 21 | 08 44 | 01 35 | 08 31 |
| 21 | ☾ | 01 20 | 10 45 | 01 39 | 10 26 | 02 02 | 10 02 | 02 33 | 09 32 | 02 48 | 09 17 |
| 22 | | 02 16 | 11 43 | 02 36 | 11 24 | 02 59 | 11 00 | 03 29 | 10 31 | 03 44 | 10 16 |
| 23 | | 03 04 | 12 44 | 03 22 | 12 26 | 03 43 | 12 05 | 04 11 | 11 39 | 04 24 | 11 26 |
| 24 | | 03 44 | 13 45 | 04 00 | 13 30 | 04 18 | 13 13 | 04 41 | 12 51 | 04 51 | 12 41 |
| 25 | | 04 18 | 14 45 | 04 30 | 14 33 | 04 45 | 14 20 | 05 03 | 14 04 | 05 11 | 13 56 |
| 26 | | 04 47 | 15 43 | 04 56 | 15 35 | 05 07 | 15 26 | 05 20 | 15 14 | 05 26 | 15 09 |
| 27 | | 05 12 | 16 40 | 05 18 | 16 35 | 05 25 | 16 30 | 05 34 | 16 23 | 05 37 | 16 21 |
| 28 | | 05 36 | 17 36 | 05 38 | 17 34 | 05 41 | 17 33 | 05 45 | 17 31 | 05 47 | 17 31 |
| 29 | ● | 05 58 | 18 32 | 05 58 | 18 34 | 05 59 | 18 36 | 05 56 | 18 39 | 05 56 | 18 41 |
| 30 | | 06 21 | 19 28 | 06 17 | 19 34 | 06 13 | 19 40 | 06 08 | 19 48 | 06 05 | 19 51 |
| 31 | | 06 45 | 20 26 | 06 39 | 20 35 | 06 30 | 20 45 | 06 23 | 20 58 | 06 17 | 21 05 |
| **Apr.** | | | | | | | | | | | |
| 1 | | 07 12 | 21 26 | 07 02 | 21 38 | 06 50 | 21 52 | 06 36 | 22 11 | 06 29 | 22 20 |
| 2 | | 07 43 | 22 28 | 07 30 | 22 43 | 07 14 | 23 01 | 06 55 | 23 24 | 06 45 | 23 36 |
| 3 | | 08 20 | 23 30 | 08 04 | 23 47 | 07 45 | — — | 07 20 | — — | 07 08 | — — |
| 4 | | 09 04 | — — | 08 46 | — — | 08 24 | 00 10 | 07 56 | 00 37 | 07 42 | 00 51 |
| 5 | | 09 58 | 00 31 | 09 39 | 00 49 | 09 15 | 01 13 | 08 45 | 01 43 | 08 30 | 01 58 |
| 6 | ☽ | 10 59 | 01 26 | 10 40 | 01 44 | 10 18 | 02 09 | 09 49 | 02 38 | 09 35 | 02 52 |
| 7 | | 12 07 | 02 17 | 11 51 | 02 35 | 11 31 | 02 55 | 11 06 | 03 20 | 10 54 | 03 32 |
| 8 | | 13 20 | 03 01 | 13 06 | 03 15 | 12 51 | 03 31 | 12 32 | 03 52 | 12 23 | 04 02 |
| 9 | | 14 33 | 03 39 | 14 23 | 03 49 | 14 13 | 04 01 | 14 01 | 04 15 | 13 54 | 04 22 |
| 10 | | 15 46 | 04 12 | 15 41 | 04 19 | 15 35 | 04 26 | 15 30 | 04 34 | 15 26 | 04 38 |
| 11 | | 16 59 | 04 43 | 16 58 | 04 45 | 16 58 | 04 47 | 16 59 | 04 50 | 16 58 | 04 52 |
| 12 | ○ | 18 13 | 05 13 | 18 16 | 05 11 | 18 21 | 05 09 | 18 28 | 05 06 | 18 30 | 05 05 |
| 13 | | 19 27 | 05 45 | 19 35 | 05 38 | 19 46 | 05 31 | 19 58 | 05 23 | 20 09 | 05 18 |
| 14 | | 20 42 | 06 18 | 20 54 | 06 08 | 21 10 | 05 56 | 21 29 | 05 42 | 21 38 | 05 35 |
| 15 | | 21 55 | 06 55 | 22 11 | 06 43 | 22 31 | 06 26 | 22 57 | 06 06 | 23 09 | 05 56 |
| 16 | | 23 05 | 07 42 | 23 24 | 07 25 | 23 47 | 07 04 | — — | 06 38 | — — | 06 25 |
| 17 | | — — | 08 34 | — — | 08 15 | — — | 07 51 | 00 15 | 07 21 | 00 30 | 07 07 |
| 18 | | 00 07 | 09 32 | 00 26 | 09 12 | 00 50 | 08 48 | 01 21 | 08 18 | 01 36 | 08 03 |
| 19 | ☾ | 00 59 | 10 34 | 01 19 | 10 15 | 01 41 | 09 53 | 02 10 | 09 25 | 02 23 | 09 12 |
| 20 | | 01 34 | 11 36 | 02 00 | 11 20 | 02 19 | 11 01 | 02 44 | 10 38 | 02 56 | 10 27 |
| 21 | | 02 20 | 12 37 | 02 34 | 12 24 | 02 49 | 12 10 | 03 09 | 11 51 | 03 18 | 11 43 |
| 22 | | 02 50 | 13 36 | 03 01 | 13 27 | 03 13 | 13 17 | 03 27 | 13 04 | 03 34 | 12 57 |
| 23 | | 03 17 | 14 33 | 03 23 | 14 28 | 03 32 | 14 21 | 03 42 | 14 13 | 03 46 | 14 10 |
| 24 | | 03 41 | 15 30 | 03 42 | 15 27 | 03 49 | 15 24 | 03 54 | 15 21 | 03 56 | 15 20 |
| 25 | | 04 03 | 16 25 | 04 04 | 16 26 | 04 04 | 16 27 | 04 05 | 16 29 | 04 06 | 16 30 |
| 26 | | 04 26 | 17 21 | 04 23 | 17 26 | 04 20 | 17 31 | 04 17 | 17 37 | 04 15 | 17 40 |
| 27 | | 04 49 | 18 19 | 04 44 | 18 27 | 04 37 | 18 36 | 04 29 | 18 47 | 04 25 | 18 52 |
| 28 | ● | 05 16 | 19 19 | 05 06 | 19 30 | 04 56 | 19 43 | 04 43 | 19 59 | 04 37 | 20 07 |
| 29 | | 05 45 | 20 21 | 05 33 | 20 35 | 05 19 | 20 52 | 05 01 | 21 14 | 04 52 | 21 24 |
| 30 | | 06 20 | 21 23 | 06 05 | 21 40 | 05 47 | 22 01 | 05 24 | 22 28 | 05 14 | 22 40 |

| DATE | Latitude 35° Moon Rise | Latitude 35° Moon Set | Latitude 40° Moon Rise | Latitude 40° Moon Set | Latitude 45° Moon Rise | Latitude 45° Moon Set | Latitude 50° Moon Rise | Latitude 50° Moon Set | Latitude 52° Moon Rise | Latitude 52° Moon Set |
|---|---|---|---|---|---|---|---|---|---|---|
| **May** | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| **1** | 07 03 | 22 25 | 06 45 | 22 44 | 06 23 | 23 07 | 05 57 | 23 36 | 05 43 | 23 51 |
| **2** | 07 53 | 23 23 | 07 34 | 23 42 | 07 11 | — — | 06 41 | — — | 06 27 | — — |
| **3** | 08 52 | — — | 08 33 | — — | 08 09 | 00 05 | 07 40 | 00 35 | 07 26 | 00 50 |
| **4** | 09 57 | 00 14 | 09 40 | 00 32 | 09 19 | 00 53 | 08 53 | 01 20 | 08 39 | 01 33 |
| **5** ☽ | 11 06 | 00 59 | 10 51 | 01 14 | 10 34 | 01 32 | 10 13 | 01 54 | 10 03 | 02 05 |
| **6** | 12 16 | 01 37 | 12 06 | 01 49 | 11 53 | 02 03 | 11 38 | 02 19 | 11 32 | 02 28 |
| **7** | 13 27 | 02 11 | 13 20 | 02 20 | 13 13 | 02 29 | 13 04 | 02 40 | 13 00 | 02 44 |
| **8** | 14 37 | 02 42 | 14 35 | 02 46 | 14 33 | 02 50 | 14 30 | 02 56 | 14 29 | 02 59 |
| **9** | 15 48 | 03 11 | 15 50 | 03 11 | 15 53 | 03 11 | 15 56 | 03 11 | 15 58 | 03 11 |
| **10** | 17 01 | 03 40 | 17 07 | 03 37 | 17 14 | 03 32 | 17 24 | 03 26 | 17 28 | 03 24 |
| **11** | 18 05 | 04 12 | 18 25 | 04 04 | 18 38 | 03 54 | 18 54 | 03 43 | 19 01 | 03 38 |
| **12** ○ | 19 30 | 04 48 | 19 44 | 04 36 | 20 02 | 04 22 | 20 23 | 04 04 | 20 34 | 03 56 |
| **13** | 20 43 | 05 30 | 21 00 | 05 14 | 21 21 | 04 56 | 21 49 | 04 32 | 22 02 | 04 21 |
| **14** | 21 50 | 06 20 | 22 09 | 06 01 | 22 33 | 05 39 | 23 03 | 05 11 | 23 18 | 04 57 |
| **15** | 22 48 | 07 16 | 23 08 | 06 57 | 23 31 | 06 33 | — — | 06 02 | — — | 05 47 |
| **16** | 23 37 | 08 18 | 23 55 | 07 59 | — — | 07 36 | 00 00 | 07 07 | 00 15 | 06 52 |
| **17** | — — | 09 22 | — — | 09 05 | 00 16 | 08 45 | 00 42 | 08 20 | 00 55 | 08 07 |
| **18** | 00 18 | 10 25 | 00 32 | 10 12 | 00 50 | 09 55 | 01 12 | 09 35 | 01 21 | 09 25 |
| **19** ☾ | 00 51 | 11 27 | 01 02 | 11 16 | 01 16 | 11 04 | 01 32 | 10 49 | 01 40 | 10 41 |
| **20** | 01 19 | 12 25 | 01 28 | 12 18 | 01 37 | 12 09 | 01 48 | 12 00 | 01 53 | 11 55 |
| **21** | 01 34 | 13 22 | 01 49 | 13 17 | 01 55 | 13 13 | 02 02 | 13 09 | 02 04 | 13 07 |
| **22** | 02 07 | 14 17 | 02 09 | 14 16 | 02 11 | 14 16 | 02 13 | 14 16 | 02 14 | 14 17 |
| **23** | 02 30 | 15 13 | 02 28 | 15 16 | 02 26 | 15 19 | 02 25 | 15 24 | 02 24 | 15 27 |
| **24** | 02 53 | 16 11 | 02 48 | 16 17 | 02 43 | 16 24 | 02 37 | 16 34 | 02 33 | 16 38 |
| **25** | 03 18 | 17 09 | 03 10 | 17 19 | 03 01 | 17 31 | 02 49 | 17 45 | 02 45 | 17 53 |
| **26** | 03 46 | 18 11 | 03 35 | 18 24 | 03 22 | 18 40 | 03 06 | 19 00 | 02 59 | 19 09 |
| **27** ● | 04 20 | 19 14 | 04 05 | 19 30 | 03 49 | 19 50 | 03 28 | 20 15 | 03 18 | 20 27 |
| **28** | 05 00 | 20 17 | 04 43 | 20 35 | 04 23 | 20 57 | 03 57 | 21 27 | 03 44 | 21 40 |
| **29** | 05 54 | 21 17 | 05 29 | 21 36 | 05 07 | 21 59 | 04 38 | 22 29 | 04 24 | 22 44 |
| **30** | 06 46 | 22 11 | 06 26 | 22 30 | 06 04 | 22 51 | 05 33 | 23 19 | 05 19 | 23 33 |
| **31** | 07 50 | 22 58 | 07 32 | 23 14 | 07 10 | 23 33 | 06 43 | 23 57 | 06 30 | — — |
| **June** | | | | | | | | | | |
| **1** | 08 58 | 23 38 | 08 42 | 23 51 | 08 24 | — — | 08 02 | — — | 07 51 | 00 08 |
| **2** | 10 08 | — — | 09 55 | — — | 09 42 | 00 06 | 09 25 | 00 25 | 09 18 | 00 33 |
| **3** ☽ | 11 17 | 00 13 | 11 09 | 00 22 | 11 00 | 00 33 | 10 49 | 00 46 | 10 45 | 00 51 |
| **4** | 12 26 | 00 44 | 12 22 | 00 49 | 12 18 | 00 56 | 12 13 | 01 02 | 12 11 | 01 06 |
| **5** | 13 35 | 01 13 | 13 34 | 01 14 | 13 35 | 01 15 | 13 36 | 01 17 | 13 37 | 01 18 |
| **6** | 14 44 | 01 41 | 14 48 | 01 38 | 14 54 | 01 35 | 15 01 | 01 32 | 15 04 | 01 30 |
| **7** | 15 55 | 02 10 | 16 03 | 02 04 | 16 14 | 01 57 | 16 27 | 01 48 | 16 33 | 01 43 |
| **8** | 17 08 | 02 43 | 17 20 | 02 33 | 17 36 | 02 21 | 17 55 | 02 06 | 18 04 | 01 59 |
| **9** | 18 20 | 03 22 | 18 36 | 03 08 | 18 56 | 02 50 | 19 21 | 02 30 | 19 34 | 02 21 |
| **10** ○ | 19 30 | 04 06 | 19 49 | 03 50 | 20 12 | 03 29 | 20 41 | 03 03 | 20 56 | 02 50 |
| **11** | 20 34 | 05 01 | 20 53 | 04 41 | 21 16 | 04 18 | 21 47 | 03 49 | 22 02 | 03 34 |
| **12** | 21 27 | 06 01 | 21 46 | 05 41 | 22 08 | 05 18 | 22 36 | 04 43 | 22 49 | 04 33 |
| **13** | 22 12 | 07 05 | 22 28 | 06 47 | 22 47 | 06 26 | 23 10 | 05 59 | 23 22 | 05 45 |
| **14** | 22 48 | 08 10 | 23 02 | 07 54 | 23 17 | 07 37 | 23 35 | 07 14 | 23 44 | 07 03 |
| **15** | 23 19 | 09 13 | 23 29 | 09 01 | 23 40 | 08 47 | 23 53 | 08 30 | — — | 08 22 |
| **16** | 23 46 | 10 14 | 23 51 | 10 05 | 23 59 | 09 56 | — — | 09 44 | 00 00 | 09 38 |
| **17** | — — | 11 11 | — — | 11 07 | — — | 11 00 | 00 08 | 10 54 | 00 11 | 10 51 |
| **18** ☾ | 00 10 | 12 08 | 00 12 | 12 06 | 00 15 | 12 04 | 00 20 | 12 02 | 00 22 | 12 02 |
| **19** | 00 32 | 13 03 | 00 32 | 13 05 | 00 31 | 13 07 | 00 31 | 13 10 | 00 31 | 13 12 |
| **20** | 00 55 | 14 00 | 00 51 | 14 05 | 00 48 | 14 11 | 00 43 | 14 19 | 00 40 | 14 22 |
| **21** | 01 19 | 14 58 | 01 13 | 15 06 | 01 05 | 15 17 | 00 55 | 15 29 | 00 52 | 15 35 |
| **22** | 01 46 | 15 58 | 01 37 | 16 10 | 01 25 | 16 25 | 01 11 | 16 43 | 01 04 | 16 51 |
| **23** | 02 17 | 17 01 | 02 05 | 17 16 | 01 49 | 17 25 | 01 30 | 17 58 | 01 21 | 18 08 |
| **24** | 02 58 | 18 05 | 02 40 | 18 24 | 02 20 | 18 44 | 01 56 | 19 11 | 01 44 | 19 25 |
| **25** | 03 42 | 19 06 | 03 23 | 19 25 | 03 00 | 19 49 | 02 33 | 20 18 | 02 19 | 20 33 |
| **26** ● | 04 36 | 20 03 | 04 17 | 20 23 | 03 53 | 20 45 | 03 23 | 21 14 | 03 09 | 21 29 |
| **27** | 05 39 | 20 54 | 05 21 | 21 12 | 04 58 | 21 32 | 04 30 | 21 57 | 04 15 | 22 08 |
| **28** | 06 47 | 21 38 | 06 31 | 21 52 | 06 12 | 22 08 | 05 47 | 22 28 | 05 36 | 22 37 |
| **29** | 07 58 | 22 14 | 07 46 | 22 25 | 07 31 | 22 36 | 07 12 | 22 51 | 07 04 | 22 57 |
| **30** | 09 09 | 22 46 | 09 00 | 22 52 | 08 50 | 23 00 | 08 37 | 23 08 | 08 32 | 23 13 |

| DATE | | Latitude **35°** Moon Rise | | Latitude **40°** Moon Rise | | Latitude **45°** Moon Rise | | Latitude **50°** Moon Rise | | Latitude **52°** Moon Rise | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rise | Set | Rise | Set | Rise | Set | Rise | Set | Rise | Set |
| **Jul.** | | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| **1** | | 10 19 | 23 16 | 10 13 | 23 18 | 10 08 | 23 21 | 10 01 | 23 24 | 09 59 | 23 26 |
| **2** | | 11 27 | 23 44 | 11 26 | 23 42 | 11 25 | 23 40 | 11 24 | 23 39 | 11 25 | 23 38 |
| **3** | ☽ | 12 35 | — — | 12 38 | — — | 12 42 | — — | 12 47 | 23 53 | 12 50 | 23 50 |
| **4** | | 13 44 | 00 12 | 13 51 | 00 07 | 14 00 | 00 00 | 14 12 | — — | 14 16 | — — |
| **5** | | 14 54 | 00 43 | 15 06 | 00 34 | 15 19 | 00 23 | 15 37 | 00 10 | 15 45 | 00 05 |
| **6** | | 16 05 | 01 21 | 16 20 | 01 06 | 16 38 | 00 51 | 17 02 | 00 32 | 17 13 | 00 23 |
| **7** | | 17 15 | 02 00 | 17 33 | 01 44 | 17 55 | 01 25 | 18 22 | 01 00 | 18 37 | 00 49 |
| **8** | | 18 20 | 02 50 | 18 39 | 02 31 | 19 02 | 02 08 | 19 33 | 01 40 | 19 48 | 01 26 |
| **9** | | 19 17 | 03 46 | 19 36 | 03 27 | 20 01 | 03 03 | 20 28 | 02 33 | 20 42 | 02 18 |
| **10** | ○ | 20 05 | 04 49 | 20 22 | 04 30 | 20 42 | 04 08 | 21 08 | 03 39 | 21 20 | 03 25 |
| **11** | | 20 45 | 05 54 | 20 59 | 05 37 | 21 16 | 05 18 | 21 36 | 04 53 | 21 46 | 04 42 |
| **12** | | 21 18 | 06 59 | 21 29 | 06 45 | 21 42 | 06 30 | 21 57 | 06 11 | 22 04 | 06 01 |
| **13** | | 21 46 | 08 01 | 21 54 | 07 50 | 22 03 | 07 39 | 22 13 | 07 26 | 22 17 | 07 20 |
| **14** | | 22 11 | 09 00 | 22 15 | 08 54 | 22 20 | 08 47 | 22 26 | 08 38 | 22 28 | 08 34 |
| **15** | | 22 34 | 09 57 | 22 35 | 09 54 | 22 36 | 09 51 | 22 37 | 09 47 | 22 38 | 09 46 |
| **16** | | 22 57 | 10 53 | 22 54 | 10 53 | 22 52 | 10 54 | 22 49 | 10 55 | 22 47 | 10 57 |
| **17** | | 23 20 | 11 49 | 23 15 | 11 53 | 23 09 | 11 58 | 23 01 | 12 03 | 22 57 | 12 07 |
| **18** | ☾ | 23 46 | 12 47 | 23 37 | 12 53 | 23 26 | 12 52 | 23 14 | 13 03 | 23 09 | 13 18 |
| **19** | | — — | 13 45 | — — | 13 55 | 23 49 | 14 08 | 23 31 | 14 24 | 23 24 | 14 32 |
| **20** | | 00 15 | 14 47 | 00 03 | 15 00 | — — | 15 17 | 23 54 | 15 38 | 23 44 | 15 48 |
| **21** | | 00 49 | 15 50 | 00 35 | 16 06 | 00 17 | 16 26 | — — | 16 52 | — — | 17 05 |
| **22** | | 01 31 | 16 52 | 01 14 | 17 03 | 00 52 | 17 33 | 00 26 | 18 02 | 00 13 | 18 17 |
| **23** | | 02 23 | 17 52 | 02 03 | 18 11 | 01 40 | 18 34 | 01 11 | 19 04 | 00 56 | 19 18 |
| **24** | | 03 22 | 18 46 | 03 03 | 19 04 | 02 41 | 19 25 | 02 01 | 19 52 | 01 56 | 20 05 |
| **25** | ● | 04 30 | 19 32 | 04 13 | 19 48 | 03 52 | 20 06 | 03 25 | 20 28 | 03 13 | 20 38 |
| **26** | | 05 43 | 20 12 | 05 28 | 20 24 | 05 11 | 20 38 | 04 50 | 20 53 | 04 41 | 21 02 |
| **27** | | 06 55 | 20 47 | 06 45 | 20 55 | 06 33 | 21 04 | 06 18 | 21 14 | 06 11 | 21 19 |
| **28** | | 08 07 | 21 18 | 08 01 | 21 21 | 07 54 | 21 25 | 07 45 | 21 30 | 07 42 | 21 33 |
| **29** | | 09 17 | 21 47 | 09 15 | 21 46 | 09 13 | 21 46 | 09 10 | 21 45 | 09 10 | 21 45 |
| **30** | | 10 27 | 22 15 | 10 28 | 22 11 | 10 31 | 22 06 | 10 35 | 22 00 | 10 37 | 21 57 |
| **31** | | 11 36 | 22 45 | 11 42 | 22 37 | 11 50 | 22 28 | 12 00 | 22 16 | 12 03 | 22 11 |
| **Aug.** | | | | | | | | | | | |
| **1** | ☽ | 12 46 | 23 19 | 12 56 | 23 07 | 13 07 | 22 43 | 13 25 | 22 36 | 13 32 | 22 28 |
| **2** | | 13 56 | 23 58 | 14 10 | 23 43 | 14 28 | 23 25 | 14 49 | 23 02 | 15 00 | 22 51 |
| **3** | | 15 06 | — — | 15 23 | — — | 15 44 | — — | 16 11 | 23 37 | 16 24 | 23 23 |
| **4** | | 16 12 | 00 43 | 16 31 | 00 26 | 16 54 | 00 04 | 17 24 | — — | 17 39 | — — |
| **5** | | 17 10 | 01 38 | 17 30 | 01 18 | 17 53 | 00 54 | 18 24 | 00 24 | 18 38 | 00 09 |
| **6** | | 18 01 | 02 38 | 18 19 | 02 19 | 18 40 | 01 55 | 19 07 | 01 26 | 19 20 | 01 11 |
| **7** | | 18 43 | 03 41 | 18 58 | 03 24 | 19 16 | 03 03 | 19 39 | 02 37 | 19 49 | 02 24 |
| **8** | ○ | 19 18 | 04 46 | 19 30 | 04 31 | 19 44 | 04 14 | 20 01 | 03 53 | 20 09 | 03 42 |
| **9** | | 19 47 | 05 49 | 19 56 | 05 38 | 20 06 | 05 24 | 20 18 | 05 09 | 20 24 | 05 01 |
| **10** | | 20 13 | 06 50 | 20 18 | 06 42 | 20 25 | 06 33 | 20 32 | 06 23 | 20 35 | 06 17 |
| **11** | | 20 37 | 07 47 | 20 39 | 07 44 | 20 44 | 07 39 | 20 44 | 07 33 | 20 45 | 07 27 |
| **12** | | 20 59 | 08 44 | 20 58 | 08 43 | 20 57 | 08 42 | 20 55 | 08 42 | 20 55 | 08 42 |
| **13** | | 21 22 | 09 40 | 21 18 | 09 42 | 21 13 | 09 46 | 21 07 | 09 50 | 21 04 | 09 52 |
| **14** | | 21 46 | 10 36 | 21 39 | 10 42 | 21 30 | 10 50 | 21 19 | 10 59 | 21 15 | 11 03 |
| **15** | | 22 13 | 11 34 | 22 03 | 11 43 | 21 48 | 11 55 | 21 35 | 12 09 | 21 27 | 12 15 |
| **16** | ☾ | 22 45 | 12 33 | 22 31 | 12 46 | 22 14 | 13 01 | 21 54 | 13 20 | 21 45 | 13 30 |
| **17** | | 23 23 | 13 34 | 23 06 | 13 51 | 22 48 | 14 09 | 22 21 | 14 34 | 22 09 | 14 46 |
| **18** | | — — | 14 37 | 23 50 | 14 55 | 23 28 | 15 17 | 22 59 | 15 45 | 22 45 | 15 59 |
| **19** | | 00 10 | 15 38 | — — | 15 57 | — — | 16 20 | 23 52 | 16 51 | 23 37 | 17 05 |
| **20** | | 01 05 | 16 33 | 00 45 | 16 52 | 00 21 | 17 15 | — — | 17 44 | — — | 17 58 |
| **21** | | 02 09 | 17 23 | 01 50 | 17 40 | 01 28 | 18 00 | 00 59 | 18 24 | 00 45 | 18 36 |
| **22** | | 03 19 | 18 06 | 03 03 | 18 19 | 02 44 | 18 35 | 02 20 | 18 54 | 02 09 | 19 03 |
| **23** | ● | 04 33 | 18 43 | 04 20 | 18 53 | 04 06 | 19 03 | 03 49 | 19 17 | 03 40 | 19 22 |
| **24** | | 05 47 | 19 16 | 05 38 | 19 21 | 05 29 | 19 27 | 05 18 | 19 34 | 05 13 | 19 38 |
| **25** | | 06 59 | 19 46 | 06 56 | 19 47 | 06 52 | 19 48 | 06 46 | 19 50 | 06 45 | 19 51 |
| **26** | | 08 11 | 20 15 | 08 12 | 20 12 | 08 13 | 20 09 | 08 14 | 20 05 | 08 15 | 20 04 |
| **27** | | 09 20 | 20 46 | 09 28 | 20 39 | 09 34 | 20 31 | 09 41 | 20 22 | 09 45 | 20 17 |
| **28** | | 10 35 | 21 19 | 10 44 | 21 09 | 10 55 | 20 56 | 11 09 | 20 40 | 11 16 | 20 33 |
| **29** | | 11 47 | 21 57 | 12 06 | 21 42 | 12 17 | 21 25 | 12 37 | 21 04 | 12 46 | 20 54 |
| **30** | ☽ | 12 59 | 22 41 | 13 15 | 22 24 | 13 35 | 22 02 | 14 01 | 21 36 | 14 13 | 21 23 |
| **31** | | 14 06 | 23 33 | 14 26 | 23 13 | 14 48 | 22 50 | 15 18 | 22 19 | 15 34 | 22 05 |

