the OBSERVER'S HANDBOOK 1972

sixty-fourth year of publication

the ROYAL ASTRONOMICAL SOCIETY
of CANADA

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
Incorporated 1890 – Royal Charter 1903
Federally Incorporated 1968

The National Office of the Society is located at 252 College Street, Toronto 130, Ontario; the business office, reading room and astronomical library are housed here.

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VISITING HOURS AT SOME CANADIAN OBSERVATORIES

David Dunlap Observatory, Richmond Hill, Ontario.
Wednesday mornings, 10:00–11:00 a.m.
Saturday evenings, April through October (by reservation).

Dominion Astrophysical Observatory, Victoria, B.C.
Summer: Daily 9:30–4:30 (Guide, Monday to Friday).
Winter: Monday to Friday, 9:30–4:30 (Saturday evenings April through November).

Dominion Observatory, Ottawa, Ontario.
Monday to Friday, daytime, rotunda only.
Saturday evenings, April through October.

Dominion Radio Astrophysical Observatory, Penticton, B.C.
Sunday, July and August only (2:00–5:00 p.m.).

Planetariums

The Calgary Centennial Planetarium, Mewata Park, Calgary 2, Alberta.
Winter: Wed.–Fri., 7:15 and 8:45 p.m.; Sat. and Sun. 3:00, 7:15, 8:45 p.m.
Summer: Daily (except Tues.) 2:00, 3:00, 4:00, 7:15 and 8:45 p.m.

Dow Planetarium, 1000 St. Jacques St. W., Montreal, P.Q.
In English: Tues. through Fri. 12:15 p.m.; Sat. 1:00 and 3:30 p.m.; Sun. 2:15 p.m. Evenings (except Monday) 8:15 p.m.
In French: Tues. through Sat. 2:15 p.m., also Sat. 4:30 p.m.; Sun. 1:00, 3:30 and 4:30 p.m. Evenings (except Monday) 9:30 p.m.

H. R. MacMillan Planetarium, 1100 Chestnut St., Vancouver 9, B.C.
Sept.–June: Tues.–Thurs., 4:00 and 8:00 p.m., Fri., 4:00, 7:30, 9:00 p.m. Sat. and holidays, 1:00, 2:30, 4:00, 7:30, 9:00 p.m. Sun., 1:00, 2:30, 4:00, 7:30 p.m.
July–August: Tues.–Sat., 1:00, 2:30, 4:00, 7:30, 9:00 p.m.; Sun., 1:00, 2:30, 4:00, 7:30 p.m. (including Christmas and Easter weeks). Closed on Mondays except holidays.

Manitoba Museum of Man & Nature Planetarium, 190 Rupert Ave., Winnipeg 2, Man.
Sept.–June: Sun. and holidays, 1:00, 2:30, 4:00 p.m.; Tue.–Fri., 3:15, 8:30 p.m. Sat., 1:00, 2:30, 4:00, 7:30, 9:00 p.m.
July–August: Sat., Sun. and holidays same as above; Tue.–Fri., 11:00 a.m., 3:00, 7:30, 9:00 p.m. (Closed Mon. except holidays.) Christmas show, 3:15, 7:30, 9:00 p.m.

McLaughlin Planetarium, 100 Queen's Park, Toronto 5, Ontario.
Tue.–Fri., 3:30, 8:00 p.m.; Sat. 2:00, 3:30, 7:30, 9:00 p.m., Sun. 2:00, 3:30, 5:00, 7:30 p.m. (During July and August no Saturday show at 11:00 a.m., additional weekday show at 2:00 p.m.)

McMaster University, School of Adult Education, GH-136, Hamilton, Ont.
Group reservations only.

Queen Elizabeth Planetarium, Edmonton, Alberta.
Winter: Tue.–Fri., 8:00 p.m., Sat. 3:00 p.m., Sun. 3:00 p.m.
Summer: Mon.–Sat., 3:00, 8:00 p.m., Sun. and holidays, 2:00, 4:00, 8:00 p.m.

The University of Manitoba Planetarium, 394 University College, 500 Dysart Rd., Winnipeg 19, Man.
Wed. and Friday 12:40 and 8:00 p.m.

THE OBSERVER'S HANDBOOK for 1972 is the sixty-fourth edition. In response to suggestions from readers, several changes and improvements have been made and a number of errors and omissions in the 1971 edition have been rectified.

My thanks go to all those who assisted in the preparation of this edition: to those whose names appear in the various sections and to my assistant editors Marie Fidler and Peter Tattersall. Special thanks go to Margaret W. Mayall, Director of the A.A.V.S.O. for the predictions of Algol and the variable stars, to Gordon E. Taylor, British Nautical Almanac Office, for the prediction of planetary appulses and occultations, and to Maude Towne and Isabel Williamson for the tables of moonrise and moonset. I also thank the Department of Energy, Mines and Resources, the Astrophysics Branch, National Research Council of Canada, and the David Dunlap Observatory for their assistance and support. Finally, my deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

JOHN R. PERCY

ANNIVERSARIES AND FESTIVALS, 1972

New Year's Day	Sat.	Jan. 1	Victoria Day	Mon.	May 22
Epiphany	Thur.	Jan. 6	Trinity Sunday		May 28
Septuagesima Sunday		Jan. 30	Corpus Christi	Thur.	June 1
Accession of Queen Elizabeth (1952)	Sun.	Feb. 6	St. John Baptist (Mid-summer Day)	Sat.	June 24
Quinquagesima (Shrove Sunday)		Feb. 13	Dominion Day	Sat.	July 1
Ash Wednesday		Feb. 16	Birthday of Queen Mother Elizabeth (1900)	Fri.	Aug. 4
St. David	Wed.	Mar. 1	Labour Day	Mon.	Sep 4
St. Patrick	Fri.	Mar. 17	Jewish New Year (Rosh Hashanah)	Sat.	Sept. 9
Palm Sunday		Mar. 26	Yom Kippur	Mon.	Sept. 18
First day of Passover	Thur.	Mar. 30	St. Michael (Michaelmas Day)	Fri.	Sept. 29
Good Friday		Mar. 31	Thanksgiving	Mon.	Oct. 9
Easter Sunday		Apr. 2	All Saints' Day	Wed.	Nov. 1
Birthday of Queen Elizabeth (1926)	Fri.	Apr. 21	Remembrance Day	Sat.	Nov. 11
St. George	Sun.	Apr. 23	St. Andrew	Thur.	Nov. 30
Rogation Sunday		May 7	First Sunday in Advent		Dec. 3
Ascension Day	Thur.	May 11	Christmas Day	Mon.	Dec. 25
Pentecost (Whit Sunday)		May 21			

JULIAN DAY CALENDAR, 1972

Jan. 1	2441318	May 1	2441439	Sept. 1	2441562
Feb. 1	2441349	June 1	2441470	Oct. 1	2441592
Mar. 1	2441378	July 1	2441500	Nov. 1	2441623
Apr. 1	2441409	Aug. 1	2441531	Dec. 1	2441653

The Julian Day commences at noon. Thus J.D. 2441318 = Jan. 1.5 U.T. = Jan. 1, 12 hours U.T.

SYMBOLS AND ABBREVIATIONS

SUN, MOON AND PLANETS

☉ The Sun	☾ The Moon generally	♃ Jupiter
● New Moon	☿ Mercury	♄ Saturn
○ Full Moon	♀ Venus	♅ 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.
α or R.A., Right Ascension; δ or Dec., Declination.
h, m, s, Hours, Minutes, Seconds of Time.
° ′ ″, Degrees, Minutes, Seconds of Arc.

SIGNS OF THE ZODIAC

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

THE GREEK ALPHABET

Α, α	Alpha	Ι, ι	Iota	Ρ, ρ	Rho
Β, β	Beta	Κ, κ	Kappa	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 33, 35, etc.), O represents the disk of the planet, d signifies that the satellite is on the disk, * signifies that the satellite is behind the disk or in the shadow. Configurations are for an inverting telescope.

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 2437965.6985 and period 2.8673285 days as published in *Sky and Telescope*, 1963.

CELESTIAL DISTANCES

Celestial distances given herein are based on the standard value of 8.794″ for the sun's parallax, and the astronomical unit of 92.957 million miles.

THE CONSTELLATIONS

Latin Names with Pronunciations and Abbreviations

Andromeda, ăn-drŏm′ė-d*ȧ*	And	Andr
Antlia, ănt′lĭ-*ȧ*	Ant	Antl
Apus, ā′p*ŭ*s	Aps	Apus
Aquarius, *ȧ*-kwâr′ĭ-*ŭ*s	Aqr	Aqar
Aquila, ăk′wĭ-l*ȧ*	Aql	Aqil
Ara, ā′r*ȧ*	Ara	Arae
Aries, ā′rĭ-ēz	Ari	Arie
Auriga, ô-rī′g*ȧ*	Aur	Auri
Boötes, bô-ō′tēz	Boo	Boot
Caelum, sē′l*ŭ*m	Cae	Cael
Camelopardalis, k*ȧ*-mĕl′ô-pär′d*ȧ*-lĭs	Cam	Caml
Cancer, kăn′sẽr	Cnc	Canc
Canes Venatici, kā′nēz vê-năt′ĭ-sī	CVn	CVen
Canis Major, kā′nĭs mā′jẽr	CMa	CMaj
Canis Minor, kā′nĭs′ mī′nẽr	CMi	CMin
Capricornus, kăp′rĭ-kôr′n*ŭ*s	Cap	Capr
Carina, k*ȧ*-rī′n*ȧ*	Car	Cari
Cassiopeia, kăs′ĭ-ô-pē′y*ȧ*′	Cas	Cas
Centaurus, sĕn-tô′r*ŭ*s	Cen	Cent
Cepheus, sē′fūs	Cep	Ceph
Cetus, sē′t*ŭ*s	Cet	Ceti
Chamaeleon, k*ȧ*-mē′lē-ŭn	Cha	Cham
Circinus, sûr′sĭ-n*ŭ*s	Cir	Circ
Columba, kô-lŭm′b*ȧ*	Col	Colm
Coma Berenices, kō′m*ȧ* bĕr′ê-nī′sēz	Com	Coma
Corona, Australis, kô-rō′n*ȧ* ôs-trā′lĭs	CrA	CorA
Corona Borealis, k*ȧ*-rō′n*ȧ* bō′rê-ā′lĭs	CrB	CorB
Corvus, kôr′v*ŭ*s	Crv	Corv
Crater, krā′tẽr	Crt	Crat
Crux, krŭks	Cru	Cruc
Cygnus, sĭg′n*ŭ*s	Cyg	Cygn
Delphinus, dĕl-fī′n*ŭ*s	Del	Dlph
Dorado, dô-rä′dō	Dor	Dora
Draco, drā′kō	Dra	Drac
Equuleus, ê-kwōō′lê-*ŭ*s	Equ	Equl
Eridanus, ê-rĭd′*ȧ*-n*ŭ*s	Eri	Erid
Fornax, fôr′năks	For	Forn
Gemini, jĕm′ĭ-nī	Gem	Gemi
Grus, grŭs	Gru	Grus
Hercules, hûr′kû′lēz	Her	Herc
Horologium, hŏr′ô-lō′jĭ-*ŭ*m	Hor	Horo
Hydra, hī′dr*ȧ*	Hya	Hyda
Hydrus, hī′dr*ŭ*s	Hyi	Hydi
Indus, ĭn′d*ŭ*s	Ind	Indi
Lacerta, l*ȧ*-sûr′t*ȧ*	Lac	Lacr
Leo, lē′ō	Leo	Leon
Leo Minor, lē′ō mī′nẽr	LMi	LMin
Lepus, lē′p*ŭ*s	Lep	Leps
Libra, lī′br*ȧ*	Lib	Libr
Lupus, lū′p*ŭ*s	Lup	Lupi
Lynx, lĭngks	Lyn	Lync
Lyra, lī′r*ȧ*	Lyr	Lyra
Mensa, mĕn′s*ȧ*	Men	Mens
Microscopium, mī′krô-skō′pĭ-*ŭ*m	Mic	Micr
Monoceros, m-ônŏs′ẽr-*ŏ*s	Mon	Mono
Musca, mŭs′k*ȧ*	Mus	Musc
Norma, nôr′m*ȧ*	Nor	Norm
Octans, ŏk′t*ă*nz	Oct	Octn
Ophiuchus, ŏf′ĭ-ūk*ŭ*s	Oph	Ophi
Orion, ô-rī′*ŏ*n	Ori	Orio
Pavo, Pā′vō	Pav	Pavo
Pegasus, pĕg′*ȧ*-s*ŭ*s	Peg	Pegs
Perseus, pûr′sūs	Per	Pers
Phoenix, fē′nĭks	Phe	Phoe
Pictor, pĭk′tẽr	Pic	Pict
Pisces, pĭs′ēz	Psc	Pisc
Piscis Austrinus, pĭs′ĭs ôs-trī′n*ŭ*s	PsA	PscA
Puppis, pŭp′ĭs	Pup	Pupp
Pyxis, pĭk′sĭs	Pyx	Pyxi
Reticulum, rê-tĭk′û-l*ŭ*m	Ret	Reti
Sagitta, s*ȧ*-jĭt′*ȧ*	Sge	Sgte
Sagittarius, săj′ĭ-tā′rĭ-*ŭ*s	Sgr	Sgtr
Scorpius, skôr′pĭ-*ŭ*s	Sco	Scor
Sculptor, skŭlp′tẽr	Scl	Scul
Scutum, skū′t*ŭ*m	Sct	Scut
Serpens, sûr′pĕnz	Ser	Serp
Sextans, sĕks′t*ă*nz	Sex	Sext
Taurus, tô′r*ŭ*s	Tau	Taur
Telescopium, tĕl′ê-skō′pĭ-*ŭ*m	Tel	Tele
Triangulum, trī-ăng′gû-l*ŭ*m	Tri	Tria
Triangulum Australe, trī-ăng′gû-l*ŭ*m ôs-trā′lē	Tra	TrAu
Tucana, tû-kā′n*ȧ*	Tuc	Tucn
Ursa Major, ûr′s*ȧ* mā′jẽr	UMa	UMaj
Ursa Minor, ûr′s*ȧ* mi′nẽr	UMi	UMin
Vela, vē′l*a*	Vel	Velr
Virgo, vûr′gō	Vir	Virg
Volans, vō′l*ă*nz	Vol	Voln
Vulpecula, vŭl-pĕk′û-l*ȧ*	Vul	Vulp

ā fāte; â chȧotic; ă tăp; *ă* fin*ă*l; ȧ ȧsk; *ȧ* ide*ȧ*; â câre; ä älms; au aught; ē bē; ê crêatê; ĕ ĕnd; *ĕ* ang*ĕ*l; ẽ makẽr; ī tīme; ĭ bĭt; *ĭ* an*ĭ*mal; ō nōte; ô anatômy; ŏ hŏt; *ŏ* *ŏ*ccur; ô ôrb; ōō mōōn; ŏŏ bŏŏk; ou out; ū tūbe; û ûnite; ŭ sŭn; *ŭ* s*ŭ*bmit; û hûrl.

MISCELLANEOUS ASTRONOMICAL DATA

UNITS OF LENGTH

1 Angstrom unit = 10^{-8} cm.
1 inch = exactly 2.54 centimetres
1 yard = exactly 0.9144 metre
1 mile = exactly 1.609344 kilometres
1 micron, μ = 10^{-4} cm. = 10^4A.
1 cm. = 10 mm. = 0.39370 ... in.
1 m. = 10^2 cm. = 1.0936 .... yd.
1 km. = 10^5 cm. = 0.62137 ... mi.
1 astronomical unit = 1.496×10^{13} cm. = 1.496×10^8 km. = 9.2957×10^7 mi.
1 light-year = 9.461×10^{17} cm. = 5.88×10^{12} mi. = 0.3068 parsecs
1 parsec = 3.084×10^{18} cm. = 1.916×10^{13} mi. = 3.260 l.y.
1 megaparsec = 10^6 parsecs

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 mean sidereal time
Synodic month = 29*d* 12*h* 44*m* 03*s*
Sidereal month = 27*d* 07*h* 43*m* 12*s*
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* 52*m* 52*s*

THE EARTH

Equatorial radius, a = 6378.160 km. = 3963.20 mi.: flattening, $c = (a - b)/a = 1/298.25$
Polar radius, b = 6356.77 km. = 3949.91 mi.
1° of latitude = $111.137 - 0.562 \cos 2\phi$ km. = $69.057 - 0.349 \cos 2\phi$ mi. (at lat. ϕ)
1° of longitude = $111.418 \cos \phi - 0.094 \cos 3\phi$ km. = $69.232 \cos \phi - 0.0584 \cos 3\phi$ mi.
Mass of earth = 5.98×10^{24} kgm. = 13.2×10^{24} lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

EARTH'S ORBITAL MOTION

Solar parallax = 8''.794 (adopted)
Constant of aberration = 20''.496 (adopted)
Annual general precession = 50''.26; obliquity of ecliptic = 23° 26' 35'' (1970)
Orbital velocity = 29.8 km./sec. = 18.5 mi./sec.
Parabolic velocity at ⊕ = 42.3 km./sec. = 26.2 mi./sec.

SOLAR MOTION

Solar apex, R.A. 18*h* 04*m*, Dec. + 30°; solar velocity = 19.4 km./sec. = 12.1 mi./sec.

THE GALACTIC SYSTEM

North pole of galactic plane R.A. 12*h* 49*m*, Dec. + 27.°4 (1950)
Centre of galaxy R.A. 17*h* 42.4*m*, Dec. − 28° 55' (1950) (zero pt. for new gal. coord.)
Distance to centre ~ 10,000 parsecs; diameter ~ 30,000 parsecs
Rotational velocity (at sun) ~ 262 km./sec.
Rotational period (at sun) ~ 2.2×10^8 years
Mass ~ 2×10^{11} solar masses

EXTERNAL GALAXIES

Red Shift ~ + 100 km./sec./megaparsec ~ 19 miles/sec./million l.y.

RADIATION CONSTANTS

Velocity of light, $c = 2.997925 \times 10^{10}$ cm./sec. = 186.282.1 mi./sec.
Frequency, $v = c/\lambda$; v in Hertz (cycles per sec.), c in cm./sec., λ in cm.
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant = 5.6694×10^{-5} c.g.s. units

MISCELLANEOUS

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.: mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.
Absolute temperature = T° K = T° C + 273° = 5/9 (T° F + 459°)

1 radian = 57°.2958
= 3437'.75
= 206,265''

π = 3.141,592,653,6
No. of square degrees in the sky = 41,253
1 gram = 0.03527 oz.

SUN—EPHEMERIS AND CORRECTION TO SUN-DIAL

Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T.
	h m s	°	m s
Jan. 1	18 42 03	−23 05.5	+ 3 16
4	18 55 17	−22 50.2	+ 4 40
7	19 08 28	−22 30.7	+ 6 01
10	19 21 35	−22 07.2	+ 7 17
13	19 34 37	−21 39.9	+ 8 28
16	19 47 34	−21 08.7	+ 9 35
19	20 00 24	−20 33.9	+10 34
22	20 13 08	−19 55.6	+11 28
25	20 25 45	−19 13.9	+12 14
28	20 38 15	−18 29.1	+12 53
31	20 50 38	−17 41.3	+13 24
Feb. 3	21 02 53	−16 50.7	+13 49
6	21 15 01	−15 57.4	+14 06
9	21 27 01	−15 01.6	+14 15
12	21 38 55	−14 03.5	+14 18
15	21 50 42	−13 03.3	+14 15
18	22 02 22	−12 01.2	+14 04
21	22 13 56	−10 57.4	+13 47
24	22 25 24	− 9 52.1	+13 24
27	22 36 46	− 8 45.5	+12 56
Mar. 1	22 48 03	− 7 37.6	+12 22
4	22 59 15	− 6 28.8	+11 44
7	23 10 24	− 5 19.2	+11 03
10	23 21 29	− 4 08.9	+10 17
13	23 32 31	− 2 58.2	+ 9 29
16	23 43 31	− 1 47.1	+ 8 39
19	23 54 28	− 0 35.9	+ 7 47
22	0 05 25	+ 0 35.2	+ 6 53
25	0 16 20	+ 1 46.1	+ 5 59
28	0 27 15	+ 2 56.6	+ 5 04
31	0 38 10	+ 4 06.6	+ 4 09
Apr. 3	0 49 05	+ 5 16.0	+ 3 15
6	1 00 02	+ 6 24.5	+ 2 23
9	1 11 02	+ 7 32.0	+ 1 33
12	1 22 03	+ 8 38.5	+ 0 45
15	1 33 07	+ 9 43.6	+ 0 01
18	1 44 15	+10 47.2	− 0 41
21	1 55 26	+11 49.3	− 1 19
24	2 06 40	+12 49.5	− 1 54
27	2 17 59	+13 47.9	− 2 24
30	2 29 22	+14 44.2	− 2 50
May 3	2 40 50	+15 38.4	− 3 11
6	2 52 23	+16 30.2	− 3 26
9	3 04 01	+17 19.6	− 3 37
12	3 15 45	+18 06.4	− 3 42
15	3 27 34	+18 50.4	− 3 42
18	3 39 28	+19 31.6	− 3 37
21	3 51 26	+20 09.8	− 3 27
24	4 03 30	+20 44.8	− 3 13
27	4 15 37	+21 16.7	− 2 54
30	4 27 49	+21 45.2	− 2 31
June 2	4 40 05	+22 10.4	− 2 05
5	4 52 25	+22 32.1	− 1 34
8	5 04 47	+22 50.2	− 1 01
11	5 17 12	+23 04.8	− 0 25
14	5 29 39	+23 15.6	+ 0 13
17	5 42 08	+23 22.8	+ 0 52
20	5 54 36	+23 26.3	+ 1 31
23	6 07 05	+23 26.0	+ 2 09
26	6 19 33	+23 22.1	+ 2 47
29	6 31 59	+23 14.4	+ 3 24