| DATE | Latitude 35° Moon Rise | Latitude 35° Moon Set | Latitude 40° Moon Rise | Latitude 40° Moon Set | Latitude 45° Moon Rise | Latitude 45° Moon Set | Latitude 50° Moon Rise | Latitude 50° Moon Set | Latitude 52° Moon Rise | Latitude 52° Moon Set |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sept.** | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| **1** | 15 07 | — — | 15 26 | — — | 15 50 | 23 47 | 16 21 | 23 17 | 16 36 | 23 01 |
| **2** | 15 59 | 00 31 | 16 18 | 00 11 | 16 40 | — — | 17 08 | — — | 17 22 | — — |
| **3** | 16 43 | 01 33 | 16 59 | 01 15 | 17 18 | 00 53 | 17 42 | 00 24 | 17 54 | 00 11 |
| **4** | 17 19 | 02 37 | 17 33 | 02 23 | 17 48 | 02 03 | 18 07 | 01 40 | 18 16 | 01 28 |
| **5** | 17 50 | 03 39 | 18 00 | 03 28 | 18 11 | 03 13 | 18 25 | 02 55 | 18 32 | 02 47 |
| **6** | 18 17 | 04 41 | 18 25 | 04 32 | 18 31 | 04 22 | 18 40 | 04 09 | 18 44 | 04 03 |
| **7** ○ | 18 41 | 05 39 | 18 44 | 05 34 | 18 47 | 05 28 | 18 52 | 05 21 | 18 54 | 05 17 |
| **8** | 19 03 | 06 36 | 19 03 | 06 34 | 19 03 | 06 32 | 19 03 | 06 32 | 19 03 | 06 29 |
| **9** | 19 26 | 07 32 | 19 22 | 07 33 | 19 19 | 07 35 | 19 16 | 07 40 | 19 12 | 07 40 |
| **10** | 19 49 | 08 28 | 19 43 | 08 33 | 19 36 | 08 39 | 19 26 | 08 46 | 19 22 | 08 50 |
| **11** | 20 15 | 09 26 | 20 05 | 09 34 | 19 54 | 09 44 | 19 40 | 09 56 | 19 34 | 10 01 |
| **12** | 20 45 | 10 24 | 20 31 | 10 35 | 20 16 | 10 49 | 19 58 | 11 07 | 19 49 | 11 16 |
| **13** | 21 19 | 11 24 | 21 03 | 11 38 | 20 44 | 11 57 | 20 21 | 12 19 | 20 10 | 12 30 |
| **14** | 22 01 | 12 25 | 21 43 | 12 42 | 21 20 | 13 04 | 20 53 | 13 40 | 20 39 | 13 44 |
| **15** ☾ | 22 51 | 13 26 | 22 31 | 13 44 | 22 08 | 14 07 | 21 38 | 14 38 | 21 33 | 14 53 |
| **16** | 23 50 | 14 21 | 23 30 | 14 41 | 23 06 | 15 04 | 22 37 | 15 35 | 22 22 | 15 50 |
| **17** | — — | 15 12 | — — | 15 31 | — — | 15 52 | 23 51 | 16 19 | 23 38 | 16 33 |
| **18** | 00 56 | 15 58 | 00 48 | 16 13 | 00 17 | 16 21 | — — | 16 53 | — — | 17 04 |
| **19** | 02 07 | 16 37 | 01 52 | 16 48 | 01 36 | 17 02 | 01 15 | 17 18 | 01 05 | 17 26 |
| **20** | 03 20 | 17 11 | 03 11 | 17 19 | 02 57 | 17 28 | 02 44 | 17 38 | 02 36 | 17 43 |
| **21** | 04 34 | 17 43 | 04 27 | 17 46 | 04 21 | 17 49 | 04 13 | 17 54 | 04 09 | 17 57 |
| **22** ● | 05 47 | 18 13 | 05 45 | 18 12 | 05 44 | 18 10 | 05 40 | 18 09 | 05 41 | 18 09 |
| **23** | 07 01 | 18 43 | 07 03 | 18 38 | 07 07 | 18 32 | 07 12 | 18 26 | 07 13 | 18 22 |
| **24** | 08 15 | 19 16 | 08 22 | 19 07 | 08 31 | 18 56 | 08 42 | 18 43 | 08 47 | 18 37 |
| **25** | 09 30 | 19 52 | 09 41 | 19 40 | 09 55 | 19 24 | 10 13 | 19 05 | 10 21 | 18 56 |
| **26** | 10 44 | 20 36 | 11 00 | 20 20 | 11 19 | 20 00 | 11 43 | 19 35 | 11 54 | 19 25 |
| **27** | 11 55 | 21 27 | 12 14 | 21 07 | 12 37 | 20 44 | 13 05 | 20 15 | 13 20 | 20 01 |
| **28** ☽ | 13 01 | 22 24 | 13 20 | 22 04 | 13 44 | 21 39 | 14 15 | 21 08 | 14 31 | 20 54 |
| **29** | 13 57 | 23 26 | 14 16 | 23 07 | 14 39 | 22 43 | 15 09 | 22 14 | 15 23 | 22 01 |
| **30** | 14 43 | — — | 15 01 | — — | 15 21 | 23 53 | 15 47 | 23 28 | 15 59 | 23 16 |
| **Oct.** | | | | | | | | | | |
| **1** | 15 22 | 00 30 | 15 36 | 00 13 | 15 53 | — — | 16 13 | — — | 16 24 | — — |
| **2** | 15 54 | 01 32 | 16 05 | 01 20 | 16 17 | 01 03 | 16 33 | 00 44 | 16 41 | 00 35 |
| **3** | 16 21 | 02 34 | 16 29 | 02 24 | 16 38 | 02 12 | 16 48 | 01 58 | 16 53 | 01 52 |
| **4** | 16 46 | 03 33 | 16 50 | 03 26 | 16 54 | 03 19 | 17 01 | 03 10 | 17 03 | 03 06 |
| **5** | 17 08 | 04 30 | 17 09 | 04 27 | 17 10 | 04 23 | 17 12 | 04 19 | 17 13 | 04 18 |
| **6** ○ | 17 31 | 05 26 | 17 28 | 05 26 | 17 26 | 05 27 | 17 23 | 05 28 | 17 21 | 05 29 |
| **7** | 17 54 | 06 22 | 17 48 | 06 26 | 17 42 | 06 30 | 17 35 | 06 36 | 17 31 | 06 39 |
| **8** | 18 18 | 07 19 | 18 10 | 07 26 | 18 00 | 07 35 | 17 47 | 07 45 | 17 42 | 07 50 |
| **9** | 18 46 | 08 17 | 18 35 | 08 27 | 18 21 | 08 40 | 18 03 | 08 56 | 17 56 | 09 03 |
| **10** | 19 18 | 09 16 | 19 04 | 09 30 | 18 46 | 09 47 | 18 24 | 10 08 | 18 14 | 10 18 |
| **11** | 19 57 | 10 17 | 19 40 | 10 33 | 19 17 | 10 54 | 18 52 | 11 20 | 18 49 | 11 32 |
| **12** | 20 45 | 11 17 | 20 25 | 11 35 | 20 02 | 11 59 | 19 31 | 12 28 | 19 17 | 12 42 |
| **13** | 21 39 | 12 14 | 21 19 | 12 33 | 20 55 | 12 57 | 20 24 | 13 28 | 20 10 | 13 42 |
| **14** ☾ | 22 40 | 13 05 | 22 21 | 13 24 | 21 59 | 13 47 | 21 31 | 14 16 | 21 17 | 14 30 |
| **15** | 23 47 | 13 51 | 23 31 | 14 08 | 23 12 | 14 28 | 22 49 | 15 03 | 22 38 | 15 04 |
| **16** | — — | 14 32 | — — | 14 46 | — — | 15 01 | — — | 15 20 | — — | 15 29 |
| **17** | 00 57 | 15 06 | 00 45 | 15 17 | 00 31 | 15 28 | 00 13 | 15 41 | 00 05 | 15 47 |
| **18** | 02 08 | 15 38 | 02 00 | 15 44 | 01 51 | 15 50 | 01 39 | 15 58 | 01 34 | 16 02 |
| **19** | 03 20 | 16 08 | 03 16 | 16 10 | 03 12 | 16 11 | 03 06 | 16 13 | 03 04 | 16 15 |
| **20** | 04 33 | 16 38 | 04 33 | 16 36 | 04 34 | 16 32 | 04 35 | 16 28 | 04 35 | 16 27 |
| **21** ● | 05 46 | 17 10 | 05 52 | 17 03 | 05 58 | 16 54 | 06 05 | 16 45 | 06 08 | 16 40 |
| **22** | 07 02 | 17 45 | 07 12 | 17 34 | 07 23 | 17 20 | 07 37 | 17 05 | 07 44 | 16 57 |
| **23** | 08 19 | 18 26 | 08 33 | 18 11 | 08 40 | 17 53 | 09 11 | 17 31 | 09 21 | 17 20 |
| **24** | 09 36 | 19 16 | 09 53 | 18 57 | 10 13 | 18 35 | 10 41 | 18 07 | 10 54 | 17 53 |
| **25** | 10 47 | 20 12 | 11 06 | 19 52 | 11 30 | 19 28 | 12 00 | 18 57 | 12 15 | 18 42 |
| **26** | 11 49 | 21 14 | 12 08 | 20 54 | 12 32 | 20 31 | 13 02 | 20 01 | 13 18 | 19 46 |
| **27** | 12 40 | 22 19 | 12 58 | 22 01 | 13 20 | 21 41 | 13 47 | 21 14 | 14 00 | 21 01 |
| **28** ☽ | 13 22 | 23 24 | 13 37 | 23 09 | 13 55 | 22 53 | 14 18 | 22 31 | 14 28 | 22 20 |
| **29** | 13 56 | — — | 14 08 | — — | 14 23 | — — | 14 40 | 23 46 | 14 48 | 23 39 |
| **30** | 14 25 | 00 27 | 14 34 | 00 15 | 14 44 | 00 02 | 14 56 | — — | 15 02 | — — |
| **31** | 14 50 | 01 27 | 14 56 | 01 19 | 15 02 | 01 10 | 15 09 | 01 00 | 15 13 | 00 55 |

| DATE | Latitude 35° Moon Rise | Latitude 35° Moon Set | Latitude 40° Moon Rise | Latitude 40° Moon Set | Latitude 45° Moon Rise | Latitude 45° Moon Set | Latitude 50° Moon Rise | Latitude 50° Moon Set | Latitude 52° Moon Rise | Latitude 52° Moon Set |
|---|---|---|---|---|---|---|---|---|---|---|
| **Nov.** | h m | h m | h m | h m | h m | h m | h m | h m | h m | h m |
| **1** | 15 13 | 02 24 | 15 16 | 02 20 | 15 18 | 02 15 | 15 20 | 02 09 | 15 22 | 02 07 |
| **2** | 15 36 | 03 20 | 15 35 | 03 19 | 15 33 | 03 18 | 15 31 | 03 18 | 15 31 | 03 18 |
| **3** | 15 59 | 04 16 | 15 54 | 04 18 | 15 49 | 04 21 | 15 43 | 04 27 | 15 40 | 04 28 |
| **4** | 16 22 | 05 12 | 16 15 | 05 18 | 16 06 | 05 26 | 15 56 | 05 35 | 15 51 | 05 39 |
| **5** | 16 49 | 06 10 | 16 39 | 06 19 | 16 26 | 06 31 | 16 11 | 06 45 | 16 03 | 06 51 |
| **6** | 17 20 | 07 09 | 17 07 | 07 22 | 16 50 | 07 37 | 16 30 | 07 56 | 16 20 | 08 06 |
| **7** | 17 57 | 08 10 | 17 41 | 08 25 | 17 21 | 08 45 | 16 56 | 09 09 | 16 43 | 09 21 |
| **8** | 18 41 | 09 11 | 18 23 | 09 29 | 18 00 | 09 51 | 17 31 | 10 20 | 17 17 | 10 33 |
| **9** | 19 34 | 10 09 | 19 14 | 10 27 | 18 50 | 10 51 | 18 19 | 11 22 | 18 05 | 11 37 |
| **10** | 20 33 | 11 02 | 20 14 | 11 21 | 19 50 | 11 44 | 19 21 | 12 14 | 19 07 | 12 28 |
| **11** | 21 36 | 11 49 | 21 20 | 12 06 | 20 59 | 12 27 | 20 34 | 12 53 | 20 22 | 13 06 |
| **12** | 22 44 | 12 30 | 22 30 | 12 45 | 22 14 | 13 02 | 21 54 | 13 23 | 21 45 | 13 32 |
| **13** | 23 52 | 13 05 | 23 42 | 13 17 | 23 30 | 13 30 | 23 17 | 13 45 | 23 11 | 13 52 |
| **14** | — — | 13 37 | — — | 13 44 | — — | 13 52 | — — | 14 02 | — — | 14 07 |
| **15** | 01 01 | 14 07 | 00 54 | 14 10 | 00 48 | 14 13 | 00 40 | 14 18 | 00 37 | 14 20 |
| **16** | 02 10 | 14 35 | 02 08 | 14 34 | 02 07 | 14 33 | 02 05 | 14 32 | 02 04 | 14 32 |
| **17** | 03 21 | 15 04 | 03 23 | 15 00 | 03 27 | 14 55 | 03 31 | 14 48 | 03 33 | 14 44 |
| **18** | 04 34 | 15 37 | 04 41 | 15 29 | 04 50 | 15 18 | 05 00 | 15 05 | 05 05 | 15 00 |
| **19** | 05 49 | 16 15 | 06 01 | 16 02 | 06 15 | 15 46 | 06 32 | 15 28 | 06 40 | 15 19 |
| **20** | 07 06 | 16 59 | 07 22 | 16 43 | 07 40 | 16 23 | 08 05 | 15 58 | 08 16 | 15 47 |
| **21** | 08 22 | 17 54 | 08 40 | 17 35 | 09 02 | 17 11 | 09 32 | 16 42 | 09 46 | 16 27 |
| **22** | 09 30 | 18 56 | 09 50 | 18 36 | 10 14 | 18 11 | 10 45 | 17 41 | 11 00 | 17 26 |
| **23** | 10 28 | 20 02 | 10 48 | 19 44 | 11 10 | 19 21 | 11 39 | 18 53 | 11 53 | 18 39 |
| **24** | 11 16 | 21 09 | 11 33 | 20 53 | 11 52 | 20 35 | 12 17 | 20 11 | 12 28 | 20 00 |
| **25** | 11 45 | 22 15 | 12 08 | 22 02 | 12 23 | 21 48 | 12 43 | 21 30 | 12 52 | 21 21 |
| **26** | 12 26 | 23 17 | 12 34 | 23 08 | 12 47 | 22 58 | 13 01 | 22 45 | 13 08 | 22 40 |
| **27** | 12 53 | — — | 12 59 | — — | 13 08 | — — | 13 17 | 23 57 | 13 20 | 23 54 |
| **28** | 13 17 | 00 16 | 13 20 | 00 11 | 13 24 | 00 05 | 13 28 | — — | 13 30 | — — |
| **29** | 13 39 | 01 13 | 13 40 | 01 11 | 13 39 | 01 09 | 13 39 | 01 06 | 13 39 | 01 06 |
| **30** | 14 02 | 02 08 | 13 59 | 02 10 | 13 55 | 02 12 | 13 51 | 02 14 | 13 49 | 02 16 |
| **Dec.** | | | | | | | | | | |
| **1** | 14 26 | 03 04 | 14 19 | 03 10 | 14 12 | 03 15 | 14 03 | 03 22 | 13 59 | 03 26 |
| **2** | 14 52 | 04 02 | 14 42 | 04 10 | 14 31 | 04 20 | 14 17 | 04 32 | 14 11 | 04 38 |
| **3** | 15 22 | 05 01 | 15 06 | 05 12 | 14 54 | 05 26 | 14 35 | 05 43 | 14 26 | 05 52 |
| **4** | 15 56 | 06 01 | 15 41 | 06 16 | 15 22 | 06 34 | 14 58 | 06 56 | 14 47 | 07 08 |
| **5** | 16 39 | 07 02 | 16 21 | 07 20 | 15 59 | 07 41 | 15 31 | 08 08 | 15 17 | 08 22 |
| **6** | 17 29 | 08 02 | 17 10 | 08 21 | 16 46 | 08 44 | 16 16 | 09 14 | 16 01 | 09 29 |
| **7** | 18 26 | 08 57 | 18 07 | 09 17 | 17 44 | 09 40 | 17 14 | 10 11 | 17 00 | 10 25 |
| **8** | 19 29 | 09 47 | 19 12 | 10 06 | 18 51 | 10 27 | 18 25 | 10 54 | 18 13 | 11 07 |
| **9** | 20 36 | 10 30 | 20 22 | 10 45 | 20 05 | 11 03 | 19 44 | 11 26 | 19 33 | 11 37 |
| **10** | 21 43 | 11 07 | 21 33 | 11 19 | 21 20 | 11 33 | 21 05 | 11 50 | 20 57 | 11 58 |
| **11** | 22 50 | 11 39 | 22 44 | 11 47 | 22 36 | 11 57 | 22 26 | 12 08 | 22 21 | 12 14 |
| **12** | 23 57 | 12 08 | 23 55 | 12 13 | 23 51 | 12 18 | 23 47 | 12 24 | 23 46 | 12 27 |
| **13** | — — | 12 36 | — — | 12 37 | — — | 12 37 | — — | 12 38 | — — | 12 39 |
| **14** | 01 05 | 13 04 | 01 06 | 13 00 | 01 08 | 12 57 | 01 09 | 12 53 | 01 11 | 12 51 |
| **15** | 02 14 | 13 34 | 02 20 | 13 27 | 02 26 | 13 18 | 02 34 | 13 08 | 02 38 | 13 03 |
| **16** | 03 26 | 14 08 | 03 35 | 13 56 | 03 47 | 13 43 | 04 02 | 13 28 | 04 08 | 13 20 |
| **17** | 04 41 | 14 48 | 04 54 | 14 33 | 05 10 | 14 15 | 05 32 | 13 53 | 05 41 | 13 42 |
| **18** | 05 56 | 15 37 | 06 13 | 15 19 | 06 33 | 14 57 | 07 00 | 14 30 | 07 13 | 14 16 |
| **19** | 07 07 | 16 35 | 07 27 | 16 15 | 07 50 | 15 51 | 08 20 | 15 21 | 08 35 | 15 05 |
| **20** | 08 12 | 17 40 | 08 30 | 17 21 | 08 54 | 16 57 | 09 24 | 16 28 | 09 29 | 16 12 |
| **21** | 09 04 | 18 49 | 09 23 | 18 31 | 09 44 | 18 01 | 10 10 | 17 46 | 10 23 | 17 32 |
| **22** | 09 48 | 19 57 | 10 03 | 19 43 | 10 20 | 19 26 | 10 42 | 19 06 | 10 52 | 18 56 |
| **23** | 10 23 | 21 02 | 10 35 | 20 52 | 10 48 | 20 40 | 11 05 | 20 25 | 11 12 | 20 18 |
| **24** | 10 53 | 22 04 | 11 01 | 21 57 | 11 10 | 21 49 | 11 21 | 21 40 | 11 26 | 21 36 |
| **25** | 11 19 | 23 02 | 11 23 | 23 01 | 11 28 | 22 56 | 11 34 | 22 51 | 11 37 | 22 50 |
| **26** | 11 42 | 23 59 | 11 43 | 23 59 | 11 44 | — — | 11 45 | — — | 11 47 | — — |
| **27** | 12 05 | — — | 12 02 | — — | 12 00 | 00 00 | 11 57 | 00 00 | 11 56 | 00 01 |
| **28** | 12 28 | 00 55 | 12 22 | 00 59 | 12 17 | 01 03 | 12 09 | 01 09 | 12 05 | 01 12 |
| **29** | 12 52 | 01 52 | 12 44 | 01 59 | 12 34 | 02 08 | 12 22 | 02 18 | 12 17 | 02 22 |
| **30** | 13 20 | 02 50 | 13 09 | 03 00 | 12 55 | 03 13 | 12 38 | 03 28 | 12 31 | 03 36 |
| **31** | 13 54 | 03 49 | 13 39 | 04 03 | 13 21 | 04 20 | 13 00 | 04 40 | 12 49 | 04 51 |

# THE PLANETS FOR 1949

By C. A. Chant

## THE SUN

The date of the maximum activity of the present sun-spot cycle has been given as 1947.4 or about May 26, 1947. In March-April 1947 there appeared the largest sun-spot group ever recorded. For May 1947 the Wolf-number was 206, the highest since 1778. The peak in May was only 3.15 years after minimum. During 1948 the solar activity continued strong and the prospects are that there will be much to observe in 1949.

## MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and it travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. With the exception of Pluto, its orbit has the greatest eccentricity and the greatest inclination to the ecliptic. It receives from the sun most light and heat per square mile of its surface, the amount on the average being 6.7 times that received by the earth. Again excepting Pluto, whose size and mass are still uncertain, Mercury's size and mass are the smallest; but its period of rotation on its axis is believed to be longest of all.

Mercury's period of revolution is 88 days, and as its orbit is well within that of the earth, the planet, as seen from the earth, appears to move quickly from one side of the sun to the other several times in the year. Its quick motion earned for it the name it bears. Its greatest elongation (i.e., its maximum angular distance from the sun) varies between 18° and 28°, and on such occasions it is visible to the naked eye for about two weeks.

When the elongation of Mercury is east of the sun it is an evening star, setting soon after the sun. When the elongation is west, it is a morning star and rises shortly before the sun. Its brightness when it is treated as a star is considerable but it is always viewed in the twilight sky and one must look sharply to see it.

The most suitable times to observe Mercury are at an eastern elongation in the spring and at a western elongation in the autumn. The dates of greatest elongation this year, together with the planet's separation from the sun and its stellar magnitude, are given in the following table:

*Maximum Elongations of Mercury during 1949*

| Elong. East—Evening Star | | | Elong. West—Morning Star | | |
|---|---|---|---|---|---|
| Date | Distance | Mag. | Date | Distance | Mag. |
| Jan. 17 | 19° | −0.3 | Feb. 28 | 27° | +0.3 |
| May 10 | 22° | −0.6 | June 28 | 22° | +0.7 |
| Sept. 7 | 27° | +0.4 | Oct. 19 | 18° | −0.3 |

The most favourable elongations to observe are: in the evening, May 10; in the morning, Oct. 19, but June 28 will also be possible. At these times Mercury is about 80 million miles from the earth and in a telescope looks like a half-moon about 7″ in diameter.

## VENUS

Venus is the next planet in order from the sun. In size and mass it is almost a twin of the earth. Venus being within the earth's orbit, its apparent motion is similar to that of Mercury but much slower and more stately. The orbit of Venus is almost a circle with a radius of 67 million miles, and its orbital speed is 22 mi. per sec.

On Jan. 1, 1949, Venus is a morning star. It crosses the meridian almost two hours before the sun, but as its declination is 22° south it is not well placed for observers in the northern hemisphere. It is slowly moving in towards the sun and reaches superior conjunction on April 16. It is in close conjunction with Mars on April 2 and with Mercury on April 12 (see p. 37) but they are all near the sun and will not be visible to the naked eye.

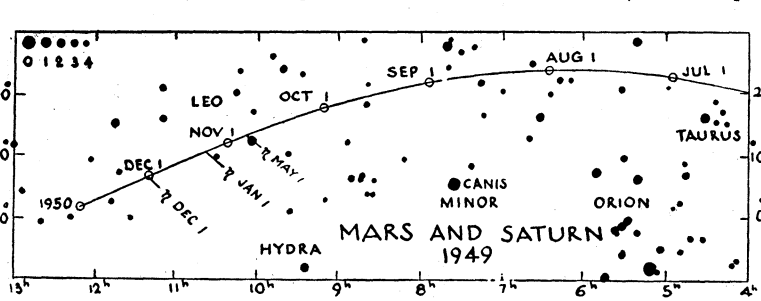
In about a month Venus will have separated from the sun far enough to be seen as an evening star and it will continue to be such all the rest of the year.

On May 27 Venus is close to Mercury (see p. 39) and on July 31 it is close to Saturn (see p. 43). On Nov. 20 it reaches its greatest elongation east, 47° 15′, but its declination is 26° south. In a telescope it looks like a half-moon with diameter 24″. On Dec. 26 it attains greatest brilliancy, when its stellar mag. is −4.4. About 35 days later, on Jan. 31, it will be in inferior conjunction with the sun and will then become a morning star.

With the exception of the sun and moon, Venus is the brightest object in the sky. Its brilliance is largely due to the dense clouds which cover the surface of the planet. They reflect well the sun's light; but they also prevent the astronomer from detecting any solid object on the surface of the body. If such could be observed it would enable him to determine the planet's rotation period. It is probably around 30 days.

## MARS

The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation with these two numbers shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere



is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24h. 37m. has been accurately determined.

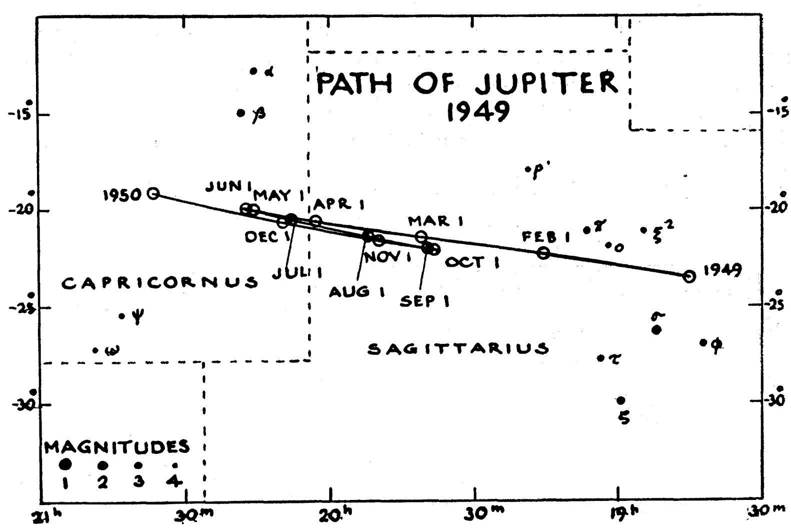
The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. The planet was in opposition on Jan. 13, 1946; next, on Feb. 17, 1948, but it does not come to opposition again until Mar. 23, 1950. It will not be a brilliant object during 1949, but its course in the sky may be followed from the accompanying map. On March 17 Mars is in conjunction with the sun.

## JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 11 satellites, two of them discovered in 1938 (see p. 59). Not so long ago it was generally believed that the planet was still cooling down from its original high temperature, but from actual measurements of the radiation from it to the earth it has been deduced that the surface is at about $-200°$ F. The spectroscope shows that its atmosphere is largely ammonia and methane (marsh-gas).

Jupiter is a fine object for the telescope. Many details of the surface as well as the flattening of the planet at the poles, which is undoubtedly due to its short rotation period, are visible. The rapidly varying phenomena of its satellites also provide a continual interest.

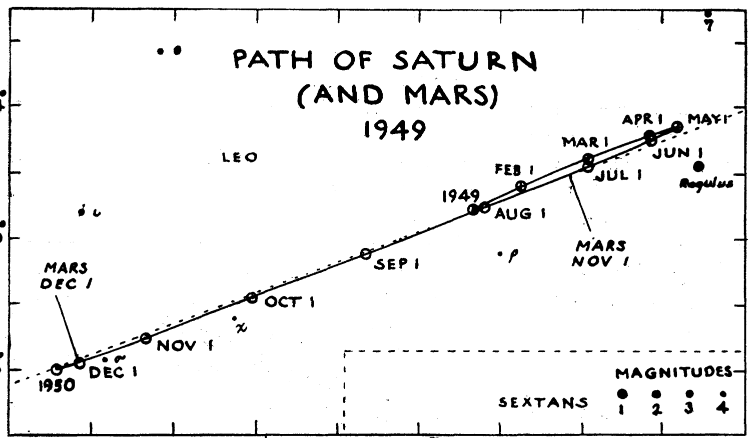
During the last hour (E.S.T.) of 1948 Jupiter reaches conjunction with the sun, and hence on Jan. 1, 1949, the two bodies come to the meridian together. They are both in declination $-23°$. The sun then moves eastward from the planet and



on Feb. 1 the planet transits at 10.30 a.m., but on account of its low declination it is not easy (in our northern hemisphere) to observe it as a morning star. On Apr. 21 it is in quadrature west of the sun and it transits at 6.16 a.m. On July 20 it is in opposition to the sun and comes to the meridian at midnight. Hence it is visible all night. It is in constellation Capricornus. At this time its distance from the earth is 382,300,000 miles (see p. 43) and its stellar magnitude is − 2.3. In the telescope its equatorial diameter is 48″ and polar diameter 3″ less. On Oct. 17 it is in quadrature east of the sun, and it will get back to conjunction again about Feb. 5, 1950.

## SATURN

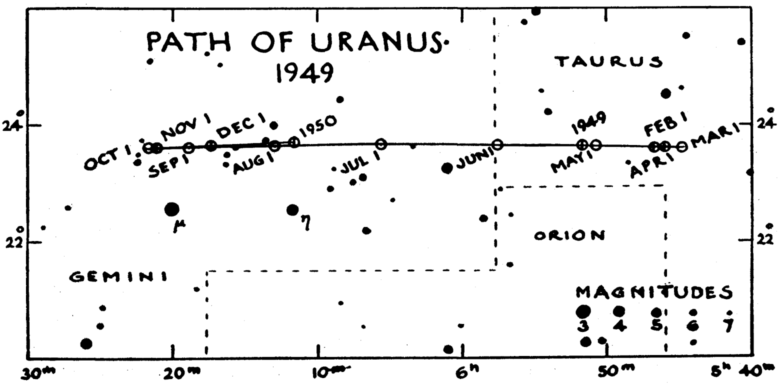
Saturn was the outermost planet known until modern times. In size it is a good second to Jupiter. In addition to its family of nine satellites, this planet has a unique system of rings, and it is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. They were invisible in 1936 and at a maximum in 1944. In 1949 they are slowly closing in but are still quite visible. Their south face is presented now.




The planet is in the constellation Leo (see accompanying map). On Feb. 21 it is in opposition to the sun and is visible all night. Its stellar magnitude then is +0.5, slightly less bright than Rigel. On May 20 it is in quadrature with the sun and is on the meridian at sunset. On Sept. 2 it is in conjunction with the sun.

## URANUS

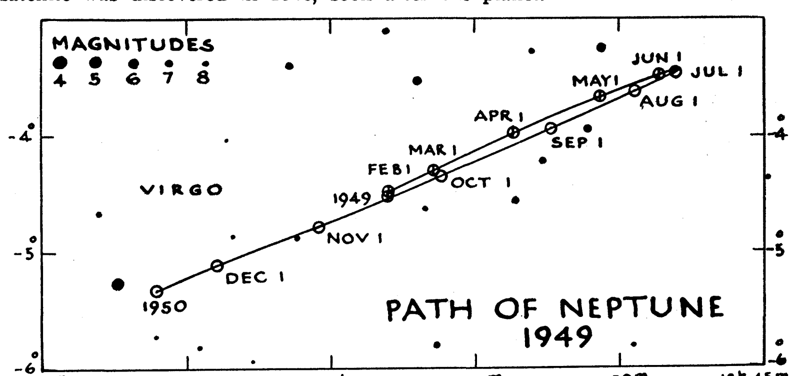
Uranus was discovered in 1781 by Sir William Herschel by means of a 6¼-in. mirror-telescope made by himself. The object did not look just like a star and he observed it again four days later. It had moved amongst the stars, and he assumed it to be a comet. He could not believe that it was a new planet. However, computation later showed that it was a planet nearly twice as far from the sun as Saturn. Its period of revolution is 84 years and it rotates on its axis in about 11 hours. Its five satellites are visible only in a large telescope. Its fifth satellite was discovered in 1948 at the McDonald Observatory (see p. 59).




As shown by the chart, Uranus in 1949 is in Taurus and Gemini. On Dec. 24, it is in opposition with the sun.

## NEPTUNE

Neptune was discovered in 1846 after its existence in the sky had been predicted from independent calculations by Leverrier in France and Adams in England. This discovery was a crowning demonstration of the correctness of Newton's law of gravitation. It caused a sensation at the time. The planet's distance from the sun is 2800 million miles and its period of revolution is 165 years. Its single satellite was discovered in 1846, soon after the planet.




During 1949 Neptune is still in the constellation Virgo. It begins to retrograde on Jan. 16 and is in opposition with the sun on April 3. Its stellar magnitude then is + 7.7 and hence it is too faint for the naked eye. In the telescope it shows a greenish tint and a diameter of 2″.5.

## PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930, following prolonged mathematical calculations and observations by photography. Its mean distance from the sun is 3666 million miles and its revolution period is 248 years. It appears as a 15th mag. star in the constellation Cancer. It is in opposition to the sun on Feb. 6, 1949, at which time its position is R.A. $9^h\ 21^m.3$, Dec. $+23°\ 43'$, courteously supplied by G. M. Clemence, the director of the U.S. Nautical Almanac.

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## ECLIPSES, 1949

In 1949 there will be *four* eclipses, two of the sun and two of the moon. Those of the sun are only partial, and not visible from North America. Those of the moon are total, and should be of great interest to observers on our continent.

I. *A Total Eclipse of the Moon*, April 13, 1949, visible from Canada. The beginning will be visible from western Asia, Europe, Africa, North America and South America; the ending from western Africa, south-western Europe, and North and South America. The circumstances of this eclipse are tabulated below.

II. *A Partial Eclipse of the Sun*, April 28, 1949, invisible from almost all of North America. This eclipse will be visible from North Africa, Europe, northern Siberia, the Arctic, Greenland, and just at sunrise from Baffin Land and possibly from the Labrador Coast. At maximum sixty-one per cent. of the sun's diameter will be obscured. Greenwich Civil Time of conjunction in right ascension, April 28th, at 8h 52m 50.5s.

III. *A Total Eclipse of the Moon*, October 6-7, 1949, visible from Canada. The area of visibility will be roughly the same as Eclipse I, but shifted slightly south and east, so that the beginning will not be visible from the extreme north-western and western parts of North America. The circumstances of the two lunar eclipses are given below.

IV. *A Partial Eclipse of the Sun*, October 21, 1949, invisible from North America; visible from part of Australia, New Zealand and Antarctica. Greenwich Civil Time of conjunction in right ascension, October 21st, at 22h 05m 05.8s.

Circumstances of the Two Lunar Eclipses

| | Greenwich Civil Time | |
|---|---|---|
| | Eclipse I | Eclipse III |
| Moon enters penumbra....... | April 13d 01h 31.6m | October 6d 23h 50.1m |
| Moon enters umbra.......... | 13 02 27.7 | 7 01 04.7 |
| Total eclipse begins.......... | 13 03 28.0 | 7 02 19.5 |
| Middle of the eclipse......... | 13 04 10.9 | 7 02 56.4 |
| Total eclipse ends............ | 13 04 53.8 | 7 03 33.2 |
| Moon leaves umbra.......... | 13 05 54.1 | 7 04 48.1 |
| Moon leaves penumbra....... | 13 06 50.3 | 7 06 02.7 |
| Magnitude of eclipse......... | 1.432 | 1.228 |

(moon's diameter, 1.000)

# THE SKY MONTH BY MONTH

By J. F. Heard

## THE SKY FOR JANUARY, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During January the sun's R.A. increases from 18h 45m to 20h 57m and its Decl. changes from 23° 03′ S. to 17° 15′ S. The equation of time changes from − 3m 22s to − 13m 38s. The earth is in perihelion or nearest the sun on the 3rd. For changes in the length of the day, see p. 11.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 18.

*Mercury* on the 15th is in R.A. 21h 02m, Decl. 17° 56′ S. and transits at 13.26. It is an evening star all month and greatest elongation is on the 17th, but this is not a very favourable elongation, Mercury being only 13° above the south-western horizon at sunset.

*Venus* on the 15th is in R.A. 18h 09m, Decl. 23° 00 S. and transits at 10.33. It is a morning star but very low in the south-east at sunrise. Its stellar magnitude is − 3.4 and, as seen in a telescope, its disk is over 90% illuminated.

*Mars* on the 15th is in R.A. 20h 43m, Decl. 19° 19′ S. and transits at 13.06. It is too close to the sun for observation.

*Jupiter* on the 15th is in R.A. 18h 59m, Decl. 22° 47′ S. and transits at 11.21. It is too close to the sun for observation.

*Saturn* on the 15th is in R.A. 10h 32m, Decl. 11° 05′ N. and transits at 2.54. It rises a few hours after sunset and is to be seen in Leo a few degrees to the east of Regulus for the rest of the night. Its motion among the stars is retrograde, that is westward, from the beginning of the year until May. The observer may confirm this by watching it in relation to Regulus.

*Uranus* on the 15th is in R.A. 5h 49m, Decl. 23° 38′ N. and transits at 22.08.

*Neptune* on the 15th is in R.A. 12h 58m, Decl. 4° 31′ S. and transits at 5.20.

*Pluto*—For information in regard to this planet, see p. 29.

# ASTRONOMICAL PHENOMENA MONTH BY MONTH

By Ruth J. Northcott

## JANUARY

75th Meridian Civil Time

| | d | h | m | | Min. of Algol h m |
|---|---|---|---|---|---|
| Sat. | 1 | | | | |
| Sun. | 2 | | | | 11 24 |
| Mon. | 3 | | | Quadrantid meteors | |
| | | 9 | | ⊕ in Perihelion. Dist. from ☉, 91,343,000 mi. | |
| Tue. | 4 | | | | |
| Wed. | 5 | 3 | | Moon in Apogee. Dist. from ⊕, 251,500 mi. | 8 14 |
| | | 14 | | □ ♆ ☉ | |
| Thu. | 6 | | | | |
| Fri. | 7 | 6 | 51 | ☽ First Quarter | |
| | | 13 | | ☌ ☿ ♂ ☿ 0° 48′ S. | |
| Sat. | 8 | | | | 5 03 |
| Sun. | 9 | | | | |
| Mon. | 10 | | | | |
| Tue. | 11 | | | | 1 52 |
| Wed. | 12 | 19 | 53 | ☌ ♅ ☾ ♅ 3° 58′ S. | |
| Thu. | 13 | | | | 22 41 |
| Fri. | 14 | 16 | 59 | ○ Full Moon | |
| Sat. | 15 | | | | |
| Sun. | 16 | 22 | | Moon in Perigee. Dist. from ⊕, 225, 700 mi. | 19 31 |
| | | 22 | | ♆ Stationary in R.A. | |
| Mon. | 17 | 5 | | ♂ Greatest Hel. Lat. S. | |
| | | 9 | 54 | ☌ ♄ ☾ ♄ 2° 40′ S. | |
| | | 22 | | ☿ Greatest elongation E., 18° 45′ | |
| Tue. | 18 | | | | |
| Wed. | 19 | 10 | | ☿ in ☊ | 16 20 |
| Thu. | 20 | 5 | 44 | ☌ ♆ ☾ ♆ 0° 18′ N. | |
| Fri. | 21 | 9 | 07 | ☾ Last Quarter | |
| Sat. | 22 | | | | 13 09 |
| Sun. | 23 | | | | |
| Mon. | 24 | 1 | | ☿ in Perihelion | |
| | | 3 | | ☿ Stationary in R.A. | |
| | | 12 | | ♀ in ☋ | |
| Tue. | 25 | | | | 9 58 |
| Wed. | 26 | 3 | | ☌ ♀ ♃ ♀ 0° 01′ S. | |
| Thu. | 27 | 1 | 13 | ☌ ♃ ☾ ♃ 4° 50′ N. | |
| | | 3 | 09 | ☌ ♀ ☾ ♀ 4° 48′ N. | |
| | | 16 | | ☌ ☿ ♂ ☿ 3° 37′ N. | |
| Fri. | 28 | 21 | 42 | ● New Moon | 6 48 |
| Sat. | 29 | 10 | 55 | ☌ ☿ ☾ ☿ 7° 59′ N. | |
| | | 16 | 50 | ☌ ♂ ☾ ♂ 3° 50′ N. | |
| Sun. | 30 | | | | |
| Mon. | 31 | | | | 3 37 |

Jupiter being near the sun, phenomena of the satellites are not given this month.

## THE SKY FOR FEBRUARY, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During February the sun's R.A. increases from 20h 57m to 22h 46m and its Decl. changes from 17° 15′ S. to 7° 47′ S. The equation of time changes from − 13m 38s to a maximum of − 14m 22s on the 11th and then to − 12m 36s at the end of the month. For changes in the length of the day, see p. 11.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 18. In the early morning of the 20th an occultation of Antares is visible in Western Canada. See p. 56.

*Mercury* on the 15th is in R.A. 20h 25m, Decl. 16° 50′ S. and transits at 10.44. It becomes a morning star on the 2nd after inferior conjunction and improves its position till greatest western elongation on the 28th. But even then it is only 10° above the south-eastern horizon at sunrise.

*Venus* on the 15th is in R.A. 20h 54m, Decl. 18° 21′ S. and transits at 11.16. It is a morning star but too near the sun for easy observation.

*Mars* on the 15th is in R.A. 22h 20m, Decl. 11° 32′ S. and transits at 12.40. It is too close to the sun for observation.

*Jupiter* on the 15th is in R.A. 19h 29m, 21° 58′ S. and transits at 9.48. It is a morning star very low in the south-east at sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 24m, Decl. 11° 56′ N. and transits at 0.44. It rises shortly after sunset and is visible all night. It is just to the east of Regulus. Opposition is on the 21st.

*Uranus* on the 15th is in R.A. 5h 45m. Decl. 23° 37′ N. and transits at 20.03.

*Neptune* on the 15th is in R.A. 12h 57m, Decl. 4° 24′ S. and transits at 3.18.

*Pluto*—For information in regard to this planet, see p. 29.

## FEBRUARY
### 75th Meridian Civil Time

| d | | h | m | | | Min. of Algol h m | Config. of Jupiter's Sat. 7h 30m |
|---|---|---|---|---|---|---|---|
| Tue. | 1 | 21 | | Moon in Apogee. Dist. from ⊕, 252,100 mi.... | | | |
| Wed. | 2 | 13 | | ☌☿☉ | Inferior......... | | |
| Thu. | 3 | 8 | | ☿ Greatest Hel. Lat. N.................. | | 00 26 | |
| Fri. | 4 | | | .................................... | | | |
| Sat. | 5 | | | .................................... | | 21 16 | |
| Sun. | 6 | 3 | 05 | ☽ First Quarter......................... | | | |
| Mon. | 7 | | | .................................... | | | |
| Tue. | 8 | | | .................................... | | 18 05 | 431O2 |
| Wed. | 9 | 4 | 51 | ☌♅☾ | ♅ 4° 06′ S.............. | | 43O21 |
| Thu. | 10 | 3 | | ☌☿♀ | ☿ 4° 02′ N.............. | | 432O* |
| Fri. | 11 | 8 | | ♂ in Perihelion......................... | | 14 54 | 41O32 |
| Sat. | 12 | | | .................................... | | | 4O123 |
| Sun. | 13 | 4 | 08 | ◯ Full Moon........................ | | | |
| | | 17 | 01 | ☌♄☾ | ♄ 2° 34′ S.............. | | 412O3 |
| Mon. | 14 | 5 | | Moon in Perigee. Dist. from ⊕, 222,800 mi.... | | 11 44 | 42O13 |
| | | 9 | | ☿ Stationary in R.A.................... | | | |
| Tue. | 15 | | | .................................... | | | 31O2* |
| Wed. | 16 | 13 | 13 | ☌♆☾ | ♆ 0° 34′ N.............. | | 3O214 |
| Thu. | 17 | | | .................................... | | 8 33 | 321O4 |
| Fri. | 18 | | | .................................... | | | dO4** |
| Sat. | 19 | 19 | 43 | ☾ Last Quarter......................... | | | O1234 |
| Sun. | 20 | | | .................................... | | 5 22 | 12O34 |
| Mon. | 21 | 13 | | ☍♄☉ | Dist. from ⊕, 769,000,000 mi... | | 2O134 |
| Tue. | 22 | | | .................................... | | | 13O24 |
| Wed. | 23 | 17 | 54 | ☌♃☾ | ♃ 5° 03′ N.............. | 2 12 | 3O124 |
| Thu. | 24 | | | .................................... | | | 3214O |
| Fri. | 25 | 2 | 21 | ☌☿☾ | ☿ 5° 30′ N.............. | 23 01 | 43O1* |
| Sat. | 26 | 10 | 02 | ☌♀☾ | ♀ 3° 35′ N.............. | | 4O32* |
| | | 18 | | ☿ in ☋ ........................... | | | |
| Sun. | 27 | 15 | 55 | ● New Moon......................... | | | 412O3 |
| | | 21 | 42 | ☌♂☾ | ♂ 2° 52′ N.............. | | |
| Mon. | 28 | 0 | | ☿ Greatest elongation W., 27° 00′......... | | 19 50 | 42O13 |
| | | 4 | | ♀ in Aphelion........................ | | | |

Jupiter being near the sun, phenomena of the satellites are not given until February 8.

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR MARCH, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During March the sun's R.A. increases from 22h 46m to 0h 40m and its Decl. changes from 7° 47′ S. to 4° 20′ N. The equation of time changes from – 12m 36s to – 4m 08s. On the 20th at 17.49 E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. For changes in the length the day, see p. 12.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 19.

*Mercury* on the 15th is in R.A. 22h 14m, Decl. 13° 01′ S. and transits at 10.47. It is a morning star but too close to the sun for observation.

*Venus* on the 15th is in R.A. 23h 10m, Decl. 6° 57′ S. and transits at 11.41. It is too near the sun for observation.

*Mars* on the 15th is in R.A. 23h 42 m, Decl. 2° 57′ S. and transits at 12.12. It is too close to the sun for observation, conjunction with the sun being on the 17th.

*Jupiter* on the 15th is in R.A. 19h 52m, Decl. 21° 07′ S. and transits at 8.21. It is a morning star visible in Capricornus in the south-east for a few hours before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 15m, Decl. 12° 45′ N. and transits at 22.41. It is well up in the east by sunset and sets just before sunrise. It is a little north and east of Regulus.

*Uranus* on the 15th is in R.A. 5h 45m, Decl. 23° 37′ N. and transits at 18.12.

*Neptune* on the 15th is in R.A. 12h 55m, Decl. 4° 10′ S. and transits at 1.25.

*Pluto*—For information in regard to this planet, see p. 29.

| | | | MARCH<br>75th Meridian Civil Time | Min. of Algol | Config. of Jupiter's Sat. 6h 30m |
|---|---|---|---|---|---|
| d | h | m | | h m | |
| Tue. 1 | 7 | | Moon in Apogee. Dist. from ⊕, 252,500 mi.... | | 41302 |
| Wed. 2 | | | | | 43012 |
| Thu. 3 | | | | 16 40 | 34210 |
| Fri. 4 | 23 | | ♅ Stationary in R.A. | | 32401 |
| Sat. 5 | | | | | 0342* |
| Sun. 6 | | | | 13 29 | d0234 |
| Mon. 7 | 19 | 42 | ☽ First Quarter | | 20134 |
| Tue. 8 | 13 | 14 | ☌ ♅ ☾ ♅ 4° 18′ S. | | d1024 |
| Wed. 9 | 1 | | ☿ in Aphelion | 10 18 | 30124 |
| Thu. 10 | | | | | 32104 |
| Fri. 11 | | | | | 32014 |
| Sat. 12 | | | | 7 07 | 10342 |
| Sun. 13 | 0 | 54 | ☌ ♄ ☾ ♄ 2° 41′ S. | | 40123 |
| Mon. 14 | 14 | 03 | ○ Full Moon | | 42013 |
| | 16 | | Moon in Perigee. Dist. from ⊕, 221,700 mi.... | | |
| Tue. 15 | 22 | 40 | ☌ ♆ ☾ ♆ 0° 39′ N. | 3 57 | 4103* |
| Wed. 16 | | | | | 43012 |
| Thu. 17 | 6 | | ☌ ♂ ☉ | | 43120 |
| | 7 | | □ ♅ ☉ | | |
| Fri. 18 | | | | 0 46 | 43201 |
| Sat. 19 | | | | | 41032 |
| Sun. 20 | 17 | 49 | ☉ enters ♈, Spring commences. Long. of ☉, 0°. | 21 35 | 40123 |
| Mon. 21 | 8 | 10 | ☾ Last Quarter | | 203** |
| Tue. 22 | 9 | | ♀ Greatest Hel. Lat. S. | | 1034* |
| Wed. 23 | 8 | 54 | ☌ ♃ ☾ ♃ 5° 11′ N. | 18 25 | 30124 |
| Thu. 24 | | | | | 31204 |
| Fri. 25 | | | | | 32014 |
| Sat. 26 | | | | 15 14 | 1024* |
| Sun. 27 | 23 | 46 | ☌ ☿ ☾ ☿ 0° 44′ N. | | 01234 |
| Mon. 28 | 8 | | Moon in Apogee. Dist. from ⊕, 252,600 mi.... | | 21043 |
| | 22 | 53 | ☌ ♀ ☾ ♀ 0° 40′ N. | | |
| Tue. 29 | 3 | 30 | ☌ ♂ ☾ ♂ 1° 11′ N. | 12 03 | d2043 |
| | 9 | | ☿ Greatest Hel. Lat. S. | | |
| | 10 | 11 | ● New Moon | | |
| Wed. 30 | | | | | 43012 |
| Thu. 31 | | | | | d4310 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR APRIL, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During April the sun's R.A. increases from 0h 40h to 2h 31m and its Decl. changes from 4° 20′ N. to 14° 55′ N. The equation of time changes from – 4m 08s to zero on the 15th and then to + 2m 52s at the end of the month. There is a partial eclipse of the sun, not visible in North America, on April 28. For changes in the length of the day, see p. 12.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 19. There is a total eclipse of the moon, visible in North America, on April 12-13. See p. 29. On the night of the 15th-16th an occultation of Antares is visible in parts of Eastern Canada. See p. 56.

*Mercury* on the 15th is in R.A. 1h 39m, Decl. 9° 50′ N. and transits at 12.11. It becomes an evening star after superior conjunction on the 13th and by the end of the month is favourably placed, being about 15° above the western horizon at sunset. On the evening of the 29th it is very close to the moon, and in the vicinity of Vancouver it is occulted by the moon about midday. See p. 56.

*Venus* on the 15th is in R.A. 1h 31m, Decl. 8° 20′ N. and transits at 12.00. It is too near the sun for observation, being in superior conjunction on the 16th.

*Mars* on the 15th is in R.A. 1h 09m, Decl. 6° 42′ N. and transits at 11.37. It is too close to the sun for observation.

*Jupiter* on the 15th is in R.A. 20h 10m, Decl. 20° 19′ S. and transits at 6.37. It is a morning star visible in Capricornus in the south-east for a few hours before sunrise. Quadrature with the sun is on the 21st. For the configurations of Jupiter's satellites see opposite page, and their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 09m, Decl. 13° 17′ N. and transits at 20.34. It is high in the eastern sky by sunset and sets a few hours after midnight. It is a little north and east of Regulus.

*Uranus* on the 15th is in R.A. 5h 48m, Decl. 23° 38′ N. and transits at 16.13.

*Neptune* on the 15th is in R.A. 12h 52m, Decl. 3° 50′ S. and transits at 23.16.

*Pluto*—For information in regard to this planet, see p. 29.

# APRIL

## 75th Meridian Civil Time

| | d | h | m | | Min. of Algol h m | Config. of Jupiter's Sat. 5h 00m |
|---|---|---|---|---|---|---|
| Fri. | 1 | | | ........................................ | 8 52 | 43201 |
| Sat. | 2 | 7 | | ☌♀♂ ♀ 0° 41′ S. ............... | | 4102* |
| Sun. | 3 | 17 | | ☍♆☉ Dist. from ⊕, 2,721,000,000 mi. | | 40123 |
| Mon. | 4 | 20 | 39 | ☌♅☾ ♅ 4° 26′ S. ............... | 5 41 | 42103 |
| Tue. | 5 | | | ........................................ | | 42013 |
| Wed. | 6 | 8 | 01 | ☽ First Quarter ........................ | | 4302* |
| Thu. | 7 | | | ........................................ | 2 31 | 31042 |
| Fri. | 8 | 10 | | ☌☿♂ ☿ 0° 47′ S. ............... | | 32014 |
| Sat. | 9 | 8 | 26 | ☌♄☾ ♄ 2° 51′ S. ............... | 23 20 | 13024 |
| Sun. | 10 | | | ........................................ | | 01324 |
| Mon. | 11 | | | ........................................ | | 12034 |
| Tue. | 12 | 4 | | Moon in Perigee. Dist. from ⊕, 222,500 mi.... | 20 09 | 20134 |
| | | 4 | | ☌☿♀ ☿ 0° 21′ N. ............... | | |
| | | 8 | 41 | ☌♆☾ ♆ 0° 35′ N. ............... | | |
| | | | | Total eclipse of ☾, see p. 29 .................. | | |
| | | 23 | 08 | ○ Full Moon ........................ | | |
| Wed. | 13 | 3 | | ☌☿☉ Superior ..................... | | 024** |
| Thu. | 14 | | | ........................................ | | d3024 |
| Fri. | 15 | | | ........................................ | 16 58 | 32041 |
| Sat. | 16 | 17 | | ☌♀☉ Superior ..................... | | 4310* |
| Sun. | 17 | 10 | | ☿ in ☊ ................................ | | 40312 |
| Mon. | 18 | | | ........................................ | 13 47 | 41203 |
| Tue. | 19 | 22 | 15 | ☌♃☾ ♃ 5° 11′ N. ............... | | 42013 |
| | | 22 | 27 | ☾ Last Quarter ........................ | | |
| Wed. | 20 | | | ........................................ | | 41032 |
| Thu. | 21 | 2 | | □♃☉ ................................... | 10 36 | 43012 |
| | | | | Lyrid meteors ............................ | | |
| Fri. | 22 | 0 | | ☿ in Perihelion ......................... | | 43201 |
| Sat. | 23 | | | ........................................ | | 3410* |
| Sun. | 24 | 17 | | Moon in Apogee. Dist. from ⊕, 252,200 mi.... | 7 25 | 03412 |
| Mon. | 25 | | | ........................................ | | 12043 |
| Tue. | 26 | | | ........................................ | | 20134 |
| Wed. | 27 | 8 | 25 | ☌♂☾ ♂ 0° 48′ S. ............... | 4 14 | 10324 |
| Thu. | 28 | 3 | 02 | ● New Moon ........................ | | 30124 |
| | | | | Partial eclipse of ☉, see p. 29 ................. | | |
| | | 11 | 11 | ☌♀☾ ♀ 2° 19′ S. ............... | | |
| Fri. | 29 | 16 | 01 | ☌☿☾ ☿ 0° 43′ S. ............... | | 3204* |
| Sat. | 30 | | | ........................................ | 1 04 | 32104 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR MAY, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During May the sun's R.A. increases from 2h 31m to 4h 34m and its Decl. changes from 14° 55′ N. to 21° 59′ N. The equation of time changes from + 2m 52s to a maximum of + 3m 46s on the 15th and then to + 2m 26s at the end of the month. For changes in the length of the day, see p. 13.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20.

*Mercury* on the 15th is in R.A. 4h 52m, Decl. 24° 43′ N. and transits at 13.21. Its position in the evening sky improves until the 10th when it is in greatest eastern elongation. It is then about 18° above the western horizon at sunset, about 7° north of Aldebaran. Early this month is the best time this year to see Mercury as an evening star. By the end of the month it is close to the sun again.

*Venus* on the 15th is in R.A. 3h 56m, Decl. 20° 18′ N. and transits at 12.28. It is an evening star now, but poorly placed until the end of the month by which time it is 10° above the western horizon at sunset.

*Mars* on the 15th is in R.A. 2h 35m, Decl. 14° 51′ N. and transits at 11.05. It is too close to the sun for observation.

*Jupiter* on the 15th is in R.A. 20h 18m, Decl. 19° 59′ S. and transits at 4.47. It is a morning star rising a little after midnight and visible in the south-east for the rest of the night. On the 20th it is stationary in R.A. and begins to retrograde, that is, move westward among the stars. For the configurations of Jupiter's satellites see opposite page and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 09m, Decl. 13° 16′ N. and transits at 18.36. It is past the meridian by sunset and it sets shortly after midnight. On the 1st it is stationary in R.A. and the observer will notice how it resumes direct or eastward motion, by watching it in relation to Regulus. Quadrature with the sun is on the 20th.

*Uranus* on the 15th is in R.A. 5h 54m, Decl. 23° 39′ N. and transits at 14.21.

*Neptune* on the 15th is in R.A. 12h 50m, Decl. 3° 34′ S. and transits at 21.16.

*Pluto*—For information in regard to this planet, see p. 29.

| | | | MAY<br>75th Meridian Civil Time | Min. of Algol | Config. of Jupiter's Sat. 3h 30m |
|---|---|---|---|---|---|
| d | h | m | | h m | |
| Sun. 1 | 13 | | ♄ Stationary in R.A.................... | | O124* |
| Mon. 2 | 3 | 59 | ☌ ♅ ☾ ♅ 4° 28′ S................ | 21 53 | d1O23 |
| | 6 | | ☿ Greatest Hel. Lat. N.................. | | |
| Tue. 3 | | | ........................................ | | 24O13 |
| Wed. 4 | | | Eta Aquarid meteors........................ | | 41O23 |
| Thu. 5 | 16 | 33 | ☽ First Quarter........................ | 18 42 | 43O12 |
| Fri. 6 | 15 | 20 | ☌ ♄ ☾ ♄ 2° 53′ S................ | | 4321O |
| Sat. 7 | | | ........................................ | | d432O |
| Sun. 8 | | | ........................................ | 15 31 | 43O12 |
| Mon. 9 | 17 | 29 | ☌ ♆ ☾ ♆ 0° 32′ N................ | | 41O23 |
| Tue. 10 | 10 | | Moon in Perigee. Dist. from ⊕, 224,900 mi.... | | 2O13* |
| | 15 | | ☿ Greatest elongation E., 21° 32′.......... | | |
| Wed. 11 | | | ........................................ | 12 20 | 1O43* |
| Thu. 12 | 7 | 51 | ◯ Full Moon........................ | | 3O124 |
| Fri. 13 | | | ........................................ | | 312O4 |
| Sat. 14 | | | ........................................ | 9 09 | 32O14 |
| Sun. 15 | | | ........................................ | | 3O24* |
| Mon. 16 | | | ........................................ | | 1O234 |
| Tue. 17 | 9 | 14 | ☌ ♃ ☾ ♃ 5° 01′ N................ | 5 57 | 2O134 |
| | 16 | | ♀ in ☊.................................. | | |
| Wed. 18 | | | ........................................ | | 1O43* |
| Thu. 19 | 14 | 22 | ☾ Last Quarter........................ | | 43O12 |
| Fri. 20 | 16 | | ♃ Stationary in R.A.................... | 2 46 | 3412O |
| | 20 | | □ ♄ ☉.................................. | | |
| Sat. 21 | | | ........................................ | | 432O1 |
| Sun. 22 | 9 | | Moon in Apogee. Dist. from ⊕, 251,600 mi.... | 23 35 | 43O2* |
| Mon. 23 | 5 | | ☿ Stationary in R.A.................... | | d4O23 |
| Tue. 24 | | | ........................................ | | 42O13 |
| Wed. 25 | 17 | | ☿ in ☋.................................. | 20 24 | 412O3 |
| Thu. 26 | 10 | 44 | ☌ ♂ ☾ ♂ 2° 29′ S................ | | d4O12 |
| Fri. 27 | 7 | | ☌ ☿ ♀ ☿ 0° 50′ S................ | | d314O |
| | 17 | 24 | ● New Moon........................ | | |
| Sat. 28 | 12 | 48 | ☌ ☿ ☾ ☿ 4° 51′ S................ | 17 13 | 32O14 |
| | 16 | 37 | ☌ ♀ ☾ ♀ 3° 43′ S................ | | |
| Sun. 29 | 12 | 28 | ☌ ♅ ☾ ♅ 4° 26′ S................ | | 31O24 |
| Mon. 30 | | | ........................................ | | dO324 |
| Tue. 31 | | | ........................................ | 14 02 | 2O134 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR JUNE, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During June the sun's R.A. increases from 4h 34m to 6h 38m and its Decl. changes from 21° 59′ N. to 23° 27′ N. at the solstice on the 21st and then to 23° 09′ N. at the end of the month. The equation of time changes from + 2m 26s to zero on the 14th and then to – 3m 33s at the end of the month. For changes in the length of the day, see p. 13.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20. In the evening of the 9th an occultation of Antares is visible in parts of Eastern Canada. See p. 56.

*Mercury* on the 15th is in R.A. 4h 31m. Decl. 17° 31′ N. and transits at 10.56. It is in inferior conjunction on the 3rd and becomes a morning star. At and near the time of greatest western elongation on the 28th it may be seen low in the east just before sunrise, a little lower than Aldebaran and a few degrees farther around towards the north.

*Venus* on the 15th is in R.A. 6h 41m, Decl. 24° 11′ N. and transits at 13.10. It is an evening star but its position is not improving very rapidly; it is still very low in the west at sunset.

*Mars* on the 15th is in R.A. 4h 06m, Decl. 20° 53′ N. and transits at 10.34. It is too close to the sun for easy observation.

*Jupiter* on the 15th is in R.A. 20h 14m, Decl. 20° 17′ S. and transits at 2.41. It rises a little before midnight and is visible in the south-east and south for the rest of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 15m, Decl. 12° 40′ N. and transits at 16.39. It is well past the meridian by sunset and it sets before midnight. It is east and a little north of Regulus.

*Uranus* on the 15th is in R.A. 6h 01m, Decl. 23° 40′ N. and transits at 12.27.

*Neptune* on the 15th is in R.A. 12h 48m, Decl. 3° 26′ S. and transits at 19.12.

*Pluto*—For information in regard to this planet, see p. 29.

| | d | h | m | JUNE<br>75th Meridian Civil Time | Min. of Algol<br>h m | Config. of Jupiter's Sat.<br>2h 30m |
|---|---|---|---|---|---|---|
| Wed. | 1 | | | | | 21O34 |
| Thu. | 2 | 22 | 38 | ☌♄☾ ♄ 2° 44′ S. | | O3124 |
| Fri. | 3 | 17 | | ☌☿☉ Inferior | 10 51 | 31O24 |
| | | 22 | 27 | ☽ First Quarter | | |
| Sat. | 4 | | | | | 32O41 |
| Sun. | 5 | 0 | | ☿ in Aphelion | | 341O2 |
| Mon. | 6 | 0 | 19 | ☌♆☾ ♆ 0° 36′ N. | 7 40 | 4O312 |
| Tue. | 7 | 2 | | Moon in Perigee. Dist. from ⊕, 228,100 mi. | | 42O3* |
| | | 3 | | ☌♀♅ ♀ 0° 35′ N. | | |
| Wed. | 8 | | | | | 421O3 |
| Thu. | 9 | | | | 4 29 | 4O132 |
| Fri. | 10 | 16 | 45 | ○ Full Moon | | 431O2 |
| Sat. | 11 | | | | | 432O1 |
| Sun. | 12 | | | | 1 17 | 341O* |
| Mon. | 13 | 12 | | ♂ in ☊ | | O412* |
| | | 16 | 48 | ☌♃☾ ♃ 4° 47′ N. | | |
| Tue. | 14 | | | | 22 06 | 21O43 |
| Wed. | 15 | 18 | | ☿ Stationary in R.A. | | d2O34 |
| Thu. | 16 | | | | | O1324 |
| Fri. | 17 | | | | 18 55 | 31O24 |
| Sat. | 18 | 7 | 29 | ☾ Last Quarter | | 32O14 |
| Sun. | 19 | 3 | | Moon in Apogee. Dist. from ⊕, 251,100 mi. | | 31O4* |
| Mon. | 20 | 12 | | ♀ in Perihelion | 15 43 | O124* |
| Tue. | 21 | 13 | 03 | ☉ enters ♋, Summer commences. Long. of ☉, 90° | | 12O43 |
| Wed. | 22 | 8 | | ☌♅☉ | | 42O13 |
| Thu. | 23 | | | | 12 32 | 4O23* |
| Fri. | 24 | 7 | | ♆ Stationary in R.A. | | 431O2 |
| | | 9 | 50 | ☌♂☾ ♂ 3° 39′ S. | | |
| | | 13 | 09 | ☌☿☾ ☿ 7° 42′ S. | | |
| Sat. | 25 | 8 | | ☿ Greatest Hel. Lat. S. | | 432O1 |
| | | 22 | 41 | ☌♅☾ ♅ 4° 27′ S. | | |
| Sun. | 26 | 5 | 02 | ● New Moon | 9 21 | 4312O |
| Mon. | 27 | 16 | 07 | ☌♀☾ ♀ 3° 41′ S. | | 43O12 |
| Tue. | 28 | 5 | | ☿ Greatest elongation W., 22° 03′ | | 412O3 |
| Wed. | 29 | | | | 6 10 | 24O13 |
| Thu. | 30 | 7 | 47 | ☌♄☾ ♄ 2° 27′ S. | | O243* |

**Explanation of symbols and abbreviations on p. 4, of time on p. 8.**

## THE SKY FOR JULY, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During July the sun's R.A. increases from 6h 38m to 8h 43m and its Decl. changes from 23° 09′ N. to 18° 10′ N. The equation of time changes from − 3m 33s to − 6m 15s. On the 2nd the earth is in aphelion, that is, farthest from the sun. For changes in the length of the day, see p. 14.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21.

*Mercury* on the 15th is in R.A. 6h 38m, Decl. 23° 14′ N. and transits at 11.11. Early in the month it is a fair morning star but by the 26th it is in superior conjunction and passes into the evening sky.

*Venus* on the 15th is in R.A. 9h 15m, Decl. 17° 37′ N. and transits at 13.46. It is still very low in the west at sunset. The close approach to Saturn on the evening of the 30th will be interesting to notice.

*Mars* on the 15th is in R.A. 5h 36m, Decl. 23° 41′ N. and transits at 10.05. It is a morning star visible in the east for an hour or so before sunrise. Near Aldebaran in Taurus at the beginning of the month, it moves towards Gemini.

*Jupiter* on the 15th is in R.A. 20h 01m, Decl. 21° 03′ S. and transits at 0.30. It rises a little after sunset and is very prominent in the southern sky all night. Opposition is on the 20th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 25m, Decl. 11° 40′ N. and transits at 14.52. It is quite low in the west by sunset, setting about two hours later. It is a few degrees east of Regulus. The close approach to Venus on the evening of the 30th will be interesting to notice.

*Uranus* on the 15th is in R.A. 6h 09m, Decl. 23° 39′ N. and transits at 10.37.