Date	Apparent R.A. 0h E.T.	Apparent Dec. 0h E.T.	Corr. to Sun-dial 12h E.T.
	h m s	°	m s
July 2	6 44 24	+23 03.1	+ 3 59
5	6 56 47	+22 48.2	+ 4 31
8	7 03 06	+22 29.6	+ 5 00
11	7 21 22	+22 07.6	+ 5 26
14	7 33 35	+21 42.1	+ 5 48
17	7 45 42	+21 13.4	+ 6 05
20	7 57 45	+20 41.4	+ 6 18
23	8 09 43	+20 06.2	+ 6 25
26	8 21 35	+19 28.1	+ 6 27
29	8 33 22	+18 47.1	+ 6 23
Aug. 1	8 45 04	+18 03.2	+ 6 14
4	8 56 40	+17 16.7	+ 6 00
7	9 08 11	+16 27.7	+ 5 41
10	9 19 37	+15 36.3	+ 5 16
13	9 30 58	+14 42.6	+ 4 46
16	9 42 14	+13 46.8	+ 4 11
19	9 53 24	+12 49.1	+ 3 32
22	10 04 31	+11 49.6	+ 2 48
25	10 15 33	+10 48.4	+ 1 59
28	10 26 31	+ 9 45.6	+ 1 08
31	10 37 27	+ 8 41.4	+ 0 13
Sept. 3	10 48 19	+ 7 36.0	− 0 45
6	10 59 09	+ 6 29.4	− 1 44
9	11 09 58	+ 5 21.9	− 2 46
12	11 20 45	+ 4 13.6	− 3 49
15	11 31 31	+ 3 04.6	− 4 52
18	11 42 17	+ 1 55.1	− 5 56
21	11 53 02	+ 0 45.3	− 7 00
24	12 03 48	− 0 24.8	− 8 04
27	12 14 36	− 1 34.9	− 9 05
30	12 25 26	− 2 44.9	−10 05
Oct. 3	12 36 18	− 3 54.7	−11 02
6	12 47 13	− 5 04.2	−11 56
9	12 58 11	− 6 13.0	−12 47
12	13 09 14	− 7 21.1	−13 33
15	13 20 21	− 8 28.3	−14 15
18	13 31 33	− 9 34.4	−14 52
21	13 42 50	−10 39.2	−15 23
24	13 54 13	−11 42.7	−15 49
27	14 05 43	−12 44.5	−16 08
30	14 17 19	−13 44.6	−16 20
Nov. 2	14 29 03	−14 42.7	−16 25
5	14 40 54	−15 38.7	−16 22
8	14 52 52	−16 32.3	−16 13
11	15 04 58	−17 23.4	−15 55
14	15 17 11	−18 11.9	−15 30
17	15 29 32	−18 57.4	−14 58
20	15 42 00	−19 40.0	−14 18
23	15 54 36	−20 19.3	−13 31
26	16 07 18	−20 55.2	−12 37
29	16 20 08	−21 27.7	−11 36
Dec. 2	16 33 04	−21 56.4	−10 29
5	16 46 05	−22 21.4	− 9 16
8	16 59 12	−22 42.5	− 7 59
11	17 12 22	−22 59.5	− 6 37
14	17 25 37	−23 12.[illegible]	− 5 12
17	17 38 53	−23 21.3	− 3 45
20	17 52 11	−23 25.9	− 2 16
23	18 05 30	−23 26.3	− 0 46
26	18 18 49	−23 22.4	+ 0 43
29	18 32 08	−23 14.3	+ 2 11

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

MEAN ORBITAL ELEMENTS (for epoch 1960 Jan. 1.5 E.T.)

Planet	Mean Distance from Sun (a) A. U.	Mean Distance from Sun (a) millions of miles	Period of Revolution Sidereal (P)	Period of Revolution Synodic	Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. at Epoch (L)
				days		°	°	°	°
Mercury	0.387	36.0	88.0d.	116	.206	7.0	47.9	76.8	222.6
Venus	0.723	67.2	224.7	584	.007	3.4	76.3	131.0	174.3
Earth	1.000	92.9	365.26	...	.017	0.0	0.0	102.3	100.2
Mars	1.524	141.5	687.0	780	.093	1.8	49.2	335.3	258.8
Jupiter	5.203	483.4	11.86y.	399	.048	1.3	100.0	13.7	259.8
Saturn	9.539	886.	29.46	378	.056	2.5	113.3	92.3	280.7
Uranus	19.18	1782.	84.01	370	.047	0.8	73.8	170.0	141.3
Neptune	30.06	2792.	164.8	367	.009	1.8	131.3	44.3	216.9
Pluto	39.44	3664.	247.7	367	.250	17.2	109.9	224.2	181.6

PHYSICAL ELEMENTS

Object	Equatorial Diameter miles	Oblateness	Mass ⊕=1	Mean Density water =1	Surface Gravity ⊕=1	Rotation Period	Inclination of Equator to Orbit °	Albedo
☉ Sun	864,000	0	332,958	1.41	27.9	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.36	0.16	$27^d\,07^h\,43^m$	6.7	0.067
☿ Mercury	3,025	0	0.055	5.46	0.38	58^d16^h	≤28	0.056
♀ Venus	7,526	0	0.815	5.23	0.90	243^d(retro.)	≤10	0.76
⊕ Earth	7,927	1/298	1.000	5.52	1.00	$23^h\,56^m\,04^s$	23.4	0.36
♂ Mars	4,218	1/192	0.107	3.93	0.38	24 37 23	24.0	0.16
♃ Jupiter	88,700	1/16	318.0	1.33	2.64	9 50 30	3.1	0.73
♄ Saturn	75,100	1/10	95.2	0.69	1.13	10 14	26.7	0.76
♅ Uranus	29,200	1/16	14.6	1.56	1.07	10 49	97.9	0.93
♆ Neptune	31,650	1/50	17.3	1.54	1.08	16	28.8	0.62
♇ Pluto	3,500?	?	0.11	5?	0.6?	$6^d9^h17^m$	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 56, the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet: miles	Mean Distance from Planet: ″ *	Revolution Period: d	h	m	Orbit Incl. ° ‡	Discovery
Satellite of the Earth									
Moon	−12.7	2160	238,900	. . .	27	07	43	Var.§	
Satellites of Mars									
Phobos	11.6	12	5,800	25	0	07	39	1.0	Hall, 1877
Deimos	12.8	(<10)	14,600	62	1	06	18	1.3	Hall, 1877
Satellites of Jupiter									
V	13.0	(100)	112,000	59	0	11	57	0.4	Barnard, 1892
Io	4.8	2020	262,000	138	1	18	28	0	Galileo, 1610
Europa	5.2	1790	417,000	220	3	13	14	0	Galileo, 1610
Ganymede	4.5	3120	665,000	351	7	03	43	0	Galileo, 1610
Callisto	5.5	2770	1,171,000	618	16	16	32	0	Galileo, 1610
VI	13.7	(50)	7,133,000	3765	250	14		27.6	Perrine, 1904
VII	16	(20)	7,295,000	3850	259	16		24.8	Perrine, 1905
X	18.6	(<10)	7,369,000	3888	263	13		29.0	Nicholson, 1938
XII	18.8	(<10)	13,200,000	6958	631	02		147	Nicholson, 1951
XI	18.1	(<10)	14,000,000	7404	692	12		164	Nicholson, 1938
VIII	18.8	(<10)	14,600,000	7715	738	22		145	Melotte, 1908
IX	18.3	(<10)	14,700,000	7779	758			153	Nicholson, 1914
Satellites of Saturn									
Janus	(14)	<300	100,000		0	17	59		A. Dollfus, 1966
Mimas	12.1	300:	116,000	30	0	22	37	1.5	W. Herschel, 1789
Enceladus	11.8	400:	148,000	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	600	183,000	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	600:	235,000	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.8	810	327,000	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	2980	759,000	197	15	22	41	0.3	Huygens, 1655
Hyperion	14.2	(100)	920,000	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0	(500)	2,213,000	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	(14)	(100)	8,053,000	2096	550	11		150	W. Pickering, 1898
Satellites of Uranus									
Miranda	16.5	(200)	77,000	9	1	09	56	0	Kuiper, 1948
Ariel	14.4	(500)	119,000	14	2	12	29	0	Lassell, 1851
Umbriel	15.3	(300)	166,000	20	4	03	38	0	Lassell, 1851
Titania	14.0	(600)	272,000	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(500)	365,000	44	13	11	07	0	W. Herschel, 1787
Satellites of Neptune									
Triton	13.6	2300	220,000	17	5	21	03	160.0	Lassell, 1846
Nereid	18.7	(200)	3,461,000	264	359	10		27.4	Kuiper, 1949

*At mean opposition distance.

†From D. L. Harris in "Planets and Satellites", *The Solar System*, vol. 3, 1961, *except* numbers in brackets which are rough estimates.

‡Inclination of orbit referred to planet's equator; a value greater than 90° indicates retrograde motion.

§Varies 18° to 29°. The eccentricity of the mean orbit of the moon is 0.05490.

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

TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages of the sun or stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time. The atomic second has been defined; atomic time has been maintained in various labs, and an internationally acceptable atomic time scale is under discussion.

A sundial indicates *apparent solar time*, but this is far from uniform because of the earth's elliptical orbit and the inclination of the ecliptic. If the real sun is replaced by a fictitious mean sun moving uniformly in the equator, we have *mean* (solar) *time*. *Apparent time* − *mean time* = *equation of time*. This is the same as *correction to sundial* on page 7, with reversed sign.

If instead of the sun we use stars, we have *sidereal time*. The sidereal time is zero when the vernal equinox or first point of Aries is on the meridian. As the earth makes one more rotation with respect to the stars than it does with respect to the sun during a year, sidereal time gains on mean time $3^m\ 56^s$ per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

Sidereal time is equal to mean solar time plus 12 hours plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Local Sidereal time may be found approximately from Standard or zone time (0 h at midnight) by applying the corrections for longitude (p. 12) and sundial (p. 7) to obtain apparent solar time, then adding 12 h and R.A. sun (p. 7). (Note that it is necessary to obtain R.A. of the sun and correction to sundial at the standard time involved.)

Local mean time varies continuously with longitude. The local mean time of Greenwich, now known as *Universal Time* (UT) is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT. When great precision is required, UT1 and UT2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

To avoid the inconveniences to travellers of a changing local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 9 standard time zones as follows: Newfoundland (N), $3^h\ 30^m$ slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; 150th meridian or Alaska-Hawaii, 10 hours; and 165th meridian or Bering, 11 hours slower than Greenwich.

The mean solar second, defined as 1/86400 of the mean solar day, has been abandoned as the unit of time because random changes in the earth's rotation make it variable. The unit of time has been redefined twice within the past two decades. In 1956 it was defined in terms of Ephemeris Time (ET) as 1/31,556,925.9747 of the tropical year 1900 January 0 at 12 hrs. ET. In 1967 it was redefined as 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium 133 atom. Ephemeris Time is required in celestial mechanics, while the cesium resonator makes the unit readily available. The difference, ΔT, between UT and ET is measured as a small error in the observed longitude of the moon, in the sense ΔT = ET − UT. The moon's position is tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1971 will be about 41 seconds.

RADIO TIME SIGNALS

National time services distribute co-ordinated time called UTC, which approximates UT2. It is derived from the cesium atomic standard by offsetting the output frequency. The offset is reviewed annually, and a change, if necessary, is applied at the beginning of the year. A divergence between UTC and UT2 amounting to 0.1s is corrected by a step adjustment at the beginning of the next month. By agreement these changes are co-ordinated through the Bureau International de l'Heure, so that most time services are synchronized to the millisecond.

A growing body of public opinion favours the use of stepped atomic time, SAT, in place of UTC. The scientific advantage would be the use of the official cesium second in everyday timekeeping. An adjustment of 1.0 second would be made when necessary to maintain UT approximately. The change, which would pass unnoticed by the general public, will not be introduced before 1972.

Radio time signals readily available in Canada include:

CHU Ottawa, Canada	3330, 7335, 14670 kHz
WWV Fort Collins, Colorado	2.5, 5, 10, 20, 25 MHz
WWVH Maui, Hawaii	2.5, 5, 10, 15 MHz

TIMES OF RISING AND SETTING OF THE SUN AND MOON

The times of sunrise and sunset for places in latitudes ranging from 30° to 54 are given on pages 13 to 18, and of twilight on page 19. The times of moonrise and moonset for the 5 h meridian are given on pages 20 to 25. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

The tabulated values are computed for the sea horizon for the rising and setting of the upper limb of the sun and moon, and are corrected for refraction. Because variations from the sea horizon usually exist on land, the tabulated times can rarely be observed.

The Standard Times for Any Station

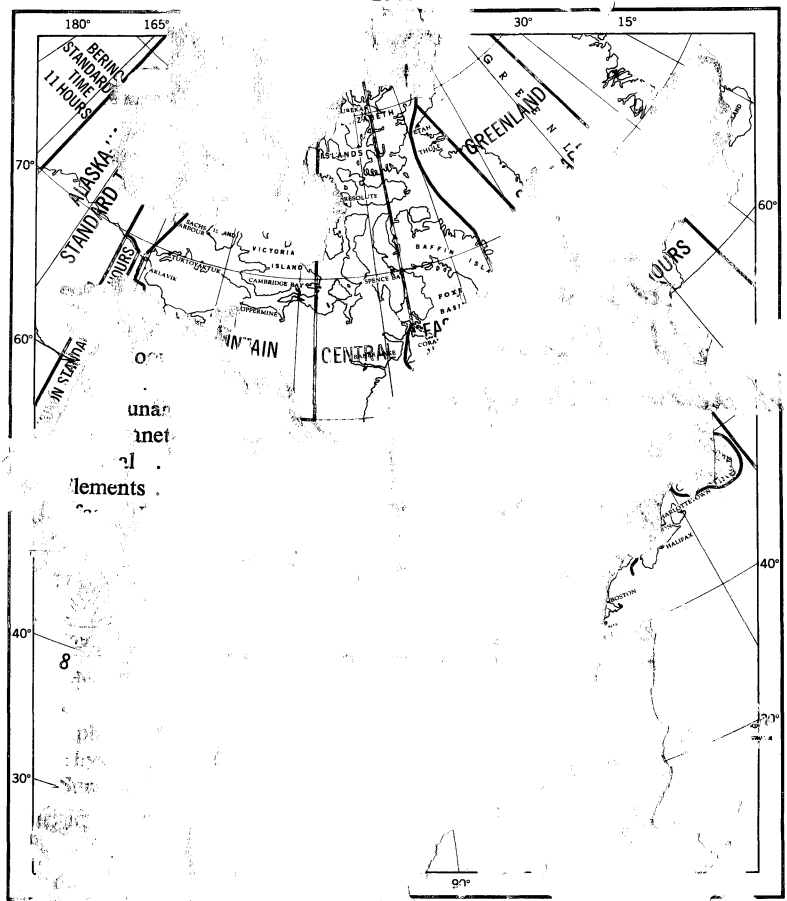
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired day. Finally apply the correction to get the Standard Time. The correction is the number of minutes of time that the place is west (plus) or east (minus) of the standard meridian. The corrections for places not listed may be obtained by converting the longitude found from an atlas into time (360° = 24 h).

CANADIAN CITIES AND TOWNS						AMERICAN CITIES		
	Lat.	Corr.		Lat.	Corr.		Lat.	Corr.
Athabasca	55°	+33M	Peterborough	44	+13E	Atlanta	34°	+37E
Baker Lake	64	+24C	Port Harrison	59	+13E	Baltimore	39	+06E
Brandon	50	+40C	Prince Albert	53	+63C	Birmingham	33	−13C
Brantford	43	+21E	Prince Rupert	54	+41P	Boston	42	−16E
Calgary	51	+36M	Quebec	47	−15E	Buffalo	43	+15E
Charlottetown	46	+12A	Regina	50	+58C	Chicago	42	−10C
Churchill	59	+17C	St. Catharines	43	+17E	Cincinnati	39	+38E
Cornwall	45	− 1E	St. Hyacinthe	46	−08E	Cleveland	42	+26E
Edmonton	54	+34M	Saint John, N.B.	45	+24A	Dallas	33	+27C
Fredericton	46	+27A	St. John's, Nfld.	48	+01N	Denver	40	00M
Gander	49	+ 8N	Sarnia	43	+29E	Detroit	42	+32E
Glace Bay	46	00A	Saskatoon	52	+67C	Fairbanks	65	−10AL
Goose Bay	53	+ 2A	Sault Ste. Marie	47	+37E	Flagstaff	35	+27M
Granby	45	−09E	Shawinigan	47	−09E	Indianapolis	40	−15C
Guelph	44	+21E	Sherbrooke	45	−12E	Juneau	58	+58P
Halifax	45	+14A	Stratford	43	+24E	Kansas City	39	+18C
Hamilton	43	+20E	Sudbury	47	+24E	Los Angeles	34	−07P
Hull	45	+03E	Sydney	46	+01A	Louisville	38	−17C
Kapuskasing	49	+30E	The Pas	54	+45C	Memphis	35	00C
Kingston	44	+06E	Timmins	48	+26E	Miami	26	+21E
Kitchener	43	+22E	Toronto	44	+18E	Milwaukee	43	−09C
London	43	+25E	Three Rivers	46	−10E	Minneapolis	45	+13C
Medicine Hat	50	+23M	Thunder Bay	48	+57E	New Orleans	30	00C
Moncton	46	+19A	Trail	49	−09P	New York	41	−04E
Montreal	46	−06E	Truro	45	+13A	Omaha	41	+24C
Moosonee	51	+23E	Vancouver	49	+12P	Philadelphia	40	+01E
Moose Jaw	50	+62C	Victoria	48	+13P	Phoenix	33	+28M
Niagara Falls	43	+16E	Whitehorse	61	00Y	Pittsburgh	40	+20E
North Bay	46	+18E	Windsor	42	+32E	St. Louis	39	+01C
Ottawa	45	+03E	Winnipeg	50	+29C	San Francisco	38	+10P
Owen Sound	45	+24E	Yellowknife	62	+38M	Seattle	48	+09P
Penticton	49°	−02P				Washington	39	+08E

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 13 the time of sunrise on February 12 for latitude 45° is 7.06; add 24 min. and we get 7.30 (Eastern Standard Time).

DARD TIME ZONES
1971

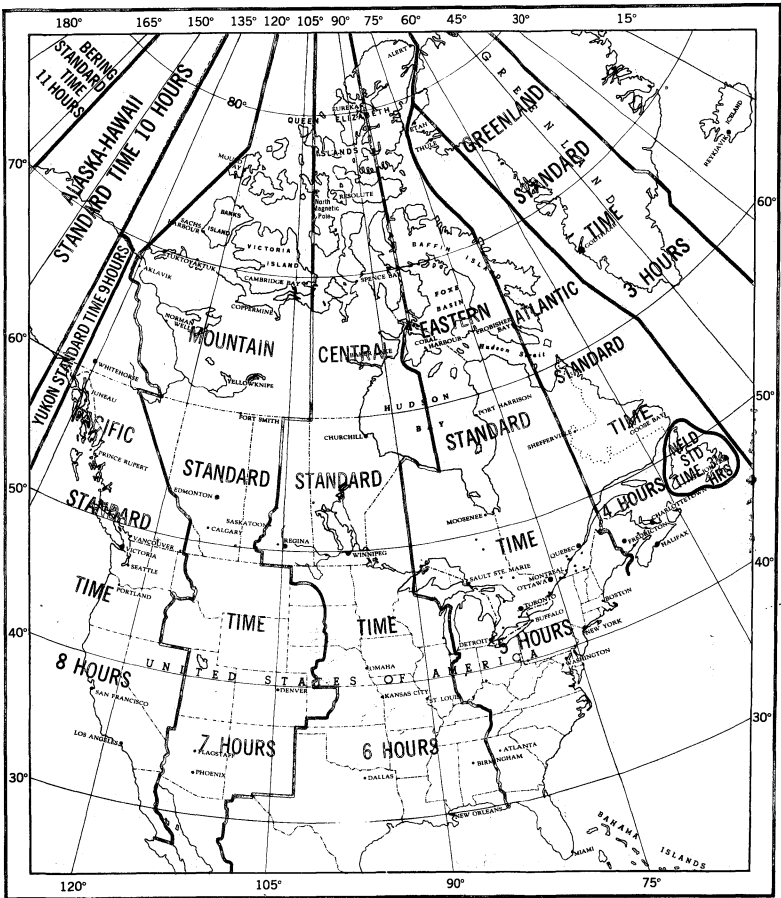


Toronto

Latitude 44°
Longitude 79.4°
Standard Longitude 75°

79.4 W
75.0 S
4.4
West ~~West~~ ~~East~~ of S.M.

MAP OF STANDARD TIME ZONES



Big Bang
Pulsating
Dead State

79.4 (75.00) 69 3/4

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

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

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

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

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

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

TWILIGHT—BEGINNING OF MORNING AND ENDING OF EVENING

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

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

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

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

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

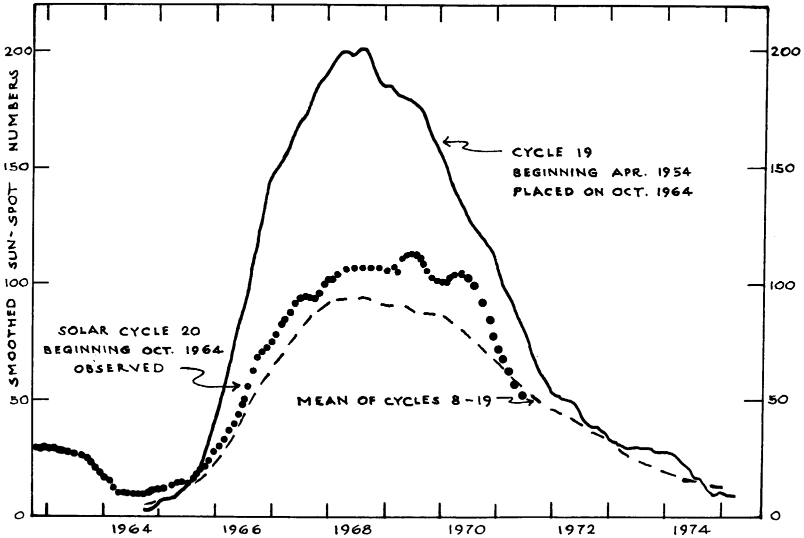
DATE	Latitude 30° Moon Rise	Set	Latitude 35° Moon Rise	Set	Latitude 40° Moon Rise	Set	Latitude 45° Moon Rise	Set	Latitude 50° Moon Rise	Set	Latitude 54° Moon Rise	Set
Sept.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	.. ..	14 02	.. ..	14 16	23 48	14 33	23 27	14 54	23 02	15 19	22 36	15 46
2	00 19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

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

THE SUN AND PLANETS FOR 1972

THE SUN

The diagram represents the sun-spot activity for the current 20th cycle, as far as the final numbers are available. The present cycle began at the minimum in October 1964. For comparison, cycle 19 which began April 1954 (solid curve), and the mean of cycles 8 to 19 (dashed curve), are placed with their minima on October 1964. Sun-spot activity declined by nearly half during early 1971, and by late 1972, will be approaching a minimum.



MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. The amount of heat and light from the sun received by it per square mile is, on the average, 6.7 times the amount received by the earth. By a radar technique in 1965, the period of rotation on its axis was found to be 59 days.

Mercury's orbit is well within that of the earth, and 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 1972

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Elong.	Mag.	Date	Elong.	Mag.
			Jan. 1	23°	−0.1
Mar. 14	18°	−0.1	Apr. 28	27°	+0.7
July 10	26°	+0.7	Aug. 25	18°	−0.1
Nov. 5	23°	0.0	Dec. 14	21°	−0.2

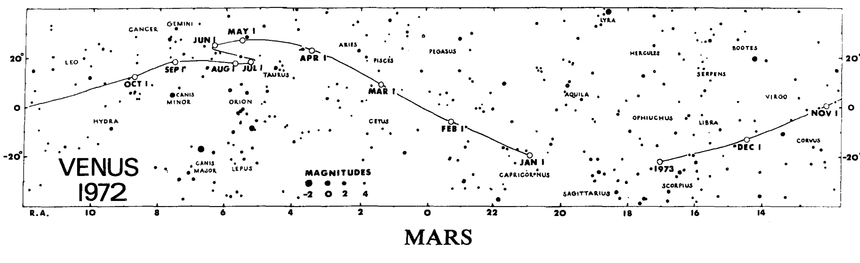
The most favourable elongations are: in the evening, March 14; in the morning, August 25. Neither of these elongations is exceptionally favourable. The apparent diameter of the planet ranges from 4.7″, at superior conjunction, through about 7.5″ at elongation, to 11″ at inferior conjunction.

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 Mercury's but much slower and more stately. The orbit of Venus is almost circular with radius of 67 million miles, and its orbital speed is 22 miles per sec.

Venus will dominate the twilight sky during much of 1972. From January 1 until early June, Venus is an evening star, high in the western sky. Inferior conjunction occurs on June 17, and Venus is a morning star for the rest of the year. Greatest elongation occurs on April 7 (46° E) and August 26 (46° W); greatest brilliancy occurs on May 11 and July 24. At these times, Venus is a magnitude −4.2 crescent, 40″ in diameter.

Its brilliance is due to its nearness and to dense clouds enshrouding the planet. Visits by Mariner II and V, and by the Russian Venera IV spacecraft, revealed a surface temperature close to 1000° F, a surface pressure of perhaps 100 times that of the earth, and little or no magnetic field. The atmosphere consists mainly of carbon dioxide, and of course the clouds, whose nature is still uncertain.



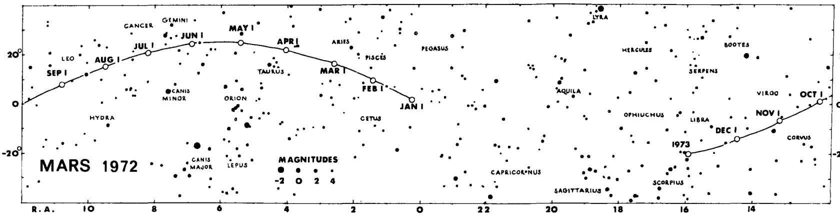
MARS

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 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 24 h. 37 m. 22.6689 s. has been accurately determined. Perhaps the most surprising result of the space programme so far is the revelation by Mariner IV that the surface of Mars contains craters much like those on the Moon. This discovery was confirmed in 1969 by Mariners VI and VII, which revealed also large areas free of craters, and other areas with unusual chaotic structure.

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. At the opposition on August 10, 1971, the planet was closer to the earth—34,931,000 mi.—than it will be for many years. Such favourable oppositions occur at intervals of 15 to 17 years.

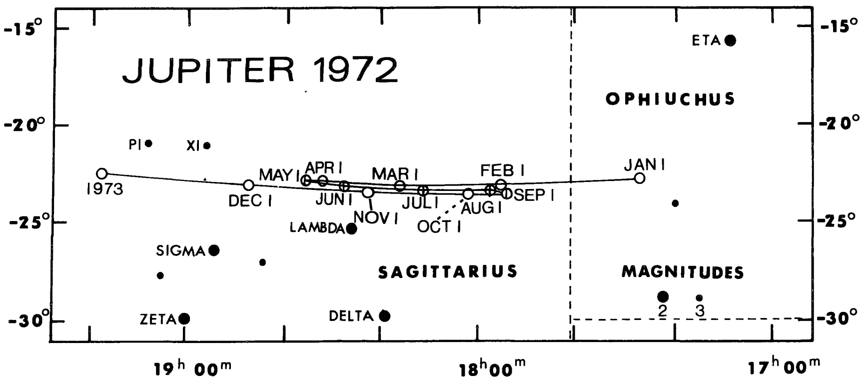
Mars is inconspicuous in 1972. Its magnitude at brightest is only +0.5. This magnitude occurs in January, when Mars is an evening star in Pisces. Thereafter the elongation decreases until September 7, when it is in conjunction. By year's end, it is a morning star in Scorpius.



JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is $2\frac{1}{2}$ 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 12 satellites, the last discovered in 1951 (see p. 9). Bands of clouds may be observed on Jupiter, interrupted by irregular spots which may be short-lived or persist for weeks. The atmosphere contains ammonia and methane at a temperature of about −200° F. Intense radiation belts (like terrestrial Van Allen belts) have been disclosed by observations at radio wave-lengths. A correlation of radio bursts with the orbital position of the satellite Io has now been found.

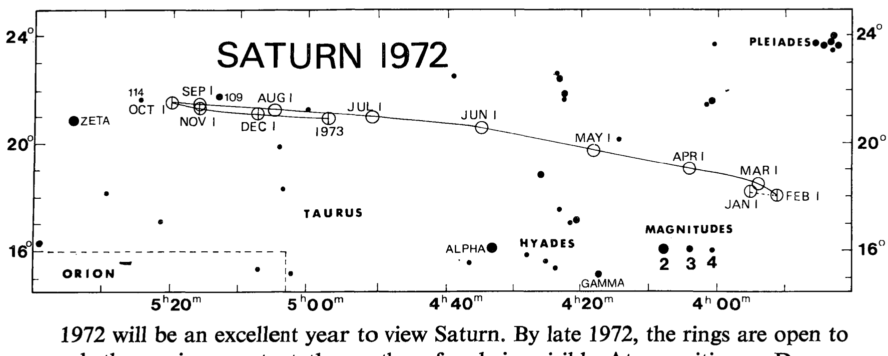
Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.



On January 1, 1972, Jupiter is a morning star in Ophiuchus, very close to the sun. In mid-January, it moves into Sagittarius, where it remains for the rest of the year. Retrograde motion occurs between April 25 and August 25. Opposition occurs on June 24, at which time the planet reaches greatest brightness (magnitude −2.2) and apparent diameter (47″). By December, Jupiter is still visible as an evening star, very low in the west.

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 ten 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. The rings were edgewise in 1950, and were again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. (The tenth satellite was discovered in 1966.)

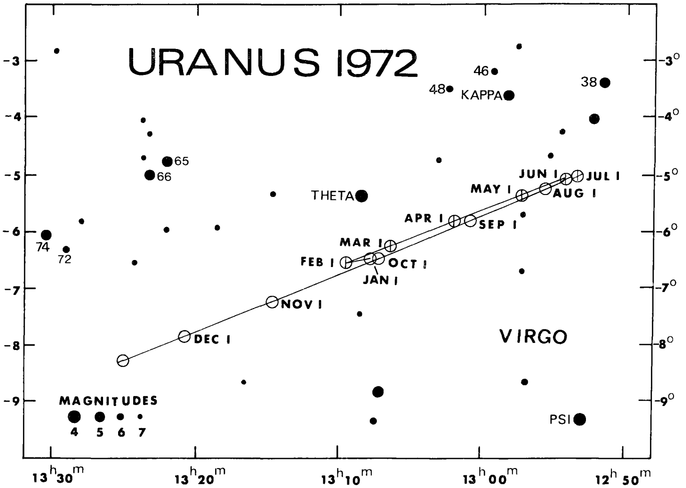


1972 will be an excellent year to view Saturn. By late 1972, the rings are open to nearly the maximum extent, the southern face being visible. At opposition on December 9, the major and minor axes of the ring system are 47″ and 21″, and the planet attains a brightness of magnitude −0.3, its brightest in some years. Early in the year, Saturn passes between the Hyades and the Pleiades; it is a conspicuous evening star at this time.

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.

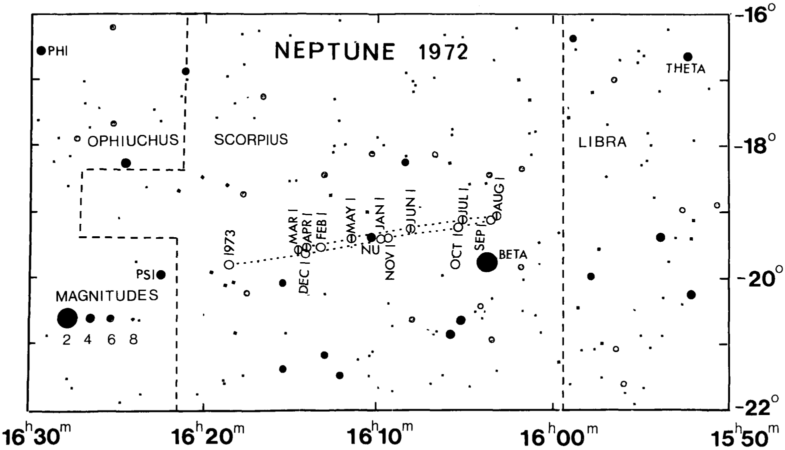
Uranus, in 1972, is in Virgo. At opposition on April 5, its magnitude is +5.7; at this time it should be faintly visible to the naked eye under a clear dark sky. Its apparent diameter reaches 4.0″, easily resolvable with a small telescope under good seeing conditions. Conjunction occurs on October 11.



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. It caused a sensation at the time. Its distance from the sun is 2791 million miles and its period of revolution is 165 years. A satellite was discovered in 1846 soon after the planet. A second satellite was discovered by G. P. Kuiper at the McDonald Observatory on May 1, 1949. Its magnitude is about 19.5, its period about a year, and diameter about 200 miles. It is named Nereid.

In 1972, Neptune is in Scorpius. Retrograde motion occurs between March 7 and August 14; opposition occurs on May 24, at which time the planet has a magnitude of +7.7 and an apparent diameter of 2.5″. Conjunction occurs on November 26. Neptune passes close to ν Sco three times in 1972 (see map).



PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930 as a result of an extended search started two decades earlier by Percival Lowell. The faint star-like image was first detected by Clyde Tombaugh by comparing photographs taken on different dates. Further observations confirmed that the object was a distant planet. Its mean distance from the sun is 3671 million miles and its revolution period is 248 years. It appears as a 14th mag. star in the constellation Coma. At opposition on March 21 its position is: R.A. 12^h 29^m, Dec. $+15°$ $11'$, and it is 2,818,000,000 miles from earth.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 18 h 42 m to 20 h 55 m and its Decl. changes from 23° 06′ S. to 17° 25′ S. The equation of time changes from −3 m 22 s to −13 m 26 s. These values of the equation of time are for noon E.S.T. on the first and last days of the month in this and in the following months. The earth is in perihelion or nearest the sun, on the 3rd at a distance of 91,397,000 mi. On the 16th there is an annular eclipse of the sun, not visible in North America. 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. On the night of the 29th–30th there is a total eclipse of the moon, visible in North America.

Mercury on the 1st is in R.A. 17 h 05 m, Decl. 20° 51′ S., and on the 15th is in R.A. 18 h 19 m, Decl. 23° 22′ S. Greatest western elongation is on the 1st. At that time Mercury stands about 16° above the south-eastern horizon at sunrise and will be an observable object just before sunrise for about two weeks following.

Venus on the 1st is in R.A. 20 h 55 m, Decl. 19° 15′ S.; and on the 15th it is in R.A. 22 h 03 m, Decl. 13° 42′ S., mag. −3.5, and transits at 14 h 29 m. It is low in the south-west at sunset and sets about three hours later.

Mars on the 15th is in R.A. 0 h 46 m, Decl. 5° 04′ N., mag. +0.8, and transits at 17 h 10 m. In Pisces, it is near the meridian at sunset and sets before midnight. It is declining in brilliancy.

Jupiter on the 15th is in R.A. 17 h 40 m, Decl. 22° 59′ S., mag. −1.4, and transits at 10 h 04 m. Moving from Ophiuchus into Sagittarius, it rises about two hours before the sun in the south-east. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 52 m, Decl. 18° 10′ N., mag. +0.1, and transits at 20 h 14 m. In Taurus, it is well up in the east at sunset and sets about three hours before dawn. Retrograding during most of the month, it is stationary in R.A. on the 31st and resumes direct, or eastward, motion among the stars.

Uranus on the 15th is in R.A. 13 h 08 m, Decl. 6° 34′ S., and transits at 5 h 33 m.

Neptune on the 15th is in R.A. 16 h 11 m, Decl. 19° 28′ S., and transits at 8 h 35 m.

Pluto—For information in regard to this planet, see p. 31.

1972			JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1	09		Mercury greatest elong. W. (23°)			87.05
Sun. 2						99.17
Mon. 3			Earth at perihelion	18 30		111.30[l]
	21		Quadrantid meteors			
Tue. 4						123.43
Wed. 5						135.57
Thur. 6	14		Mercury 0.8° N. of Jupiter	15 20		147.71
Fri. 7						159.85
Sat. 8			Mars at ascending node			172.00
	8	31	☾ Last Quarter			
	15		Uranus 6° N. of Moon			
	23		Moon at apogee (251,300 mi.)			
Sun. 9				12 10		184.16
Mon. 10						196.33[b]
Tues. 11	02		Pallas stationary			208.50
Wed. 12	00		Pluto stationary	9 00		220.67
	09		Neptune 6° N. of Moon			
	16		Antares 0.2° S. of Moon			
Thur. 13	23		Jupiter 4° N. of Moon			232.85
Fri. 14	15		Mercury 3° N. of Moon			245.04
Sat. 15			Mercury at descending node	5 50		257.22
Sun. 16	05	52	● New Moon. Eclipse of ⊙, p. 57			269.41[l]
Mon. 17						281.60
Tues. 18				2 40		293.79
Wed. 19	03		Venus 4° S. of Moon			305.98
Thur. 20				23 30		318.16
Fri. 21						330.34
Sat. 22	00		Moon at perigee (229,950 mi.)			342.51
	06		Mars 5° S. of Moon			
Sun. 23	04	29	☽ First Quarter	20 20	14O32	354.68
	06		Uranus stationary			
Mon. 24					3O124	6.83[b]
Tues. 25			Mercury at aphelion		32O4*	18.99
	05		Saturn 7° S. of Moon			
Wed. 26				17 10	31O4*	31.13
Thur. 27					O3124	43.27
Fri. 28					12O34	55.41
Sat. 29				14 00	2O134	67.54
Sun. 30	05	58	○ Full Moon. Eclipse of ☾, p. 57		1O324	79.67[l]
Mon. 31	18		Saturn stationary		3O142	91.80

Explanation of time on p. 10, of colongitude on p. 58.

[l]Jan. 3, +5.56°; Jan. 16, −4.98°; Jan. 30, +4.81°.

[b]Jan. 10, +6.84°; Jan. 24, −6.75°.

THE SKY FOR FEBRUARY 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 20 h 55 m to 22 h 48 m and its Decl. changes from 17° 25′ S. to 7° 38′ S. The equation of time changes from −13 m 35 s to −12 m 36 s. It is at a maximum of −14 m 18 s on the 11th. 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 1st is in R.A. 20 h 10 m, Decl. 21° 50′ S., and on the 15th is in R.A. 21 h 46 m, Decl. 15° 35′ S. It is too close to the sun for observation, superior conjunction being on the 17th.

Venus on the 1st is in R.A. 23 h 20 m, Decl. 5° 29′ S.; and on the 15th it is in R.A. 0 h 21 m, Decl. 1° 50′ N., mag. −3.6, and transits at 14 h 44 m. It is an evening star in the south-west at sunset and sets about three hours later.

Mars on the 15th is in R.A. 2 h 02 m, Decl. 13° 04′ N., mag. +1.2, and transits at 16 h 24 m. Moving into Aries, it is past the meridian at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 18 h 06 m, Decl. 23° 05′ S., mag. −1.5, and transits at 8 h 28 m. In Sagittarius, it rises about three hours before the sun and is to be seen low in the south-east. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 52 m, Decl. 18° 17′ N., mag. +0.3, and transits at 18 h 12 m. In Taurus, it is approaching the meridian at sunset and sets about two hours after midnight.

Uranus on the 15th is in R.A. 13 h 08 m, Decl. 6° 28′ S., and transits at 3 h 30 m.

Neptune on the 15th is in R.A. 16 h 14 m, Decl. 19° 33′ S., and transits at 6 h 36 m.

Pluto—For information in regard to this planet, see p. 31.

1972			FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 5h E.S.T.	Sun's Selen. Colong. 0 h U.T.
d	h	m		h m		°
Tues. 1				10 50	324O*	103.93
Wed. 2					4321O	116.07
Thur. 3					4O312	128.20
Fri. 4	23		Uranus 6° N. of Moon	7 40	41O3d	140.35
Sat. 5	15		Ceres at opposition		42O13	152.49
	20		Moon at apogee (251,400 mi.)			
Sun. 6					41O23	164.65[b]
Mon. 7	06	11	☾ Last Quarter	4 30	43O12	176.81
Tues. 8	19		Neptune 6° N. of Moon		3421O	188.97
Wed. 9	01		Antares 0.2° S. of Moon		32O4d	201.14
Thur. 10	18		Jupiter 3° N. of Moon	1 20	O124*	213.32
Fri. 11	12		Juno stationary		1O234	225.50
Sat. 12				22 00	2O134	237.69[l]
Sun. 13					1O234	249.88
Mon. 14			Mercury greatest hel. lat. S.		3O124	262.08
	19	29	● New Moon			
Tues. 15				18 50	321O4	274.28
Wed. 16					32O14	286.48
Thur. 17	02		Mercury in superior conjunction		O42**	298.67
	14		Moon at perigee (226,900 mi.)			
	23		Venus 5° S. of Moon			
Fri. 18				15 40	41O23	310.87
Sat. 19	19		Mars 5° S. of Moon		42O13	323.06
Sun. 20			Venus at ascending node		41O3*	335.24[b]
Mon. 21	11		Saturn 7° S. of Moon	12 30	43O12	347.42
	12	20	☽ First Quarter			
Tues. 22					4312O	359.59
Wed. 23					432O1	11.76
Thur. 24				9 20	43O2*	23.92
Fri. 25					41O23	36.07[l]
Sat. 26					2O413	48.22
Sun. 27				6 10	1O34*	60.36
Mon. 28	22	12	○ Full Moon		O124d	72.51
Tues. 29					312O4	84.65

Explanation of time on p. 10, of colongitude on p. 58.

[l]Feb. 12, −6.01°; Feb. 25, +5.37°. [b]Feb. 6, +6.83°; Feb. 20, −6.72°.

THE SKY FOR MARCH 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 22 h 48 m to 0 h 42 m and its Decl. changes from 7° 38′ S. to 4° 30′ N. The equation of time changes from −12 m 20 s to −4 m 5 s. 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 1st is in R.A. 23 h 30 m, Decl. 4° 00′ S., and on the 15th is in R.A. 0 h 43 m, Decl. 7° 06′ N. On the 14th it is at greatest eastern elongation, and on that date it stands about 17° above the western horizon at sunset. For about a week preceding and following the 14th the planet should be easily observed low in the west just after sunset, but by the 31st it is in inferior conjunction.

Venus on the 1st is in R.A. 1 h 24 m, Decl. 9° 32′ N.; and on the 15th it is in R.A. 2 h 23 m, Decl. 16° 01′ N., mag. −3.8, and transits at 14 h 53 m. It is an evening star visible in the west for nearly four hours after sunset.

Mars on the 15th is in R.A. 3 h 17 m, Decl. 19° 09′ N., mag. +1.5, and transits at 15 h 45 m. Moving into Taurus, it is well past the meridian at sunset and sets before midnight.

Jupiter on the 15th is in R.A. 18 h 25 m, Decl. 22° 59′ S., mag. −1.7, and transits at 6 h 53 m. In Sagittarius, it rises about two hours after midnight and is near the meridian in the south at dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 3 h 58 m, Decl. 18° 44′ N., mag. +0.4, and transits at 16 h 24 m. In Taurus, it is past the meridian at sunset and sets about midnight.

Uranus on the 15th is in R.A. 13 h 05 m, Decl. 6° 07′ S., and transits at 1 h 33 m.

Neptune on the 15th is in R.A. 16 h 15 m, Decl. 19° 33′ S., and transits at 4 h 42 m.