*Neptune* on the 15th is in R.A. 12h 49m, Decl. 3° 30′ S. and transits at 17.15.

*Pluto*—For information in regard to this planet, see p. 29.

## JULY

75th Meridian Civil Time

| | d | h | m | | Min. of Algol h m | Config. of Jupiter's Sat. 1h 00m |
|---|---|---|---|---|---|---|
| Fri. | 1 | | | | | d3O24 |
| Sat. | 2 | 16 | | ⊕ in Aphelion. Dist. from ☉, 94,453,000 mi. | 2 58 | 32O14 |
| | | 17 | | Moon in Perigee. Dist. from ⊕, 229,800 mi. | | |
| Sun. | 3 | 3 | 08 | ☽ First Quarter | | 312O4 |
| | | 6 | 00 | ☌ ♆ ☾ ♆ 0° 49′ N. | | |
| Mon. | 4 | 14 | | □ ♆ ☉ | 23 47 | 3O124 |
| Tue. | 5 | | | | | 1O234 |
| Wed. | 6 | | | | | 2O134 |
| Thu. | 7 | | | | 20 36 | 1O243 |
| Fri. | 8 | | | | | dd4O2 |
| Sat. | 9 | | | | | 432O1 |
| Sun. | 10 | 2 | 41 | ○ Full Moon | 17 24 | 4321O |
| | | 20 | 34 | ☌ ♃ ☾ ♃ 4° 37′ N. | | |
| Mon. | 11 | 0 | | ☌ ☿ ♅ ☿ 0° 54′ S. | | 43O12 |
| Tue. | 12 | 4 | | ♀ Greatest Hel. Lat. N. | | 41O23 |
| Wed. | 13 | | | | 14 13 | 42O13 |
| Thu. | 14 | 9 | | ☿ in ☊ | | 41O23 |
| Fri. | 15 | | | | | 4O312 |
| Sat. | 16 | 21 | | Moon in Apogee. Dist. from ⊕, 251,100 mi. | 11 01 | 32O** |
| Sun. | 17 | | | | | 321O4 |
| Mon. | 18 | 1 | 01 | ☾ Last Quarter | | 3O124 |
| Tue. | 19 | 0 | | ☿ in Perihelion | 7 50 | 1O324 |
| Wed. | 20 | 3 | | ☍ ♃ ☉ Dist. from ⊕, 382,300,000 mi. | | 2O134 |
| Thu. | 21 | | | | | 1O34* |
| Fri. | 22 | | | | 4 39 | O3124 |
| Sat. | 23 | 6 | 07 | ☌ ♂ ☾ ♂ 4° 16′ S. | | 321O4 |
| | | 10 | 17 | ☌ ♅ ☾ ♅ 4° 34′ S. | | |
| Sun. | 24 | | | | | d32O4. |
| Mon. | 25 | 10 | 33 | ☌ ☿ ☾ ☿ 3° 28′ S. | 1 27 | 34O12 |
| | | 14 | 33 | ● New Moon | | |
| Tue. | 26 | 16 | | ☌ ☿ ☉ Superior | | 41O32 |
| Wed. | 27 | 3 | | ☌ ♂ ♅ ♂ 0° 16′ N. | 22 16 | 42O13 |
| | | 13 | 22 | ☌ ♀ ☾ ♀ 2° 27′ S. | | |
| | | 19 | 47 | ☌ ♄ ☾ ♄ 2° 07′ S. | | |
| Thu. | 28 | | | Delta Aquarid meteors | | 412O3 |
| | | 20 | | Moon in Perigee. Dist. from ⊕, 227,600 mi. | | |
| Fri. | 29 | 5 | | ☿ Greatest Hel. Lat. N. | | 4O132 |
| Sat. | 30 | 12 | 21 | ☌ ♆ ☾ ♆ 1° 06′ N. | 19 04 | 4312O |
| Sun. | 31 | 1 | | ☌ ♀ ♄ ♀ 0° 10′ S. | | d432O |

**Explanation of symbols and abbreviations on p. 4, of time on p. 8.**

## THE SKY FOR AUGUST, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During August the sun's R.A. increases from 8h 43m to 10h 39m and its Decl. changes from 18° 10′ N. to 8° 29′ N. The equation of time changes from − 6m 15s to − 0m 10s. For changes in the length of the day, see p. 14.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21.

*Mercury* on the 15th is in R.A. 10h 46m, Decl. 8° 44′ N. and transits at 13.16. It is an evening star all month but poorly placed for observation.

*Venus* on the 15th is in R.A. 11h 37m, Decl. 3° 37′ N. and transits at 14.05. It is still rather poorly placed—only about 12° above the western horizon at sunset. In the morning of the 26th it is occulted by the moon for observers in parts of Eastern Canada. See p. 56.

*Mars* on the 15th is in R.A. 7h 06m, Decl. 23° 17′ N. and transits at 9.33. It is a morning star visible in the east for several hours before sunrise. It is in Gemini to the south of Castor and Pollux.

*Jupiter* on the 15th is in R.A. 19h 45m, Decl. 21° 48′ S. and transits at 22.08. It is visible in the south-east after sunset and is prominent in the southern sky most of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 38m, Decl. 10° 21′ N. and transits at 13.04. It is too low in the west at sunset for easy observation.

*Uranus* on the 15th is in R.A. 6h 16m, Decl. 23° 37′ N. and transits at 8.42.

*Neptune* on the 15th is in R.A. 12h 51m, Decl. 3° 45′ S. and transits at 15.15.

*Pluto*—For information in regard to this planet, see p. 29.

| | | | AUGUST<br>75th Meridian Civil Time | Min. of Algol | Config. of Jupiter's Sat. 23h 15m |
|---|---|---|---|---|---|
| d | h | m | | h m | |
| Mon. 1 | 7 | 57 | ☽ First Quarter........................ | | 1042* |
| Tue. 2 | | | ........................................ | 15 53 | 20134 |
| Wed. 3 | | | ........................................ | | 12034 |
| Thu. 4 | | | ........................................ | | 01324 |
| Fri. 5 | | | ........................................ | 12 42 | 13024 |
| Sat. 6 | 21 | 48 | ☌♃☾ ♃ 4° 35′ N............... | | 32014 |
| Sun. 7 | | | ........................................ | | 31024 |
| Mon. 8 | 14 | 33 | ◯ Full Moon........................... | 9 30 | 31024 |
| Tue. 9 | | | ........................................ | | d2013 |
| Wed. 10 | | | ........................................ | | 42103 |
| Thu. 11 | | | ........................................ | 6 19 | 40123 |
| Fri. 12 | | | Perseid meteors.............................. | | 41302 |
| Sat. 13 | 9 | | ☌☿♄ ☿ 0° 38′ S............... | | 43201 |
| | 15 | | Moon in Apogee. Dist. from ⊕, 251,600 mi.... | | |
| Sun. 14 | | | ........................................ | 3 07 | 4310* |
| Mon. 15 | | | ........................................ | | d4302 |
| Tue. 16 | 17 | 59 | ☾ Last Quarter......................... | 23 56 | 42013 |
| Wed. 17 | | | ........................................ | | 21403 |
| Thu. 18 | | | ........................................ | | 01423 |
| Fri. 19 | 22 | 03 | ☌♅☾ ♅ 4° 45′ S............... | 20 44 | 13024 |
| Sat. 20 | | | ........................................ | | 32014 |
| Sun. 21 | 0 | 20 | ☌♂☾ ♂ 4° 24′ S............... | | 3104* |
| | 17 | | ☿ in ☋............................... | | |
| Mon. 22 | | | ........................................ | 17 33 | 30124 |
| Tue. 23 | 22 | 59 | ● New Moon........................... | | 2034* |
| Wed. 24 | 10 | 34 | ☌♄☾ ♄ 1° 48′ S............... | | 21034 |
| Thu. 25 | 14 | 26 | ☌☿☾ ☿ 2° 45′ S............... | 14 22 | 01423 |
| | 16 | | Moon in Perigee. Dist. from ⊕, 224,500 mi.... | | |
| Fri. 26 | 9 | 58 | ☌♀☾ ♀ 0° 23′ S............... | | d1402 |
| | 21 | 01 | ☌♆☾ ♆ 1° 21′ N............... | | |
| Sat. 27 | | | ........................................ | | 43201 |
| Sun. 28 | | | ........................................ | 11 10 | 43120 |
| Mon. 29 | | | ........................................ | | 43012 |
| Tue. 30 | 14 | 16 | ☽ First Quarter........................ | | 42103 |
| Wed. 31 | 23 | | ☿ in Aphelion.......................... | 7 59 | 42103 |

**Explanation of symbols and abbreviations on p. 4, of time on p. 8.**

## THE SKY FOR SEPTEMBER, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During September the sun's R.A. increases from 10h 39m to 12h 27m and its Decl. changes from 8° 29′ N. to 2° 58′ S. The equation of time changes from − 0m 10s to + 10m 06s, reversing its sign on the 1st. On the 23rd at 4.06 E.S.T. the sun crosses the equator, enters the sign of Libra and autumn commences. For changes in the length of the day, see p. 15.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22.

*Mercury* on the 15th is in R.A. 12h 58m, Decl. 9° 56′ S. and transits at 13.22. Greatest eastern elongation is on the 7th but this is a very poor one, Mercury being less than 10° above the western horizon at sunset.

*Venus* on the 15th is in R.A. 13h 52m, Decl. 12° 04′ S. and transits at 14.18. It is still poorly placed, being only about 13° above the south-western horizon at sunset.

*Mars* on the 15th is in R.A. 8h 30m, Decl. 20° 04′ N. and transits at 8.55. It is a morning star visible in Cancer for several hours before sunrise.

*Jupiter* on the 15th is in R.A. 19h 37m, Decl. 22° 09′ S. and transits at 19.58. It is well up in the south-east by sunset and it sets before midnight. On the 18th it is stationary in R.A. and resumes direct, or eastward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

*Saturn* on the 15th is in R.A. 10h 53m, Decl. 8° 54′ N. and transits at 11.16. It is in conjunction with the sun on the 2nd and becomes a morning star but will not be observable most of the month.

*Uranus* on the 15th is in R.A. 6h 21m, Decl. 23° 36′ N. and transits at 6.44.

*Neptune* on the 15th is in R.A. 12h 54m, Decl. 4° 07′ S. and transits at 13.17.

*Pluto*—For information in regard to this planet, see p. 29.

| | | | SEPTEMBER<br>75th Meridian Civil Time | Min. of Algol | Config. of Jupiter's Sat. 21h 30m |
|---|---|---|---|---|---|
| d | h | m | | h m | |
| Thu. 1 | 3 | | ☌ ♀ ♆ ♀ 1° 23′ S. | | 40123 |
| Fri. 2 | 5 | | ☌ ♄ ☉ | | 41032 |
| | 23 | 29 | ☌ ♃ ☾ ♃ 4° 41′ N. | | |
| Sat. 3 | | | | 4 47 | 3201* |
| Sun. 4 | | | | | 31204 |
| Mon. 5 | | | | | 30124 |
| Tue. 6 | 5 | | ♀ in ♉ | 1 36 | 1024* |
| Wed. 7 | 4 | 59 | Full Moon | | 20134 |
| | 18 | | ☿ Greatest elongation E., 26° 59′ | | |
| Thu. 8 | | | | 22 24 | 0234* |
| Fri. 9 | | | | | 10324 |
| Sat. 10 | 6 | | Moon in Apogee. Dist. from ⊕, 252,200 mi. | | 32014 |
| Sun. 11 | | | | 19 13 | 32104 |
| Mon. 12 | 16 | | ☌ ☿ ♆ ☿ 5° 06′ S. | | 34012 |
| Tue. 13 | | | | | 4102* |
| Wed. 14 | | | | 16 02 | 42013 |
| Thu. 15 | 9 | 29 | ☾ Last Quarter | | 403** |
| Fri. 16 | 8 | 24 | ☌ ♅ ☾ ♅ 4° 54′ S. | | 41032 |
| Sat. 17 | | | | 12 50 | 43201 |
| Sun. 18 | 14 | | ♃ Stationary in R.A. | | 43210 |
| | 16 | 56 | ☌ ♂ ☾ ♂ 4° 00′ S. | | |
| Mon. 19 | | | | | 34012 |
| Tue. 20 | 20 | | ☿ Stationary in R.A. | 9 39 | 13042 |
| Wed. 21 | 2 | 58 | ☌ ♄ ☾ ♄ 1° 31′ S. | | 20134 |
| | 7 | | ☿ Greatest Hel. Lat. S. | | |
| Thu. 22 | 7 | 21 | New Moon | | 1034* |
| | 23 | | Moon in Perigee. Dist. from ⊕, 222,400 mi. | | |
| Fri. 23 | 4 | 06 | ☉ enters ♎, Autumn commences. Long. of ☉, 180° | 6 27 | d0324 |
| | 8 | 22 | ☌ ♆ ☾ ♆ 1° 30′ N. | | |
| | 11 | 53 | ☌ ☿ ☾ ☿ 4° 09′ S. | | |
| Sat. 24 | | | | | 32014 |
| Sun. 25 | 5 | 17 | ☌ ♀ ☾ ♀ 1° 16′ N. | | 32104 |
| Mon. 26 | | | | 3 16 | 30124 |
| Tue. 27 | 9 | | ☌ ☿ ♆ ☿ 5° 35′ S. | | 13024 |
| Wed. 28 | 5 | | □ ♅ ☉ | | d2013 |
| | 23 | 18 | ☽ First Quarter | | |
| Thu. 29 | | | | 0 05 | 41203 |
| Fri. 30 | 4 | 46 | ☌ ♃ ☾ ♃ 4° 46′ N. | | 40123 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR OCTOBER, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During October the sun's R.A. increases from 12h 27m to 14h 23m and its Decl. changes from 2° 58′ S. to 14° 15′ S. The equation of time changes from + 10m 06s to + 16m 21s. There is a partial eclipse of the sun, not visible in North America, on October 21st. For changes in the length of the day, see p. 15.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. The full moon of October 6th is the Harvest Moon. There is a total eclipse of the moon, visible in North America, on the evening of the 6th, see p. 29.

*Mercury* on the 15th is in R.A. 12h 18m, Decl. 0° 39′ S. and transits at 10.44. After inferior conjunction on the 3rd Mercury becomes a morning star. By the 19th it has reached greatest western elongation. This is a good time to see it as a morning star; it is then about 18° above the eastern horizon at sunrise. On the morning of the 20th it is quite close to the moon.

*Venus* on the 15th is in R.A. 16h 11m, Decl. 23° 26′ S. and transits at 14.39. It is still relatively poorly placed—about as in September.

*Mars* on the 15th is in R.A. 9h 43m, Decl. 15° 09′ N. and transits at 8.10. It is a morning star rising about an hour after midnight. On the 24th it passes about a degree to the north of Regulus.

*Jupiter* on the 15th is in R.A. 19h 42m, Decl. 21° 58′ S. and transits at 18.05. It is on the meridian in the early evening and sets in the south-west a few hours later. It is in quadrature with the sun on the 17th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

*Saturn* on the 15th is in R.A. 11h 06m, Decl. 7° 36′ N. and transits at 9.32. It is a morning star rising about an hour after Regulus and a few hours before the sun.

*Uranus* on the 15th is in R.A. 6h 22m, Decl. 23° 36′ N. and transits at 4.48.

*Neptune* on the 15th is in R.A. 12h 58m, Decl. 4° 33′ S. and transits at 11.23.

*Pluto*—For information in regard to this planet, see p. 29.

| | d | h | m | OCTOBER<br>75th Meridian Civil Time | Min. of Algol<br>h m | Config. of Jupiter's Sat. 20h 15m |
|---|---|---|---|---|---|---|
| Sat. | 1 | | | | 20 53 | d43O* |
| Sun. | 2 | | | | | 4321O |
| Mon. | 3 | 15 | | ☌ ☿ ☉ Inferior | | 43O21 |
| Tue. | 4 | | | | 17 42 | 431O2 |
| Wed. | 5 | | | | | 42O13 |
| Thu. | 6 | | | Total eclipse of ☾, see p. 29 | | |
| | | 21 | 52 | 🌕 Full Moon Harvest Moon | | 124O3 |
| Fri. | 7 | 12 | | Moon in Apogee. Dist. from ⊕, 252,500 mi. | 14 31 | O123* |
| Sat. | 8 | 8 | | ☌ ♆ ☉ | | 1O324 |
| Sun. | 9 | | | | | d32O4 |
| Mon. | 10 | 8 | | ☿ in ☊ | 11 19 | 3O14* |
| | | 20 | | ♀ in Aphelion | | |
| Tue. | 11 | 1 | | ♅ Stationary in R.A | | 31O24 |
| | | 23 | | ☿ Stationary in R.A | | |
| Wed. | 12 | | | | | 2O314 |
| Thu. | 13 | 16 | 03 | ☌ ♅ ☾ ♅ 4° 56′ S | 8 08 | 21O34 |
| Fri. | 14 | 23 | | ☿ in Perihelion | | O1243 |
| | | 23 | 06 | ☾ Last Quarter | | |
| Sat. | 15 | | | | | 14O23 |
| Sun. | 16 | | | | 4 57 | 423O1 |
| Mon. | 17 | 3 | | □ ♃ ☉ | | 43O** |
| | | 7 | 44 | ☌ ♂ ☾ ♂ 3° 00′ S | | |
| Tue. | 18 | 19 | 02 | ☌ ♄ ☾ ♄ 1° 11′ S | | 431O2 |
| Wed. | 19 | 4 | | ☿ Greatest elongation W., 18° 14′ | 1 46 | 42O1* |
| Thu. | 20 | 10 | 48 | ☌ ☿ ☾ ☿ 1° 24′ N | | 421O3 |
| | | 21 | 13 | ☌ ♆ ☾ ♆ 1° 36′ N | | |
| Fri. | 21 | 10 | | Moon in Perigee. Dist. from ⊕, 222,000 mi. | 22 34 | 4O123 |
| | | 16 | 23 | 🌑 New Moon | | |
| | | | | Partial eclipse of ☉, see p. 29 | | |
| Sat. | 22 | | | Orionid meteors | | 41O23 |
| Sun. | 23 | | | | | 234O1 |
| Mon. | 24 | 22 | 58 | ☌ ♀ ☾ ♀ 1° 49′ N | 19 23 | 32O4* |
| Tue. | 25 | 5 | | ☿ Greatest Hel. Lat. N | | 31O24 |
| | | 8 | | ☌ ☿ ♆ ☿ 0° 34′ N | | |
| Wed. | 26 | | | | | 2O14* |
| Thu. | 27 | 15 | 32 | ☌ ♃ ☾ ♃ 4° 45′ N | 16 12 | 21O34 |
| Fri. | 28 | 12 | 04 | ☽ First Quarter | | O2134 |
| Sat. | 29 | | | | | 1O234 |
| Sun. | 30 | | | | 13 01 | 23O14 |
| Mon. | 31 | | | | | 321O4 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR NOVEMBER, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During November the sun's R.A. increases from 14h 23m to 16h 27m and its Decl. changes from 14° 15′ S. to 21° 43′ S. The equation of time changes from + 16m 21s to a maximum of + 16m 24s on the 4th and then to + 11m 10s at the end of the month. For changes in the length of the day, see p. 16.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23. The full moon of November 5th is the Hunter's Moon.

*Mercury* on the 15th is in R.A. 15h 04m, Decl. 16° 57′ S. and transits at 11.30. It is a morning star until superior conjunction on the 21st and thereafter an evening star but at no time well placed for observation.

*Venus* on the 15th is in R.A. 18h 42m, Decl. 26° 22′ S. and transits at 15.07. Its position in the evening sky is improving now. It is about 17° above the horizon at sunset, just west of the meridian, and is visible for about two hours. Greatest eastern elongation is on the 20th.

*Mars* on the 15th is in R.A. 10h 51m, Decl. 9° 18′ N. and transits at 7.15. It is a morning star rising just after midnight. It is to the east of Regulus. At the beginning of the month it is well separated from Saturn which is to its south-east but during the month it draws closer to Saturn and on the 30th the two planets are in conjunction only 9′ apart and of the same brightness. These two should be a fine sight about this time.

*Jupiter* on the 15th is in R.A. 19h 58m, Decl. 21° 16′ S. and transits at 16.20. It is on the meridian about at sunset and sets in the south-west a few hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

*Saturn* on the 15th is in R.A. 11h 17m, Decl. 6° 33′ N. and transits at 7.40. It is a morning star rising an hour or so after Regulus and a couple of hours after midnight. It is south-east of Mars until the end of the month. (See Mars on this page.) On the 15th there is a daytime occultation of Saturn. See p. 56.

*Uranus* on the 15th is in R.A. 6h 20m, Decl. 23° 38′ N. and transits at 2.43.

*Neptune* on the 15th is in R.A. 13h 02m, Decl. 4° 57′ S. and transits at 9.25.

*Pluto*—For information in regard to this planet, see p. 29.

## NOVEMBER

75th Meridian Civil Time

| | d | h | m | | Min. of Algol h m | Config. of Jupiter's Sat. 19h 00m |
|---|---|---|---|---|---|---|
| Tue. | 1 | | | | | 34012 |
| Wed. | 2 | 2 | | ♀ Greatest Hel. Lat. S | 9 50 | d430* |
| Thu. | 3 | 13 | | Moon in Apogee. Dist. from ⊕, 252,300 mi. | | 42103 |
| Fri. | 4 | | | | | 40213 |
| Sat. | 5 | 16 | 09 | 🌕 Full Moon Hunter's Moon | 6 39 | 41023 |
| Sun. | 6 | | | | | 42301 |
| Mon. | 7 | | | | | 43210 |
| Tue. | 8 | | | | 3 27 | 34012 |
| Wed. | 9 | 21 | 08 | ☌ ♅ ☾ ♅ 4° 51′ S | | 3402* |
| Thu. | 10 | | | | | 21034 |
| Fri. | 11 | | | | 0 16 | 0134* |
| Sat. | 12 | | | | | 10234 |
| Sun. | 13 | 10 | 47 | ☾ Last Quarter | 21 05 | d2014 |
| Mon. | 14 | 19 | 52 | ☌ ♂ ☾ ♂ 1° 24′ S | | 32104 |
| Tue. | 15 | 8 | 31 | ☌ ♄ ☾ ♄ 0° 46′ S | | 30124 |
| Wed. | 16 | | | Leonid meteors | 17 54 | 31024 |
| Thu. | 17 | 9 | 23 | ☌ ♆ ☾ ♆ 1° 46′ N | | d2043 |
| | | 16 | | ☿ in ☋ | | |
| Fri. | 18 | 21 | | Moon in Perigee. Dist. from ⊕, 223,400 mi. | | 4013* |
| Sat. | 19 | | | | 14 43 | 41023 |
| Sun. | 20 | 2 | 11 | ☌ ☿ ☾ ☿ 3° 14′ N | | 42031 |
| | | 2 | 29 | ● New Moon | | |
| | | 13 | | ♀ Greatest elongation E., 47° 15′ | | |
| Mon. | 21 | 17 | | ☌ ☿ ☉ Superior | | 43210 |
| Tue. | 22 | | | | 11 32 | 43012 |
| Wed. | 23 | 14 | 10 | ☌ ♀ ☾ ♀ 2° 00′ N | | 43102 |
| Thu. | 24 | 7 | 38 | ☌ ♃ ☾ ♃ 4° 34′ N | | 4201* |
| Fri. | 25 | | | | 8 21 | 4203* |
| Sat. | 26 | | | | | 1023* |
| Sun. | 27 | | | Bielid meteors | | 20314 |
| | | 5 | 01 | ☽ First Quarter | | |
| | | 23 | | ☿ in Aphelion | | |
| Mon. | 28 | | | | 5 10 | 32104 |
| Tue. | 29 | | | | | 30214 |
| Wed. | 30 | 16 | | ☌ ♂ ♄ ♂ 0° 09′ N | | 31024 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

## THE SKY FOR DECEMBER, 1949

Positions of the sun and planets are given for 0h Greenwich Civil Time.

The times of transit at the 75th meridian are given in local mean time, 0h at midnight; to change to Standard Time, see p. 10. Estimates of altitude are for an observer in latitude 45° N.

*The Sun*—During December the sun's R.A. increases from 16h 27m to 18h 44m and its Decl. changes from 21° 43′ to a maximum of 23° 27′ S. at the time of the solstice on the 21st and then to 23° 04′ S. at the end of the month. The equation of time changes from + 11m 10s to − 3m 14s, being zero on the 25th. For changes in the length of the day, see p. 16.

*The Moon*—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 23.

*Mercury* on the 15th is in R.A. 18h 24m, Decl. 25° 33′ S. and transits at 12.52. Its position as an evening star improves all month but even on the 31st it is only about 12° above the south-western horizon at sunset.

*Venus* on the 15th is in R.A. 20h 40m, Decl. 20° 18′ S. and transits at 15.06. Its position is about as in November. It is now much more brilliant than earlier in the year with stellar magnitude − 4.4 at the time of greatest brilliancy on the 26th. Seen in a telescope the illuminated part of the disk is now rapidly assuming the crescent form. (See Jupiter on this page.)

*Mars* on the 15th is in R.A. 11h 46m, Decl. 3° 56′ N. and transits at 6.12. It is a morning star rising about midnight. During the month it moves from Leo into Virgo and draws away from Saturn towards the east and south. Quadrature of Mars with the sun is on the 19th.

*Jupiter* on the 15th is in R.A. 20h 21m, Decl. 20° 06′ S. and transits at 14.45. It is well past the meridian at sunset and sets a few hours later in the south-west. The close approach (a few degrees) of Jupiter and Venus on the evening of the 6th will be interesting to notice. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

*Saturn* on the 15th is in R.A. 11h 23m, Decl. 6° 02′ N. and transits at 5.48. It is a morning star rising about midnight. (See Mars on this page.) Quadrature of Saturn with the sun is on the 11th and on the 31st it is stationary in R.A. and begins to retrograde, i.e., move westward among the stars.

*Uranus* on the 15th is in R.A. 6h 15m, Decl. 23° 40′ N. and transits at 0.41.

*Neptune* on the 15th is in R.A. 13h 05m, Decl. 5° 14′ S. and transits at 7.30.

*Pluto*—For information in regard to this planet, see p. 29.

| | d | h | m | DECEMBER<br>75th Meridian Civil Time | Min. of Algol<br>h m | Config. of Jupiter's Sat. 18h 00m |
|---|---|---|---|---|---|---|
| Thu. | 1 | 1 | | Moon in Apogee. Dist. from ⊕, 251,900 mi.... | 1 59 | 2O14* |
| Fri. | 2 | | | ........................................ | | 21O34 |
| Sat. | 3 | | | ........................................ | 22 48 | dO243 |
| Sun. | 4 | | | ........................................ | | O2143 |
| Mon. | 5 | 10 | 13 | 🌕 Full Moon ........................ | | 2431O |
| Tue. | 6 | 22 | | ☌ ♀ ♃ ♀ 2° 02′ S. ................ | 19 37 | 43O1* |
| Wed. | 7 | 1 | 20 | ☌ ⛢ ☾ ⛢ 4° 42′ S. ................ | | 431O2 |
| Thu. | 8 | | | ........................................ | | 423O1 |
| Fri. | 9 | | | ........................................ | 16 26 | 421O3 |
| Sat. | 10 | | | ........................................ | | 4O123 |
| Sun. | 11 | 7 | | □ ♄ ☉ ................................ | | 4O23* |
| Mon. | 12 | | | Geminid meteors ........................ | 13 15 | 2413O |
| | | 17 | 56 | ☌ ♄ ☾ ♄ 0° 15′ S. ................ | | |
| | | 20 | 48 | ☾ Last Quarter ........................ | | |
| Tue. | 13 | 3 | 43 | ☌ ♂ ☾ ♂ 0° 33′ N. ................ | | 3O41* |
| Wed. | 14 | 18 | 53 | ☌ ♆ ☾ ♆ 2° 03′ N. ................ | | 31O24 |
| Thu. | 15 | 10 | | ♂ Greatest Hel. Lat. N. ................ | 10 04 | 32O14 |
| Fri. | 16 | | | ........................................ | | 21O34 |
| Sat. | 17 | 2 | | Moon in Perigee. Dist. from ⊕, 226,500 mi.... | | O1234 |
| Sun. | 18 | 7 | | ☿ Greatest Hel. Lat. S. ................ | 6 54 | O234* |
| Mon. | 19 | 5 | | □ ♂ ☉ ................................ | | d21O4 |
| | | 13 | 55 | 🌑 New Moon ........................ | | |
| Tue. | 20 | 17 | 55 | ☌ ☿ ☾ ☿ 2° 49′ N. ................ | | 32O14 |
| Wed. | 21 | 23 | 24 | ☉ enters ♑, Winter commences. Long. of ☉, 270° | 3 43 | 31O42 |
| Thu. | 22 | 3 | 21 | ☌ ♃ ☾ ♃ 4° 16′ N. ................ | | 432O1 |
| | | 18 | 05 | ☌ ♀ ☾ ♀ 3° 41′ N. ................ | | |
| Fri. | 23 | | | ........................................ | | 421O3 |
| Sat. | 24 | 21 | | ☍ ⛢ ☉ Dist. from ⊕, 1,669,000,000 mi.. | 0 32 | 4O123 |
| Sun. | 25 | | | ........................................ | | 41O23 |
| Mon. | 26 | 10 | | ♀ Greatest brilliancy ................ | 21 21 | d42O3 |
| Tue. | 27 | 1 | 31 | ☽ First Quarter ........................ | | 432O1 |
| Wed. | 28 | 9 | | ♀ in ☊ ................................ | | 431O2 |
| | | 19 | | Moon in Apogee. Dist. from ⊕, 251,400 mi.... | | |
| Thu. | 29 | | | ........................................ | 18 10 | d34O1 |
| Fri. | 30 | | | ........................................ | | 21O43 |
| Sat. | 31 | 1 | | ♄ Stationary in R.A. ................ | | O2143 |

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

# PHENOMENA OF JUPITER'S SATELLITES, 1949

By CHARLES E. APGAR, Westfield, New Jersey

### JANUARY

Jupiter being near the Sun, phenomena of the Satellites are not given from January 1 to February 7.