Pluto—For information in regard to this planet, see p. 31.

1972			MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4h E.S.T.	Sun's Selen. Colong. 0 h U.T.
d	h	m		h m		°
Wed. 1				3 00	32O14	96.79
Thur. 2					31O24	108.94
Fri. 3	06		Uranus 6° N. of Moon	23 50	O1234	121.09
Sat. 4			Mercury at ascending node		2O43*	133.24
	14		Moon at apogee (251,850 mi.)			
Sun. 5					12O43	145.39[b]
Mon. 6				20 40	4O312	157.56
Tues. 7	03		Neptune 6° N. of Moon		431O2	169.72
	07		Neptune stationary			
	09		Antares 0.3° S. of Moon			
Wed. 8	02	05	☾ Last Quarter		432O1	181.90
Thur. 9			Mercury at perihelion	17 30	431O2	194.08
	11		Jupiter 3° N. of Moon			
Fri. 10					4O132	206.26
Sat. 11					42O3*	218.46[l]
Sun. 12				14 20	421O3	230.65
Mon. 13					4O312	242.86
Tues. 14	05		Mercury greatest elong. E. (18°)		31O24	255.07
Wed. 15	06	35	● New Moon	11 10	32O14	267.28
Thur. 16	15		Mercury 2° S. of Moon		31O4*	279.49
	16		Moon at perigee (223,750 mi.)			
Fri. 17					O124*	291.70
Sat. 18	13		Venus 3° S. of Moon	8 00	21O34	303.91[b]
Sun. 19			Mercury greatest hel. lat. N.		2O34d	316.12
	09		Mars 4° S. of Moon			
	20		Saturn 6° S. of Moon			
Mon. 20	07	22	Equinox. Spring begins		O1324	328.32
Tues. 21	00		Pluto at opposition	4 50	31O24	340.52
	06		Mercury stationary			
	21	12	☽ First Quarter			
Wed. 22					32O41	352.71
Thur. 23					341O*	4.89[l]
Fri. 24				1 30	43O12	17.07
Sat. 25			Venus at perihelion		412O3	29.24
	06		Ceres stationary			
Sun. 26				22 20	42O13	41.40
Mon. 27					4O23*	53.57
Tues. 28					413O2	65.73
Wed. 29	15	05	○ Full Moon	19 10	432O1	77.89
Thur. 30	10		Uranus 6° N. of Moon		3124O	90.05
	18		Vesta in conjunction			
Fri. 31	07		Mercury in inferior conjunction		3O412	102.21

Explanation of time on p. 10, of colongitude on p. 58.

[l]Mar. 11, −7.17°; Mar. 23, +6.61°. [b]Mar. 5, +6.72°; Mar. 18, −6.59°.

THE SKY FOR APRIL 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 0 h 42 m to 2 h 33 m and its Decl. changes from 4° 30′ N. to 15° 03′ N. The equation of time changes from −3 m 47 s to +2 m 51 s, being zero on the 15th. 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 1st is in R.A. 0 h 34 m, Decl. 6° 42′ N., and on the 15th is in R.A. 0 h 15 m, Decl. 0° 48′ N. On the 28th it is in greatest western elongation, but this is a poor elongation, Mercury being less than 10° above the eastern horizon at sunrise.

Venus on the 1st is in R.A. 3 h 36 m, Decl. 22° 18′ N.; and on the 15th it is in R.A. 4 h 34 m, Decl. 25° 44′ N., mag. −4.0, and transits at 15 h 01 m. It dominates the western sky for about four hours after sunset. On the night of the 16th–17th an occultation of Venus by the moon will be visible in some parts of the world.

Mars on the 15th is in R.A. 4 h 42 m, Decl. 23° 20′ N., mag. +1.7, and transits at 15 h 08 m. In Taurus, it is well down in the west at sunset and sets within four hours.

Jupiter on the 15th is in R.A. 18 h 35 m, Decl. 22° 53′ S., mag. −1.9, and transits at 5 h 01 m. In Sagittarius, it rises about midnight and is past the meridian, low in the southern sky at dawn. On the 24th it is stationary in R.A. and commences retrograde, or westward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 4 h 10 m, Decl. 19° 24′ N., mag. +0.4, and transits at 14 h 34 m. In Taurus it is well down in the west at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 13 h 00 m, Decl. 5° 37′ S., and transits at 23 h 22 m. Opposition is on the 5th.

Neptune on the 15th is in R.A. 16 h 13 m, Decl. 19° 27′ S., and transits at 2 h 39 m.

Pluto—For information in regard to this planet, see p. 31.

1972			APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1	02		Moon at apogee (252,350 mi.)	16 00	1O34d	114.37[b]
	02		Juno at opposition			
	02		Mars 3° N. of Saturn			
Sun. 2					2O134	126.54
Mon. 3	10		Neptune 6° N. of Moon		O234*	138.71
	16		Antares 0.6° S. of Moon			
Tues. 4				12 50	3O24d	150.88
Wed. 5	19		Uranus at opposition		32O14	163.06
Thur. 6	00		Jupiter 2° N. of Moon		321O4	175.24
	18	44	☾ Last Quarter			
Fri. 7	19		Venus greatest elong. E. (46°)	9 40	3O124	187.44
Sat. 8	06		Venus 5° N. of Saturn		14O23	199.63[l]
Sun. 9					42O13	211.84
Mon. 10				6 30	41O23	224.05
Tues. 11			Mercury at descending node		4O32d	236.27
	22		Mars 7° N. of Aldebaran			
Wed. 12	11		Mercury 5° S. of Moon		432O1	248.49
	17		Mercury stationary			
Thur. 13	15	31	● New Moon	3 20	4321O	260.72
Fri. 14	01		Moon at perigee (222,000 mi.)		43O12	272.95[b]
	21		Venus 9° N. of Aldebaran			
Sat. 15					41O23	285.18
Sun. 16			Venus greatest hel. lat. N.	0 10	24O13	297.40
	09		Saturn 6° S. of Moon			
	21		Venus 0.1° N. of Moon			
	23		Mars 3° S. of Moon			
Mon. 17					1O43*	309.63
Tues. 18				21 00	O1324	321.85
Wed. 19					32O4*	334.06
Thur. 20	7	45	☽ First Quarter		321O4	346.27[l]
Fri. 21	21		Lyrid meteors	17 50	3O124	358.47
Sat. 22			Mercury at aphelion		1O324	10.67
	15		Venus 3° N. of Mars			
Sun. 23					2O134	22.86
Mon. 24	20		Jupiter stationary	14 40	1O43*	35.05
Tues. 25					4O132	47.23
Wed. 26	14		Uranus 6° N. of Moon		432O*	59.41
Thur. 27				11 30	432Od	71.58
Fri. 28	05		Moon at apogee (252,550 mi.)		43O12	83.76[b]
	07		Mercury greatest elong. W. (27°)			
	07	44	○ Full Moon			
Sat. 29					41O2*	95.94
Sun. 30	15		Neptune 6° N. of Moon	8 10	42O13	108.11
	22		Antares 0.7° S. of Moon. Occ'n.			

Explanation of time on p. 10, of colongitude on p. 58.

[l]Apr. 8, −7.83°; Apr. 20, +7.39°.

[b]Apr. 1, +6.59°; Apr. 14, −6.48°; Apr. 28, +6.57°.

THE SKY FOR MAY 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 2 h 33 m to 4 h 36 m and its Decl. changes from 15° 03′ N. to 22° 02′ N. The equation of time changes from +2 m 59 s to a maximum of +3 m 43 s on the 14th, and then to +2 m 21 s at the end of the month. 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 1st is in R.A. 0 h 56 m, Decl. 2° 50′ N., and on the 15th is in R.A. 2 h 07 m, Decl. 10° 14′ N. It is too close to the sun for observation.

Venus on the 1st is in R.A. 5 h 33 m, Decl. 27° 30′ N.; and on the 15th it is in R.A. 6 h 09 m, Decl. 27° 22′ N., mag. −4.2, and transits at 14 h 36 m. It dominates the western sky for about three hours after sunset. Greatest brilliancy is on the 11th.

Mars on the 15th is in R.A. 6 h 07 m, Decl. 24° 37′ N., mag. +1.9, and transits at 14 h 35 m. Moving into Gemini, it is low in the west at sunset and sets within three hours. On the 15th the planet is occulted by the moon. This occultation is not visible in North America.

Jupiter on the 15th is in R.A. 18 h 33 m, Decl. 22° 57′ S., mag. −2.1, and transits at 3 h 01 m. In Sagittarius, it rises in the late evening and is well past the meridian by dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 4 h 25 m, Decl. 20° 05′ N., and transits at 12 h 52 m. In Taurus, it is too low in the west at sunset for easy observation even at the beginning of the month. On the 31st it is in conjunction.

Uranus on the 15th is in R.A. 12 h 56 m, Decl. 5° 12′ S., and transits at 21 h 20 m.

Neptune on the 15th is in R.A. 16 h 10 m, Decl. 19° 19′ S., and transits at 0 h 38 m. Opposition is on the 24th.

Pluto—For information in regard to this planet, see p. 31.

1972			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1					41203	120.29
Tues. 2					40132	132.48
Wed. 3	07		Jupiter 2° N. of Moon	5 00	3104d	144.66
Thur. 4	22		η Aquarid meteors		32014	156.85
Fri. 5					3024*	169.05
Sat. 6	07	26	☾ Last Quarter	1 50	1024*	181.25
Sun. 7					20134	193.46[l]
Mon. 8				22 40	21034	205.68
Tues. 9					01324	217.90
Wed. 10					13024	230.13
Thur. 11	06		Venus greatest brilliancy	19 30	32041	242.37
	14		Mercury 8° S. of Moon			
Fri. 12			Mercury greatest hel. lat. S.		34102	254.61[b]
	12		Moon at perigee (222,100 mi.)			
	23	08	● New Moon			
Sat. 13					4302d	266.85
Sun. 14	01		Saturn 5° S. of Moon	16 20	42013	279.10
Mon. 15	15		Venus 2° N. of Moon		42103	291.34
	15		Mars 1° S. of Moon			
Tues. 16					40123	303.58
Wed. 17	01		Venus 3° N. of Mars	13 10	41302	315.81
Thur. 18					43201	328.04[l]
Fri. 19	20	16	☽ First Quarter		3410*	340.27[l]
Sat. 20				10 00	3042d	352.49
Sun. 21					20134	4.70
Mon. 22					21034	16.91
Tues. 23	19		Uranus 6° N. of Moon	6 50	01234	29.11
Wed. 24	19		Neptune at opposition		10324	41.31
Thur. 25	10		Moon at apogee (252,350 mi.)		32014	53.50[b]
	10		Juno stationary			
Fri. 26	19		Venus stationary	3 30	3104*	65.70
Sat. 27	19		Neptune 6° N. of Moon		30142	77.89
	23	28	○ Full Moon			
Sun. 28	04		Antares 0.8° S. of Moon. Occ'n.		2403*	90.07
Mon. 29				0 20	42103	102.26
Tues. 30	10		Jupiter 2° N. of Moon		40213	114.45
Wed. 31			Mercury at ascending node	21 10	41032	126.65
	03		Saturn in conjunction			

Explanation of time on p. 10, of colongitude on p. 58.

[l]May 7, −7.76°; May 18, 19, +7.36°. [b]May 12, −6.50°; May 25, +6.66°.

THE SKY FOR JUNE 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 4 h 36 m to 6 h 40 m and its Decl. changes from 22° 02′ N. to 23° 07′ N. The equation of time changes from +2 m 12 s to −3 m 38 s, being zero on the 12th. 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 1st is in R.A. 4 h 16 m, Decl. 21° 20′ N., and on the 15th is in R.A. 6 h 26 m, Decl. 25° 10′ N. It is too close to the sun for observation, superior conjunction being on the 4th.

Venus on the 1st is in R.A. 6 h 19 m, Decl. 25° 29′ N.; and on the 15th it is in R.A. 5 h 52 m, Decl. 22° 33′ N., mag. −2.8, and transits at 12 h 14 m. Early in the month it is still to be seen low in the west for an hour after sunset, but by the 17th it has reached inferior conjunction, and later in the month it is visible in the east as a morning star just before sunrise.

Mars on the 15th is in R.A. 7 h 33 m, Decl. 22° 56′ N., mag. +2.0, and transits at 13 h 59 m. Moving through Gemini into Cancer, it is very low in the west at sunset, so that with its present faintness it is difficult to observe. On the 13th Mars is occulted by the moon. This occultation is not visible in North America.

Jupiter on the 15th is in R.A. 18 h 20 m, Decl. 23° 09′ S., mag. −2.2, and transits at 0 h 46 m. In Sagittarius it rises about at sunset and is visible quite low in the southern sky until dawn. Opposition is on the 24th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 4 h 42 m, Decl. 20° 42′ N., and transits at 11 h 06 m. A morning star now, it will be the end of the month before it can be observed, very low in the east just before sunrise.

Uranus on the 15th is in R.A. 12 h 53 m, Decl. 5° 00′ S., and transits at 19 h 16 m.

Neptune on the 15th is in R.A. 16 h 07 m, Decl. 19° 10′ S., and transits at 22 h 29 m.

Pluto—For information in regard to this planet, see p. 31.

1972			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thur. 1					4312O	138.84
Fri. 2					43O12	151.04
Sat. 3				18 00	41O23	163.25[l]
Sun. 4	16		Mercury in superior conjunction		24O3d	175.46[l]
	16	22	☾ Last Quarter			
Mon. 5			Mercury at perihelion		O1243	187.67
Tues. 6				14 50	1O324	199.90
Wed. 7					23O14	212.13
Thur. 8					321O4	224.37[b]
Fri. 9	19		Moon at perigee (223,950 mi.)	11 40	3O124	236.61
Sat. 10					1O24*	248.86
Sun. 11			Venus at descending node		2O134	261.11
	06	30	● New Moon			
Mon. 12				8 30	O243*	273.36
Tues. 13	08		Mars 0.7° N. of Moon		41O32	285.62
Wed. 14					432O1	297.87
Thur. 15			Mercury greatest hel. lat. N.	5 20	4321O	310.11
Fri. 16	01		Pluto stationary		43O12	322.35[l]
Sat. 17	10		Venus in inferior conjunction		413O2	334.59
Sun. 18	10	41	☽ First Quarter	2 10	42O13	346.82
	17		Mars 6° S. of Pollux			
Mon. 19					41O3*	359.04
Tues. 20	01		Uranus 6° N. of Moon	22 50	41O23	11.26
Wed. 21	02	06	Solstice. Summer begins		23O41	23.48[b]
	20		Uranus stationary			
	22		Moon at apogee (251,800 mi.)			
Thur. 22					321O4	35.68
Fri. 23				19 40	3O124	47.89
Sat. 24	01		Neptune 6° N. of Moon		13O24	60.09
	11		Antares 0.8° S. of Moon			
	12		Mercury 5° S. of Pollux			
	16		Jupiter at opposition			
Sun. 25					2O134	72.29
Mon. 26	10		Jupiter 2° N. of Moon	16 30	12O34	84.48
	13	46	○ Full Moon			
Tues. 27					O234d	96.67
Wed. 28	11		Mercury 0.3° N. of Mars		32O14	108.87
Thur. 29				13 20	321O4	121.06
Fri. 30					34O12	133.26

Explanation of time on p. 10, of colongitude on p. 58.

[l]June 3, 4, −6.86°; June 16, +6.77°. [b]June 8, −6.66°; June 21, +6.79°.

THE SKY FOR JULY 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 6 h 40 m to 8 h 45 m and its Decl. changes from 23° 07′ N. to 18° 03′ N. The equation of time changes from −3 m 50 s to a maximum of −6 m 27 s on the 25th and then to −6 m 17 s at the end of the month. On the 5th the earth is in aphelion, or farthest from the sun, at a distance of 94,514,000 mi. There is a total eclipse of the sun on the 10th, visible in North America. 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. On the night of the 25th–26th there is a partial eclipse of the moon, visible in North America.

Mercury on the 1st is in R.A. 8 h 24 m, Decl. 20° 37′ N., and on the 15th is in R.A. 9 h 22 m, Decl. 14° 06′ N. On the 10th it is in greatest eastern elongation, standing about 15° above the western horizon at sunset. For about a week at this time it will be easily observed.

Venus on the 1st is in R.A. 5 h 16 m, Decl. 18° 59′ N.; and on the 15th it is in R.A. 5 h 13 m, Decl. 17° 53′ N., mag. −4.1, and transits at 9 h 40 m. It rises to the north of east about two hours before the sun and reaches greatest brilliancy for the second time this year on the 24th.

Mars on the 15th is in R.A. 8 h 52 m, Decl. 18° 47′ N., and transits at 13 h 20 m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 18 h 04 m, Decl. 23° 18′ S., mag. −2.2, and transits at 22 h 27 m. In Sagittarius, it is visible low in the south-east just after sunset and is prominent in the southern sky until nearly dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 70.

Saturn on the 15th is in R.A. 4 h 58 m, Decl. 21° 08′ N., mag. +0.3, and transits at 9 h 24 m. In Taurus, it rises two or three hours before the sun.

Uranus on the 15th is in R.A. 12 h 54 m, Decl. 5° 06′ S., and transits at 17 h 19 m.

Neptune on the 15th is in R.A. 16 h 04 m, Decl. 19° 04′ S., and transits at 20 h 28 m.

Pluto—For information in regard to this planet, see p. 31.

1972			JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1					41302	145.46[l]
Sun. 2				10 10	42013	157.67
Mon. 3	22	25	☾ Last Quarter		41203	169.88
Tues. 4					40123	182.10
Wed. 5			Earth at aphelion	7 00	4O*dd	194.33[b]
Thur. 6					4321O	206.56
Fri. 7	18		Moon at perigee (226,950 mi.)		34O12	218.80
Sat. 8			Mercury at descending node	3 50	31O42	231.05
	07		Saturn 5° S. of Moon			
	13		Venus 8° S. of Moon			
	21		Venus stationary			
Sun. 9					2O134	243.30
Mon. 10	14	39	● New Moon. Eclipse of ☉, p. 57		12O34	255.55
	18		Mercury greatest elong. E. (26°)			
Tues. 11			Mars greatest hel. lat. N.	0 40	O1234	267.80
Wed. 12	02		Mars 2° N. of Moon		1O324	280.06
	16		Mercury 1° N. of Moon			
Thur. 13				21 20	32O4d	292.31
Fri. 14					3O214	304.56[l]
Sat. 15			Venus at aphelion		31O42	316.80
Sun. 16				18 10	24O31	329.04
Mon. 17	09		Uranus 6° N. of Moon		412O3	341.28
Tues. 18	02	46	☽ First Quarter		4O123	353.51[b]
Wed. 19			Mercury at aphelion	15 00	41O23	5.73
	15		Moon at apogee (251,300 mi.)			
Thur. 20					423O1	17.95
Fri. 21	07		Neptune 6° N. of Moon		43O**	30.16
	18		Antares 0.7° S. of Moon. Occ'n.			
Sat. 22				11 50	431O2	42.36
Sun. 23	11		Jupiter 2° N. of Moon		42O1*	54.56
	21		Mercury stationary			
Mon. 24	04		Venus greatest brilliancy		214O3	66.76
Tues. 25				8 40	O1243	78.95
Wed. 26	02	24	○ Full Moon. Eclipse of ☾, p. 57		1O234	91.15
Thur. 27					23O14	103.34[l]
Fri. 28			δ Aquarid meteors	5 30	32O4*	115.53
Sat. 29	10		Mercury 6° S. of Mars		31O24	127.72
Sun. 30					2O14*	139.92
Mon. 31				2 20	21O34	152.12

Explanation of time on p. 10, of colongitude on p. 58.

[l]July 1, −5.64°; July 14, +5.84°; July 27, −4.99°.

[b]July 5, −6.76°; July 18, +6.84°.

THE SKY FOR AUGUST 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 8 h 45 m to 10 h 41 m and its Decl. changes from 18° 03′ N. to 8° 20′ N. The equation of time changes from −6 m 13 s to −0 m 09 s. 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 1st is in R.A. 9 h 25 m, Decl. 10° 17′ N., and on the 15th is in R.A. 8 h 50 m, Decl. 14° 05′ N. Inferior conjunction is on the 7th, but by the 25th it is in greatest western elongation, standing about 18° above the eastern horizon at sunrise. For a week or more at this time it may be seen as a morning star low in the east just before sunrise.

Venus on the 1st is in R.A. 5 h 45 m, Decl. 18° 35′ N.; and on the 15th it is in R.A. 6 h 30 m, Decl. 19° 20′ N., mag. −4.1, and transits at 8 h 56 m. A morning star, it rises about three hours before the sun and dominates the eastern sky until dawn.

Mars on the 15th is in R.A. 10 h 10 m, Decl. 12° 32′ N., and transits at 12 h 35 m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 17 h 54 m, Decl. 23° 22′ S., mag. −2.1, and transits at 20 h 16 m. In Sagittarius, it is approaching the meridian just after sunset and dominates the southern sky until about midnight when it sets. On the 25th 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. 71.

Saturn on the 15th is in R.A. 5 h 11 m, Decl. 21° 24′ N., mag. +0.4, and transits at 7 h 35 m. In Taurus, it rises about at midnight and is approaching the meridian at dawn.

Uranus on the 15th is in R.A. 12 h 58 m, Decl. 5° 30′ S., and transits at 15 h 21 m.

Neptune on the 15th is in R.A. 16 h 03 m, Decl. 19° 03′ S., and transits at 18 h 25 m.

Pluto—For information in regard to this planet, see p. 31.

1972			AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tues. 1					O2413	164.33[b]
Wed. 2	03	02	☾ Last Quarter	23 00	14O23	176.54
Thur. 3	10		Moon at perigee (229,500 mi.)		423O1	188.76
Fri. 4	19		Saturn 5° S. of Moon		4321O	200.99
Sat. 5	15		Venus 7° S. of Moon	19 50	43O2d	213.22
Sun. 6					43O1d	225.46
Mon. 7			Venus greatest hel. lat. S.		421O3	237.70
	15		Mercury in inferior conjunction			
Tues. 8			Mercury greatest hel. lat. S.	16 40	4O213	249.95
Wed. 9	00	26	● New Moon		41O23	262.19
Thur. 10					23O41	274.44[l]
Fri. 11	23		Perseid meteors	13 30	321O4	286.69
Sat. 12					3O124	298.93
Sun. 13	19		Uranus 6° N. of Moon		3O24*	311.17
Mon. 14	07		Neptune stationary	10 20	21O34	323.41
Tues. 15					O134*	335.64[b]
Wed. 16	10		Moon at apogee (251,200 mi.)		1O234	347.87
	20	09	☽ First Quarter			
Thur. 17			Mars at aphelion	7 10	23O14	0.09
	02		Mercury stationary			
	15		Neptune 6° N. of Moon			
Fri. 18	02		Antares 0.8° S. of Moon		321O4	12.30
Sat. 19	17		Jupiter 2° N. of Moon		34O12	24.50
Sun. 20				4 00	431O2	36.70
Mon. 21					421O3	48.90
Tues. 22					4O13*	61.09
Wed. 23				0 40	41O23	73.27[l]
Thur. 24	13	22	○ Full Moon		42O31	85.46
Fri. 25	03		Jupiter stationary	21 30	4321O	97.64
	10		Mercury greatest elong. W. (18°)			
Sat. 26	21		Venus greatest elong. W. (46°)		34O12	109.82
Sun. 27					31O2*	122.00
Mon. 28	15		Moon at perigee (228,550 mi.)	18 20	2O34d	134.18
Tues. 29					2O134	146.37[b]
Wed. 30					1O234	158.56
Thur. 31	07	48	☾ Last Quarter	15 10	2O314	170.76

Explanation of time on p. 10, of colongitude on p. 58.

[l]Aug. 10, +5.10°; Aug. 23, −5.41°.

[b]Aug. 1, −6.74°; Aug. 15, +6.78°; Aug. 29, −6.61°.

THE SKY FOR SEPTEMBER 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 10 h 41 m to 12 h 29 m and its Decl. changes from 8° 20′ N. to 3° 08′ S. The equation of time changes from +0 m 10 s to +10 m 10 s. For changes in the length of the day, see p. 17.

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. 24.

Mercury on the 1st is in R.A. 9 h 40 m, Decl. 14° 55′ N. and on the 15th is in R.A. 11 h 18 m, Decl. 6° 23′ N. It is too close to the sun for observation, superior conjunction being on the 19th.

Venus on the 1st is in R.A. 7 h 37 m, Decl. 18° 59′ N.; and on the 15th it is in R.A. 8 h 38 m, Decl. 17° 07′ N., mag. −3.8, and transits at 9 h 02 m. It dominates the eastern sky for nearly four hours before sunrise.

Mars on the 15th is in R.A. 11 h 24 m, Decl. 5° 00′ N. and transits at 11 h 47 m. It is too close to the sun for observation, conjunction being on the 7th.

Jupiter on the 15th is in R.A. 17 h 56 m, Decl. 23° 27′ S., mag. −1.9, and transits at 18 h 17 m. In Sagittarius, it is about on the meridian, low in the south at sunset, and sets before midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 5 h 18 m, Decl. 21° 30′ N., mag. +0.3, and transits at 5 h 40 m. In Taurus, it rises before midnight and is past the meridian at dawn.

Uranus on the 15th is in R.A. 13 h 04 m, Decl. 6° 08′ S., and transits at 13 h 25 m.

Neptune on the 15th is in R.A. 16 h 04 m, Decl. 19° 08′ S., and transits at 16 h 25 m.

Pluto—For information in regard to this planet, see p. 31.

1972			SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1			Mercury at perihelion		321O4	182.97
	04		Saturn 5° S. of Moon			
Sat. 2	08		Venus 9° S. of Pollux		3O214	195.18
	16		Pallas in conjunction			
Sun. 3	18		Venus 2° S. of Moon	12 00	31O24	207.40
Mon. 4	18		Mercury 1.1° N. of Regulus		24O13	219.63
Tues. 5					42O3*	231.86
Wed. 6				8 50	41O23	244.09[l]
Thur. 7	06		Mars in conjunction		4O13d	256.33
	12	28	● New Moon			
Fri. 8					4231O	268.56
Sat. 9				5 40	43O21	280.80
Sun. 10	06		Uranus 6° N. of Moon		431O2	293.03
Mon. 11			Mercury greatest hel. lat. N.		42O1*	305.26[b]
Tues. 12				2 20	241O3	317.49
Wed. 13	05		Moon at apogee (251,600 mi.)		O423d	329.71
	23		Neptune 6° N. of Moon			
Thur. 14			Jupiter at descending node	23 10	O1234	341.92
	10		Antares 1.0° S. of Moon			
Fri. 15	14	13	☽ First Quarter		231O4	354.13
Sat. 16	03		Jupiter 2° N. of Moon		3O214	6.34
Sun. 17				20 00	31O24	18.53
Mon. 18					23O14	30.72
Tues. 19	15		Mercury in superior conjunction		21O34	42.90
Wed. 20				16 50	O1423	55.08[l]
Thur. 21					4O23*	67.25
Fri. 22	17	33	Equinox. Autumn begins		4213O	79.42
	23	07	○ Full Moon. Harvest Moon			
Sat. 23				13 40	43O1*	91.58
Sun. 24	16		Pluto in conjunction		431O2	103.75
Mon. 25	02		Moon at perigee (225,350 mi.)		432O1	115.91[b]
Tues. 26				10 30	421O3	128.08
Wed. 27					4O123	140.25
Thur. 28	11		Saturn 4° S. of Moon		4O23*	152.43
Fri. 29	14	16	☾ Last Quarter	7 20	214Od	164.61
Sat. 30					32O14	176.80

Explanation of time on p. 10, of colongitude on p. 58.

[l]Sept. 6, +5.08°; Sept. 20, −6.39°. [b]Sept. 11, +6.66°; Sept. 25, −6.52°.

THE SKY FOR OCTOBER 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 12 h 29 m to 14 h 25 m and its Decl. changes from 3° 08′ S. to 14° 24′ S. The equation of time changes from +10 m 28 s to +16 m 23 s. For changes in the length of the day, see p. 17.

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. 24.

Mercury on the 1st is in R.A. 13 h 01 m, Decl. 6° 03′ S., and on the 15th is in R.A. 14 h 22 m, Decl. 15° 24′ S. It is too close to the sun for observation.

Venus on the 1st is in R.A. 9 h 49 m, Decl. 13° 05′ N.; and on the 15th it is in R.A. 10 h 52 m, Decl. 8° 07′ N., mag. −3.6, and transits at 9 h 17 m. It dominates the eastern sky for more than three hours before sunrise.

Mars on the 15th is in R.A. 12 h 35 m, Decl. 2° 48′ S., and transits at 10 h 59 m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 18 h 10 m, Decl. 23° 29′ S., mag. −1.7, and transits at 16 h 32 m. In Sagittarius, it is past the meridian at sunset and is to be seen low in the south-west for about three hours. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 5 h 19 m, Decl. 21° 27′ N., mag. +0.1, and transits at 3 h 43 m. In Taurus, it rises about three hours after sunset. On the 2nd it is stationary in R.A. and begins to retrograde, or move westward among the stars.

Uranus on the 15th is in R.A. 13 h 11 m, Decl. 6° 51′ S., and transits at 11 h 34 m. Conjunction is on the 11th.

Neptune on the 15th is in R.A. 16 h 07 m, Decl. 19° 17′ S., and transits at 14 h 30 m.

Pluto—For information in regard to this planet, see p. 31.

1972			OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1					31O24	188.99
Mon. 2			Venus at ascending node	4 00	32O14	201.19[l]
	13		Saturn stationary			
Tues. 3	13		Venus 3° N. of Moon		21O34	213.40
Wed. 4			Mercury at descending node		O1234	225.61
	14		Mercury 2° N. of Spica			
	18		Venus 0.3° S. of Regulus			
Thur. 5				0 50	1O234	237.83
Fri. 6					2O34d	250.05
Sat. 7	03	08	● New Moon	21 40	32O4*	262.27
Sun. 8	11		Mercury 5° N. of Moon		341O2	274.49[b]
Mon. 9					43O1d	286.70
Tues. 10	22		Moon at apogee (252,200 mi.)	18 30	421O*	298.92
Wed. 11	08		Neptune 5° N. of Moon		4O213	311.13
	17		Ceres in conjunction			
	18		Uranus in conjunction			
Thur. 12	14		Vesta stationary		41O23	323.34
Fri. 13	16		Jupiter 2° N. of Moon	15 20	42O13	335.54
Sat. 14					432O*	347.74
Sun. 15			Mercury at aphelion		341O2	359.93
	07	55	☽ First Quarter			
Mon. 16				12 10	3O421	12.11
Tues. 17					21O34	24.29
Wed. 18					O134*	36.46[l]
Thur. 19				9 00	1O234	48.62
Fri. 20					2O134	60.78
Sat. 21	01		Orionid meteors		231O4	72.93
Sun. 22	08	25	○ Full Moon. Hunter's Moon	5 50	31O24	85.08[b]
Mon. 23	07		Moon at perigee (222,600 mi.)		3O214	97.22
Tues. 24					213O4	109.37
Wed. 25	18		Saturn 4° S. of Moon	2 30	4O13*	121.52
Thur. 26					41O23	133.67
Fri. 27				23 20	42O13	145.83
Sat. 28	23	41	☾ Last Quarter		4231O	157.99
Sun. 29					43O12	170.16
Mon. 30				20 10	43O2*	182.34[l]
Tues. 31	07		Mars 0.2° N. of Uranus		4213O	194.52

Explanation of time on p. 10, of colongitude on p. 58.

[l]Oct. 2, +6.15°; Oct. 18, −7.39°; Oct. 30, +7.30°.

[b]Oct. 8, +6.56°; Oct. 22, −6.51°.

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 14 h 25 m to 16 h 29 m and its Decl. changes from 14° 24′ S. to 21° 47′ S. The equation of time changes from +16 m 24 s to a maximum of +16 m 25 s on the 2nd, and then to +11 m 10 s at the end of the month. For changes in the length of the day, see p. 18.

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. 25.

Mercury on the 1st is in R.A. 15 h 55 m, Decl. 23° 03′ S., and on the 15th is in R.A. 16 h 42 m, Decl. 24° 28′ S. On the 5th it is in greatest eastern elongation, but this is an unfavourable elongation, Mercury being less than 10° above the south-western horizon at sunset. On the 7th Mercury is occulted by the moon; this occultation is not visible in the Northern Hemisphere.

Venus on the 1st is in R.A. 12 h 07 m, Decl. 0° 53′ N.; and on the 15th it is in R.A. 13 h 10 m, Decl. 5° 29′ S., mag. −3.5, and transits at 9 h 34 m. It rises near the east point about two hours before the sun.

Mars on the 15th is in R.A. 13 h 50 m, Decl. 10° 38′ S., and transits at 10 h 13 m. A morning star in Virgo, it rises about two hours before the sun. Early in the month it passes a few degrees north of Spica.

Jupiter on the 15th is in R.A. 18 h 33 m, Decl. 23° 20′ S., mag. −1.5, and transits at 14 h 54 m. In Sagittarius it is low in the south-west at sunset and sets about two hours later. On the 10th Jupiter is occulted by the moon; this occultation is visible only in Antarctica. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 5 h 13 m, Decl. 21° 19′ N., mag. −0.1, and transits at 1 h 35 m. In Taurus, it rises about two hours after sunset.

Uranus on the 15th is in R.A. 13 h 18 m, Decl. 7° 33′ S., and transits at 9 h 39 m.

Neptune on the 15th is in R.A. 16 h 11 m, Decl. 19° 30′ S., and transits at 12 h 32 m. Conjunction is on the 26th.

Pluto—For information in regard to this planet, see p. 31.

1972			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 18 h E.S.T.	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1					42O13	206.71
Thur. 2	18		Venus 7° N. of Moon	17 00	1O423	218.90
Fri. 3	22		Mercury 4° S. of Neptune		O134d	231.10
Sat. 4			Mercury greatest hel. lat. S.		213O4	243.30[b]
	02		Uranus 6° N. of Moon			
	02		Mars 3° N. of Spica			
	06		Mars 6° N. of Moon			
			Taurid meteors			
Sun. 5			Venus at perihelion	13 50	3O124	255.50
	05		Mercury greatest elong. E. (23°)			
	20	21	● New Moon			
Mon. 6	18		Juno in conjunction		31O24	267.70
Tues. 7	08		Moon at apogee (252,600 mi.)		231O4	279.91
	16		Neptune 5° N. of Moon			
	23		Mercury 0.5° N. of Moon			
Wed. 8	07		Mercury 1.8° N. of Antares	10 40		292.11
Thur. 9						304.31
Fri. 10	08		Jupiter 0.9° N. of Moon			316.50
Sat. 11				7 30		328.69
Sun. 12						340.88
Mon. 13						353.06
Tues. 14	00	01	☽ First Quarter	4 20		5.23
Wed. 15	19		Mercury stationary			17.39[l]
Thur. 16	12		Venus 1.3° N. of Uranus			29.55
	19		Leonid meteors			
Fri. 17	18		Venus 4° N. of Spica	1 10		41.70
Sat. 18						53.85[b]
Sun. 19				21 50		65.98
Mon. 20	18	07	○ Full Moon			78.12
	19		Moon at perigee (221,500 mi.)			
Tues. 21						90.25
Wed. 22	02		Saturn 4° S. of Moon	18 40		102.38
Thur. 23			Mercury at ascending node			114.52
Fri. 24						126.65
Sat. 25	23		Mercury in inferior conjunction	15 30		138.79
Sun. 26			Venus greatest hel. lat. N.			150.94
	22		Neptune in conjunction			
Mon. 27	12	45	☾ Last Quarter			163.09[l]
Tues. 28			Mercury at perihelion	12 20		175.26
Wed. 29						187.42
Thur. 30	15		Vesta at opposition			199.59

Explanation of time on p. 10, of colongitude on p. 58.

[l]Nov. 15, −7.84°; Nov. 27, +7.77°. [b]Nov. 4, +6.60°; Nov. 18, −6.60°.

THE SKY FOR DECEMBER 1972

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

The times of transit at the 75th meridian are given in local mean time, 0 h 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 16 h 29 m to 18 h 45 m and its Decl. changes from 21° 47′ S. to 23° 02′ S. The equation of time changes from +10 m 48 s to −3 m 14 s, being zero on the 24th. For changes in the length of the day, see p. 18.

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. 25.

Mercury on the 1st is in R.A. 15 h 46 m, Decl. 17° 39′ S., and on the 15th is in R.A. 16 h 01 m, Decl. 18° 26′ S. On the 14th it is in greatest western elongation, standing about 15° above the south-eastern horizon at sunrise. Thus for about a week at mid-month it will be easily observed low in the south-east just before sunrise.

Venus on the 1st is in R.A. 14 h 25 m, Decl. 12° 28′ S.; and on the 15th it is in R.A. 15 h 33 m, Decl. 17° 38′ S., mag. −3.4, and transits at 9 h 59 m. It rises in the south-east about two hours before the sun.

Mars on the 15th is in R.A. 15 h 08 m, Decl. 17° 10′ S., and transits at 9 h 33 m. Moving into Libra, it rises about three hours before the sun, but is not prominent.

Jupiter on the 15th is in R.A. 19 h 01 m, Decl. 22° 52′ S., mag. −1.4, and transits at 13 h 23 m. In Sagittarius, it is very close to the south-western horizon at sunset, and at month's end it will be difficult to observe. On the 8th Jupiter is occulted by the moon. This occultation is not visible in the Northern Hemisphere. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 71.

Saturn on the 15th is in R.A. 5 h 03 m, Decl. 21° 08′ N., mag. −0.2, and transits at 23 h 23 m. In Taurus, it rises about at sunset (being in opposition on the 8th) and is visible all night.

Uranus on the 15th is in R.A. 13 h 23 m, Decl. 8° 05′ S., and transits at 7 h 46 m.

Neptune on the 15th is in R.A. 16 h 16 m, Decl. 19° 42′ S., and transits at 10 h 39 m.

Pluto—For information in regard to this planet, see p. 31.

1972			DECEMBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1	11		Uranus 6° N. of Moon	9 10		211.77[b]
Sat. 2						223.96
Sun. 3	01		Venus 7° N. of Moon			236.14
	01		Mars 5° N. of Moon			
	18		Venus 1.3° N. of Mars			
Mon. 4	07		Mercury 7° N. of Moon	6 00		248.33
	09		Moon at apogee (252,600 mi.)			
Tues. 5	10		Mercury stationary			260.52
	15	24	● New Moon			
Wed. 6						272.71
Thur. 7				2 50		284.90
Fri. 8			Mercury greatest hel. lat. N.			297.09
	01		Jupiter 0.3° N. of Moon			
	21		Saturn at opposition			
Sat. 9				23 40		309.28
Sun. 10						321.46
Mon. 11						333.64
Tues. 12				20 30		345.81
Wed. 13	13	36	☽ First Quarter			357.98[l]
	16		Geminid meteors			
Thur. 14	01		Mercury greatest elong. W. (21°)			10.14
Fri. 15				17 20		22.29
Sat. 16						34.44[b]
Sun. 17						46.57
Mon. 18	01		Mercury 0.2° N. of Neptune	14 10		58.71
Tues. 19	08		Moon at perigee (222,500 mi.)			70.83
	10		Saturn 4° S. of Moon			
Wed. 20	01		Uranus 3° N. of Spica			82.96
	04	45	○ Full Moon			
	05		Mercury 6° N. of Antares			
Thur. 21	13	13	Solstice. Winter begins	10 50		95.08
Fri. 22	09		Ursid meteors			107.21
Sat. 23	09		Venus 0.4° S. of Neptune			119.34
Sun. 24				7 40		131.47
Mon. 25	09		Venus 6° N. of Antares			143.61[l]
Tues. 26						155.75
Wed. 27	05	27	☾ Last Quarter	4 30		167.90
Thur. 28	19		Uranus 6° N. of Moon			180.06[b]
Fri. 29						192.22
Sat. 30				1 20		204.39
Sun. 31			Mercury at descending node			216.56
	17		Moon at apogee (252,200 mi.)			

Explanation of time on p. 10, of colongitude on p. 58.

[l]Dec. 13, −7.42°; Dec. 25, +7.32°.

[b]Dec. 1, +6.73°; Dec. 16, −6.73°; Dec. 28, +6.83°.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1972

For 0h U.T.

Date		P	B_0	L_0	Date		P	B_0	L_0
		°	°	°			°	°	°
Jan.	1	+ 2.45	−2.98	352.05	July	4	− 1.28	+3.25	70.37
	6	+ 0.02	−3.55	286.20		9	+ 0.99	+3.78	4.19
	11	− 2.39	−4.10	220.36		14	+ 3.23	+4.28	298.03
	16	− 4.77	−4.61	154.52		19	+ 5.44	+4.75	231.87
	21	− 7.08	−5.09	88.69		24	+ 7.59	+5.19	165.71
	26	− 9.31	−5.53	22.85		29	+ 9.67	+5.60	99.57
	31	−11.45	−5.92	317.02	Aug.	3	+11.67	+5.96	33.44
Feb.	5	−13.48	−6.27	251.19		8	+13.58	+6.28	327.33
	10	−15.38	−6.57	185.36		13	+15.38	+6.57	261.23
	15	−17.16	−6.81	119.52		18	+17.07	+6.80	195.14
	20	−18.79	−7.00	53.68		23	+18.64	+6.99	129.06
	25	−20.28	−7.14	347.83		28	+20.08	+7.13	62.99
Mar.	1	−21.62	−7.22	281.97	Sept.	2	+21.39	+7.21	356.94
	6	−22.80	−7.25	216.10		7	+22.56	+7.25	290.91
	11	−23.81	−7.22	150.22		12	+23.58	+7.23	224.89
	16	−24.66	−7.14	84.32		17	+24.45	+7.16	158.88
	21	−25.34	−7.00	18.41		22	+25.17	+7.04	92.87
	26	−25.85	−6.81	312.47		27	+25.72	+6.87	26.88
	31	−26.18	−6.57	246.52	Oct.	2	+26.10	+6.65	320.90
Apr.	5	−26.33	−6.28	180.55		7	+26.30	+6.37	254.93
	10	−26.30	−5.94	114.56		12	+26.33	+6.05	188.97
	15	−26.09	−5.57	48.55		17	+26.17	+5.68	123.02
	20	−25.69	−5.15	342.52		22	+25.81	+5.27	57.07
	25	−25.11	−4.70	276.47		27	+25.27	+4.82	351.13
	30	−24.34	−4.22	210.40	Nov.	1	+24.53	+4.33	285.19
May	5	−23.40	−3.70	144.31		6	+23.59	+3.80	219.27
	10	−22.28	−3.17	78.20		11	+22.46	+3.25	153.35
	15	−20.98	−2.61	12.08		16	+21.13	+2.67	87.43
	20	−19.52	−2.03	305.94		21	+19.62	+2.07	21.52
	25	−17.91	−1.44	239.79		26	+17.93	+1.45	315.62
	30	−16.16	−0.84	173.63	Dec.	1	+16.08	+0.82	249.72
June	4	−14.28	−0.24	107.46		6	+14.08	+0.18	183.84
	9	−12.29	+0.36	41.28		11	+11.93	−0.46	117.96
	14	−10.20	+0.96	335.11		16	+ 9.70	−1.10	52.08
	19	− 8.03	+1.56	268.92		21	+ 7.38	−1.73	346.21
	24	− 5.81	+2.14	202.74		26	+ 4.99	−2.35	280.34
	29	− 3.56	+2.71	136.55		31	+ 2.57	−2.95	214.49

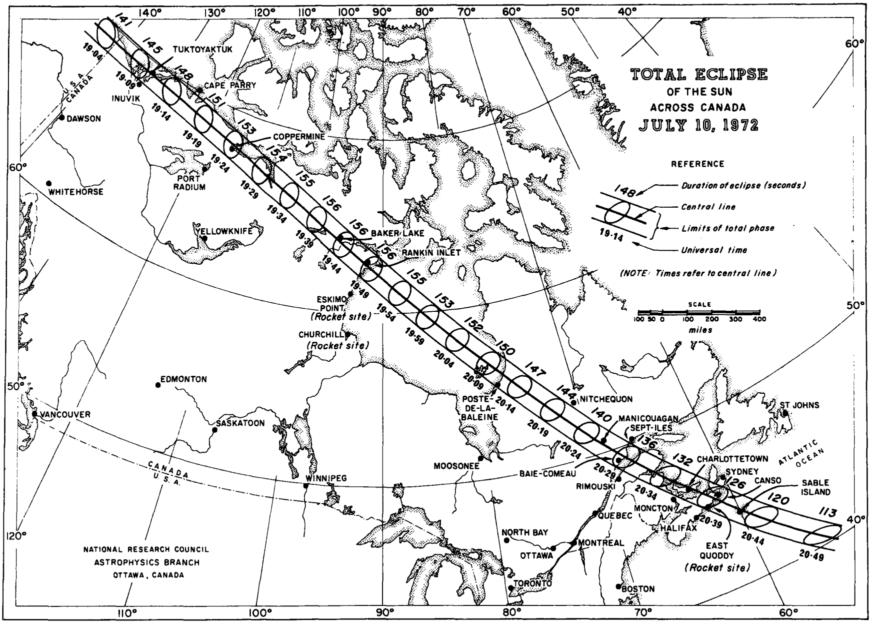
P—The position angle of the axis of rotation, measured eastward from the north point of the disk.