### FEBRUARY

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 10 | 06 | 11 | I | ED |
| 11 | 06 | 23 | I | Te |
| | 06 | 27 | II | OR |
| | 06 | 27 | III | OR |
| 15 | 06 | 15 | IV | ED |
| 18 | 06 | 07 | I | TI |
| 19 | 05 | 39 | I | OR |

### MARCH

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 1 | 05 | 22 | III | Te |
| 6 | 04 | 47 | II | SI |
| 6 | 05 | 50 | I | Se |
| 8 | 05 | 31 | III | Se |
| 13 | 05 | 29 | I | SI |
| 19 | 04 | 17 | III | OR |
| 21 | 04 | 38 | I | ED |
| | 04 | 50 | IV | OD |
| 22 | 04 | 05 | I | Se |
| | 04 | 26 | II | ED |
| | 05 | 15 | I | Te |
| 24 | 04 | 28 | II | Te |
| 26 | 05 | 01 | III | OD |
| 29 | 03 | 44 | I | SI |
| | 04 | 56 | I | TI |
| | 05 | 24 | IV | Se |
| 30 | 04 | 32 | I | OR |
| 31 | 04 | 24 | II | TI |
| | 04 | 38 | II | Se |

### APRIL

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 2 | 04 | 07 | III | ED |
| 7 | 03 | 36 | I | Te |
| | 03 | 44 | IV | OR |
| | 04 | 30 | II | SI |
| 9 | 04 | 09 | II | OR |
| 13 | 03 | 15 | III | TI |
| | 04 | 48 | I | ED |
| 14 | 03 | 16 | I | TI |
| | 04 | 13 | I | Se |
| 15 | 02 | 52 | I | OR |
| 21 | 03 | 52 | I | SI |
| 22 | 04 | 47 | I | OR |
| 23 | 03 | 57 | II | ED |
| 25 | 04 | 25 | II | Te |
| 29 | 03 | 03 | I | ED |
| 30 | 01 | 31 | I | TI |
| | 02 | 29 | I | Se |
| | 03 | 46 | I | Te |

### MAY

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 2 | 01 | 36 | II | SI |
| | 02 | 31 | IV | TI |
| | 04 | 12 | II | TI |
| | 04 | 21 | II | Se |
| 7 | 02 | 07 | I | SI |
| | 03 | 22 | I | TI |
| | 04 | 22 | I | Se |
| 8 | 03 | 00 | I | OR |
| | 03 | 29 | III | ER |
| 9 | 04 | 12 | II | SI |
| 10 | 03 | 40 | IV | ER |
| 11 | 03 | 40 | II | OR |
| 14 | 04 | 00 | I | SI |
| 15 | 01 | 19 | I | ED |
| | 03 | 59 | III | ED |
| 16 | 00 | 44 | I | Se |
| | 01 | 57 | I | Te |
| 18 | 00 | 56 | II | ED |
| 19 | 02 | 13 | III | Te |
| 20 | 01 | 14 | II | Te |
| 22 | 03 | 13 | I | ED |
| 23 | 00 | 22 | I | SI |
| | 01 | 30 | I | TI |
| | 02 | 37 | I | Se |
| | 03 | 46 | I | Te |
| 24 | 01 | 08 | I | OR |
| 25 | 03 | 31 | II | ED |
| 26 | 01 | 20 | III | Se |
| | 02 | 21 | III | TI |
| 27 | 00 | 52 | II | TI |
| | 01 | 25 | II | Se |
| | 03 | 39 | II | Te |
| | 04 | 13 | IV | OD |
| 30 | 02 | 15 | I | SI |
| | 03 | 19 | I | TI |
| | 23 | 35 | I | ED |
| 31 | 02 | 56 | I | OR |

### JUNE

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 1 | 00 | 02 | I | Te |
| 2 | 01 | 51 | III | SI |
| 3 | 01 | 15 | II | SI |
| | 03 | 15 | II | TI |
| | 04 | 01 | II | Se |
| 4 | 02 | 20 | IV | SI |
| 5 | 00 | 10 | II | OR |
| | 23 | 26 | III | OR |
| 6 | 04 | 09 | I | SI |
| 7 | 01 | 29 | I | ED |
| | 23 | 33 | I | TI |
| 8 | 00 | 53 | I | Se |
| | 01 | 49 | I | Te |
| | 23 | 10 | I | OR |
| 10 | 03 | 50 | II | SI |
| 12 | 02 | 31 | II | OR |
| 13 | 00 | 03 | IV | OR |
| | 02 | 55 | III | OR |
| 14 | 03 | 23 | I | ED |
| 15 | 00 | 31 | I | SI |
| | 01 | 19 | I | TI |
| | 02 | 47 | I | Se |
| | 03 | 36 | I | Te |
| 16 | 00 | 56 | I | OR |
| 19 | 00 | 33 | II | ED |
| | 23 | 54 | III | ED |
| 20 | 22 | 29 | II | Se |
| | 23 | 52 | II | Te |
| 21 | 00 | 16 | IV | Se |
| | 02 | 48 | IV | TI |
| 22 | 02 | 25 | I | SI |
| | 03 | 04 | I | TI |
| | 23 | 45 | I | ED |
| 23 | 02 | 41 | I | OR |
| | 23 | 10 | I | Se |
| | 23 | 48 | I | Te |
| 26 | 03 | 09 | II | ED |
| 27 | 03 | 53 | III | ED |
| | 22 | 17 | II | SI |
| | 23 | 21 | II | TI |
| 28 | 01 | 04 | II | Se |
| | 02 | 09 | II | Te |
| 30 | 01 | 39 | I | ED |
| | 22 | 47 | I | SI |
| | 23 | 14 | III | Te |
| | 23 | 15 | I | TI |

### JULY

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 1 | 01 | 04 | I | Se |
| | 01 | 32 | I | Te |
| | 22 | 52 | I | OR |
| 5 | 00 | 52 | II | SI |
| | 01 | 36 | II | TI |
| | 03 | 39 | II | Se |
| 6 | 22 | 32 | II | OR |
| 7 | 03 | 33 | I | ED |
| | 21 | 30 | IV | Te |
| | 21 | 46 | III | SI |
| | 22 | 58 | III | TI |
| 8 | 00 | 41 | I | SI |
| | 00 | 59 | I | TI |
| | 01 | 18 | III | Se |
| | 02 | 32 | III | Te |
| | 02 | 59 | I | Se |
| | 03 | 17 | I | Te |
| | 22 | 02 | I | ED |
| 9 | 00 | 36 | I | OR |
| | 21 | 27 | I | Se |
| | 21 | 43 | I | Te |
| 12 | 03 | 27 | II | SI |
| | 03 | 51 | II | TI |
| 13 | 21 | 39 | II | ED |
| 14 | 00 | 47 | II | OR |
| 15 | 01 | 46 | III | SI |
| | 02 | 15 | III | TI |
| | 02 | 36 | I | SI |
| | 02 | 43 | I | TI |
| | 23 | 56 | I | ED |
| 16 | 00 | 08 | IV | ED |
| | 02 | 19 | I | OR |
| | 21 | 04 | I | SI |
| | 21 | 09 | I | TI |
| | 23 | 22 | I | Se |
| | 23 | 27 | I | Te |
| 17 | 20 | 45 | I | OR |
| 21 | 00 | 12 | II | OD |
| | 03 | 05 | II | ER |
| 22 | 21 | 59 | II | Te |
| | 22 | 07 | II | Se |
| 23 | 01 | 46 | I | OD |
| | 04 | 07 | I | ER |
| | 22 | 53 | I | TI |
| | 22 | 59 | I | SI |
| 24 | 01 | 11 | I | Te |
| | 01 | 16 | I | Se |
| | 20 | 12 | I | OD |
| | 22 | 36 | I | ER |
| 25 | 23 | 26 | III | ER |
| 28 | 02 | 27 | II | OD |
| 29 | 21 | 26 | II | TI |
| | 21 | 55 | II | SI |
| 30 | 00 | 13 | II | Te |
| | 00 | 42 | II | Se |
| | 03 | 30 | I | OD |
| 31 | 00 | 37 | I | TI |
| | 00 | 54 | I | SI |
| | 02 | 55 | I | Te |
| | 03 | 11 | I | Se |
| | 21 | 56 | I | OD |

### AUGUST

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 1 | 00 | 30 | I | ER |
| | 21 | 21 | I | Te |
| | 21 | 40 | I | Se |
| | 22 | 21 | IV | ER |
| | 22 | 32 | III | OD |
| 2 | 03 | 26 | III | ER |
| 5 | 23 | 40 | II | TI |
| 6 | 00 | 30 | II | SI |
| | 02 | 28 | II | Te |
| 7 | 02 | 22 | I | TI |
| | 02 | 49 | I | SI |
| | 21 | 38 | II | ER |
| | 23 | 40 | I | OD |
| 8 | 02 | 25 | I | ER |
| | 20 | 48 | I | TI |
| | 21 | 18 | I | SI |
| | 23 | 06 | I | Te |
| | 23 | 35 | I | Se |
| 9 | 01 | 52 | III | OD |
| | 20 | 53 | I | ER |
| | 21 | 44 | IV | TI |
| 10 | 01 | 54 | IV | Te |
| | 02 | 37 | IV | SI |
| 12 | 21 | 20 | III | Se |
| 13 | 01 | 56 | II | TI |
| 14 | 20 | 10 | II | OD |
| 15 | 00 | 16 | II | ER |
| | 01 | 25 | I | OD |
| | 22 | 34 | I | TI |
| | 23 | 13 | I | SI |
| 16 | 00 | 51 | I | Te |
| | 01 | 30 | I | Se |
| | 19 | 52 | I | OD |
| | 22 | 48 | I | ER |
| 17 | 19 | 59 | I | Se |
| 19 | 21 | 47 | III | SI |
| | 22 | 24 | III | Te |
| 20 | 01 | 21 | III | Se |
| 21 | 22 | 29 | II | OD |
| 23 | 00 | 21 | I | TI |
| | 01 | 08 | I | SI |
| | 20 | 10 | II | Te |
| | 21 | 38 | I | OD |
| | 21 | 45 | II | Se |
| 24 | 00 | 43 | I | ER |
| | 19 | 37 | I | SI |
| | 21 | 04 | I | Te |
| | 21 | 54 | I | Se |
| 26 | 20 | 46 | IV | SI |
| | 22 | 19 | III | TI |
| 27 | 01 | 03 | IV | Se |
| 29 | 00 | 51 | II | OD |
| 30 | 19 | 29 | III | ER |
| | 19 | 44 | II | TI |
| | 21 | 33 | II | SI |
| | 22 | 30 | II | Te |
| | 23 | 25 | I | OD |
| 31 | 00 | 20 | II | Se |
| | 20 | 35 | I | TI |
| | 21 | 32 | I | SI |
| | 22 | 52 | I | Te |
| | 23 | 49 | I | Se |

### SEPTEMBER

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| 1 | 21 | 06 | I | ER |
| 3 | 21 | 06 | IV | OD |
| 6 | 19 | 14 | III | OR |
| | 19 | 53 | III | ED |
| | 22 | 06 | II | TI |
| | 23 | 29 | III | ER |
| 7 | 00 | 09 | II | SI |
| | 22 | 24 | I | TI |
| | 23 | 28 | I | SI |
| 8 | 00 | 41 | I | Te |
| | 19 | 40 | I | OD |
| | 21 | 30 | II | ER |
| | 23 | 01 | I | ER |
| 9 | 19 | 09 | I | Te |
| | 20 | 14 | I | Se |
| 12 | 19 | 17 | IV | Se |
| 13 | 19 | 18 | III | OD |

| d | h | m | Sat. | Phen. |
|---|---|---|---|---|
| **September—cont'd** | | | | |
| 13 | 22 | 52 | III | OR |
| | 23 | 54 | III | ED |
| 15 | 00 | 15 | I | TI |
| | 18 | 55 | II | OD |
| | 21 | 30 | I | OD |
| 16 | 00 | 08 | II | ER |
| | 19 | 52 | I | SI |
| | 20 | 59 | I | Te |
| | 22 | 09 | I | Se |
| 17 | 18 | 49 | II | Se |
| | 19 | 25 | I | ER |
| 20 | 23 | 00 | III | OD |
| 22 | 21 | 24 | II | OD |
| | 23 | 21 | I | OD |
| 23 | 20 | 34 | I | TI |
| | 21 | 48 | I | SI |
| | 22 | 51 | I | Te |
| 24 | 18 | 37 | II | SI |
| | 18 | 57 | II | Te |
| | 21 | 20 | I | ER |
| | 21 | 24 | II | Se |
| | 21 | 26 | III | Se |
| 25 | 18 | 34 | I | Se |
| 28 | 20 | 59 | IV | TI |
| 30 | 22 | 27 | I | TI |
| **OCTOBER** | | | | |
| d | h | m | Sat. | Phen. |
| 1 | 18 | 42 | II | TI |
| 1 | 19 | 41 | I | OD |
| | 20 | 14 | III | Te |
| | 21 | 12 | II | SI |
| | 21 | 27 | II | Te |
| | 21 | 52 | III | SI |
| 2 | 19 | 12 | I | Te |
| | 20 | 29 | I | Se |
| 3 | 18 | 45 | II | ER |
| 7 | 18 | 35 | IV | ED |
| 8 | 20 | 37 | III | TI |
| | 21 | 14 | II | TI |
| | 21 | 35 | I | OD |
| 9 | 18 | 50 | I | TI |
| | 20 | 08 | I | SI |
| | 21 | 06 | I | Te |
| | 22 | 25 | I | Se |
| 10 | 19 | 39 | I | ER |
| | 21 | 24 | II | ER |
| 12 | 19 | 34 | III | ER |
| 15 | 18 | 50 | IV | Te |
| 16 | 20 | 45 | I | TI |
| | 22 | 04 | I | SI |
| 17 | 17 | 58 | I | OD |
| | 18 | 58 | II | OD |
| | 21 | 34 | I | ER |
| 18 | 18 | 50 | I | Se |
| 19 | 18 | 11 | III | OR |
| | 18 | 28 | II | Se |
| | 19 | 57 | III | ED |
| 24 | 19 | 54 | I | OD |
| | 21 | 08 | II | OD |
| 25 | 18 | 29 | I | SI |
| | 19 | 27 | I | Te |
| | 20 | 46 | I | Se |
| 26 | 17 | 58 | I | ER |
| | 18 | 16 | II | SI |
| | 18 | 30 | II | Te |
| | 18 | 41 | III | OD |
| | 21 | 04 | II | Se |
| **NOVEMBER** | | | | |
| d | h | m | Sat. | Phen. |
| 1 | 19 | 08 | I | TI |
| | 20 | 24 | I | SI |
| | 21 | 24 | IV | SI |
| | 21 | 25 | I | Te |
| 2 | 18 | 23 | II | TI |
| | 19 | 53 | I | ER |
| | 20 | 52 | II | SI |
| | 21 | 09 | II | Te |
| 4 | 18 | 39 | II | ER |
| 6 | 17 | 58 | III | SI |
| 9 | 18 | 18 | I | OD |
| | 19 | 28 | IV | OD |
| 10 | 17 | 53 | I | Te |
| | 19 | 06 | I | Se |
| 13 | 20 | 44 | III | Te |
| 16 | 20 | 16 | I | OD |
| 17 | 17 | 35 | I | TI |
| | 18 | 45 | I | SI |
| | 19 | 52 | I | Te |
| 18 | 18 | 12 | I | ER |
| 18 | 18 | 42 | II | OD |
| | 20 | 13 | IV | Se |
| 20 | 18 | 10 | II | Se |
| 24 | 19 | 35 | I | TI |
| | 19 | 41 | III | ER |
| 25 | 20 | 08 | I | ER |
| 26 | 17 | 27 | I | Se |
| | 19 | 28 | IV | OR |
| 27 | 17 | 57 | II | SI |
| | 18 | 40 | II | Te |
| **DECEMBER** | | | | |
| d | h | m | Sat. | Phen. |
| 1 | 19 | 33 | III | OR |
| 2 | 18 | 45 | I | OD |
| 3 | 18 | 23 | I | Te |
| | 19 | 22 | I | Se |
| 4 | 18 | 38 | II | TI |
| 6 | 18 | 31 | II | ER |
| 10 | 18 | 07 | I | TI |
| | 19 | 00 | I | SI |
| 11 | 18 | 27 | I | ER |
| 12 | 17 | 41 | III | Se |
| 13 | 19 | 07 | IV | ED |
| 19 | 17 | 42 | I | Se |
| | 18 | 04 | III | SI |
| | 18 | 34 | III | Te |
| 22 | 17 | 54 | II | Se |
| 29 | 17 | 39 | II | SI |
| 30 | 17 | 59 | IV | ER |

E—eclipse, O—occultation, T—transit. S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. 75th Meridian Civil Time. (For other times see p. 8.)

# LUNAR OCCULTATIONS

Prepared by J. F. HEARD

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation. The passage of the star behind the east limb of the moon is called the immersion and its appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, adapted from the 1949 Nautical Almanac, give the times of immersion or emersion or both for occultations of stars of magnitude 4.5 or brighter visible at Toronto and at Montreal and also at Vancouver and Calgary, at night. Emersions at the bright limb of the moon are given only in the case of stars brighter than magnitude 3.5. The terms $a$ and $b$ are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if $\lambda_0$, $\phi_0$, be the longitude and latitude of the standard station and $\lambda$, $\phi$, the longitude and latitude of the neighbouring station then for the neighbouring station we have—

$$\text{Standard Time of phenomenon} = \text{Standard Time of phenomenon at the standard station} + a(\lambda - \lambda_0) + b(\phi - \phi_0)$$

where $\lambda - \lambda_0$ and $\phi - \phi_0$ are expressed in degrees. The quantity $P$ in the table is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1949

| Date | Star | Mag. | I or E | Age of Moon | Toronto E.S.T. | a | b | P | Montreal E.S.T. | a | b | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | d | h m | m | m | ° | h m | m | m | ° |
| Feb. 20 | σ Sco | 3.1 | I | 22.4 | 05 25.9 | −1.8 | +0.5 | 95 | 05 38.0 | −2.0 | +0.4 | 84 |
| Apr. 4 | 136 Tau | 4.5 | I | 6.5 | 22 54.0 | −0.2 | −1.2 | 86 | 22 52.9 | −0.2 | −1.0 | 75 |
| 16 | α Sco | 1.2 | I | 17.7 | 01 32.4 | −1.1 | 0.0 | 127 | 01 39.6 | −1.4 | +0.1 | 117 |
| 16 | α Sco | 1.2 | E | 17.7 | 02 46.1 | −1.8 | +0.1 | 276 | 02 56.4 | −1.7 | −0.3 | 283 |
| Jun. 9 | α Sco | 1.2 | I | 13.2 | 21 33.6 | −0.6 | −0.4 | 147 | 21 38.0 | −1.0 | −0.1 | 135 |
| 9 | α Sco | 1.2 | E | 13.2 | 22 34.6 | −2.1 | +0.7 | 257 | 22 47.0 | −1.9 | +0.2 | 266 |
| July 20 | δ Ari | 4.5 | I | 23.9 | 01 26.2 | +0.4 | +1.9 | 39 | 01 27.5 | +0.3 | +1.9 | 41 |
| 20 | δ Ari | 4.5 | E | 23.9 | 02 18.3 | −0.3 | +1.5 | 269 | 02 23.0 | −0.4 | +1.6 | 265 |
| Aug. 26 | Venus* | −3.4 | E | 2.5 | 09 03.2 | −0.2 | +1.0 | 284 | 09 06.4 | −0.3 | +0.7 | 293 |
| Nov. 15 | Saturn* | 1.2 | I | 24.7 | 08 20.1 | −1.0 | −1.7 | 144 | 08 23.9 | −1.2 | −1.4 | 130 |
| 15 | Saturn* | 1.2 | E | 24.7 | 09 31.5 | −1.4 | −1.4 | 295 | 09 35.6 | −1.0 | −1.7 | 307 |
| Dec. 13 | β Vir | 3.8 | I | 23.1 | No occ. | ..... | ..... | ... | 06 09.9 | — | — | 201 |
| 13 | β Vir | 3.8 | E | 23.1 | No occ. | ..... | ..... | ... | 06 33.6 | — | — | 238 |

*Daytime occultation.

LUNAR OCCULTATIONS VISIBLE AT VANCOUVER AND CALGARY, 1949

| Date | Star | Mag. | I or E | Age of Moon | Vancouver P.S.T. | a | b | P | Calgary M.S.T. | a | b | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | d | h m | m | m | ° | h m | m | m | ° |
| Feb. 20 | α Sco | 1.2 | I | 22.5 | 06 49.2 | — | — | 180 | 07 53.5 | — | — | 166 |
| 20 | α Sco | 1.2 | E | 22.5 | 07 12.4 | — | — | 213 | 08 31.5 | — | — | 224 |
| Apr. 1 | δ Ari | 4.5 | I | 3.5 | 19 35.1 | −0.5 | −1.1 | 73 | 20 37.5 | −0.3 | −0.8 | 63 |
| 4 | 136 Tau | 4.5 | I | 6.5 | 19 17.2 | −1.2 | −2.1 | 117 | 20 23.9 | −1.0 | −1.8 | 106 |
| 29 | Mercury* | −0.6 | I | 1.5 | 12 03.9 | ..... | ..... | 122 | Graze | ..... | ..... | ... |
| 29 | Mercury* | −0.6 | E | 1.5 | 12 49.6 | ..... | ..... | 178 | Graze | ..... | ..... | ... |
| Oct. 12 | 136 Tau | 4.5 | I | 20.8 | 22 07.8 | −0.3 | +0.8 | 125 | 23 13.7 | −0.9 | +0.3 | 138 |
| 12 | 136 Tau | 4.5 | E | 20.8 | 22 47.6 | +0.6 | +2.4 | 214 | 23 45.0 | +0.8 | +3.2 | 201 |
| Nov. 15 | Saturn | 1.2 | I | 24.7 | Graze | ..... | ..... | ... | 05 44.8 | −0.3 | −2.4 | 176 |
| 15 | Saturn | 1.2 | E | 24.7 | Graze | ..... | ..... | ... | 06 27.4 | −1.9 | +2.0 | 253 |
| 15 | σ Leo | 4.1 | I | 24.7 | No occ. | ..... | ..... | ... | 06 36.8 | — | — | 195 |
| 15 | σ Leo | 4.1 | E | 24.7 | No occ. | ..... | ..... | ... | 07 02.0 | — | — | 237 |

*Daytime occultation.

# METEORS AND METEORITES

By Peter M. Millman

A meteor or "shooting star" appears when one of the larger particles comprising the dust of space happens to encounter the earth's atmosphere at high velocity. In general the particle is completely vapourized high in the upper atmosphere but occasionally it is large enough so that a portion reaches the earth's surface, and this solid lump of iron or stone is known as a meteorite. The study of meteors and meteorites contributes a large amount of valuable information concerning the nature and origin of the universe and there are many intriguing problems in this field awaiting solution. The amateur can do work of lasting value here, as the large and very expensive instrumental equipment required for most astronomical research is not needed for the study of meteors.

For any given observation point there is no way of predicting in advance just where the next meteor will appear, in other words, it is chiefly a matter of chance whether it appears north, south, east, west, or directly overhead. Taking an overall average for the whole year and all parts of the night a single observer with an unobstructed view of the sky will see 10 meteors per hour on a clear moonless night. This statement must be qualified by the fact that meteors are roughly twice as numerous during the second half of the night as they are during the first, and their rate of appearance is approximately doubled for the second half of the year as compared with the first six months. There is also a great variation in meteor frequency from one night to the next. The observed meteors range in brightness all the way from those only visible in fairly large telescopes up to great fireballs exceeding the full moon in luminosity. The frequency of meteors increases approximately in inverse proportion to their brightness.

In addition to the stray so-called "sporadic" meteors which appear on any night of the year, there are various swarms of meteors, each swarm moving along in its particular lliptical orbit about the sun. In most cases these meteor orbits are found to correspond closely with those of certain comets. When the earth encounters such a swarm of meteors the apparent paths, when projected backwards in the sky, all seem to meet in a point, a result of perspective. This point indicates the direction from which the meteors are coming and is called the "radiant". The meteor shower is commonly called after the constellation in which the radiant is located. The best known meteor showers are listed in the accompanying table which has been compiled from various sources. Of these showers the Perseids and Geminids are the most consistent. Some, such as the Leonids, Giacobinids, and Bielids, have provided spectacular displays in certain years and in others have been almost or totally absent. The Bielids have scarcely been observed at all since the 19th century; the Giacobinids were first observed in 1933. The hourly number listed in the table is the approximate number of meteors which are likely to be seen in one hour by a single observer on a clear moonless night at the shower maximum in a normal year.

Amateur cooperation assists greatly in the scientific study of meteors. Visual observations may be divided into two types:

(a) *Systematic programs.* These may be carried out either by a single observer or by groups of observers. In this case the sky is observed continuously for a period of time and the numbers of meteors seen, their brightness, colour, position, and other characteristics recorded. Plotting the observations on a star map is more important when the program is carried out in cooperation with another party observing some distance away.

(b) *The chance observation of a bright meteor or fireball.* Any meteor markedly brighter than Jupiter (mag. −2) should be carefully recorded and the observation forwarded to some observatory where meteor records are being kept. In this case it is very important to note the position of the meteor in the sky, as well as all other features observed. Information equally important, but often forgotten, is the exact time and date of the phenomenon and an accurate description of where the observer was situated, given within 100 yds. if possible.

Skilled visual or photographic observations from two or more stations make possible the computation of meteor heights. Most meteors are visible in the range from 40 to 80 miles above the earth's surface and move with velocities ranging from 20 to 60 miles per second.

*Continued on page 79.*

# PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

## ORBITAL ELEMENTS (Jan. 1, $12^h$, 1945)

| Planet | Mean Distance from Sun (a) $\oplus = 1$ | Mean Distance from Sun (a) millions of miles | Period (P) | Eccentricity (e) | Inclination (i) | Long. of Node (☊) | Long. of Perihelion ($\pi$) | Mean Long. of Planet |
|---|---|---|---|---|---|---|---|---|
| | | | | | ° | ° | ° | ° |
| Mercury....... | .387 | 36.0 | 88.0days | .206 | 7.0 | 47.6 | 76.5 | 120.5 |
| Venus......... | .723 | 67.2 | 224.7 | .007 | 3.4 | 76.1 | 130.7 | 36.0 |
| Earth.......... | 1.000 | 92.9 | 365.3 | .017 | .... | ..... | 101.9 | 99.8 |
| Mars.......... | 1.524 | 141.5 | 687.0 | .093 | 1.9 | 49.1 | 334.9 | 267.4 |
| Jupiter........ | 5.203 | 483.3 | 11.86yrs. | .048 | 1.3 | 99.8 | 13.3 | 164.4 |
| Saturn......... | 9.54 | 886. | 29.46 | .056 | 2.5 | 113.1 | 91.8 | 97.1 |
| Uranus........ | 19.19 | 1783. | 84.0 | .047 | 0.8 | 73.7 | 169.7 | 76.8 |
| Neptune....... | 30.07 | 2793. | 164.8 | .009 | 1.8 | 131.1 | 44.1 | 184.0 |
| Pluto.......... | 39.46 | 3666. | 247.7 | .249 | 17.1 | 109.5 | 223.4 | 158.3 |

## PHYSICAL ELEMENTS

| Object | Symbol | Mean Diameter miles | Mass $\oplus = 1$ | Density water = 1 | Axial Rotation | Mean Surface Gravity $\oplus = 1$ | Albedo Bond's | Magnitude at Opposition or Elongation |
|---|---|---|---|---|---|---|---|---|
| **Sun**........ | ☉ | 864,000 | 332,000 | 1.4 | $24^d.7$ (equatorial) | 27.9 | | − 26.7 |
| Moon....... | ☾ | 2,160 | .0123 | 3.3 | $27^d\ 7.7^h$ | .16 | .07 | − 12.6 |
| Mercury.... | ☿ | 3,010 | .056 | 3.8 | $88^d$ | .27 | .07 | 0± |
| Venus...... | ♀ | 7,580 | .82 | 4.9 | $30^d$ ? | .85 | .59 | − 4± |
| Earth....... | ⊕ | 7,918 | 1.00 | 5.5 | $23^h\ 56^m$ | 1.00 | .29 | |
| Mars....... | ♂ | 4,220 | .108 | 4.0 | $24^h\ 37^m$ | .38 | .15 | − 2± |
| Jupiter..... | ♃ | 87,000 | 318. | 1.3 | $9^h\ 50^m$± | 2.6 | .56? | − 2± |
| Saturn...... | ♄ | 72,000 | 95. | .7 | $10^h 15^m$± | 1.2 | .63? | 0± |
| Uranus..... | ⛢ | 31,000 | 14.6 | 1.3 | $10^h.8$± | .9 | .63? | + 5.7 |
| Neptune.... | ♆ | 33,000 | 17.2 | 1.3 | $16^h$ ? | 1.0 | .73? | + 7.6 |
| Pluto...... | ♇ | 4,000? | .8 ? | | | | | + 14 |

# SATELLITES OF THE SOLAR SYSTEM

| Name | Stellar Mag. | Mean Dist. from Planet | | Revolution Period | | | Diameter Miles | Discoverer |
|---|---|---|---|---|---|---|---|---|
| | | " * | Miles | d | h | m | | |
| **Satellite of the Earth** | | | | | | | | |
| Moon | −12.6 | 530 | 238,857 | 27 | 07 | 43 | 2160 | |
| **Satellites of Mars** | | | | | | | | |
| Phobos | 12 | 8 | 5,800 | 0 | 07 | 39 | 10? | Hall, 1877 |
| Deimos | 13 | 21 | 14,600 | 1 | 06 | 18 | 5? | Hall, 1877 |
| **Satellites of Jupiter** | | | | | | | | |
| V | 13 | 48 | 112,600 | 0 | 11 | 57 | 100? | Barnard, 1892 |
| Io | 5 | 112 | 261,800 | 1 | 18 | 28 | 2300 | Galileo, 1610 |
| Europa | 6 | 178 | 416,600 | 3 | 13 | 14 | 2000 | Galileo, 1610 |
| Ganymede | 5 | 284 | 664,200 | 7 | 03 | 43 | 3200 | Galileo, 1610 |
| Callisto | 6 | 499 | 1,169,000 | 16 | 16 | 32 | 3200 | Galileo, 1610 |
| VI | 14 | 3037 | 7,114,000 | 250 | 16 | | 100? | Perrine, 1904 |
| VII | 16 | 3113 | 7,292,000 | 260 | 01 | | 40? | Perrine, 1905 |
| X | 18 | 3116 | 7,300,000 | 260 | | | 15? | Nicholson, 1938 |
| XI | 18 | 5990 | 14,000,000 | 692 | | | 15? | Nicholson, 1938 |
| VIII | 16 | 6240 | 14,600,000 | 739 | | | 40? | Melotte, 1908 |
| IX | 17 | 6360 | 14,900,000 | 758 | | | 20? | Nicholson, 1914 |
| **Satellites of Saturn** | | | | | | | | |
| Mimas | 12 | 27 | 115,000 | 0 | 22 | 37 | 400? | W. Herschel, 1789 |
| Enceladus | 12 | 34 | 148,000 | 1 | 08 | 53 | 500? | W. Herschel, 1789 |
| Tethys | 11 | 43 | 183,000 | 1 | 21 | 18 | 800? | G. Cassini, 1684 |
| Dione | 11 | 55 | 234,000 | 2 | 17 | 41 | 700? | G. Cassini, 1684 |
| Rhea | 10 | 76 | 327,000 | 4 | 12 | 25 | 1100? | G. Cassini, 1672 |
| Titan | 8 | 177 | 759,000 | 15 | 22 | 41 | 2600? | Huygens, 1655 |
| Hyperion | 13 | 214 | 920,000 | 21 | 06 | 38 | 300? | G. Bond, 1848 |
| Iapetus | 11 | 515 | 2,210,000 | 79 | 07 | 56 | 1000? | G. Cassini, 1671 |
| Phoebe | 14 | 1870 | 8,034,000 | 550 | | | 200? | W. Pickering, 1898 |
| **Satellites of Uranus** | | | | | | | | |
| V | 17 | 9 | 81,000 | 1 | 06 | | | Kuiper, 1948 |
| Ariel | 16 | 14 | 119,000 | 2 | 12 | 29 | 600? | Lassell, 1851 |
| Umbriel | 16 | 19 | 166,000 | 4 | 03 | 28 | 400? | Lassell, 1851 |
| Titania | 14 | 32 | 272,000 | 8 | 16 | 56 | 1000? | W. Herschel, 1787 |
| Oberon | 14 | 42 | 364,000 | 13 | 11 | 07 | 900? | W. Herschel, 1787 |
| **Satellite of Neptune** | | | | | | | | |
| Triton | 13 | 16 | 220,000 | 5 | 21 | 03 | 3000? | Lassell, 1846 |

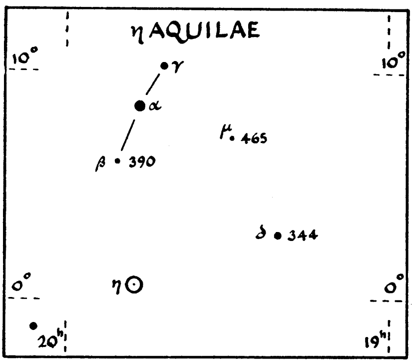
*As seen from the sun.