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 Synodic Rotations, 1972

No.	Commences	No.	Commences	No.	Commences
1584	Jan. 27.74	1589	June 12.12	1594	Oct. 26.33
1585	Feb. 24.08	1590	July 9.32	1595	Nov. 22.63
1586	Mar. 22.40	1591	Aug. 5.53	1596	Dec. 19.95
1587	Apr. 18.68	1592	Sept. 1.77		
1588	May 15.91	1593	Sept. 29.04		



In 1972 there will be four eclipses, two of the sun and two of the moon.

1. *An annular eclipse of the sun* on January 16, visible in Antarctica and the southern tip of South America, but not at all in North America.

2. *A total eclipse of the moon* on the night of January 29–30, visible in North America.

Moon enters penumbra	Jan. 30, 3.02 E.S.T.
Moon enters umbra	4.11 E.S.T.
Total eclipse begins	5.35 E.S.T.
Middle of eclipse	5.53 E.S.T.
Total eclipse ends	6.11 E.S.T.
Moon leaves umbra	7.35 E.S.T.
Moon leaves penumbra	8.45 E.S.T.

Magnitude of the eclipse 1.054.

3. *A total eclipse of the sun* on July 10, totality visible in a narrow band across northern Canada over the middle of Hudson Bay and across Quebec and northern Nova Scotia. Elsewhere in Canada and in the U.S.A. the eclipse will be partial. Further information about this eclipse is contained in the accompanying diagram.

4. *A partial eclipse of the moon* on the night of July 25–26, visible in North America.

Moon enters penumbra	July 25, 23.38 E.S.T.
Moon enters umbra	July 26, 0.55 E.S.T.
Middle of eclipse	2.16 E.S.T.
Moon leaves umbra	3.36 E.S.T.
Moon leaves penumbra	4.54 E.S.T.

Magnitude of the eclipse 0.548.

THE OBSERVATION OF THE MOON

During 1972 the ascending node of the moon's orbit moves from Capricornus into Sagittarius (☊ from 306 to 287°). See p. 59 for occultations of stars.

The sun's selenographic colongitude is essentially a convenient way of indicating the position of the sunrise terminator as it moves across the face of the moon. It provides an accurate method of recording the exact conditions of illumination (angle of illumination), and makes it possible to observe the moon under exactly the same lighting conditions at a later date.

The sun's selenographic colongitude is numerically equal to the selenographic longitude of the sunrise terminator reckoned eastward from the mean centre of the disk. Its value increases at the rate of nearly 12.2° per day or about $\frac{1}{2}$° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 0 h U.T. starting on p. 33.)

Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic longitude of the point. The longitude of the sunset terminator differs by 180° from that of the sunrise terminator.

The sun's selenographic latitude varies between $+1\frac{1}{2}$° and $-1\frac{1}{2}$° during the year.

By the moon's libration is meant the shifting, or rather apparent shifting, of the visible disk. Sometimes the observer sees features farther around the eastern or the western limb (libration in longitude), or the northern or southern limb (libration in latitude). The quantities called the earth's selenographic longitude and latitude are a convenient way of indicating the two librations. When the libration in longitude, that is the selenographic longitude of the earth, is positive, the mean central point of the disk of the moon is displaced eastward on the celestial sphere, exposing to view a region on the west limb. When the libration in latitude, or the selenographic latitude of the earth, is positive, the mean central point of the disk of the moon is displaced towards the south, and a region on the north limb is exposed to view.

In the Astronomical Phenomena Month by Month the dates of the greatest positive and negative values of the libration in longitude are indicated by ^{l} in the column headed "Sun's Selenographic Colongitude," and their values are given in the footnotes. Similarly the extreme values of the libration in latitude are indicated by ^{b}.

Two areas suspected of showing changes are Alphonsus and Aristarchus.

OCCULTATIONS BY THE MOON

The moon often passes between the earth and a star; the phenomenon is called an occultation. During an occultation a star suddenly disappears as the east limb of the moon crosses the line between the star and observer. This is referred to as immersion (I). The reappearance from behind the west limb of the moon is called emersion (E). Because the moon moves through an angle about equal to its own diameter every hour, the longest time for an occultation is about an hour. The time can be shorter if the occultation is not central. Occultations are equivalent to total solar eclipses, except that they are total eclipses of stars other than the sun.

The elongation of the moon is its angular distance from the sun, in degrees, counted eastward around the sky. Thus, elongations of 0°, 90°, 180° and 270° correspond to new, first quarter, full and last quarter moon. When elongation is less than 180°, a star will disappear at the dark limb and reappear at the bright limb. If the elongation is greater than 180° the reverse is true.

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, are adapted from data supplied by the British Nautical Almanac Office and give the times of immersion or emersion or both for occultations visible from six stations distributed across Canada. Stars of magnitude 7.5 or brighter are included as well as daytime occultations of very bright stars and planets. Since an occultation at the bright limb of the moon is difficult to observe the predictions are limited to phenomena occurring at the dark limb.

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 λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have: Standard Time of phenomenon = 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. This formula must be evaluated with due regard for the algebraic signs of the terms. The quantity P is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

Since observing occultations is rather easy, provided the weather is good and the equipment is available, timing occultations should be part of any amateur's observing program. The method of timing is as follows: Using as large a telescope as is available, with a medium power eyepiece, the observer starts a stopwatch at the time of immersion or emersion. The watch is stopped again on a time signal from a WWV or CHU station. The elapsed time is read from the stopwatch and is then subtracted from the standard time signal to obtain the time of occultation. All times should be recorded to 0.1 second and all timing errors should be held to within 0.5 second if possible. The position angle P of the point of contact on the moon's disk reckoned from the north point towards the east may also be estimated.

The following information should be included: (1) Description of the star (catalogue number), (2) Date, (3) Derived time of the occultation, (4) Longitude and latitude to nearest second of arc, height above sea level to the nearest 100 feet, (5) Seeing conditions, (6) Stellar magnitude, (7) Immersion or emersion, (8) At dark or light limb; Presence or absence of earthshine, (9) Method used, (10) Estimate of accuracy, (11) Anomalous appearance: gradual disappearance, pausing on the limb. All occultation data should be sent to the world clearing house for occultation data: H.M. Nautical Almanac Office, Royal Greenwich Observatory, Herstmonceux Castle, Hailsham, Sussex, England.

The co-ordinates of the standard stations are: Halifax, λ_0 63° 36.0′, ϕ_0 +44° 38.0′; Montreal, λ_0 73° 34.5′, ϕ_0 +45° 30.3′; Toronto, λ_0 79° 24.0′, ϕ_0 +43° 39.8′; Winnipeg, λ_0 97° 06.0′, ϕ_0 +49° 55.0′; Edmonton, λ_0 113° 04.5′, ϕ_0 +53° 32.0′; Vancouver, λ_0 123° 06.0′, ϕ_0 +49° 30.0′.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1972

Date	Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Halifax				Montreal			
						A.S.T.	a	b	P	E.S.T.	a	b	P
					°	h m	m	m	°	h m	m	m	°
Jan. 11	−23° 12133	2174	6.4	E	301	Sun				5 25.4	−1.9	+1.5	257
19	255 B. Aqr	3366	6.6	I	45	Low				19 30.3	+0.1	+2.4	2
21	136 B. Psc	89	6.5	I	72	21 05.2	−0.7	−0.9	76	19 56.2	−1.0	−0.5	69
23	26 Ari	370	6.1	I	98	20 56.6	−1.6	−2.5	116	19 37 3	−1.9	−1.5	106
23/4	+19° 389	387	6.9	I	100	0 24.4	−0.4	−0.3	53	23 19.3	−0.6	−0.4	58
26	+25° 731	717	7.5	I	128	Low				2 30.0	−0.1	−0.9	74
26	+26° 884	849	6.5	I	139	23 23.0	−2.1	+1.3	49	22 03.6	−2.0	+1.4	54
27/8	ε Gem	1030	3.2	I	152	1 20.1			36	23 55.6	−2.2	+0.9	57
28	ε Gem	1030	3.2	E	152	1 41.5			0	0 42.4	−0.1	−3.5	338
Feb. 4	21 q Vir	1800	5.4	E	237	5 13.8			4	4 07.7	−0.7	−2.0	345
17	45 Psc	51	7.2	I	41	Low				20 01.2	−0.3	+0.5	31
20	161 B. Ari	470	7.0	I	81	20 25.4	−1.3	0.0	60	19 11.6	−1.5	+0.4	58
21	χ Tau	647	5.5	I	96	23 45.2	−0.6	−0.6	63	22 38.1	−0.7	−0.8	73
24	58 Gem	1118	6.0	I	134	23 52.8	−0.9	−2.0	124	22 41.9	−0.9	−2.3	136
Mar. 2	370 B. Vir	1852	6.0	E	215	23 09.1	−1.0	+0.8	288	22 01.1	−0.8	+1.2	278
3	−11° 3398	1858	6.5	E	216	1 18.1	−1.4	−0.4	304	0 04.0	−1.4	+0.4	290
8	95 G. Oph	2470	6.1	E	272	5 11.6			205	No occ.			
18	134 B. Ari	438	6.7	I	51	21 39.3	0.0	−1.0	78	20 37.4	−0.2	−1.2	85
19	+24° 599	587	6.4	I	64	20 13.6	−0.4	−2.7	127	19 05.6	−0.7	−3.2	133
22	ω Gem	1070	5.2	I	103	19 50.3	−2.4	+1.3	61	18 29.1	−2.1	+1.4	67
24/5	o^2 Cnc	1337	5.6	I	129	0 37.9	−0.3	−2.2	141	23 32.7	−0.3	−2.6	154
Apr. 5	4 G. Sgr	2558	6.2	E	253	4 38.5			322	3 21.1	−1.4	−0.3	320
16	+24° 674	703	6.3	I	46	20 50.5	+0.5	−2.6	142	19 54.3	+0.9	−4.2	158
17	+25° 941	867	6.9	I	59	20 58.8			175	No occ.			
17	+25° 978	877	6.6	I	60	22 06.9	0.0	−1.3	94	21 05.0	−0.1	−1.6	104
18	87 B. Gem	1050	5.8	I	74	23 31.1	+0.7	−2.2	153	22 36.6	+0.9	−2.9	167
19	+21° 1679	1174	7.5	I	86	21 40.5	−0.6	−1.8	114	20 31.9	−0.7	−2.0	126
21	15 B. Leo	1399	6.9	I	109	21 13.9	−0.8	−2.3	147	20 04.5	−0.6	−2.8	163
26	21 q Vir	1800	5.4	I	156	2 01.1			50	0 40.6			63
30	α Sco	2366	1.2	E	210	22 37.2	−1.1	+1.5	265	Low			
30	116 B. Sco	2373	6.2	E	210	23 48.1	−1.6	+1.1	268	Low			
May 17	20 d^1 Cnc	1259	5.9	I	67	No occ.				21 18.4			45
19	+8° 2316	1478	7.2	I	92	23 19.7	−0.3	−1.8	114	22 14.1	−0.5	−1.9	121
30	127 G. Sgr	2767	6.4	E	214	23 51.8	−1.7	+2.1	223	Low			
30/1	172 B. Sgr	2771	5.7	E	214	1 11.3	−1.8	+1.4	228	23 55.4	−1.7	+1.8	228
June 16	32 Sex	1546	7.2	I	72	21 30.1	−0.6	−1.7	104	Sun			
23/4	48 B. Sco	2298	5.1	I	151	0 04.2	−1.7	−1.1	102	22 45.0	−1.9	−0.7	100
July 21	α Sco	2366	1.2	I	129	17 59.4	−1.4	+1.2	90	16 49.4	−0.8	+1.1	101
21	α Sco	2366	1.2	E	129	19 18.7	−1.5	+0.2	297	18 05.2	−1.3	+0.7	288
Aug. 19	−26° 12724	2605	7.1	I	121	21 29.3	−1.2	+0.7	34	20 17.7			21
20	162 B. Sgr	2761	6.6	I	133	21 07.7	−2.1	−0.1	96	19 48.1	−1.9	+0.5	90
29	ε Ari	440	4.6	E	249	22 20.7	−0.6	0.0	317	No occ.			
30/1	36 Tau	598	5.7	E	263	0 07.0	+0.2	+1.8	237	23 10.3	+0.2	+1.5	249
Sept. 13	2 A Sco	2268	4.8	I	68	19 11.3	−1.6	−1.5	107	Sun			
14	−26° 11533	2409	6.8	I	79	18 58.0	−1.9	−1.1	108	Sun			
18	26 B. Cap	2977	6.9	I	125	No occ.				20 48.7			122
18	−19° 5830	2993	6.6	I	126	Low				23 51.7	−0.8	−0.7	68
18	o Cap	2994	6.1	I	126	Low				23 52.5	−0.8	−0.7	68
19	−14° 5997	3120	7.0	I	138	23 57.4	−1.0	−0.1	57	22 48.1	−0.9	+0.6	40
21	θ Aqr	3269	4.3	I	152	Low				2 06.6	−0.7	−0.9	77
25	μ Ari	399	5.7	E	218	22 48.9	−0.7	+1.5	257	21 44.0	−0.5	+1.3	271
26/7	104 B. Tau	556	5.5	E	233	0 20.1	−0.3	+2.4	220	23 18.6	−0.3	+2.0	236
27	+23° 563	564	6.1	E	233	1 12.7	−1.2	+1.3	258	0 02.5	−1.1	+1.1	274
Oct. 1	85 Gem	1193	5.4	E	286	1 26.2	+0.2	+1.8	253	Low			
1	217 B. Gem	1205	6.3	E	287	3 53.1	−1.0	+0.5	293	2 44.6	−0.8	+0.4	301
2	o^1Cnc	1336	5.2	E	300	Sun				4 20.9	−1.0	−0.5	319
16	94 B. Cap	3064	6.0	I	106	Low				22 07.3	−1.3	−1.3	90
17	λ Cap	3188	5.4	I	117	No occ.				21 09.5			117
18	186 B. Aqr	3308	6.2	I	129	18 23.6	−1.9	+0.6	111	Sun			
18	−7° 5805	3311	7.0	I	129	No occ.				18 05.8			130
20	+1° 4744	3482	5.6	I	146	Low				2 14.1	−0.4	+0.2	41
24	62 Tau	652	6.4	E	214	22 03.5	−0.2	+2.1	231	21 03.8	−0.1	+1.7	246
25	+24° 674	703	6.3	E	217	5 18.2			338	4 08.3			330
25	118 Tau	822	5.9	E	228	21 52.4	−0.6	+0.4	305	20 46.1	−0.8	−0.4	326
27	+23° 1491	1036	6.5	E	244	4 04.2	−2.0	+1.9	239	2 47.7	−1.6	+2.2	240
28	79 Gem	1171	6.3	E	257	3 32.2	−1.8	+4.0	228	2 20.8	−1.2	+3.4	233
30	ξ Leo	1409	5.1	E	282	3 47.8	−1.4	+3.7	238	2 40.1	−0.8	+3.4	240
31	155 B. Leo	1519	6.5	E	295	Sun				4 54.3	−1.5	+1.5	266

Date	Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Halifax A.S.T.	Halifax a	Halifax b	Halifax P	Montreal E.S.T.	Montreal a	Montreal b	Montreal P
					°	h m	m	m	°	h m	m	m	°
Nov. 13	18 Aqr	3131	5.5	I	85	20 21.4	−0.1	+1.6	11	No occ.			
14	36 Aqr	3247	7.0	I	96	18 02.6			346	No occ.			
16	+3° 4909	3524	6.9	I	124	22 47.9	−0.7	+1.6	21	21 44.9	−0.2	+3.1	1
17	136 B. Psc	89	6.5	I	135	17 21.1	+0.4	+3.1	359	No occ.			
22	5 Gem	936	5.9	E	210	23 54.9	−1.4	+0.8	274	22 43.3	−1.1	+0.7	283
23/4	δ Gem	1110	·3.5	I	224	1 06.1	−1.4	+2.6	58	23 57.0	−0.9	+3.2	51
24	δ Gem	1110	3.5	E	224	1 59.2	−1.4	−2.2	329	0 42.8	−1.5	−2.1	332
24	149 B. Gem	1125	6.4	E	226	Graze				4 18.6	−0.3	−3.8	346
24	63 Gem	1129	5.3	E	226	Graze				4 49.7	−0.2	−3.5	344
25	25 d²Cnc	1262	6.2	E	239	Sun				5 06.2	−2.1	−0.1	260
27	π Leo	1468	4.9	E	262	0 15.2	−0.1	+2.3	250	Low			
Dec. 13	+1° 4744	3482	5.6	I	92	21 09.3	−2.0	−3.1	115	19 48.4	−1.9	−1.2	94
14	45 Psc	51	7.2	I	105	Graze				19 00.3	−2.4	−0.7	101
16	+17° 339	336	7.4	I	132	20 48.2	−1.8	+0.1	86	19 32.0	−1.5	+1.0	72
17/8	66 Ari	501	6.1	I	148	1 08.1	−1.1	−0.6	75	23 55.4	−1.3	−0.4	76
23	o Leo	1428	3.8	I	231	23 45.7			181	22 36.8	−0.6	−2.9	175
23/4	o Leo	1428	3.8	E	231	0 13.9			230	23 07.0	−0.8	+4.3	231

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1972

Date	Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Toronto E.S.T.	Toronto a	Toronto b	Toronto P	Winnipeg C.S.T.	Winnipeg a	Winnipeg b	Winnipeg P
					°	h m	m	m	°	h m	m	m	°
Jan. 6	388 B. Leo	1662	6.3	E	247	Sun				6 53.7	−1.6	−1.2	275
11	−23° 12133	2174	6.4	E	301	5 09.6	−2.4	+2.8	238	Low			
12	65 B. Sco	2312	5.6	E	313	6 25.2	−1.2	+0.7	288	Low			
19	255 B. Aqr	3366	6.6	I	45	19 26.6	0.0	+2.1	6	No occ.			
21	136 B. Psc	89	6.5	I	72	19 50.8	−1.2	−0.5	72	18 32.7	−0.9	+1.1	36
23	26 Ari	370	6.1	I	98	19 28.0	−2.2	−1.5	109	17 56.7	−1.3	+1.1	67
23	+19° 389	387	6.9	I	100	23 16.6	−0.7	−0.6	68	21 58.1	−1.1	+0.1	53
25	16 Tau	536	5.4	I	115	Low				1 27.1	−0.3	−0.9	69
25	17 Tau	537	3.8	I	115	Low				1 28.5	0.0	−1.8	108
25	19 q Tau	539	4.4	I	115	Low				1 54.1	−1.1	+1.4	20
25	20 Tau	541	4.0	I	115	Low				1 55.1	−0.3	−0.6	55
25	+23° 523	546	7.0	I	115	Low				2 05.3	0.0	−1.2	83
25	η Tau	552	3.0	I	115	Low				2 32.6	+0.4	−1.9	120
25	+23° 540	553	6.8	I	115	Low				2 29.6	+0.1	−1.1	79
25	105 B. Tau	557	6.6	I	116	Low				2 53.5	+0.1	−0.9	70
26	+25° 731	717	7.5	I	128	2 31.3	−0.1	−1.1	85	1 17.6	−0.5	−1.4	90
26	+26° 884	849	6.5	I	139	21 49.9	−2.0	+1.1	65	20 34.5	−1.2	+3.7	34
27	ε Gem	1030	3.2	I	152	23 42.2	−2.1	+0.2	73	22 12.9	−1.8	+1.6	62
27/8	ε Gem	1030	3.2	E	152	0 45.4	−0.7	−2.7	321	23 12.3	−1.2	−2.4	322
Feb. 4	21 q Vir	1800	5.4	E	237	4 05.9	−1.1	−1.6	331	2 40.7	−1.0	−0.4	315
16	+0° 5009	3462	7.5	I	27	18 48.3	−0.3	+0.4	38	Sun			
17	45 Psc	51	7.2	I	41	19.58.5	−0.4	+0.3	39	18 57.0	−0.4	+2.2	6
20	161 B. Ari	470	7.0	I	81	19 01.8	−1.6	+0.4	64	Sun			
21	χ Tau	647	5.5	I	96	22 35.3	−0.8	−1.1	84	21 10.6	−1.3	−0.6	78
23	+25° 879	842	6.3	I	112	Low				2 32.2	+0.3	−1.5	109
24	52 B. Gem	1015	6.4	I	124	Low				3 06.5	+0.5	−2.0	141
24	+24° 1332	1019	6.7	I	124	Low				3 40.5	+1.2	−2.8	172
24	+24° 1343	1023	6.5	I	125	Low				3 47.1	+0.4	−1.5	111
24	58 Gem	1118	6.0	I	134	22 41.4	−0.8	−3.0	151	21 05.7	−1.2	−2.3	147
26	θ Cnc	1275	5.6	I	149	Low				4 29.6	−0.1	−1.5	87
Mar. 2	−11° 3398	1858	6.5	E	216	23 54.2	−1.5	+1.0	276	Low			
18	134 B. Ari	438	6.7	I	51	20 38.5	−0.3	−1.5	96	19 20.3	−0.8	−1.2	87
19	+24° 599	587	6.4	I	64	19 09.2	.	.	150	Sun			
22	+25° 1225	966	7.2	I	94	Low				1 36.4	+0.1	−1.0	69
24	o²Cnc	1337	5.6	I	129	23 37.0	0.0	−3.1	169	Graze			
Apr. 3	48 B. Sco	2298	5.1	E	231	Sun				3 33.2	−1.5	−0.4	311
5	4 G. Sgr	2558	6.2	E	253	3 13.5	−1.3	0.0	312	Low			
7	53 Sgr	2872	6.2	E	276	4 05.9	.	.	199	Low			
7	274 B. Sgr	2875	6.1	E	276	4 11.0	.	.	190	Low			
15	9 Tau	521	6.7	I	32	20 48.0	+1.0	−3.1	147	Sun			

Date		Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Toronto				Winnipeg			
							E.S.T.	a	b	P	C.S.T.	a	b	P
						°	h m	m	m	°	h m	m	m	°
Apr.	17	+25° 978	877	6.6	I	60	21 07.2	−0.1	−1.8	115	Sun			
	19	+21° 1679	1174	7.5	I	86	20 31.7	−0.7	−2.4	139	Sun			
	21	52 Cnc	1324	7.2	I	100	Low				1 21.7	0.0	−1.4	82
	21	15 B. Leo	1399	6.9	I	109	20 09.1			183	Sun			
	25/6	21 q Vir	1800	5.4	I	156	0 28.3	−2.4	−0.7	75	22 45.9	−2.0	−0.1	94
May	16	+21° 1630	1143	6.8	I	56	Low				22 26.3	+0.3	−1.7	126
	17	20 d¹ Cnc	1259	5.9	I	67	21 10.8	−1.2	−0.7	64	Sun			
	19	+8° 2316	1478	7.2	I	92	22 14.6	−0.6	−2.0	129	Sun			
	28	α Sco	2366	1.2	I	183	Low				3 24.6	−1.1	−1.2	83
	31	189 B. Sgr	2790	6.2	E	216	2 58.7			181	1 49.2	−1.5	+1.3	212
June	4	186 B. Aqr	3308	6.2	E	263	2 56.4	−1.3	+1.4	265	1 47.6	−0.7	+1.5	282
	18	RW Vir	1745	7.0	I	96	Low				22 34.1			57
	23	48 B. Sco	2298	5.1	I	151	22 34.4	−2.0	−0.4	103	21 03.01	−1.4	+0.4	108
	29	υ Cap	3017	5.3	E	209	Sun				2 32.2	−1.6	+0.3	255
July	1	ρ Aqr	3278	5.4	E	234	3 38.7	−1.1	+1.5	212	2 24.8	−1.3	+1.3	244
	6	μ Ari	399	5.7	E	299	3 06.0	+0.4	+2.4	202	2 22.7	+0.2	+1.7	231
	7	23 Tau	545	4.2	I	313	3 45.5	+0.6	+2.5	22	No occ.			
	21	α Sco	2366	1.2	E	129	17 56.3	−1.2	+1.0	278	Low			
	29	λ Psc	3494	4.6	E	228	No occ.				23 05.0	0.0	+2.6	181
Aug.	3	66 Ari	501	6.1	E	282	3 38.9			183	2 56.8	−0.2	+2.0	231
	18	93 G. Oph	2468	6.9	I	111	22 02.0	−1.9	−1.6	115	20 23.6	−1.8	−0.4	97
	19	−26° 12724	2605	7.1	I	121	20 05.4			22	Sun			
	20	172 B. Sgr	2771	5.7	I	134	No occ.				20 52.8	−2.0	−0.2	125
	30	36 Tau	598	5.7	E	263	23 09.2	+0.3	+1.4	252	Low			
Sept.	18	26 B. Cap	2977	6.9	I	125	20 33.7	−2.7	−0.6	114	Sun			
	18	−19° 5830	2993	6.6	I	126	23 47.9	−0.9	−0.5	64	22 35.4	−0.5	+0.7	24
	18	o Cap	2994	6.1	I	126	23 48.7	−0.9	−0.5	64	22 36.3	−0.5	+0.7	24
	19	−14° 5997	3120	7.0	I	138	22 41.4	−0.9	+0.9	34	No occ.			
	21	θ Aqr	3269	4.3	I	152	2 03.6	−0.9	−0.8	76	0 48.0	−0.7	+0.5	37
	25	μ Ari	399	5.7	E	218	21 38.9	−0.4	+1.2	275	20 38.7	−0.4	+0.7	308
	26	ε Ari	440	4.6	E	222	Sun				4 58.4	−1.3	−0.4	258
	26	104 B. Tau	556	5.5	E	233	23 13.6	−0.2	+1.8	239	22 19.9	−0.1	+1.4	270
	26	+23° 563	564	6.1	E	233	23 54.7	−1.0	+1.0	277	22 38.0			331
	28	98 k Tau	743	5.6	E	248	No occ.				0 48.1	−0.3	+2.1	237
	30	44 Gem	1078	5.9	E	275	No occ.				2 16.3	0.0	+3.2	225
Oct.	1	217 B. Gem	1205	6.3	E	287	2 39.7	−0.6	+0.5	299	1 29.4	−0.7	−1.1	341
	2	o¹ Cnc	1336	5.2	E	300	4 16.3	−0.8	−0.2	313	2 58.8	−0.8	−2.3	351
	13	67 B. Sgr	2652	6.4	I	71	19 53.4	−1.3	−1.0	82	18 27.7	−1.3	−0.1	53
	16	94 B. Cap	3064	6.0	I	106	22 01.4	−1.5	−1.0	86	20 37.5	−1.1	+0.4	46
	17	λ Cap	3188	5.4	I	117	20 55.6	−2.8	−1.2	108	19 21.9	−1.4	+0.9	68
	17	129 G. Cap	3205	6.8	I	119	No occ.				23 44.9	−1.8	−3.1	117
	18	96 B. Aqr	3208	6.5	I	119	Low				0 02.5	−0.8	−1.0	78
	20	+1° 4744	3482	5.6	I	146	2 11.2	−0.5	+0.2	45	1 09.3	−0.2	+2.3	4
	24	62 Tau	652	6.4	E	214	21 00.5	0.0	+1.6	249	20 09.5	+0.1	+1.2	278
	25	+24° 674	703	6.3	E	217	4 08.2	−1.4	−3.0	315	No occ.			
	27	+23° 1491	1036	6.5	E	244	2 34.2	−1.4	+2.8	233	1 27.2	−0.9	+1.4	265
	28	79 Gem	1171	6.3	E	257	2 08.2	−0.7	+4.2	224	1 13.4	−0.5	+1.7	262
	30	ξ Leo	1409	5.1	E	282	2 29.3	−0.4	+4.6	228	1 41.8	−0.1	+1.7	265
	31	155 B. Leo	1519	6.5	E	295	4 41.8	−1.5	+2.5	252	3 37.8	−0.6	+1.7	269
Nov.	1	69 p⁵ Leo	1623	5.4	E	308	Sun				6 18.3	−0.6	−1.1	336
	12	−17° 6039	3011	7.0	I	74	20 51.5	+0.4	+1.8	8	No occ.			
	14	θ Aqr	3269	4.3	I	98	No occ.				19 26.2	−2.3	−0.8	106
	16	+3° 4909	3524	6.9	I	124	21 38.5	+0.1	+3.6	357	No occ.			
	22	5 Gem	936	5.9	E	210	22 35.8	−1.0	+0.8	282	21 22.5	−0.9	−0.3	324
	22	8 Gem	954	6.1	E	211	No occ.				23 25.2	−0.5	+3.2	221
	23	δ Gem	1110	3.5	I	224	23 47.0	−0.7	+2.7	56	No occ.			
	24	δ Gem	1110	3.5	E	224	0 37.3	−1.5	−1.4	324	No occ.			
	24	149 B. Gem	1125	6.4	E	226	4 20.4	−1.0	−2.7	329	2 45.2	−1.1	−2.7	336
	24	63 Gem	1129	5.3	E	226	4 51.9	−0.8	−2.6	327	3 18.8	−1.1	−2.3	329
	25	25 d²Cnc	1262	6.2	E	239	4 51.1	−2.9	+1.6	242	3 20.4	−1.9	+2.2	243
Dec.	10	−15° 5908	3100	6.4	I	55	No occ.				17 39.5	−2.3	−1.6	110
	11	−9° 5908	3233	7.2	I	68	Low				21 00.9	−1.1	−2.5	108
	13	+1° 4744	3482	5.6	I	92	19 38.5	−2.1	−0.7	91	18 12.6	−1.2	+1.2	49
	14	45 Psc	51	7.2	I	104	18 47.2	−2.3	−0.1	96	17 25.6	−1.0	+1.6	55
	16	+17° 339	336	7.4	I	132	19 21.5	−1.4	+1.3	68	18 18.7	−0.3	+2.4	30
	17	66 Ari	501	6.1	I	148	23 47.8	−1.5	−0.5	83	22 22.9	−1.3	+1.1	57
	23	54 Cnc	1323	6.3	E	218	0 34.8	−0.9	−3.1	349	No occ.			
	26	87 e Leo	1670	5.1	E	258	Sun				5 56.3	−2.2	+0.1	263
	28	−11° 3398	1858	6.5	E	280	2 56.8	+0.2	−1.9	352	Low			

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1972

Date	Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Edmonton M.S.T.	Edmonton a	Edmonton b	Edmonton P	Vancouver P.S.T.	Vancouver a	Vancouver b	Vancouver P
					°	h m	m	m	°	h m	m	m	°
Jan. 6	388 B. Leo	1662	6.3	E	247	5 20.4	−2.3	+0.3	254	No occ.			
8	370 B. Vir	1852	6.0	E	269	4 05.1	0.0	−1.4	352	3 05.2	−0.5	−0.3	325
8	−11° 3398	1858	6.5	E	270	6 00.5			15	5 07.9	−0.6	−1.3	341
20	22 Psc	3512	5.8	I	59	18 30.8			121	Sun			
23	+19° 389	387	6.9	I	100	20 42.2	−1.1	+1.2	38	19 25.6	−1.3	+1.3	46
24/5	16 Tau	536	5.4	I	115	0 15.7	−0.6	−1.0	73	23 13.1	−0.8	−1.4	92
24/5	17 Tau	537	3.8	I	115	0 18.6	−0.4	−2.1	112	23 25.6	−0.3	−3.5	136
24/5	19 q Tau	539	4.4	I	115	0 40.7	−1.0	+0.7	30	23 30.4	−1.0	−0.2	55
24/5	20 Tau	541	4.0	I	115	0 45.2	−0.6	−0.7	61	23 42.2	−0.7	−1.1	81
24/5	21 Tau	542	5.8	I	115	No occ.				23 57.4	−1.1	+0.6	36
24/5	22 Tau	543	6.5	I	115	Graze				23 57.5	−1.0	+0.1	45
25	+23° 523	546	7.0	I	115	0 57.6	−0.3	−1.4	88	0 00.5	−0.4	−1.9	108
25	+24° 562	548	6.7	I	115	1 29.2	−1.0	+1.0	23	0 20.0	−0.8	−0.3	52
25	η Tau	552	3.0	I	115	1 29.8	+0.2	−2.5	128	No occ.			
25	η Tau	552	3.0	E	115	2 11.4	−0.4	−0.4	223	No occ.			
25	+23° 540	553	6.8	I	115	1 23.8	−0.2	−1.4	85	0 27.6	−0.3	−1.8	105
25	105 B. Tau	557	6.6	I	116	1 49.1	−0.2	−1.2	77	0 52.7	−0.2	−1.6	96
25	27 Tau	560	3.8	I	116	2 23.8			163	No occ.			
25	28 Tau	561	5.2	I	116	2 10.6	+0.4	−2.3	128	Graze			
25	+23° 561	562	6.6	I	116	2 10.1	−0.1	−1.1	73	1 13.9	−0.2	−1.4	91
25/6	+25° 731	717	7.5	I	128	0 01.2	−0.9	−1.4	94	22 57.8	−1.1	−1.9	113
27	139 Tau	900	4.9	I	143	4 10.7	−0.2	−1.0	62	3 12.8	−0.3	−1.2	81
27	ε Gem	1030	3.2	I	152	20 57.9	−1.1	+3.1	47	19 36.8	−0.9	+2.4	60
27	ε Gem	1030	3.2	E	152	21 43.9	−1.3	−2.4	330	20 36.1	−1.5	−1.0	313
Feb. 2	69 p^5 Leo	1623	5.4	E	217	Sun				6 17.8	−1.0	−1.5	264
4	21 q Vir	1800	5.4	E	237	1 26.1	−0.8	+0.4	303	0 14.6	−0.9	+1.2	281
16	15 Psc	3477	6.6	I	28	18 46.6	−0.3	+0.2	35	Sun			
19	26 Ari	370	6.1	I	71	Low				22 53.8	−0.1	−0.7	63
21	χ Tau	647	5.5	I	96	19 48.1	−1.4	+0.2	70	18 32.1	−1.6	+0.3	82
23	+25° 879	842	6.3	I	112	1 29.7	+0.1	−1.9	119	0 40.2	+0.3	−2.5	140
23	125 Tau	852	5.0	I	112	2 43.0	+0.3	−1.5	106	1 52.8	+0.3	−1.8	122
24	52 B. Gem	1015	6.4	I	124	2 06.1	+0.5	−2.6	155	No occ.			
24	+24° 1343	1023	6.5	I	125	2 45.8	+0.2	−1.8	121	1 55.8	+0.3	−2.1	138
24	58 Gem	1118	6.0	I	134	19 39.0	−1.3	−1.0	138	18 31.7	−1.4	−2.2	155
26	θ Cnc	1275	5.6	I	149	3 20.3	−0.4	−1.7	97	2 23.1	−0.5	−1.8	112
Mar. 21/2	+25° 1225	966	7.2	I	94	0 31.0	−0.2	−1.3	80	23 34.7	−0.2	−1.5	97
22	34 B. Gem	977	6.6	I	95	Low				1 15.6	+0.1	−1.1	78
25	+15° 1984	1360	7.5	I	131	2 37.5	−0.4	−1.5	73	1 38.6	−0.6	−1.6	88
Apr. 3	65 B. Sco	2312	5.6	E	232	Sun				4 00.8	−2.0	+0.2	239
15	23 Tau	545	4.2	I	34	Low				21 05.1	−0.2	−0.2	43
16	+25° 746	733	7.2	I	49	22 43.1	+0.4	−1.4	105	21 53.3	+0.4	−1.8	122
20	217 B. Gem	1205	6.3	I	89	1 10.6	+0.3	−1.7	126	0 21.0	+0.3	−1.9	136
20/1	52 Cnc	1324	7.2	I	100	0 12.6	−0.4	−1.7	91	23 15.0	−0.5	−1.8	105
22	+11° 2087	1433	6.8	I	113	Low				1 29.3	+0.1	−1.9	134
22	43 Leo	1518	6.3	I	123	22 14.6			60	20 52.4	−2.0	−0.3	92
24	69 p^5 Leo	1623	5.4	I	136	Low				1 41.1	−0.5	−2.0	121
25	21 q Vir	1800	5.4	I	156	21 20.5	−1.3	+0.3	110	20 09.1	−0.9	−0.1	132
30	2 A Sco	2268	4.8	E	202	Sun				3 37.2	−1.7	−1.9	326
May 16	+21° 1630	1143	6.8	I	56	21 22.4	+0.1	−2.0	136	20 32.9	+0.3	−2.5	155
24	−13° 3665	1893	7.0	I	139	Low				0 17.6	−1.1	−1.7	112
28	α Sco	2366	1.2	I	183	2 01.3	−1.4	−0.6	72	0 46.7	−1.8	−0.1	75
28	α Sco	2366	1.2	E	183	3 14.9	−1.3	−1.5	293	2 05.7	−1.6	−1.2	294
June 28/9	υ Cap	3017	5.3	E	209	1 08.7	−1.5	+0.8	273	23 50.3	−1.4	+1.1	274
30/1	ρ Aqr	3278	5.4	E	234	1 11.4	−1.0	+1.5	260	23 56.1	−0.8	+1.6	262
July 1	170 B. Aqr	3285	6.1	E	235	Sun				1 58.4			299
21	88 G. Sco	2404	6.9	I	132	Low				21 31.7	−1.8	−0.3	85
31	136 B. Psc	89	6.5	E	243	Sun				1 56.4	−1.6	+0.9	278
Aug. 1	101 Psc	233	6.2	E	257	Sun				2 09.3	−0.3	+2.3	207
3	66 Ari	501	6.1	E	282	2 01.0	−0.1	+1.7	253	0 54.4	+0.1	+1.5	257
28	20 H^1 Ari	317	6.4	E	238	22 40.4			169	21 39.0	+0.9	+2.7	179
Sept. 4	20 d^1 Cnc	1259	5.9	E	319	Sun				3 54.8	−0.5	−0.4	329
16	126 B. Sgr	2719	5.8	I	103	Low				20 31.2	−1.1	0.0	48
20	θ Aqr	3269	4.3	I	152	23 45.3	+0.1	+2.0	0	22 38.6			348
21	ρ Aqr	3278	5.4	I	153	Graze				0 10.6			127
21	170 B. Aqr	3285	6.1	I	154	Low				2 06.6	−1.1	−1.9	99
26	ε Ari	440	4.6	E	222	3 34.4	−1.5	−0.5	277	2 19.3	−1.6	+0.2	272
26	104 B. Tau	556	5.5	E	233	21 23.2	0.0	+1.1	290	Low			
27	36 Tau	598	5.7	E	237	4 30.0	−1.3	+1.1	236	3 11.1	−1.2	+1.9	227
27	98 k Tau	743	5.6	E	248	23 51.1	−0.2	+1.6	261	22 44.3	0.0	+1.4	264
30	44 Gem	1078	5.9	E	275	1 24.9	0.0	+1.9	253	0 18.9	+0.3	+1.7	252

Date		Star	Z.C. No.	Mag.	I or E	Elong. of Moon	Edmonton				Vancouver			
							M.S.T.	a	b	P	P.S.T.	a	b	P
						°	h m	m	m	°	h m	m	m	°
Oct.	16	94 B. Cap	3064	6.0	I	106	19 25.7	−0.7	+1.2	20	18 12.3	−0.8	+1.8	13
	17	λ Cap	3188	5.4	I	117	18 07.3	−1.0	+1.5	52	Sun			
	17	129 G. Cap	3205	6.8	I	119	22 15.9	−1.3	−0.6	80	21 03.1	−1.5	0.0	75
	17	96 B. Aqr	3208	6.5	I	119	22 47.5	−0.8	−0.1	50	21 38.0	−1.0	+0.4	46
	18	209 B. Aqr	3328	7.0	I	131	21 19.0	−1.7	0.0	91	20 00.8	−1.6	+0.7	83
	18/9	231 B. Aqr	3344	6.8	I	133	0 57.7	−1.0	−2.1	103	23 53.5	−1.6	−2.2	107
	26/7	+23° 1491	1036	6.5	E	244	0 20.7	−0.5	+1.1	286	23 12.0	−0.3	+1.1	284
	27/8	79 Gem	1171	6.3	E	257	0 13.6	−0.2	+1.2	283	23 07.9	0.0	+1.1	280
	28	85 Gem	1193	5.4	E	259	5 18.2	−1.0	−2.1	332	4 12.3	−1.3	−0.9	311
	29	54 Cnc	1323	6.3	E	272	6 06.8	−1.2	−0.8	306	4 54.5	−1.5	+0.2	285
Nov.	1	69 p^5 Leo	1623	5.4	E	308	5 07.8	−0.4	−0.6	335	4 05.0	−0.4	+0.1	315
	12	−17° 6059	3022	6.9	I	75	19 34.4	−1.4	−1.1	92	18 21.5	−1.7	−0.4	86
	13	75 B. Aqr	3155	6.8	I	87	21 03.3	−0.7	−0.2	50	19 55.2	−0.9	+0.2	47
	14	θ Aqr	3269	4.3	I	98	17 58.5	−1.4	+0.9	76	16 40.4	−1.3	+1.4	70
	22	8 Gem	954	6.1	E	211	22 26.9	−0.4	+1.9	249	21 16.8	−0.1	+1.9	247
	24	149 B. Gem	1125	6.4	E	226	1 15.2			355	0 13.5	−1.2	−1.5	332
	24	63 Gem	1129	5.3	E	226	1 52.9	−1.1	−2.3	338	0 46.7	−1.2	−0.8	319
	25	25 d^2 Cnc	1262	6.2	E	239	2 03.9	−1.2	+2.1	250	0 41.9	−0.8	+4.0	229
Dec.	9	π Cap	2981	5.2	I	45	Low				17 59.2	−1.1	−0.9	76
	11	−9° 5908	3233	7.2	I	68	19 37.7	−1.1	−0.8	76	18 27.8	−1.4	−0.3	73
	12	6 G. Psc	3370	6.2	I	82	Low				22 22.2	−0.6	−2.1	100
	13	+1° 4744	3482	5.6	I	92	17 04.7	−0.5	+1.9	21	Sun			
	13	19 Psc	3501	5.3	I	94	23 13.7	−0.4	−0.5	53	22 10.2	−0.7	−0.5	62
	15	136 B. Psc	89	6.5	I	108	1 17.5	+0.1	−3.5	127	No occ.			
	17	66 Ari	501	6.1	I	148	21 12.1	−0.7	+2.5	31	19 55.2	−0.6	+2.6	33
	18	104 B. Tau	556	5.5	I	152	Low				4 44.5	−0.1	−0.6	57
	21	209 B. Gem	1186	6.1	E	205	21 57.1	0.0	+4.6	217	No occ.			
	22	10 H. Cnc	1217	6.1	E	207	4 07.9			7	3 19.5	−0.7	−2.4	331
	26	87 e Leo	1670	5.1	E	258	4 22.3			240	No occ.			