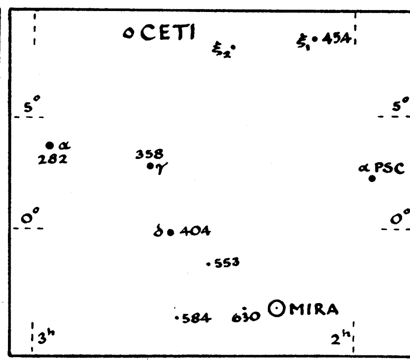
Satellites Io, Europa, Ganymede, Callisto are usually denoted **I, II, III, IV** respectively, in order of distance from the planet.

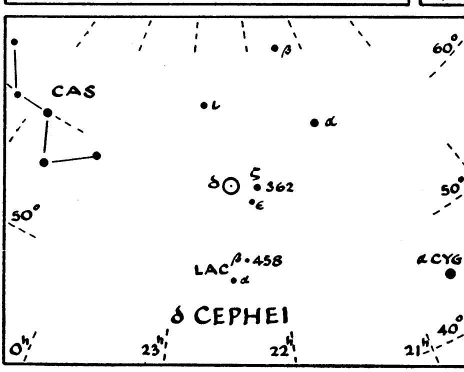
# VARIABLE STARS

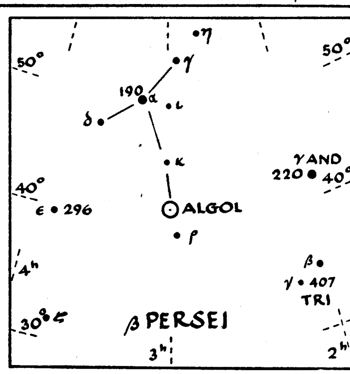
Much pleasure may be derived from the estimation of the brightness of variable stars. Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. These magnitudes are given as magnitudes, tenths and hundredths, with the decimal point omitted. Thus a star 362 is of magnitude 3.62. To determine the brightness of the variable at any time, carefully estimate the brightness as some fraction of the interval between two comparison stars, one brighter and one fainter than the variable. The result may then be expressed in magnitudes and tenths. Record the magnitude and time of observation. When a number of observations have been made, a graph may be plotted showing the magnitude estimate as ordinates against the date (days and tenths of a day) as abscissae. Such studies of naked-eye estimates of brightness will at once reveal the differences in variation between the different kinds of variable. For each short period variable the observations made on any one cycle may be carried forward one, two or any number of periods to form a combined light curve.

For the two cepheids, good mean curves may be readily found by observing the variables once a night on as many nights as possible. For Algol, which changes rapidly for a few hours before and after minimum, estimates should be made at quarter or half hour intervals around the times of minimum as tabulated on pages 31-53. Mira may be observed for a couple of months as it rises from the naked-eye limit to 2nd or 3rd magnitude maximum and fades again.



## REPRESENTATIVE BRIGHT VARIABLE STARS

| Name | Design. | Max. | Min. | Sp. | Period | Type | Date | Discoverer |
|---|---|---|---|---|---|---|---|---|
| η Aql | 194700 | 3.7 | 4.4 | G4 | 7.17652 | Cep | 1784 | Pigott |
| N Aql | 184300 | -0.2 | 10.9 | Q | Irr. | Nova | 1918 | Bower |
| ε Aur | 045443 | 3.3 | 4.1 | F5p | 9833. | Ecl | 1821 | Fritsch |
| δ Cep | 222557 | 3.6 | 4.3 | G0 | 5.36640 | Cep | 1784 | Goodricke |
| U Cep | 005381 | 6.8 | 9.2 | A0 | 2.49293 | Ecl | 1880 | W. Ceraski |
| o Cet[1] | 0214*03* | 2.0 | 10.1 | M5e | 331.8 | LPV | 1596 | Fabricius |
| RR Cet | 012700 | 8.4 | 9.0 | F0 | 0.55304 | Clus | 1906 | Oppolzer |
| R CrB | 154428 | 5.8 | 13.8 | cG0e | Irr. | RCrB | 1795 | Pigott |
| χ Cyg | 194632 | 4.2 | 14.0 | M7e | 412.9 | LPV | 1686 | Kirch |
| P Cyg | 201437a | 3.5 | 6.0 | B1qk | Irr. | Nova | 1600 | Blaeu |
| SS Cyg | 213843 | 8.1 | 12.0 | Pec. | Irr. | SSCyg | 1896 | Wells |
| XX Cyg | 200158 | 11.4 | 12.1 | A | 0.13486 | Clus | 1904 | L. Ceraski |
| ζ Gem | 065820 | 3.7 | 4.1 | cG1 | 10.15353 | Cep | 1847 | Schmidt |
| η Gem | 060822 | 3.3 | 4.2 | M2 | 235.58 | LPV | 1865 | Schmodt |
| R Gem | 070122a | 6.5 | 14.3 | Se | 370.1 | LPV | 1848 | Hind |
| U Gem | 074922 | 8.8 | 13.8 | Pec. | Irr. | SSCyg | 1855 | Hind |
| α Her | 171014 | 3.1 | 3.9 | M5 | Irr. | SemiR | 1795 | W. Herschel |
| R Hya | 1324*22* | 3.5 | 10.1 | M7e | 414.7 | LPV | 1670 | Montanari |
| R Leo | 094211 | 5.0 | 10.5 | M7e | 310.3 | LPV | 1782 | Koch |
| β Lyr | 184633 | 3.4 | 4.3 | B5e | 12.92504 | Ecl | 1784 | Goodricke |
| RR Lyr | 192242 | 7.2 | 8.0 | A5 | 0.56685 | Clus | 1901 | Fleming |
| α Ori[2] | 054907 | 0.2 | 1.2 | M2 | 2070. Irr. | SemiR | 1840 | J. Herschel |
| U Ori | 054920 | 5.4 | 12.2 | M7e | 376.9 | LPV | 1885 | Gore |
| β Per[3] | 030140 | 2.3 | 3.5 | B8 | 2.86731 | Ecl | 1669 | Montanari |
| ρ Per | 025838 | 3.3 | 4.1 | M4 | Irr. | Irr. | 18 | 54Schmidt |
| R Sge | 200916 | 8.6 | 10.4 | cG7 | 70.84 | SemiR | 1859 | Baxendell |
| R Sct | 1842*05* | 4.5 | 9.0 | K5e | 141.5 | SemiR | 1795 | Pigott |
| λ Tau | 035512 | 3.8 | 4.1 | B3 | 3.95294 | Ecl | 1848 | Baxendell |
| RV Tau | 044126 | 9.4 | 12.5 | K0 | 78.60 | SemiR | 1905 | L. Ceraski |
| SU Tau | 054319 | 9.5 | 15.4 | G0e | Irr. | RCrB | 1908 | Cannon |
| α UMi[4] | 012288 | 2.3 | 2.4 | cF7 | 3.96858 | Cep | 1911 | Hertzsprung |
| N Her | 180445 | 1.5 | 14.0 | Q | Irr. | Nova | 1934 | Prentice |
| N Lac | 221255 | 2.2 | — | Q | Irr. | Nova | 1936 | Peltier |

[1]oCet (Mira); [2]αOri (Betelgeuse); [3]βPer (Algol); [4]αUMi (Polaris).

The designation (Harvard) gives the 1900 position of the variable; here the first two figures give the hours, and the next two figures the minutes of R.A., while the last two figures give the declination in degrees, italicised for southern declinations. Thus the position of the fourth star of the list, δ Cep (222557) is R.A. 22h 25m, Dec. + 57°. The period is in days and decimals of a day. The type is based on the classification of Gaposchkin and Gaposchkin's comprehensive text-book, *Variable Stars*. The abbreviations here used are: Ecl, Eclipsing Binaries; LPV, Long Period Variables; Semi R, Semiregular; Cep, Cepheids; Clus, cluster type; Nova; SS Cyg and R Cr B, irregular variables of which SS Cygni and R Coronae Borealis are prototypes; and Irr, other irregular variables.

# DOUBLE AND MULTIPLE STARS

A number of the stars which appear as single to the unaided eye may be separated into two or more components by field glasses or a small telescope. Such objects are spoken of as *double* or *multiple stars*. With larger telescopes pairs which are still closer together may be resolved, and it is found that, up to the limits of modern telescopes, over ten per cent. of all the stars down to the ninth magnitude are members of double stars.

The possibility of resolving a double star of any given separation depends on the diameter of the telescope objective. Dawes' simple formula for this relation is $d'' = 4.5/A$, where $d$ is the separation, in seconds of arc, of a double star that can be just resolved, and $A$ is the diameter of the objective in inches. Thus a one-inch telescope should resolve a double star with a distance of $4''.5$ between its components, while a ten-inch telescope should resolve a pair $0''.45$ apart. It should be noted that this applies only to stars of comparable brightness. If one star is markedly brighter than its companion, the glare from the brighter makes it impossible to separate stars as close as the formula indicates. This formula may be applied to the observation of double stars to test the quality of the seeing and telescope.

It is obvious that a star may appear double in one of two ways. If the components are at quite different distances from the observer, and merely appear close together in the sky the stars form an *optical* double. If, however, they are in the same region of space, and have common proper motion, or orbital motion about one another, they form a *physical* double. An examination of the probability of stars being situated sufficiently close together in the sky to appear as double shows immediately that almost all double stars must be physical rather than optical.

Double stars which show orbital motion are of great astrophysical importance, in that a careful determination of their elliptical orbits and parallaxes furnishes a measure of the gravitational attraction between the two components, and hence the mass of the system.

In the case of many unresolvable close doubles, the orbital motion may be determined by means of the spectroscope. In still other doubles, the observer is situated in the orbital plane of the binary, and the orbital motion is shown by the fluctuations in light due to the periodic eclipsing of the components. Such doubles are designated as *spectroscopic* binaries and *eclipsing* variables.

The accompanying table provides a list of double stars, selected on account of their brightness, suitability for small telescopes, or particular astrophysical interest. The data are taken chiefly from Aitken's *New General Catalogue of Double Stars*, and from the Yale *Catalogue of Bright Stars*. Successive columns give the star, its 1950 equatorial coordinates, the magnitudes and spectral classes of its components, their separation, in seconds of arc, and the approximate distance of the double star in light years. The last column gives, for binary stars of well determined orbits, the period in years, and the mean separation of the components in astronomical units. For stars sufficiently bright to show colour differences in the telescope used, the spectral classes furnish an indication of the colour. Thus O and B stars are bluish white, A and F white, G yellow, K orange and M stars reddish.

A good reference work in the historical, general, and mathematical study of double stars is Aitken's *The Binary Stars*.

REPRESENTATIVE DOUBLE STARS

| Star | | α 1950 | δ | Mag. and Spect. | d | D | Remarks |
|---|---|---|---|---|---|---|---|
| | | h m | ° ′ | | ″ | L.Y. | |
| π | And | 00 34.2 | +33 27 | 4.4B3; 8.5 | 36 | 470 | † |
| η | Cas | 00 46.0 | +57 33 | 3.6F8; 7.2M0 | 8 | 18 | 526y; 66AU |
| α | UMi | 01 48.8 | +89 02 | var. F8; 8.8 | 19 | 470 | Polaris |
| γ | Ari | 01 50.8 | +19 03 | 4.8A0; 4.8A0 | 8.3 | 150 | |
| α | Pis | 01 59.4 | +02 31 | 5.2A2; 4.3A2 | 2.4 | 130 | †† |
| γ | And | 02 00.8 | +42 05 | 2.3K0; 5.4A0; 6.6 | 10, 0.7 | 410 | 56y; 23AU |
| 6 | Tri | 02 09.5 | +30 04 | 5.4G4; 7.0F3 | 3.6 | 330 | †† |
| η | Per | 02 47.0 | +55 41 | 3.9K0; 8.5 | 28 | 540 | |
| 32 | Eri | 03 51.8 | −03 06 | 5.0A; 6.3G5 | 6.7 | 300 | |
| β | Ori | 05 12.1 | −08 15 | 0.3B8; 7.0 | 9 | 540 | † |
| θ | Ori | 05 32.8 | −05 25 | 5.4;6.8; 6.8; 7.9; O | 13, 17 | 540 | Trapezium |
| β | Mon | 06 26.4 | −07 00 | 4.7B2; 5.2; 5.6 | 7, 25 | 470 | † |
| 12 | Lyn | 06 41.8 | +59 30 | 5.3A2; 6.2; 7.4 | 1.7, 8 | 180 | † |
| α | CMa | 06 43.0 | −16 39 | −1.6A0; 8.5F | 11 | 9 | 50y; 20AU |
| δ | Gem | 07 17.1 | +22 05 | 3.5F0; 8.0M0 | 6.8 | 58 | † |
| α | Gem | 07 31.4 | +32 00 | 2.0A0; 2.8A0; 9M10 | 4, 70 | 47 | 340y; 79AU |
| ζ | Cnc | 08 09.3 | +17 48 | 5.6G0; 6.0; 6.2 | 1, 5 | 78 | 60y; 21AU |
| γ | Leo | 10 17.2 | +20 06 | 2.6K0; 3.8G5 | 4 | 160 | 400y |
| ξ | UMa | 11 15.5 | +31 48 | 4.4G0; 4.9G0 | 2 | 25 | ††60y; 20AU |
| ι | Leo | 11 21.3 | +10 48 | 4.1F3; 6.8F3 | 2 | 69 | |
| γ | Vir | 12 39.1 | −01 10 | 3.6F0; 3.7F0 | 6 | 34 | 171y; 42AU |
| α | CVn | 12 53.7 | +38 35 | 2.9A0; 5.4A0 | 20 | 140 | †† |
| ζ | UMa | 13 21.9 | +55 11 | 2.4A2; 4.0A2 | 14 | 78 | †† |
| π | Boo | 14 38.4 | +16 38 | 4.9A0; 5.1A0 | 6 | 360 | † |
| ε | Boo | 14 42.8 | +27 17 | 2.7K0; 5.1A0 | 3 | 220 | |
| ξ | Boo | 14 49.1 | +19 18 | 4.8G5; 6.7 | 3 | 22 | 151y; 31AU |
| δ | Ser | 15 32.4 | +10 42 | 4.2F0; 5.2F0 | 4 | 170 | |
| ξ | Sco | 16 01.6 | −11 14 | 5.1F3; 4.8; 7G7 | 1, 7 | 84 | 44.7y; 19AU |
| α | Her | 17 12.4 | +14 27 | var.M5; 5.4G | 5 | 540 | † |
| δ | Her | 17 13.0 | +24 54 | 3.2A0; 8.1G2 | 11 | 100 | † Optical |
| ε | Lyr | 18 42.7 | +39 37 | 5:1, 6.0A3; 5.1, 5.4A5 | 3, 2 | 200 | Pairs 207″ |
| β | Cyg | 19 28.7 | +27 51 | 3.2K0; 5.4B9 | 34 | 410 | † |
| α | Cap | 20 14.9 | −12 40 | 3.8G5; 4.6G0 | 376 | | Optical |
| γ | Del | 20 44.3 | +15 57 | 4.5G5; 5.5F8 | 10 | 110 | |
| 61 | Cyg | 21 04.6 | +38 30 | 5.6K5; 6.3K5 | 23 | 11 | |
| β | Cep | 21 28.1 | +70 20 | var.B1; 8.0A3 | 14 | 540 | † |
| ζ | Aqr | 22 26.2 | −00 17 | 4.4F2; 4.6F1 | 3 | 140 | |
| δ | Cep | 22 27.3 | +58 10 | var.G0; 7.5A0 | 41 | 650 | |
| 8 | Lac | 22 33.6 | +39 23 | 5.8B3; 6.5B5 | 22 | 1100 | † |
| σ | Cas | 23 56.5 | +55 29 | 5.1B2; 7.2B3 | 3 | 820 | |

† or ††, one, or two of the components are themselves very close visual double or more generally, spectroscopic binaries.

# THE BRIGHTEST STARS†

*Their Magnitudes, Types, Proper Motions, Distances and Radial Velocities*

The accompanying table contains the principal facts regarding 259 stars brighter than apparent magnitude 3.51 which it is thought may be of interest to our amateur members. The various columns should be self-explanatory but some comments may be in order.

The first column gives the name of the star and if it is preceded by the sign || such means that the star is a visual double and the combined magnitude is entered in the fourth column. Besides the 48 thus indicated there are 12 others on the list with faint companions but for these it is not thought that there is any physical connection. In the case of the 20 stars variable in light this fourth column shows their maximum and minimum magnitudes. The 19 first magnitude stars are set up in bold face type.

In the fifth column are given the types as revised at various observatories—principally at our own, but omitting the *s* and *n* designations descriptive of the line character. The annual proper motion follows in the next column and this may not necessarily be correct to the third decimal place.

The parallaxes are taken from the Yale Catalogue of Stellar Parallaxes 1935, the mean of the trigonometric and spectroscopic being adopted. The few negative trigonometric parallaxes were adjusted by Dyson's tables before being combined with the spectroscopic. The distance is given also in light years in the eighth column as to the lay mind that seems a fitting unit. The absolute magnitudes in the ninth column are the magnitudes the stars would have if all were at a uniform distance of 32.6 light years ($\pi = 0.''1$). At that distance the sun would appear as a star of magnitude 4.8.

The radial velocities in the last column have been taken from Vol. 18 of the Lick Publications. An asterisk * following the velocity means that such is variable. In these cases the velocity of the system, if known, is given; otherwise a mean velocity for the observations to date is set down.

Of the 259 stars or star systems here listed 146 are south and 113 north of the equator. This is to be expected from the fact that the northern half of the sky includes less of the Milky Way than the southern.

The number in each spectral class, apart from the one marked peculiar, is as follows: O, 3; B, 74; A, 55; F, 22; G, 43, K, 42 and M, 19. The B-stars are intrinsically luminous and appear in this list out of all proportion to their total number. The stars in Classes A and K are by far the most numerous but the revision of types throws many originally labelled K back into the G group.

From the last column we see that 98 velocities are starred, indicating that 38 per cent of the bright stars, or at least one in every three, are binary in character. For visual binaries the proportion has usually been listed as one in nine. Our list shows one in six but it is only natural to expect that we would observe a higher proportion among the nearby stars, such as these are on the average.

Other relationships can be established from the list if our amateur members care to study it.

**†This feature of the Handbook, first appearing in the 1925 edition, was prepared and frequently revised by the late Dr. W. E. Harper (1878-1940).**

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | ″ | ″ | | | km./sec. |
| α Andr........ | 0 6 | +28 49 | 2.2 | A1 | .217 | .034 | 96 | −0.1 | −13.0* |
| β Cass........ | 6 | +58 52 | 2.4 | F2 | .561 | .080 | 41 | 1.9 | +11.4 |
| γ Pegs........ | 11 | +14 54 | 2.9 | B2 | .015 | .005 | 652 | −3.6 | + 5.0* |
| β Hydi........ | 23 | −77 32 | 2.9 | G0 | 2.243 | .162 | 21 | 4.0 | +22.8 |
| α Phoe........ | 24 | −42 35 | 2.4 | G5 | .448 | .040 | 81 | 0.4 | +74.6* |
| δ Andr........ | 37 | +30 35 | 3.5 | K3 | .167 | .026 | 125 | 0.6 | − 7.1* |
| α Cass........ | 38 | +56 16 | 2.2–2.8 | G8 | .062 | .018 | 181 | −1.5 | − 3.8 |
| β Ceti........ | 41 | −18 16 | 2.2 | G7 | .233 | .052 | 63 | 0.8 | +13.1 |
| ‖γ Cass........ | 54 | +60 27 | 2.2 | B0e | .031 | .035 | 93 | −0.1 | − 6.8 |
| ‖β Phoe........ | 1 04 | −46 59 | 3.4 | G4 | .043 | .020 | 163 | −0.1 | − 1.2 |
| β Andr........ | 07 | +35 21 | 2.4 | M0 | .219 | .041 | 79 | 0.5 | + 0.1 |
| δ Cass........ | 23 | +59 59 | 2.8–2.9 | A3 | .308 | .050 | 65 | 1.3 | + 6.8 |
| γ Phoe........ | 26 | −43 34 | 3.4 | M1 | .223 | .008 | 407 | −2.1 | +25.7* |
| α **Erid**........ | 36 | −57 29 | 0.6 | B9 | .093 | .046 | 71 | −1.1 | +19. |
| ‖α U. Min...... | 49 | +89 02 | 2.3–2.4 | F7 | .043 | .008 | 407 | −3.4 | −17.4* |
| ε Cass........ | 51 | +63 25 | 3.4 | B5 | .043 | .011 | 296 | −1.4 | − 8.1 |
| β Arie........ | 52 | +20 34 | 2.7 | A3 | .150 | .066 | 49 | 1.8 | − 0.6* |
| α Hydi........ | 57 | −61 49 | 3.0 | A7 | .255 | .080 | 41 | 2.5 | + 7.0* |
| ‖γ Andr........ | 2 01 | +42 05 | 2.3 | K0 | .073 | .020 | 163 | −1.2 | −11.7 |
| α Arie........ | 04 | +23 14 | 2.2 | K2 | .242 | .045 | 72 | 0.5 | −14.3 |
| β Tria........ | 07 | +34 45 | 3.1 | A6 | .161 | .029 | 112 | 0.4 | +10.4* |
| ‖o Ceti........ | 17 | − 3 12 | 1.7–9.6 | M6e | .239 | .013 | 251 | −2.7 | +57.8* |
| ‖θ Erid........ | 56 | −40 30 | 3.4 | A2 | .068 | .032 | 102 | 0.9 | +11.9* |
| α Ceti........ | 3 00 | + 3 54 | 2.8 | M1 | .080 | .018 | 181 | −0.9 | −25.7 |
| γ Pers........ | 01 | +53 19 | 3.1 | F9 | .012 | .017 | 192 | −0.7 | + 1.0* |
| ρ Pers........ | 02 | +38 39 | 3.3–4.1 | M6 | .176 | .024 | 136 | 0.3 | +28.2 |
| β Pers........ | 05 | +40 46 | 2.1–3.2 | B8 | .011 | .033 | 99 | −0.3 | + 5.7* |
| α Pers........ | 21 | +49 41 | 1.9 | F4 | .041 | .017 | 192 | −2.0 | − 2.4 |
| δ Pers........ | 39 | +47 38 | 3.1 | B5 | .047 | .012 | 272 | −1.5 | −10. * |
| ‖η Taur........ | 45 | +23 57 | 3.0 | B5p | .053 | .014 | 233 | −1.3 | +10.3 |
| γ Hydi........ | 48 | −74 24 | 3.2 | M3 | .124 | .008 | 407 | −2.3 | +16.0 |
| ζ Pers........ | 51 | +31 44 | 2.9 | B1 | .023 | .008 | 407 | −2.6 | +20.9 |
| ‖ε Pers........ | 54 | +39 52 | 3.0 | B2 | .041 | .006 | 543 | −3.1 | − 6 * |
| γ Erid........ | 56 | −13 39 | 3.2 | M0 | .133 | .012 | 272 | −1.6 | +61.7 |
| λ Taur........ | 58 | +12 21 | 3.8–4.2 | B3 | .015 | .008 | 407 | −2.2 | +13.0* |
| α **Reti**........ | 4 14 | −62 36 | 3.4 | G5 | .070 | .016 | 204 | −0.6 | +35.6 |

α U. Min., *Polaris:* RA. 1h 48.2 m; Dec. + 89° 01′ (1949)

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | ″ | ″ | | | km /sec. |
| α **Taur**....... | 4 33 | +16 24 | 1.1 | K8 | .205 | .060 | 54 | 0.0 | +54.1 |
| α Dora....... | 33 | −55 09 | 3.5 | A0p | ...... | .. . | ..... | ...... | +25.6 |
| $\pi^3$ Orio........ | 47 | + 6 52 | 3.3 | F5 | .474 | .124 | 26 | 3.8 | +24.6 |
| ι Auri........ | 54 | +33 05 | 2.9 | K4 | .030 | .020 | 163 | −0.6 | +17.6 |
| ε Auri........ | 58 | +43 45 | 3.1–3.8 | F2 | .015 | 006 | 543 | −2.7 | −4.1 * |
| η Auri........ | 5 03 | +41 10 | 3.3 | B3 | .082 | 013 | 251 | −1.1 | + 7.8 |
| ε Leps........ | 03 | −22 26 | 3.3 | K5 | .074 | .016 | 204 | −0.7 | + 1.0 |
| β Erid........ | 05 | − 5 09 | 2.9 | A1 | .117 | .055 | 59 | 1.6 | − 7 |
| μ Leps........ | 11 | −16 16 | 3.3 | A0p | .053 | .020 | 163 | −0.2 | +27.7 |
| ‖β **Orio**........ | 12 | − 8 15 | 0.3 | B8p | .005 | .006 | 543 | −5.8 | +23.6* |
| ‖α **Auri**........ | 13 | +45 57 | 0.2 | G1 | .439 | .078 | 42 | −0.3 | +30.2 |
| ‖η Orio........ | 22 | − 2 26 | 3.4 | B0 | .009 | .006 | 543 | −2.7 | +19.5* |
| γ Orio........ | 22 | + 6 18 | 1.7 | B2 | .019 | .015 | 217 | −2.4 | +18.0 |
| β Taur........ | 23 | +28 34 | 1.8 | B8 | .180 | .028 | 116 | −1.0 | + 8.0 |
| β Leps........ | 26 | −20 48 | 3.0 | G2 | .095 | .018 | 181 | −0.7 | −13.5 |
| ‖δ Orio........ | 29 | − 0 20 | 2.4–2.5 | B0 | .006 | .007 | 466 | −3.4 | +19.9* |
| α Leps........ | 31 | −17 51 | 2.7 | F6 | .006 | .012 | 272 | −2.1 | +24.7 |
| ι Orio........ | 33 | − 5 56 | 2.9 | O8 | .007 | .021 | 155 | −0.5 | +21.5* |
| ε Orio........ | 34 | − 1 14 | 1.8 | B0 | .004 | .008 | 407 | −3.7 | +25.8 |
| ζ Taur........ | 35 | +21 07 | 3.0 | B3e | .028 | 010 | 326 | −2.0 | +16.4* |
| ‖ζ Orio........ | 38 | − 1 58 | 1.8 | B0 | .012 | .011 | 296 | −3.0 | +18.8 |
| α Colm....... | 38 | −34 06 | 2.8 | B8 | .036 | .022 | 148 | −0.6 | +34.6 |
| κ Orio........ | 45 | − 9 41 | 2.2 | B0 | .009 | .006 | 543 | −3.9 | +20.1 |
| β Colm....... | 49 | −35 47 | 3.2 | K0 | .397 | .026 | 125 | 0.3 | +89.4 |
| α **Orio**....... | 52 | + 7 24 | 0.5–1.1 | M2 | .032 | .012 | 272 | −4.1 | +21.0* |
| β Auri........ | 56 | +44 57 | 2.1–2.2 | A0p | .046 | .052 | 63 | 0.7 | −18.1* |
| ‖θ Auri........ | 56 | +37 13 | 2.7 | A1 | .106 | .029 | 112 | 0.0 | +28.6 |
| η Gemi....... | 6 12 | +22 31 | 3.2–4.2 | M2 | .062 | .014 | 233 | −1.1 | +21.4* |
| ζ C Maj...... | 18 | −30 02 | 3.1 | B3 | .012 | .013 | 251 | −0.7 | +33.1* |
| μ Gemi....... | 20 | +22 32 | 3.2 | M3 | .129 | .016 | 204 | −0.8 | +54.8 |
| β C Maj...... | 20 | −17 56 | 2.0 | B1 | .003 | .014 | 233 | −2.3 | +34.4* |
| α **Cari**........ | 23 | −52 40 | −0.9 | F0 | .022 | .005 | 652 | −7.4 | +20.5 |
| γ Gemi....... | 35 | +16 27 | 1.9 | A2 | .066 | .050 | 65 | 0.4 | −11.3* |
| ν Pupp....... | 36 | −43 09 | 3.2 | B8 | .021 | .023 | 148 | 0.0 | +28.2* |
| ε Gemi....... | 41 | +25 12 | 3.2 | G9 | .020 | .009 | 362 | −2.0 | + 9.9 |
| ξ Gemi....... | 42 | +12 57 | 3.4 | F5 | .230 | .054 | 60 | 2.1 | +25.1 |
| ‖α **C Maj**...... | 43 | −16 39 | −1.6 | A2 | 1.315 | .386 | 8 | 1.3 | − 7.5* |
| α Pict........ | 48 | −61 53 | 3.3 | A5 | .271 | ..... | ..... | ...... | +20.6 |

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | ″ | ″ | | | km./sec. |
| τ Pupp...... | 6 49 | −50 33 | 2.8 | G8 | .091 | .025 | 130 | −0.2 | +36.4* |
| ‖ε C Maj...... | 57 | −28 54 | 1.6 | B1 | .005 | .010 | 326 | −3.4 | +27.4 |
| ζ Gemi....... | 7 01 | +20 39 | 3.7–4.3 | G0p | .007 | .005 | 652 | −2.8 | + 6.7* |
| $o^2$ C Maj...... | 01 | −23 45 | 3.1 | B5p | .006 | .007 | 466 | −2.7 | +48.6 |
| δ C Maj...... | 06 | −26 19 | 2.0 | G4p | .003 | .006 | 543 | −4.1 | +34.3* |
| $L^3$ Pupp....... | 12 | −44 33 | 3.4–6.2 | M5e | .332 | .018 | 181 | −0.3 | +53.0 |
| π Pupp....... | 15 | −37 00 | 2.7 | K5 | .004 | .018 | 181 | −1.0 | +15.8 |
| η C Maj...... | 22 | −29 12 | 2.4 | B5p | .007 | .012 | 272 | −2.2 | +40.4 |
| β C Min...... | 24 | + 8 23 | 3.1 | B8 | .063 | .022 | 148 | −0.2 | +22 * |
| σ Pupp....... | 28 | −43 12 | 3.3 | M0 | .191 | .016 | 204 | −0.7 | +88.1* |
| $\alpha_1$ Gemi....... | 31 | +32 00 | 2.0 | A2 | .201 | .074 | 44 | 1.4 | + 6.0* |
| $\alpha_2$ Gemi....... | 31 | +32 00 | 2.8 | A0 | .209 | .074 | 44 | 2.2 | − 1.2* |
| ‖α C Min...... | 37 | +5 21 | 0.5 | F5 | 1.242 | .316 | 10 | 3.0 | − 3.0* |
| β **Gemi**....... | 42 | +28 09 | 1.2 | G9 | .623 | .105 | 31 | 1.3 | + 3.3 |
| ξ Pupp....... | 47 | −24 44 | 3.5 | K1 | .004 | .006 | 543 | −2.6 | + 3.7* |
| ζ Pupp....... | 8 02 | −39 52 | 2.3 | O8 | .032 | .004 | 815 | −4.7 | −24. |
| ρ Pupp....... | 05 | −24 10 | 2.9 | F6 | .097 | .025 | 130 | −0.1 | +46.6 |
| ‖γVelr......... | 08 | −47 12 | 2.2 | OW9 | .002 | ..... | ..... | ..... | + 3.5 |
| ‖ε Cari........ | 21 | −59 21 | 1.7 | K0 | .030 | .010 | 326 | −3.3 | +11.5 |
| ο U Maj...... | 26 | +60 53 | 3.5 | G2 | .166 | .014 | 233 | −0.8 | +19.8 |
| ‖δ Velr........ | 43 | −54 32 | 2.0 | A0 | .093 | .030 | 109 | −0.6 | + 2.2 |
| ‖ε Hyda....... | 44 | + 6 36 | 3.5 | F9 | .193 | .012 | 272 | −1.1 | +36.8* |
| ζ Hyda....... | 53 | + 6 08 | 3.3 | G7 | .101 | .026 | 125 | 0.3 | +22.6 |
| ‖ι U Maj...... | 56 | +48 14 | 3.1 | A4 | .500 | .060 | 54 | 2.0 | +12.6 |
| λ Velr........ | 9 06 | −43 14 | 2.2 | K4 | .024 | .016 | 204 | −1.8 | +18.4 |
| β Cari........ | 13 | −69 31 | 1.8 | A0 | .192 | ..... | ..... | ..... | − 5. |
| ι Cari........ | 16 | −59 04 | 2.2 | F0 | .023 | ..... | ..... | ..... | +13.3 |
| α Lync....... | 18 | +34 36 | 3.3 | K8 | .214 | .022 | 148 | 0.0 | +37.4 |
| κ Velr........ | 21 | −54 48 | 2.6 | B3 | .017 | .017 | 192 | −1.2 | +21.7* |
| α Hyda....... | 25 | − 8 26 | 2.2 | K4 | .036 | .018 | 181 | −1.5 | − 4.4 |
| θ U Maj...... | 30 | +51 54 | 3.3 | F7 | 1.096 | .072 | 45 | 2.6 | +15.8 |
| N Velr........ | 30 | −56 49 | 3.4–4.2 | K5 | .038 | .022 | 148 | 0.1 | −13.9 |
| ε Leon........ | 43 | +24 00 | 3.1 | G0 | .045 | .009 | 362 | −2.1 | + 5.1 |
| ‖υ Cari........ | 46 | −64 50 | 3.1 | F0 | .019 | ..... | ..... | ..... | +13.6 |
| α **Leon**....... | 10 06 | +12 13 | 1.3 | B6 | .244 | .046 | 71 | −0.4 | + 2.6 |
| q Cari........ | 15 | −61 05 | 3.4 | K5 | .043 | .014 | 233 | −0.9 | + 8.6 |

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | | ″ | ″ | | km./sec. |
| ‖γ Leo......... | 10 17 | +20 06 | 2.3 | G8 | .347 | .024 | 136 | −0.8 | −36.8 |
| μ U Maj...... | 19 | +41 45 | 3.2 | K4 | .082 | .031 | 105 | 0.7 | −20.3* |
| θ Cari........ | 41 | −64 08 | 3.0 | B0 | .022 | .007 | 466 | −2.8 | +24. * |
| η Cari........ | 43 | −59 25 | 1.0–7.4 | Pec | .007 | ..... | ..... | ...... | −25.0 |
| ‖μ Velr........ | 45 | −49 09 | 2.8 | G5 | .079 | .033 | 99 | 0.4 | + 6.9 |
| ν Hyda....... | 47 | −15 56 | 3.3 | K3 | .218 | .020 | 163 | −0.2 | − 1.0 |
| β U Maj...... | 59 | +56 39 | 2.4 | A3 | .089 | .045 | 72 | 0.7 | −12.1* |
| α U Maj...... | 11 01 | +62 01 | 2.0 | G5 | .137 | .036 | 91 | −0.2 | − 8.6* |
| ψ U Maj...... | 07 | +44 46 | 3.2 | K0 | .067 | .035 | 93 | 0.9 | − 3.6 |
| δ Leon........ | 11 | +20 47 | 2.6 | A2 | .208 | .058 | 56 | 1.4 | −23.2 |
| θ Leon........ | 12 | +15 42 | 3.4 | A2 | .103 | .025 | 130 | 0.4 | + 7.8 |
| λ Cent........ | 33 | −62 45 | 3.3 | B9 | .045 | .031 | 105 | 0.8 | + 7.9 |
| β Leon........ | 47 | +14 51 | 2.2 | A2 | .507 | .084 | 39 | 1.8 | − 2.3 |
| γ U Maj...... | 51 | +53 58 | 2.5 | A0 | .095 | .035 | 93 | 0.2 | −11.1 |
| δ Cent........ | 12 06 | −50 27 | 2.9 | B3e | .040 | .015 | 217 | −1.2 | + 9. |
| ε Corv........ | 08 | −22 30 | 3.2 | K2 | .063 | .024 | 136 | 0.1 | + 4.9 |
| δ Cruc........ | 12 | −58 28 | 3.1 | B3 | .045 | .017 | 192 | −0.7 | +26.4 |
| δ U Maj...... | 13 | +57 19 | 3.4 | A0 | .113 | .050 | 65 | 1.9 | −12. |
| γ Corv........ | 13 | −17 16 | 2.8 | B8 | .159 | .024 | 136 | −0.3 | − 4.2* |
| $\alpha^1$ Cruc........ | 24 | −62 49 | 1.6 | B1 | .048 | .022 | 148 | −1.7 | −12.2* |
| $\alpha^2$ Cruc........ | 24 | −62 49 | 2.1 | B3 | .048 | .022 | 148 | −1.2 | + 0.3* |
| ‖δ Corv........ | 27 | −16 14 | 3.1 | A0 | .249 | .026 | 125 | 0.2 | + 8.7 |
| γ Cruc........ | 28 | −56 50 | 1.5 | M4 | .270 | ..... | ..... | ...... | +21.3 |
| β Corv........ | 32 | −23 07 | 2.8 | G5 | .059 | .027 | 121 | 0.0 | − 7.7 |
| α Musc....... | 34 | −68 52 | 2.9 | B5 | .040 | .015 | 217 | −1.2 | +18. |
| ‖γ Cent........ | 39 | −48 41 | 2.4 | A0 | .200 | .032 | 102 | −0.1 | − 7.5 |
| ‖γ Virg........ | 39 | − 1 10 | 2.9 | F0 | .561 | .080 | 41 | 2.4 | −19.6 |
| ‖β Musc....... | 43 | −67 50 | 3.3 | B3 | .039 | .011 | 296 | −1.5 | +42. * |
| β Cruc........ | 45 | −59 25 | 1.5 | B1 | .054 | .007 | 466 | −4.3 | −20. * |
| ε U Maj...... | 52 | +56 14 | 1.7 | A2 | .117 | .067 | 49 | 0.8 | −11.9* |
| ‖$\alpha^2$ C. Ven...... | 54 | +38 35 | 2.8 | A1 | .233 | .030 | 109 | 0.2 | − 3.5 |
| ε Virg........ | 13 00 | +11 14 | 3.0 | G6 | .270 | .037 | 88 | 0.8 | −14.0 |
| γ Hyda....... | 16 | −22 54 | 3.3 | G7 | .085 | .028 | 116 | 0.5 | − 5.4 |
| ι Cent........ | 18 | −36 27 | 2.9 | A2 | .351 | .049 | 67 | 1.4 | + 0.1 |
| ‖$\zeta^1$ U. Maj...... | 22 | +55 11 | 2.4 | A2p | .131 | .042 | 78 | 0.5 | − 9.9* |
| α Virg........ | 23 | −10 54 | 1.2 | B2 | .051 | .018 | 181 | −2.5 | + 1.6* |
| ζ Virg........ | 32 | − 0 20 | 3.4 | A2 | .285 | .038 | 86 | 1.3 | −13.1 |

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | ″ | ″ | | | km./sec. |
| ε Cent........ | 13 37 | −53 13 | 2.6 | B2 | .039 | .012 | 272 | −2.0 | − 5.6 |
| η U. Maj...... | 46 | +49 34 | 1.9 | B3 | .116 | .015 | 217 | −2.2 | −10.9 |
| μ Cent ....... | 47 | −42 13 | 3.3 | B3e | .026 | .009 | 362 | −1.9 | +12.6 |
| ζ Cent........ | 52 | −47 02 | 3.1 | B3 | .080 | .013 | 251 | −1.3 | * |
| η Boot........ | 52 | +18 39 | 2.8 | G1 | .370 | .100 | 33 | 2.8 | − 0.2* |
| **β Cent**....... | 14 00 | −60 08 | 0.9 | B3 | .039 | .026 | 125 | −2.0 | −12. * |
| π Hyda....... | 04 | −26 26 | 3.5 | K3 | .164 | .037 | 88 | 1.3 | +27.2 |
| θ Cent........ | 04 | −36 07 | 2.3 | G8 | .745 | .056 | 58 | 1.0 | + 1.3 |
| **α Boot**....... | 13 | +19 26 | 0.2 | K0 | 2.287 | .102 | 32 | 0.2 | − 5.1 |
| γ Boot........ | 30 | +38 32 | 3.0 | A3 | .182 | .063 | 52 | 2.0 | −35.5 |
| η Cent........ | 32 | −41 56 | 2.6 | B3 | .046 | .012 | 272 | −2.0 | − 0.2* |
| ‖**α Cent**....... | 36 | −60 38 | 0.1 | G0 | 3.682 | .768 | 4 | 4.5 | −22.2* |
| α Circ........ | 38 | −64 46 | 3.4 | F0 | .308 | .063 | 52 | 2.4 | + 7.4 |
| α Lupi........ | 39 | −46 10 | 2.9 | B2 | .033 | .009 | 362 | −2.3 | + 7.3* |
| ‖ε Boot........ | 43 | +27 17 | 2.7 | G8 | .045 | .019 | 172 | −0.9 | −16.4 |
| ‖$α^2$ Libr........ | 48 | −15 47 | 2.9 | F1 | .128 | .056 | 58 | 1.6 | −10. * |
| β U. Min...... | 51 | +74 22 | 2.2 | K4 | .028 | .030 | 109 | −0.4 | +16.9 |
| β Lupi........ | 55 | −42 56 | 2.8 | B3 | .067 | .012 | 272 | −1.8 | − 0.3* |
| κ Cent........ | 56 | −41 54 | 3.4 | B2 | .034 | .011 | 296 | −1.4 | + 9.1* |
| σ Libr........ | 15 01 | −25 05 | 3.4 | M4 | .091 | .020 | 163 | −0.1 | − 4.3 |
| ζ Lupi........ | 09 | −51 55 | 3.5 | G5 | .125 | .027 | 121 | 0.7 | − 9.7 |
| γ Tr. Au...... | 14 | −68 30 | 3.1 | A0 | .064 | ..... | ..... | ..... | 0. |
| β Libr........ | 14 | − 9 12 | 2.7 | B8 | .100 | .015 | 217 | −1.4 | −37. * |
| δ Lupi........ | 18 | −40 28 | 3.4 | B3 | .031 | .012 | 272 | −1.2 | + 1.6 |
| γ U. Min...... | 21 | +72 01 | 3.1 | A2 | .016 | .022 | 148 | −0.2 | − 3.9* |
| ι Drac........ | 24 | +59 08 | 3.5 | K3 | .010 | .030 | 109 | 0.9 | −11.1 |
| ‖γ Lupi........ | 32 | −41 00 | 3.0 | B3 | .038 | .013 | 251 | −1.4 | + 6. |
| α Cor. B...... | 33 | +26 53 | 2.3 | A0 | .160 | .054 | 60 | 1.0 | + 1.0* |
| α Serp........ | 42 | + 6 35 | 2.8 | K3 | .142 | .043 | 76 | 1.0 | + 3.0 |
| β Tr. Au...... | 51 | −63 17 | 3.0 | F0 | .436 | .096 | 34 | 2.9 | − 0.3 |
| π Scor........ | 56 | −25 58 | 3.0 | B3 | .037 | .012 | 272 | −1.6 | − 3.0* |
| δ Scor........ | 57 | −22 29 | 2.5 | B1 | .039 | .011 | 296 | −2.3 | −16. * |
| ‖β Scor........ | 16 03 | −19 40 | 2.8 | B3 | .029 | .016 | 204 | −1.2 | − 9.3* |
| δ Ophi........ | 12 | − 3 34 | 3.3 | K8 | .159 | .030 | 109 | 0.7 | −19 8 |
| ε Ophi........ | 16 | − 4 34 | 3.3 | G9 | .088 | .031 | 105 | 0.8 | −10.3 |
| ‖σ Scor........ | 18 | −25 28 | 3.1 | B1 | .033 | .009 | 362 | −2.1 | − 0.4* |
| ‖η Drac........ | 23 | +61 38 | 2.9 | G5 | .062 | .038 | 86 | 0.8 | −14.3 |

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° | | | ″ | ″ | | | km./sec. |
| ‖α **Scor**........ | 16 26 | −26 19 | 1.2 | M1 | .032 | .019 | 172 | −2.4 | − 3.2* |
| β Herc........ | 28 | +21 36 | 2.8 | G4 | .104 | .020 | 163 | −0.7 | −25.8* |
| τ Scor........ | 33 | −28 07 | 2.9 | B1 | .037 | .009 | 362 | −2.3 | + 0.6 |
| ζ Ophi........ | 34 | −10 28 | 2.7 | B0 | .023 | .008 | 407 | −2.8 | −19. * |
| ‖ζ Herc........ | 39 | +31 42 | 3.0 | G0 | .601 | .105 | 31 | 3.1 | −70.8* |
| α Tr. Au...... | 43 | −68 56 | 1.9 | K5 | .031 | .025 | 130 | −1.1 | − 3.7 |
| ε Scor........ | 47 | −34 12 | 2.4 | G9 | .665 | .038 | 86 | 0.3 | − 2.5 |
| $\mu^1$ Scor........ | 48 | −37 58 | 3.1 | B3p | .030 | .011 | 296 | −1.7 | * |
| ζ Arae........ | 54 | −55 55 | 3.1 | K5 | .046 | .028 | 116 | 0.3 | − 6.0 |
| κ Ophi........ | 55 | + 9 27 | 3.1–4.0 | K3 | .290 | .042 | 78 | 1.2 | −55.6 |
| ‖η Ophi........ | 17 08 | −15 40 | 2.6 | A2 | .095 | .047 | 69 | 1.0 | − 1.0 |
| η Scor........ | 08 | −43 11 | 3.4 | A7 | .294 | .066 | 49 | 2.5 | −28.4 |
| ζ Drac........ | 09 | +65 47 | 3.2 | B8 | .023 | .028 | 116 | 0.4 | −14.1 |
| ‖$\alpha^1$ Herc........ | 12 | +14 27 | 3.1–3.9 | M7 | .030 | .008 | 407 | −2.4 | −32.5 |
| δ Herc........ | 13 | +24 54 | 3.2 | A2 | .164 | .036 | 91 | 1.0 | −39. * |
| π Herc........ | 13 | +36 52 | 3.4 | K3 | .021 | .018 | 181 | −0.3 | −25.7 |
| θ Ophi........ | 19 | −24 57 | 3.4 | B2 | .031 | .008 | 407 | −2.1 | − 3.6 |
| β Arae........ | 21 | −55 29 | 2.8 | K1 | .036 | .023 | 142 | −0.4 | − 0.4 |
| υ Scor........ | 27 | −37 15 | 2.8 | B3 | .042 | .010 | 326 | −2.2 | +18. * |
| α Arae........ | 28 | −49 50 | 3.0 | B3e | .090 | .015 | 217 | −1.1 | − 2.2 |
| β Drac........ | 29 | +52 20 | 3.0 | G0 | .012 | .007 | 466 | −2.8 | −20.1 |
| λ Scor........ | 30 | −37 04 | 1.7 | B2 | .036 | .016 | 204 | −2.3 | 0. * |
| α Ophi........ | 33 | +12 35 | 2.1 | A0 | .264 | .060 | 54 | 1.0 | +15. * |
| θ Scor........ | 34 | −42 58 | 2.0 | F0 | .012 | .024 | 136 | −1.1 | + 1.4 |
| κ Scor........ | 39 | −39 00 | 2.5 | B3 | .028 | .009 | 362 | −2.7 | −10. * |
| β Ophi........ | 41 | + 4 35 | 2.9 | K2 | .157 | .030 | 109 | 0.3 | −11.9 |
| $\iota^1$ Scor........ | 44 | −40 06 | 3.1 | F8 | .004 | .008 | 407 | −2.4 | −27.6* |
| ‖μ Herc........ | 44 | +27 45 | 3.5 | G5 | .817 | .114 | 28 | 3.8 | −16.1 |
| G Scor........ | 46 | −37 02 | 3.2 | K2 | .069 | .029 | 112 | 0.5 | +24.7 |
| ν Ophi........ | 56 | − 9 46 | 3.5 | G7 | .118 | .022 | 148 | 0.2 | +12.4 |
| γ Drac........ | 55 | +51 30 | 2.4 | K5 | .026 | .026 | 125 | −0.5 | −27.8 |
| γ Sgtr........ | 18 03 | −30 26 | 3.1 | K0 | .202 | .030 | 109 | 0.5 | +22.3* |
| η Sgtr........ | 14 | −36 47 | 3.2 | M4 | .216 | .030 | 109 | 0.6 | + 0.5 |
| δ Sgtr........ | 18 | −29 51 | 2.8 | K4 | .052 | .033 | 99 | 0.4 | −20.0 |
| η Serp........ | 19 | − 2 55 | 3.4 | G9 | .898 | .050 | 65 | 1.9 | + 8.9 |
| ε Sgtr........ | 21 | −34 25 | 2.0 | A0 | .139 | .020 | 163 | −1.5 | −10.8 |
| λ Sgtr........ | 25 | −25 27 | 2.9 | K1 | .196 | .036 | 91 | 0.7 | −43.3 |
| α **Lyra**....... | 35 | +38 44 | 0.1 | A1 | .348 | .140 | 23 | 0.8 | −13.8 |

| Star | R.A. 1950 | Decl. 1950 | Mag. | Type | Ann. Proper Motion | Parallax | Distance in Light Years | Abs. Mag. | Rad. Vel. |
|---|---|---|---|---|---|---|---|---|---|
| | h m | ° ′ | | | ″ | ″ | | | km./sec. |
| φ Sgtr | 18 43 | −27 03 | 3.3 | B8 | .150 | .015 | 217 | −0.8 | +21.5* |
| ‖β Lyra | 48 | +33 18 | 3.4–4.1 | B2p | .011 | .006 | 543 | −2.7 | −19.0* |
| σ Sgtr | 52 | −26 22 | 2.1 | B3 | .067 | .021 | 155 | −1.3 | −10.7 |
| γ Lyra | 57 | +32 37 | 3.3 | B9p | .008 | .016 | 204 | −0.7 | −21.5* |
| ‖ζ Sgtr | 59 | −29 57 | 2.7 | A2 | .019 | .035 | 93 | 0.4 | +22.1 |
| ζ Aqil | 19 03 | +13 47 | 3.0 | A0 | .103 | .038 | 86 | 0.9 | −25. * |
| τ Sgtr | 04 | −27 45 | 3.4 | K0 | .268 | .036 | 91 | 1.2 | +45.4* |
| π Sgtr | 07 | −21 06 | 3.0 | F2 | .041 | .017 | 192 | −0.8 | − 9.8 |
| δ Drac | 13 | +67 34 | 3.2 | G8 | .135 | .028 | 116 | 0.4 | +24.8 |
| δ Aqil | 23 | + 3 01 | 3.4 | A3 | .267 | .052 | 63 | 2.0 | −32.3* |
| ‖β¹ Cygn | 29 | +27 51 | 3.2 | K0 | .010 | .010 | 326 | −1.8 | −23.9* |
| ‖δ Cygn | 43 | +45 00 | 3.0 | A1 | .067 | .023 | 116 | 0.2 | −20. |
| γ Agil | 44 | +10 29 | 2.8 | K3 | .018 | .018 | 181 | −0.9 | − 2.0 |
| **α Aqil** | 48 | + 8 44 | 0.9 | A2 | .659 | .184 | 18 | 2.2 | −26.1 |
| θ Aqil | 20 09 | − 0 58 | 3.4 | A0 | .035 | .018 | 181 | −0.3 | −28.6* |
| ‖β Capr | 18 | −14 56 | 3.2 | F8 | .042 | .022 | 148 | −0.1 | −19.0* |
| γ Cygn | 20 | +40 06 | 2.3 | F8 | .006 | .008 | 407 | −3.2 | − 7.6 |
| α Pavo | 22 | −56 54 | 2.1 | B3 | .087 | .014 | 233 | −2.2 | + 1.8* |
| α Indi | 34 | −47 28 | 3.2 | G2 | .072 | .034 | 96 | 0.9 | − 1.1 |
| **α Cygn** | 40 | +45 06 | 1.3 | A2p | .004 | .002 | 1630 | −7.2 | − 6.3* |
| ε Cygn | 44 | +33 47 | 2.6 | G7 | .485 | .040 | 81 | 0.6 | −10.5* |
| ζ Cygn | 21 11 | +30 01 | 3.4 | G6 | .061 | .018 | 181 | −0.3 | +16.9* |
| α Ceph | 17 | +62 22 | 2.6 | A2 | .163 | .076 | 43 | 2.0 | − 8. |
| β Ceph | 28 | +70 20 | 3.3–3.4 | B1 | .013 | .006 | 543 | −2.8 | − 7.2 |
| β Aqar | 29 | − 5 48 | 3.1 | G1 | .020 | .008 | 407 | −2.4 | + 6.7 |
| ε Pegs | 42 | + 9 39 | 2.5 | K2 | .028 | .014 | 233 | −1.8 | + 5.2 |
| δ Capr | 44 | −16 21 | 3.0 | A3 | .395 | .062 | 53 | 2.0 | − 6.4* |
| γ Grus | 51 | −37 36 | 3.2 | B8 | .114 | .020 | 163 | −0.3 | − 2.1 |
| α Aqar | 22 03 | − 0 34 | 3.2 | G0 | .019 | .006 | 543 | −2.9 | + 7.6 |
| α Grus | 05 | −47 12 | 2.2 | B5 | .202 | .036 | 91 | 0.0 | +11.8 |
| α Tucn | 15 | −60 31 | 2.9 | K5 | .088 | .019 | 172 | −0.7 | +42.2* |
| β Grus | 40 | −47 09 | 2.2 | M6 | .131 | .010 | 326 | −2.8 | + 1.6 |
| η Pegs | 41 | +29 58 | 3.1 | G1 | .039 | .016 | 204 | −0.9 | + 4.4* |
| **α Psc. A** | 55 | −29 53 | 1.3 | A3 | .367 | .118 | 28 | 1.7 | + 6.5 |
| β Pegs | 23 01 | +27 49 | 2.6 | M3 | .235 | .020 | 163 | −0.9 | + 8.6 |
| α Pegs | 02 | +14 56 | 2.6 | A0 | .077 | .033 | 99 | 0.2 | − 4. * |
| γ Ceph | 37 | +77 21 | 3.4 | K1 | .167 | .062 | 53 | 2.4 | −42.0 |

# STAR CLUSTERS

The star clusters for this observing list have been selected to include the more conspicuous members of the two main classes—open clusters and globular clusters. Most of the data are from Shapley's *Star Clusters* and from Trumpler's catalogue in Lick Bulletin No. 420. In the following table *N.G.C.* indicates the serial number of the cluster in the New General Catalogue of Clusters and Nebulae; *M*, its number in Messier's catalogue; *Con.*, the constellation in which it is located; $\alpha$ and $\delta$, its right ascension and declination; *Cl.*, the kind of cluster, *Op* for open or galactic and *Gl* for globular; *Diam.*, the apparent diameter in minutes of arc; *Mag. B.S.*, the magnitude of the fifth brightest star in the case of open clusters, the mean of the 25 brightest for globulars; *No.*, the number of stars in the open clusters down to the limiting magnitudes of the photographs on which the particular clusters were studied; *Int. mag.*, the total apparent magnitude of the globular clusters; and *Dist.*, the distance in light years.

| N.G.C. | M | Con. | $\alpha$ 1950 h m | $\delta$ ° ′ | Cl. | Diam. ′ | Mag. B.S. | No. | Int. mag. | Dist. l.y |
|---|---|---|---|---|---|---|---|---|---|---|
| 869 | | h Per | 02 15.5 | +56 55 | Op | 30 | 7 | | | 4,300 |
| 884 | | χPer | 02 18.9 | +56 53 | Op | 30 | 7 | | | 4,300 |
| 1039 | 34 | Per | 02 38.3 | +42 35 | Op | 30 | 9 | 80 | | 1,500 |
| Pleiades | 45 | Tau | 03 44.5 | +23 58 | Op | 120 | 4.2 | 250 | | 490 |
| Hyades | | Tau | 04 17 | +15 30 | Op | 400 | 4.0 | 100 | | 120 |
| 1912 | 38 | Aur | 05 25.3 | +35 48 | Op | 18 | 9.7 | 100 | | 2,800 |
| 2099 | 37 | Aur | 05 49.0 | +32 33 | Op | 24 | 9.7 | 150 | | 2,700 |
| 2168 | 35 | Gem | 06 05.7 | +24 21 | Op | 29 | 9.0 | 120 | | 2,700 |
| 2287 | 41 | C Ma | 06 44.9 | −20 42 | Op | 32 | 9 | 50 | | 1,300 |
| 2632 | 44 | Cnc | 08 37.2 | +20 10 | Op | 90 | 6.5 | 350 | | 490 |
| 5139 | | ωCen | 13 23.7 | −47 03 | Gl | 23 | 12.9 | | 3 | 22,000 |
| 5272 | 3 | C Vn | 13 39.9 | +28 38 | Gl | 10 | 14.2 | | 4.5 | 40,000 |
| 5904 | 5 | Ser | 15 15.9 | +02 16 | Gl | 13 | 14.0 | | 3.6 | 35,000 |
| 6121 | 4 | Scr | 16 20.5 | −26 24 | Gl | 14 | 13.9 | | 5.2 | 24,000 |
| 6205 | 13 | Her | 16 39.9 | +36 33 | Gl | 10 | 13.8 | | 4.0 | 34,000 |
| 6218 | 12 | Oph | 16 44.6 | −01 51 | Gl | 9 | 14.0 | | 6.0 | 36,000 |
| 6254 | 10 | Oph | 16 54.5 | −04 02 | Gl | 8 | 14.1 | | 5.4 | 36,000 |
| 6341 | 92 | Her | 17 15.6 | +43 12 | Gl | 8 | 13.9 | | 5.1 | 36,000 |
| 6494 | 23 | Sgr | 17 54.0 | −19 01 | Op | 27 | 10.2 | 120 | | 2,200 |
| 6611 | 16 | Ser | 18 16.0 | −13 48 | Op | 8 | 10.6 | 55 | | 6,700 |
| 6656 | 22 | Sgr | 18 33.3 | −23 57 | Gl | 17 | 12.9 | | 3.6 | 22,000 |
| 7078 | 15 | Peg | 21 27.6 | +11 57 | Gl | 7 | 14.3 | | 5.2 | 43,000 |
| 7089 | 2 | Aqr | 21 30.9 | −01 04 | Gl | 8 | 14.6 | | 5.0 | 45,000 |
| 7092 | 39 | Cyg | 21 30.5 | +48 13 | Op | 32 | 6.5 | 25 | | 1,000 |
| 7654 | 52 | Cas | 23 22.0 | +61 19 | Op | 13 | 11.0 | 120 | | 4,400 |

# GALACTIC NEBULAE

The galactic nebulae here listed have been selected to include the most readily observable representatives of planetary nebulae such as the Ring Nebula in Lyra, diffuse bright nebulae like the Orion nebula and dark absorbing nebulosities such as the Coal Sack. These objects are all located in our own galactic system. The first five columns give the identification and position as in the table of clusters. In the *Cl* column is given the classification of the nebula, planetary nebulae being listed as *Pl*, diffuse nebulae as *Dif*, and dark nebulae as *Drk*. *Size* indicates approximately the greatest apparent diameter in minutes of arc; and *m n* is the magnitude of the planetary nebula and *m ** is the magnitude of its central star. The distance is given in light years, and the name of the nebulae is added for the better known objects.

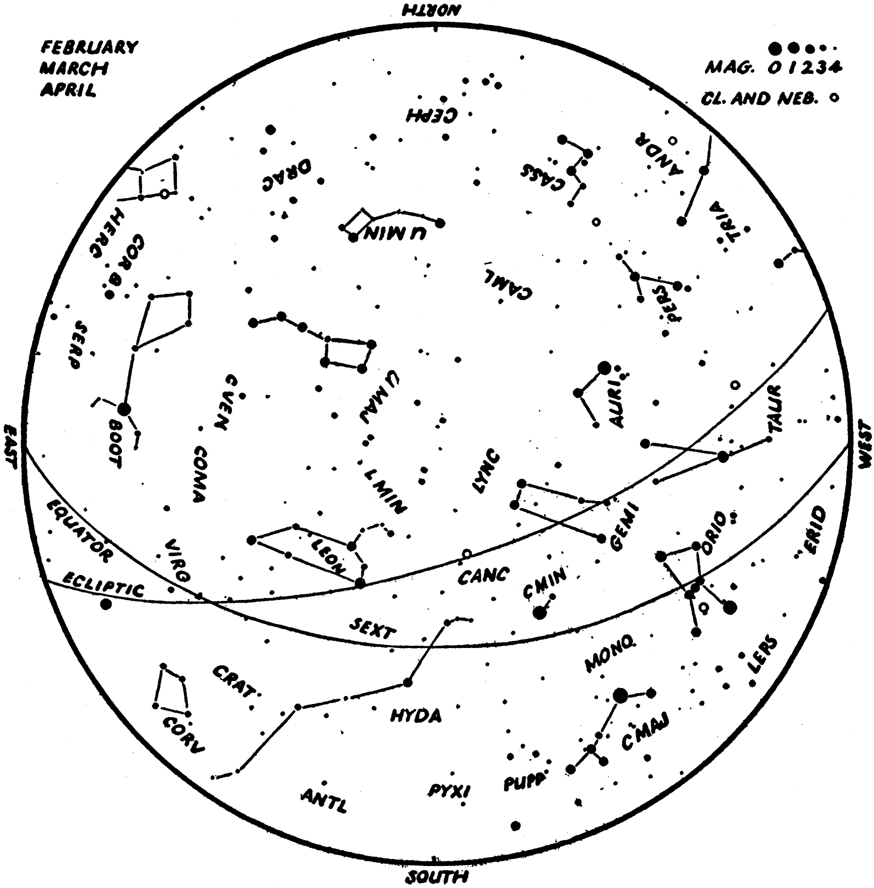
| N.G.C. | M | Con | α 1950 h m | δ ° ′ | Cl | Size ′ | m n | m * | Dist. l.y. | Name |
|---|---|---|---|---|---|---|---|---|---|---|
| 650 | 76 | Per | 01 38.3 | +51 20 | Pl | 1.5 | 11 | 17 | 15,000 | |
| 1952 | 1 | Tau | 05 31.5 | +21 59 | Pl | 6 | 11 | 16 | 10,000 | Crab |
| 1976 | 42 | Ori | 05 32.5 | −05 25 | Dif | 30 | | | 1,800 | Orion |
| B33 | | Ori | 05 38.0 | −02 29 | Drk | 4 | | | 300 | Horsehead |
| 2261 | | Mon | 06 36.4 | +08 47 | Dif | 2 | | | | Hubble's var |
| 2392 | | Gem | 07 26.2 | +21 02 | Pl | 0.3 | 8 | 10 | 2,800 | |
| 2440 | | Pup | 07 39.6 | −18 05 | Pl | 0.9 | 11 | 16 | 8,600 | |
| 3587 | 97 | UMa | 11 11.8 | +55 17 | Pl | 3.3 | 11 | 14 | 12,000 | Owl |
| | | Cru | 12 48 | −63 | Drk | 300 | | | 300 | Coalsack |
| 6210 | | Her | 16 42.4 | +23 54 | Pl | 0.3 | 10 | 12 | 5,600 | |
| B72 | | Oph | 17 20.5 | −23 36 | Drk | 20 | | | 400 | S nebula |
| 6514 | 20 | Sgr | 17 59.3 | −23 02 | Dif | 24 | | | 3,200 | Trifid |
| B86 | | Sgr | 17 59.9 | −27 52 | Drk | 5 | | | | |
| 6523 | 8 | Sgr | 18 00.6 | −24 23 | Dif | 50 | | | 3,600 | Lagoon |
| 6543 | | Dra | 17 58.6 | +66 38 | Pl | 0.4 | 9 | 11 | 3,500 | |
| 6572 | | Oph | 18 10.2 | +06 50 | Pl | 0.2 | 9 | 12 | 4,000 | |
| B92 | | Sgr | 18 12.7 | −18 15 | Drk | 15 | | | | |
| 6618 | 17 | Sgr | 18 18.0 | −16 12 | Dif | 26 | | | 3,000 | Horseshoe |
| 6720 | 57 | Lyr | 18 52.0 | +32 58 | Pl | 1.4 | 9 | 14 | 5,400 | Ring |
| 6826 | | Cyg | 19 43.5 | +50 24 | Pl | 0.4 | 9 | 11 | 3,400 | |
| 6853 | 27 | Vul | 19 57.4 | +22 35 | Pl | 8 | 8 | 13 | 3,400 | Dumb-bell |
| 6960 | | Cyg | 20 43.6 | +30 32 | Dif | 60 | | | | Network |
| 7000 | | Cyg | 20 57.0 | +44 07 | Dif | 100 | | | | N. America |
| 7009 | | Aqr | 21 01.4 | −11 34 | Pl | 0.5 | 8 | 12 | 3,000 | |
| 7662 | | And | 23 23.4 | +42 12 | Pl | 0.3 | 9 | 13 | 3,900 | |

## EXTRA-GALACTIC NEBULAE

Among the hundreds of thousands of systems far beyond our own galaxy relatively few are readily seen in small telescopes. The following list contains a selection of the closer brighter objects of this kind. The first five columns give the catalogue numbers, constellation and position on the celestial sphere. In the column *Cl*, *E* indicates an elliptical nebula, *I* an irregular object, and *Sa*, *Sb*, *Sc* spiral nebulae, in which the spiral arms become increasingly dominant compared with the nucleus as we pass from *a* to *c*. The remaining columns give the apparent magnitude of the nebula, its distance in light years and the radial velocity in kilometers per second. As these objects have been selected on the basis of ease of observation, the faint, very distant objects which have spectacularly large red shifts, corresponding to large velocities of recession, are not included.

| N.G.C. | M | Con | α 1950 h m | δ ° ′ | Cl | Dimens. ′ ′ | Mag. | Distance l.y. | Vel. km/sec |
|---|---|---|---|---|---|---|---|---|---|
| 221 | 32 | And | 00 39.9 | +40 36 | E | 3×3 | 8.8 | 800,000 | − 185 |
| 224 | 31 | And | 00 40.0 | +41 00 | Sb | 160×40 | 5.0 | 800,000 | − 220 |
| SMC | | Tuc | 00 53 | −72 38 | I | 220×220 | 1.5 | 100,000 | + 170 |
| 598 | 33 | Tri | 01 31.0 | +30 24 | Sc | 60×40 | 7.0 | 700,000 | − 70 |
| LMC | | Dor | 05 21 | −69 27 | I | 430×530 | 0.5 | 90,000 | + 280 |
| 3031 | 81 | UMa | 09 51.5 | +69 18 | Sb | 16×10 | 8.3 | 2,400,000 | − 30 |
| 3034 | 82 | UMa | 09 51.8 | +69 58 | I | 7× 2 | 9.0 | 2,600,000 | + 290 |
| 3368 | 96 | Leo | 10 44.1 | +12 05 | Sa | 7× 4 | 10.0 | 5,700,000 | + 940 |
| 3623 | 65 | Leo | 11 16.3 | +13 22 | Sb | 8× 2 | 9.9 | 5,000,000 | + 800 |
| 3627 | 66 | Leo | 11 17.6 | +13 16 | Sb | 8× 2 | 9.1 | 4,300,000 | + 650 |
| 4258 | | CVn | 12 16.5 | +47 34 | Sb | 20× 6 | 8.7 | 4,600,000 | + 500 |
| 4374 | 84 | Vir | 12 22.5 | +13 09 | E | 3× 2 | 9.9 | 6,000,000 | +1050 |
| 4382 | 85 | Com | 12 22.9 | +18 28 | E | 4× 2 | 10.0 | 3,700,000 | + 500 |
| 4472 | 49 | Vir | 12 27.2 | +08 16 | E | 5× 4 | 10.1 | 5,700,000 | + 850 |
| 4565 | | Com | 12 33.9 | +26 16 | Sb | 15× 1 | 11.0 | 7,600,000 | +1100 |
| 4594 | | Vir | 12 37.4 | −11 20 | Sa | 7× 2 | 9.2 | 7,200,000 | +1140 |
| 4649 | 60 | Vir | 12 41.1 | +11 50 | E | 4× 3 | 9.5 | 7,500,000 | +1090 |
| 4736 | 94 | CVn | 12 48.6 | +41 24 | Sb | 5× 4 | 8.4 | 3,000,000 | + 290 |
| 4826 | 64 | Com | 12 54.3 | +21 57 | Sb | 8× 4 | 9.2 | 1,300,000 | + 150 |
| 5005 | | CVn | 13 08.6 | +37 20 | Sc | 5× 2 | 11.1 | 6,600,000 | + 900 |
| 5055 | 63 | CVn | 13 13.6 | +42 18 | Sb | 8× 3 | 9.6 | 3,600,000 | + 450 |
| 5194 | 51 | CVn | 13 27.8 | +47 27 | Sc | 12× 6 | 7.4 | 3,000,000 | + 250 |
| 5236 | 83 | Hya | 13 34.2 | −29 36 | Sc | 10× 8 | 8 | 2,900,000 | + 500 |
| 6822 | | Sgr | 19 42.4 | −14 53 | I | 20×10 | 11 | 1,000,000 | − 150 |
| 7331 | | Peg | 22 34.8 | +33 59 | Sb | 9× 2 | 10.4 | 5,200,000 | + 500 |

## STAR MAP I

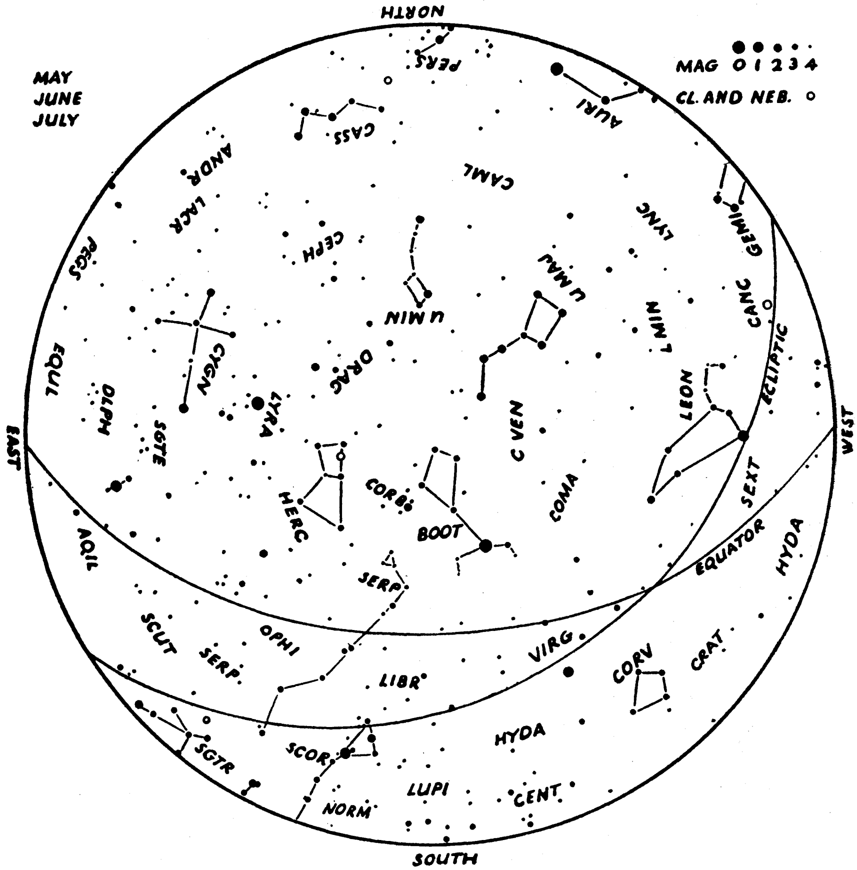



The above map represents the evening sky at

| | | |
|---|---|---|
| Midnight | Feb. | 6 |
| 11 p.m. | " | 21 |
| 10 " | Mar. | 7 |
| 9 " | " | 22 |
| 8 " | Apr. | 6 |
| 7 " | " | 21 |

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

## STAR MAP 2

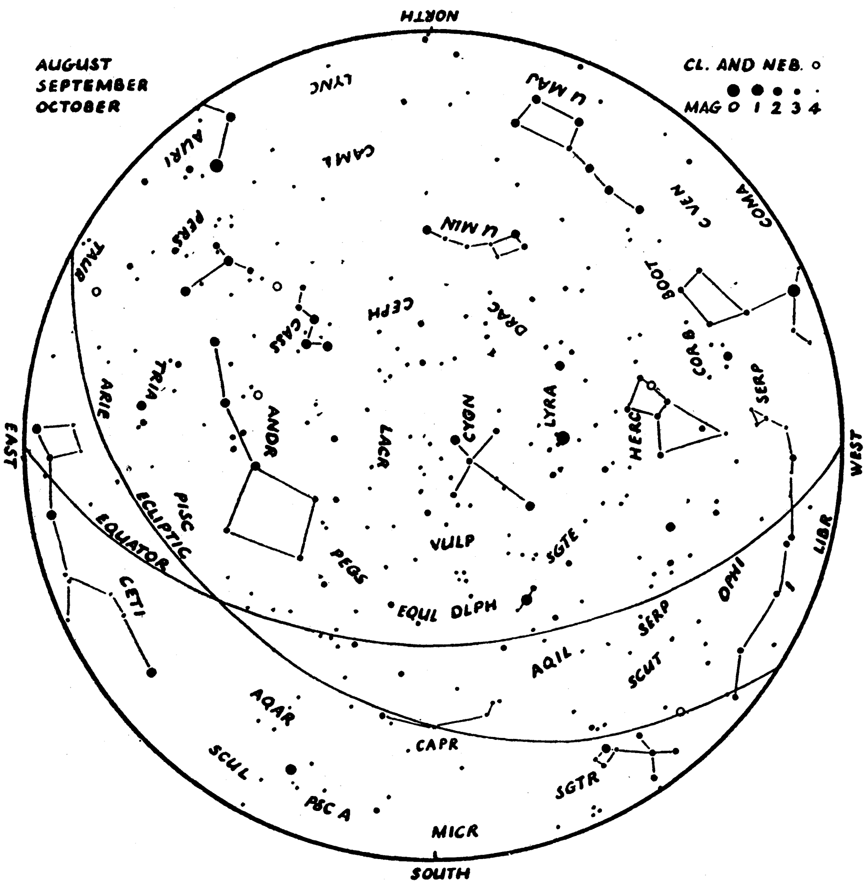



The above map represents the evening sky at

| | |
|---|---|
| Midnight............ | May 8 |
| 11 p.m............. | " 24 |
| 10 " ............ | June 7 |
| 9 " ............ | " 22 |
| 8 " ............ | July 6 |

The centre of the map is the zenith, the circumference the horizon. To identify **the stars** hold the map so that the part of the horizon you are facing is down.

## STAR MAP 3

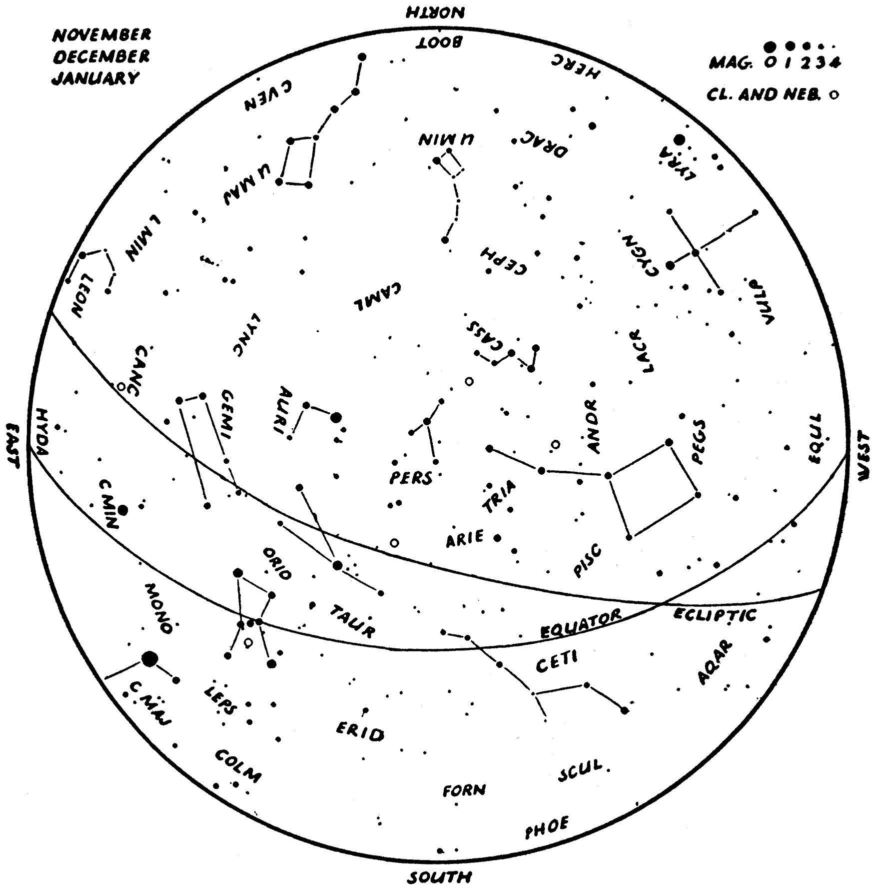



The above map represents the evening sky at

| | | |
|---|---|---|
| Midnight | Aug. | 5 |
| 11 p.m. | " | 21 |
| 10 " | Sept. | 7 |
| 9 " | " | 23 |
| 8 " | Oct. | 10 |
| 7 " | " | 26 |
| 6 " | Nov. | 6 |
| 5 " | " | 21 |

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

## STAR MAP 4




The above map represents the evening sky at

| | |
|---|---|
| Midnight | Nov. 6 |
| 11 p.m. | " 21 |
| 10 " | Dec. 6 |
| 9 " | " 21 |
| 8 " | Jan. 5 |
| 7 " | " 20 |
| 6 " | Feb. 6 |

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.

*Continued from page 57.*

# METEORS AND METEORITES

Many common terrestrial stones have mistakenly been thought to have a meteoric origin, and any supposed meteorite should be investigated carefully. Contrary to popular belief, meteorites do not contain valuable minerals in quantities sufficient to make them of commercial interest, but they have a definite scientific value. Meteorites are of two main types, iron and stone. The irons have specific gravity ranging from 7 to 8 and are amost entirely composed of metallic nickel-iron. The stones have a specific gravity ranging from 2 to 4 or greater and, with very few exceptions, contain metallic inclusions that are revealed on grinding or filing the specimen. A freshly fallen meteorite is covered by a smooth black fusion crust but oxidation removes this where the object has lain in the ground for any length of time. Any object whose history and structure indicate that it is of meteoric origin should be submitted to some authority for further study.

A more detailed discussion of both visual and photographic observations of meteors will be found in "General Instructions for Meteor Observing." Meteor observations for the United States may be sent to the American Meteor Society, Flower Observatory, Upper Darby, Pa.; those for Canada to the writer at the Dominion Observatory, Ottawa, Ont.

PRINCIPAL METEOR SHOWERS FOR THE NORTHERN HEMISPHERE

| Shower | Approx. Radiant | | Current Maximum Date | Spectacular Displays | Hourly Number (all meteors) | Duration (in days) | Abbreviations (for use in observing records) |
|---|---|---|---|---|---|---|---|
| | $\alpha$ | $\delta$ | | | | | |
| Quadrantids.... | 232° | +52° | Jan. 3 | | 20 | 4 | Q |
| Lyrids......... | 280 | +37 | Apr. 21 | | 10 | 4 | Y |
| Eta Aquarids... | 336 | − 1 | May 4 | | 10 | 8 | E |
| Delta Aquarids . | 340 | −17 | July 28 | | 20 | 12 | D |
| Perseids........ | 47 | +57 | Aug. 12 | | 50 | 25 | P |
| Giacobinids..... | 267 | +55 | Oct. 9 | 1933, 1946 | | 1 | J |
| Orionids....... | 96 | +15 | Oct. 22 | | 20 | 14 | O |
| Taurids........ | 56 | +16 | Nov. 10? | | | 30 | T |
| Leonids........ | 152 | +22 | Nov. 16 | 1799, 1833, 1866, 1867 | 20 | 14 | L |
| Bielids......... | 25 | +45 | Nov. 27 | 1872, 1885 | | | B |
| Geminids....... | 110 | +33 | Dec. 12 | | 30 | 14 | G |

## EPHEMERIS FOR THE PHYSICAL OBSERVATION OF THE SUN

| Date | P | $B_0$ | $L_0$ | Date | P | $B_0$ | $L_0$ |
|---|---|---|---|---|---|---|---|
| | ° | ° | ° | | ° | ° | ° |
| Jan. 1 | + 2.15 | − 3.08 | 341.91 | July 5 | − 1.01 | + 3.35 | 60.16 |
| " 6 | − 0.28 | − 3.65 | 276.07 | " 10 | + 1.26 | + 3.87 | 353.99 |
| " 11 | − 2.70 | − 4.19 | 210.22 | " 15 | + 3.50 | + 4.37 | 287.82 |
| " 16 | − 5.06 | − 4.70 | 144.38 | " 20 | + 5.71 | + 4.83 | 221.66 |
| " 21 | − 7.37 | − 5.17 | 78.55 | " 25 | + 7.85 | + 5.27 | 155.51 |
| " 26 | − 9.60 | − 5.60 | 12.72 | " 30 | + 9.93 | + 5.66 | 89.38 |
| " 31 | − 11.72 | − 5.99 | 306.89 | Aug. 4 | + 11.92 | + 6.02 | 23.25 |
| Feb. 5 | − 13.74 | − 6.33 | 241.06 | " 9 | + 13.82 | + 6.34 | 317.13 |
| " 10 | − 15.63 | − 6.61 | 175.22 | " 14 | + 15.61 | + 6.61 | 251.03 |
| " 15 | − 17.39 | − 6.85 | 109.38 | " 19 | + 17.29 | + 6.84 | 184.94 |
| " 20 | − 19.01 | − 7.03 | 43.54 | " 24 | + 18.84 | + 7.02 | 118.87 |
| " 25 | − 20.49 | − 7.16 | 337.69 | " 29 | + 20.28 | + 7.14 | 52.82 |
| May 2 | − 21.80 | − 7.23 | 271.83 | Sept. 3 | + 21.57 | + 7.22 | 346.77 |
| " 7 | − 22.96 | − 7.25 | 205.96 | " 8 | + 22.72 | + 7.25 | 280.73 |
| " 12 | − 23.96 | − 7.21 | 140.07 | " 13 | + 23.73 | + 7.22 | 214.71 |
| " 17 | − 24.79 | − 7.12 | 74.17 | " 18 | + 24.59 | + 7.15 | 148.70 |
| " 22 | − 25.45 | − 6.97 | 8.25 | " 23 | + 25.28 | + 7.02 | 82.70 |
| " 27 | − 25.94 | − 6.77 | 302.31 | " 28 | + 25.81 | + 6.83 | 16.72 |
| Apr. 1 | − 26.25 | − 6.52 | 236.36 | Oct. 3 | + 26.17 | + 6.60 | 310.74 |
| " 6 | − 26.37 | − 6.22 | 170.39 | " 8 | + 26.35 | + 6.32 | 244.77 |
| " 11 | − 26.32 | − 5.88 | 104.39 | " 13 | + 26.35 | + 5.99 | 178.80 |
| " 16 | − 26.09 | − 5.50 | 38.37 | " 18 | + 26.17 | + 5.61 | 112.85 |
| " 21 | − 25.66 | − 5.07 | 332.34 | " 23 | + 25.79 | + 5.19 | 46.91 |
| " 26 | − 25.06 | − 4.62 | 266.28 | " 28 | + 25.22 | + 4.73 | 340.97 |
| May 1 | − 24.27 | − 4.13 | 200.21 | Nov. 2 | + 24.46 | + 4.23 | 275.04 |
| " 6 | − 23.30 | − 3.61 | 134.12 | " 7 | + 23.49 | + 3.71 | 209.11 |
| " 11 | − 22.16 | − 3.07 | 68.01 | " 12 | + 22.34 | + 3.15 | 143.19 |
| " 16 | − 20.84 | − 2.50 | 1.88 | " 17 | + 20.98 | + 2.56 | 77.28 |
| " 21 | − 19.37 | − 1.93 | 295.74 | " 22 | + 19.45 | + 1.96 | 11.37 |
| " 26 | − 17.74 | − 1.34 | 229.59 | " 27 | + 17.74 | + 1.34 | 305.47 |
| " 31 | − 15.96 | − 0.74 | 163.43 | Dec. 2 | + 15.86 | + 0.70 | 239.58 |
| June 5 | − 14.06 | − 0.13 | 97.26 | " 7 | + 13.84 | + 0.06 | 173.69 |
| " 10 | − 12.06 | + 0.47 | 31.08 | " 12 | + 11.69 | − 0.58 | 107.80 |
| " 15 | − 9.96 | + 1.07 | 324.89 | " 17 | + 9.43 | − 1.21 | 41.93 |
| " 20 | − 7.78 | + 1.66 | 258.71 | " 22 | + 7.10 | − 1.84 | 336.06 |
| " 25 | − 5.55 | + 2.24 | 192.53 | " 27 | + 4.70 | − 2.46 | 270.20 |
| " 30 | − 3.29 | + 2.80 | 126.34 | Jan. 1 | + 2.27 | − 3.05 | 204.35 |

P—The position angle of the axis rotation, measured eastward from the north point of the disk.

$B_0$—The heliographic latitude of the centre of the disk.

$L_0$—The heliographic longitude of the centre of the disk, from Carrington's solar meridian.

Carrington's Rotation Numbers—Greenwich date of commencement of the synodic rotations.

| No. | Commences | No. | Commences | No. | Commences |
|---|---|---|---|---|---|
| 1275 | 1948 Dec. 30.63 | 1280 | 1949 May 16.14 | 1285 | 1949 Sep. 29.27 |
| 1276 | 1949 Jan. 26.97 | 1281 | June 12.35 | 1286 | Oct. 26.56 |
| 1277 | Feb. 23.31 | 1282 | July 9.55 | 1287 | Nov. 22.86 |
| 1278 | Mar. 22.62 | 1283 | Aug. 5.76 | 1288 | Dec. 20.18 |
| 1279 | Apr. 18.90 | 1284 | Sep. 2.00 | 1289 | 1950 Jan. 16.52 |

# TABLE OF PRECESSION FOR 50 YEARS

| R.A | Prec. in Dec. | Precession in Right Ascension | | | | | | | | | | | | | | Prec. in Dec. | R.A. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | δ = +85° | +80° | +75° | +70° | +60° | +50° | +40° | +30° | +20° | +10° | 0° | −10° | −20° | −30° | | |
| h m | ′ | m | m | m | m | m | m | m | m | m | m | m | m | m | m | ′ | h m |
| 0 00 | + 16.7 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | − 16.7 | 12 00 |
| 0 30 | + 16.6 | + 4.22 | 3.38 | 3.10 | 2.96 | 2.81 | 2.73 | 2.68 | 2.64 | 2.61 | 2.59 | 2.56 | 2.53 | 2.51 | 2.48 | − 16.6 | 11 30 |
| 1 00 | + 16.1 | + 5.85 | 4.19 | 3.64 | 3.36 | 3.06 | 2.90 | 2.80 | 2.73 | 2.67 | 2.61 | 2.56 | 2.51 | 2.45 | 2.39 | − 16.1 | 11 00 |
| 1 30 | + 15.4 | + 7.43 | 4.98 | 4.15 | 3.73 | 3.30 | 3.07 | 2.92 | 2.81 | 2.72 | 2.64 | 2.56 | 2.49 | 2.40 | 2.31 | − 15.4 | 10 30 |
| 2 00 | + 14.5 | + 8.92 | 5.72 | 4.64 | 4.09 | 3.52 | 3.22 | 3.03 | 2.88 | 2.76 | 2.66 | 2.56 | 2.46 | 2.36 | 2.24 | − 14.5 | 10 00 |
| 2 30 | + 13.2 | +10.31 | 6.40 | 5.09 | 4.42 | 3.73 | 3.37 | 3.13 | 2.95 | 2.81 | 2.68 | 2.56 | 2.44 | 2.31 | 2.17 | − 13.2 | 9 30 |
| 3 00 | + 11.8 | +11.56 | 7.02 | 5.50 | 4.73 | 3.92 | 3.50 | 3.22 | 3.02 | 2.85 | 2.70 | 2.56 | 2.42 | 2.27 | 2.11 | − 11.8 | 9 00 |
| 3 30 | + 10.2 | +12.66 | 7.57 | 5.86 | 4.99 | 4.09 | 3.61 | 3.30 | 3.07 | 2.88 | 2.72 | 2.56 | 2.40 | 2.24 | 2.05 | − 10.2 | 8 30 |
| 4 00 | + 8.3 | +13.58 | 8.03 | 6.16 | 5.21 | 4.23 | 3.71 | 3.37 | 3.12 | 2.91 | 2.73 | 2.56 | 2.39 | 2.21 | 2.00 | − 8.3 | 8 00 |
| 4 30 | + 6.4 | +14.32 | 8.40 | 6.40 | 5.39 | 4.34 | 3.79 | 3.42 | 3.16 | 2.93 | 2.74 | 2.56 | 2.38 | 2.19 | 1.97 | − 6.4 | 7 30 |
| 5 00 | + 4.3 | +14.85 | 8.66 | 6.58 | 5.52 | 4.42 | 3.84 | 3.46 | 3.18 | 2.95 | 2.75 | 2.56 | 2.37 | 2.17 | 1.94 | − 4.3 | 7 00 |
| 5 30 | + 2.2 | +15.18 | 8.82 | 6.68 | 5.60 | 4.47 | 3.88 | 3.49 | 3.20 | 2.96 | 2.75 | 2.56 | 2.37 | 2.16 | 1.92 | − 2.2 | 6 30 |
| 6 00 | + 0.0 | +15.29 | 8.88 | 6.72 | 5.62 | 4.49 | 3.89 | 3.50 | 3.20 | 2.97 | 2 76 | 2.56 | 2.36 | 2.16 | 1.92 | 0.0 | 6 00 |
| 12 00 | 16.7 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 2 56 | + 2.56 | + 2.56 | + 2.56 | + 2.56 | + 16.7 | 24 00 |
| 12 30 | − 16.6 | + 0.90 | 1.82 | 2.02 | 2.16 | 2.31 | 2.39 | 2.44 | 2.48 | 2.51 | 2.53 | 2.56 | 2.59 | 2.61 | 2.64 | + 16.6 | 23 30 |
| 13 00 | − 16.1 | − 0.73 | + 0.93 | 1.48 | 1.77 | 2.06 | 2.22 | 2.32 | 2.39 | 2.45 | 2.51 | 2.56 | 2.61 | 2.67 | 2.73 | + 16.1 | 23 00 |
| 13 30 | − 15.4 | − 2.31 | + 0.14 | 0.97 | 1.39 | 1.82 | 2.05 | 2.20 | 2.31 | 2.40 | 2.49 | 2.56 | 2.64 | 2.72 | 2.81 | + 15.4 | 22 30 |
| 14 00 | − 14.5 | − 3.80 | − 0.60 | + 0.46 | 1.03 | 1.60 | 1.90 | 2.09 | 2.24 | 2.36 | 2.46 | 2.56 | 2.66 | 2.76 | 2.88 | + 14.5 | 22 00 |
| 14 30 | − 13.2 | − 5.19 | − 1.28 | + 0.03 | 0.70 | 1.39 | 1.75 | 1.99 | 2.17 | 2.31 | 2.44 | 2.56 | 2.68 | 2.81 | 2.95 | + 13.2 | 21 30 |
| 15 00 | − 11.8 | − 6.44 | − 1.90 | − 0.38 | + 0.40 | 1.20 | 1.62 | 1.90 | 2.11 | 2.27 | 2.42 | 2.56 | 2.70 | 2.85 | 3.02 | + 11.8 | 21 00 |
| 15 30 | − 10.2 | − 7.54 | − 2.45 | − 0.74 | + 0.13 | 1.03 | 1.51 | 1.81 | 2.05 | 2.24 | 2.40 | 2.56 | 2.72 | 2.88 | 3.07 | + 10.2 | 20 30 |
| 16 00 | − 8.3 | − 8.46 | − 2.91 | − 1.04 | − 0.09 | + 0.89 | 1.41 | 1.75 | 2.00 | 2.21 | 2.39 | 2.56 | 2.73 | 2.91 | 3.12 | + 8.3 | 20 00 |
| 16 30 | − 6.4 | − 9.20 | − 3.27 | − 1.28 | − 0.27 | + 0.78 | 1.33 | 1.70 | 1.97 | 2.19 | 2.38 | 2.56 | 2.74 | 2.93 | 3.16 | + 6.4 | 19 30 |
| 17 00 | − 4.3 | − 9.73 | − 3.54 | − 1.45 | − 0.40 | + 0.70 | 1.28 | 1.66 | 1.94 | 2.17 | 2.37 | 2.56 | 2.75 | 2.95 | 3.18 | + 4.3 | 19 00 |
| 17 30 | − 2.2 | −10.06 | − 3.70 | − 1.56 | − 0.47 | + 0.65 | 1.25 | 1.63 | 1.92 | 2.16 | 2.37 | 2.56 | 2.75 | 2.96 | 3.20 | + 2.2 | 18 30 |
| 18 00 | − 0.0 | −10.17 | − 3.75 | − 1.60 | − 0.50 | + 0.63 | 1.23 | 1.62 | 1.92 | 2.16 | 2.36 | 2.56 | 2.76 | 2.97 | 3.20 | + 0.0 | 18 00 |