MAP OF THE MOON

South appears at the top.

PLANETARY APPULSES AND OCCULTATIONS

According to Mr. Gordon E. Taylor, H.M. Nautical Almanac Office, Jupiter will occult the 8^m9 star SAO 186658 on June 19, 1972. Disappearance occurs about 3^h23^m U.T. in position angle 262°, and reappearance occurs at about 5^h47^m U.T. in position angle 92°. These phenomena are visible throughout most of the Americas.

No planetary appulses involving bright stars are predicted in 1972.

MARS—LONGITUDE OF THE CENTRAL MERIDIAN

During the early part of 1972, Mars is visible in the evening sky. The following table lists the longitude of the central meridian of the geometric disk of Mars for each date at 0 hours U.T. (19 hours E.S.T. on the preceding date). To obtain the longitude of the central meridian for other times, add 14.6° for each hour elapsed since 0 hours U.T.

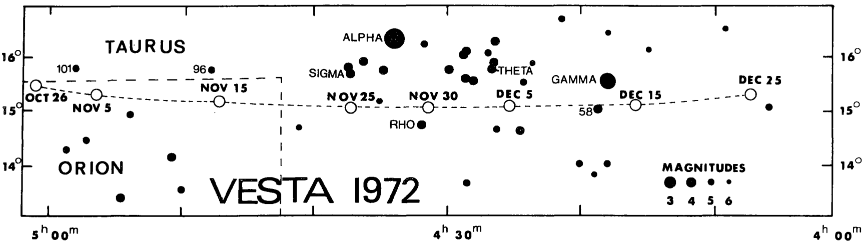
A map of the surface of Mars appeared in the 1971 edition of the OBSERVER'S HANDBOOK; single copies of this map may be obtained without charge by writing to the Editor.

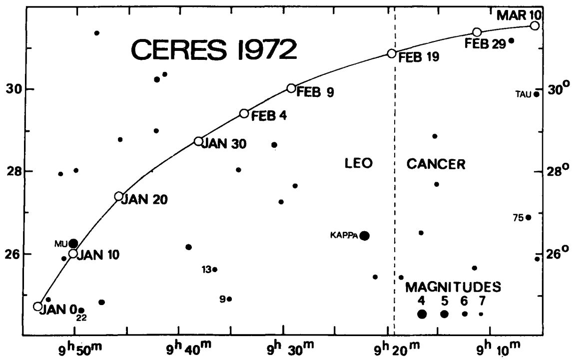
Date	Jan.	Feb.	Mar.	Apr.	Date	Jan.	Feb.	Mar.	Apr.
1	123.68	178.74	254.57	312.38	17	326.22	21.78	98.42	156.92
2	113.84	168.92	244.80	302.66	18	316.38	11.98	88.67	147.21
3	104.00	159.10	235.03	292.94	19	306.54	2.19	78.93	137.50
4	94.16	149.28	225.26	283.22	20	296.70	352.40	69.18	127.80
5	84.32	139.46	215.49	273.49	21	286.87	342.60	59.44	118.09
6	74.47	129.65	205.73	263.77	22	277.03	332.81	49.70	108.38
7	64.63	119.83	195.96	254.06	23	267.20	323.03	39.96	98.68
8	54.79	110.02	186.20	244.34	24	257.36	313.24	30.23	88.98
9	44.95	100.21	176.44	234.62	25	247.53	303.46	20.49	79.27
10	35.10	90.40	166.68	224.91	26	237.70	293.68	10.76	69.57
11	25.26	80.59	156.93	215.19	27	227.87	283.90	1.03	59.87
12	15.42	70.78	147.17	205.48	28	218.04	274.12	351.30	50.16
13	5.58	60.98	137.42	195.76	29	208.21	264.35	341.57	40.46
14	355.74	51.18	127.66	186.05	30	198.39		331.84	30.76
15	345.90	41.38	117.91	176.34	31	188.56		322.11	
16	336.06	31.58	108.16	166.63					

ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1972

The asteroids are many small objects revolving around the sun, mainly between the orbits of Mars and Jupiter. The largest, Ceres, is only 480 miles in diameter. Vesta, though half the diameter of Ceres, is brighter. The next brightest asteroids, Juno and Pallas, are 120 and 300 miles in diameter, respectively. Unlike the planets, the asteroids move in orbits which are appreciably elongated. Thus the distance of an asteroid from the earth (and consequently its magnitude) varies at different oppositions.

Three of the four brightest asteroids—Ceres, Vesta and Juno—come to opposition in 1972. Ephemerides near opposition are given for Ceres and Vesta, together with maps. Since Juno is scarcely brighter than magnitude 10.0 at opposition, no ephemeris or map is given. Its position at opposition is: R.A. 12 h 53.0 m, Dec. +2° 2.6′, on April 1.





Vesta (No. 4)
Opposition Nov. 30 in Taurus;
Mag. 6.5

Date	R.A.	Dec.
	h m	° ′
Oct. 26	5 01.0	+15 31
Nov. 5	4 55.5	15 21
15	4 47.3	15 13
25	4 37.2	15 07
30	4 31.6	15 06
Dec. 5	4 26.3	15 06
15	4 15.9	15 10
25	4 07.2	15 22

Ceres (No. 1)
Opposition Feb. 5 in Leo;
Mag. 6.4

Date	R.A.	Dec.
	h m	° ′
Jan. 0	9 53.7	+24 40
10	9 51.3	+25 57
20	9 46.0	+27 21
30	9 38.4	+28 44
Feb. 4	9 33.9	+29 22
9	9 29.3	+29 56
19	9 20.0	+30 50
29	9 11.8	+31 21
Mar. 10	9 05.8	+31 28

JUPITER—LONGITUDE OF CENTRAL MERIDIAN

The table lists the longitude of the central meridian of the illuminated disk of Jupiter at 0^h **U.T.** daily during the period when the planet is favourably placed. Longitude increases hourly by 36.58° in System I (which applies to regions between the middle of the North Equatorial Belt and the middle of the South Equatorial Belt) and by 36.26° in System II (which applies to the rest of the planet). Detailed ancillary tables may be found on pages 274 and 275 of *The Planet Jupiter* by B. M. Peek (Faber and Faber, 1958).

	SYSTEM I									
Day (0^h U.T.)	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
	°	°	°	°	°	°	°	°	°	°
1	199.1	95.3	309.2	7.6	225.9	286.9	143.9	357.5	50.1	258.5
2	356.9	253.1	107.2	165.6	23.9	84.9	301.8	155.3	207.9	56.2
3	154.6	50.9	265.1	323.5	181.9	242.9	99.7	313.1	5.6	213.9
4	312.4	208.8	63.0	121.5	340.0	40.9	257.6	110.8	163.3	11.5
5	110.2	6.6	220.9	279.5	138.0	198.9	55.5	268.6	321.0	169.2
6	268.0	164.5	18.8	77.5	296.0	356.9	213.4	66.4	118.7	326.9
7	65.7	322.3	176.7	235.5	94.1	154.9	11.3	224.2	276.4	124.5
8	223.5	120.2	334.7	33.5	252.1	312.9	169.2	22.0	74.1	282.2
9	21.3	278.0	132.6	191.5	50.1	110.9	327.1	179.8	231.8	79.9
10	179.1	75.9	290.5	349.5	208.2	268.9	125.0	337.5	29.5	237.5
11	336.9	233.7	88.4	147.5	6.2	66.9	282.9	135.3	187.2	35.2
12	134.7	31.6	246.4	305.5	164.3	224.9	80.7	293.1	344.9	192.8
13	292.5	189.4	44.3	103.5	322.3	22.9	238.6	90.8	142.6	350.5
14	90.2	347.3	202.3	261.5	120.3	180.8	36.5	248.6	300.3	148.2
15	248.0	145.2	0.2	59.5	278.4	338.8	194.3	46.4	98.0	305.8
16	45.8	303.0	158.1	217.5	76.4	136.8	352.2	204.1	255.7	103.5
17	203.6	100.9	316.1	15.5	234.4	294.8	150.1	1.9	53.4	261.1
18	1.4	258.8	114.0	173.5	32.5	92.7	307.9	159.6	211.1	58.8
19	159.3	56.6	272.0	331.6	190.5	250.7	105.8	317.4	8.8	216.4
20	317.1	214.5	69.9	129.6	348.5	48.7	263.6	115.1	166.4	14.1
21	114.9	12.4	227.9	287.6	146.6	206.6	61.4	272.9	324.1	171.8
22	272.7	170.3	25.9	85.6	304.6	4.6	219.3	70.6	121.8	329.4
23	70.5	328.2	183.8	243.6	102.6	162.5	17.1	228.3	279.5	127.1
24	228.3	126.1	341.8	41.7	260.7	320.5	174.9	26.1	77.2	284.7
25	26.1	283.9	139.7	199.7	58.7	118.4	332.8	183.8	234.8	82.4
26	184.0	81.8	297.7	357.7	216.7	276.4	130.6	341.5	32.5	240.0
27	341.8	239.7	95.7	155.7	14.8	74.3	288.4	139.3	190.2	37.7
28	139.6	37.6	253.7	313.8	172.8	232.2	86.2	297.0	347.9	195.3
29	297.4	195.5	51.6	111.8	330.8	30.2	244.0	94.7	145.5	353.0
30		353.4	209.6	269.8	128.8	188.1	41.9	252.4	303.2	150.6
31		151.3		67.8		346.0	199.7		100.9	

	SYSTEM II									
Day (0^h U.T.)	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
	°	°	°	°	°	°	°	°	°	°
1	214.9	249.8	227.2	56.6	38.4	230.4	211.0	188.0	11.8	343.7
2	5.0	40.0	17.5	207.0	188.8	20.8	1.3	338.2	161.9	133.8
3	155.2	190.2	167.8	357.3	339.2	171.2	151.6	128.4	312.0	283.8
4	305.3	340.4	318.1	147.7	129.6	321.6	301.8	278.5	102.1	73.8
5	95.5	130.6	108.3	298.0	280.0	112.0	92.1	68.7	252.2	223.9
6	245.6	280.8	258.6	88.4	70.4	262.4	242.4	218.8	42.2	13.9
7	35.8	71.0	48.9	238.8	220.8	52.7	32.6	9.0	192.3	163.9
8	185.9	221.3	199.2	29.1	11.2	203.1	182.9	159.1	342.4	314.0
9	336.1	11.5	349.5	179.5	161.6	353.5	333.2	309.3	132.5	104.0
10	126.2	161.7	139.8	329.9	312.0	143.8	123.4	99.4	282.5	254.0
11	276.4	311.9	290.1	120.2	102.4	294.2	273.7	249.6	72.6	44.1
12	66.5	102.2	80.4	270.6	252.8	84.5	63.9	39.7	222.7	194.1
13	216.7	252.4	230.7	61.0	43.2	234.9	214.1	189.9	12.7	344.1
14	6.9	42.6	21.0	211.4	193.6	25.3	4.4	340.0	162.8	134.2
15	157.0	192.9	171.3	1.7	344.0	175.6	154.6	130.1	312.9	284.2
16	307.2	343.1	321.6	152.1	134.5	326.0	304.8	280.2	102.9	74.2
17	97.4	133.3	112.0	302.5	284.9	116.3	95.1	70.4	253.0	224.2
18	247.5	283.6	262.3	92.9	75.3	266.6	245.3	220.5	43.1	14.3
19	37.7	73.8	52.6	243.3	225.7	57.0	35.5	10.6	193.1	164.3
20	187.9	224.1	202.9	33.6	16.1	207.3	185.7	160.7	343.2	314.3
21	338.1	14.3	353.3	184.0	166.5	357.6	335.9	310.8	133.2	104.3
22	128.3	164.6	143.6	334.4	316.9	147.9	126.1	100.9	283.3	254.4
23	278.4	314.8	293.9	124.8	107.3	298.3	276.3	251.1	73.3	44.4
24	68.6	105.1	84.2	275.2	257.7	88.6	66.5	41.2	223.4	194.4
25	218.8	255.3	234.6	65.6	48.1	238.9	216.7	191.3	13.4	344.4
26	9.0	45.6	24.9	216.0	198.5	29.2	6.9	341.4	163.5	134.5
27	159.2	195.9	175.3	6.4	348.9	179.5	157.1	131.5	313.5	284.5
28	309.4	346.1	325.6	156.8	139.3	329.8	307.3	281.6	103.6	74.5
29	99.6	136.4	115.9	307.2	289.7	120.1	97.5	71.7	253.6	224.5
30		286.7	266.3	97.6	80.1	270.4	247.7	221.7	43.6	14.6
31		76.9		248.0		60.7	37.9		193.7	

JUPITER—PHENOMENA OF THE BRIGHTEST SATELLITES 1972

Times and dates given are E.S.T. The phenomena are given for latitude 45° N., for Jupiter at least one hour above the horizon, and the sun at least one hour below the horizon.

The symbols are as follows: E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress. Satellites move from east to west across the face of the planet, and from west to east behind it. Before opposition, shadows fall to the west, and after opposition to the east. Thus eclipse phenomena occur on the west side until June 24, and on the east thereafter.

JANUARY

d	h	m	Sat.	Phen.
23	5	40	III	Se
	5	52	III	TI
	7	44	I	ED
	8	40	III	Te
24	5	38	I	TI
	7	06	I	Se
	7	50	I	Te
25	5	12	I	OR
26	9	04	II	OR
30	6	56	III	SI
31	6	48	I	SI
	7	38	I	TI
	8	59	I	Se

FEBRUARY

d	h	m	Sat.	Phen.
1	7	12	I	OR
2	7	25	II	ED
4	5	11	II	Se
	7	00	II	Te
7	8	41	I	SI
	9	37	I	TI
8	6	00	I	ED
	9	11	I	OR
9	5	21	I	Se
	6	18	I	Te
10	4	44	III	OD
	7	35	III	OR
11	5	05	II	SI
	7	03	II	TI
	7	47	II	Se
15	7	54	I	ED
16	5	03	I	SI
	6	04	I	TI
	7	15	I	Se
	8	17	I	Te
17	4	48	III	ED
	5	39	I	OR
	7	34	III	ER
	9	01	III	OD
18	7	40	II	SI
20	6	42	II	OR
23	6	57	I	SI
	8	02	I	TI
24	4	16	I	ED
	7	37	I	OR
	8	45	III	ED
25	3	37	I	Se
	4	44	I	Te
27	4	24	II	ED
28	3	25	III	TI
	6	17	III	Te
29	4	35	II	Te

MARCH

d	h	m	Sat.	Phen.
2	6	09	I	ED
3	3	18	I	SI
	4	28	I	TI
	5	30	I	Se
	6	41	I	Te
4	4	03	I	OR
5	6	58	II	ED
6	5	32	III	Se
	7	36	III	TI
7	4	33	II	TI
	4	50	II	Se
	7	15	II	Te
9	8	03	I	ED
10	5	12	I	SI
	6	24	I	TI
	7	23	I	Se
11	2	31	I	ED
	5	59	I	OR
12	3	06	I	Te
13	6	43	III	SI
14	4	43	II	SI
	7	13	II	TI
	7	24	II	Se
16	4	06	II	OR
17	4	40	III	OR
	7	05	I	SI
18	4	24	I	ED
	7	54	I	OR
19	2	48	I	TI
	3	45	I	Se
	5	01	I	Te
20	2	23	I	OR
21	7	18	II	SI
23	6	44	II	OR
24	3	27	III	ER
	5	46	III	OD
25	1	49	II	Te
	6	18	I	ED
26	3	27	I	SI
	4	42	I	TI
	5	39	I	Se
	6	55	I	Te
27	4	17	I	OR
28	1	24	I	Te
30	3	59	II	ED
31	4	34	III	ED
	7	26	III	ER

APRIL

d	h	m	Sat.	Phen.
1	1	42	II	TI
	1	50	II	Se
	4	23	II	Te
2	5	20	I	SI
	6	36	I	TI
	7	32	I	Se
3	2	39	I	ED
	6	10	I	OR
4	2	01	I	Se
	2	40	III	Te
	3	17	I	Te
6	6	34	II	ED
8	1	44	II	SI
	4	14	II	TI
	4	25	II	Se
	6	55	II	Te
9	7	13	I	SI
10	1	10	II	OR
	4	33	I	ED
11	1	25	III	Se
	1	42	I	SI
	2	56	I	TI
	3	37	III	TI
	3	54	I	Se
	5	09	I	Te
	6	33	III	Te
12	2	29	I	OR
15	4	18	II	SI
	6	44	II	TI
	6	59	II	Se
17	3	41	II	OR
	6	26	I	ED
18	2	33	III	SI
	3	35	I	SI
	4	47	I	TI
	5	25	III	Se
	5	48	I	Se
	7	00	I	Te
19	0	54	I	ED
	4	20	I	OR
20	0	16	I	Se
	1	28	I	Te
22	0	12	III	OR
	6	52	II	SI
24	1	01	II	ED
	6	10	II	OR
25	5	28	I	SI
	6	31	III	SI
	6	37	I	TI
26	1	06	II	Te
	2	48	I	ED
	6	09	I	OR
	23	57	I	SI
27	1	04	I	TI
	2	10	I	Se
	3	18	I	Te
28	0	36	I	OR
29	0	55	III	OD
	3	54	III	OR

MAY

d	h	m	Sat.	Phen.
1	3	37	II	ED
3	0	49	II	TI
	1	23	II	Se
	3	30	II	Te
	4	41	I	ED
4	1	50	I	SI
	2	53	I	TI
	4	04	I	Se
	5	07	I	Te
5	2	25	I	OR
	23	34	I	Te
6	0	23	III	ED
	3	19	III	ER
	4	31	III	OD
8	6	13	II	ED
10	1	16	II	SI
	3	11	II	TI.
	3	57	II	Se
	5	52	II	Te
	6	34	I	ED
11	3	44	I	SI
	4	41	I	TI
	5	58	I	Se
12	0	13	II	OR
	1	03	I	ED
	4	12	I	OR
	23	07	I	TI
13	0	26	I	Se
	1	22	I	Te
	4	21	III	ED
	22	38	I	OR
17	0	49	III	Te
	3	50	II	SI
	5	31	II	TI
	6	31	II	Se
18	5	38	I	SI
	6	27	I	TI
19	2	35	II	OR
	2	56	I	ED
	5	58	I	OR
20	0	06	I	SI
	0	54	I	TI
	2	20	I	Se
	3	08	I	Te
21	0	24	I	OR
23	22	23	III	SI
24	1	18	III	TI
	1	19	III	Se
	4	16	III	Te
	6	24	II	SI
26	0	43	II	ED
	4	49	I	ED
	4	55	II	OR
27	2	00	I	SI
	2	40	I	TI
	4	14	I	Se
	4	54	I	Te
	22	22	II	Se
	23	18	I	ED
	23	38	II	Te
28	2	09	I	OR
	22	43	I	Se
	23	20	I	Te
31	2	21	III	SI
	4	41	III	TI
	5	19	III	Se

JUNE

d	h	m	Sat.	Phen.
2	3	19	II	ED
3	3	54	I	SI
	4	25	I	TI
	6	08	I	Se
	22	14	II	SI
	23	13	II	TI
4	0	56	II	Se
	1	11	I	ED
	1	54	II	Te
	3	54	I	OR
	22	22	I	SI
	22	51	I	TI
5	0	37	I	Se
	1	05	I	Te
	22	20	I	OR
9	5	56	II	ED
10	5	48	I	SI
	6	09	I	TI
11	0	35	III	OR
	0	48	II	SI
	1	27	II	TI
	3	05	I	ED
	3	29	II	Se
	4	08	II	Te
	5	38	I	OR
12	0	17	I	SI
	0	35	I	TI
	2	31	I	Se
	2	50	I	Te

d	h	m	Sat.	Phen.
12	21	33	I	ED
	22	37	II	OR
13	0	04	I	OR
	21	00	I	Se
	21	16	I	Te
18	0	12	III	ED
	3	22	II	SI
	3	41	II	TI
	3	52	III	OR
	4	59	I	ED
	6	03	II	Se
19	2	11	I	SI
	2	19	I	TI
	4	26	I	Se
	4	34	I	Te
	21	51	II	ED
	23	27	I	ED
20	0	53	II	OR
	1	47	I	OR
	20	40	I	SI
	20	45	I	TI
	22	55	I	Se
	23	00	I	Te
25	4	09	III	OD
	5	54	II	TI
	5	56	II	SI
26	4	03	I	TI
	4	05	I	SI
	6	18	I	Te
	6	21	I	Se
27	0	21	II	OD
	1	18	I	OD
	3	16	II	ER
	3	34	I	ER
	22	29	I	TI
	22	34	I	SI
28	0	44	I	Te
	0	49	I	Se
	20	51	III	Te
	21	17	III	Se
	21	42	II	Te
	21	55	II	Se
	22	03	I	ER

JULY

d	h	m	Sat.	Phen.
3	5	47	I	TI
	6	00	I	SI
4	2	37	II	OD
	3	02	I	OD
	5	29	I	ER
	5	54	II	ER
5	0	14	I	TI
	0	29	I	SI
	2	29	I	Te
	2	44	I	Se
	21	09	III	TI
	21	15	II	TI
	21	28	I	OD
	21	47	II	SI
	22	15	III	SI
	23	56	II	Te
	23	57	I	ER
6	0	08	III	Te
	0	29	II	Se
	1	17	III	Se
	20	55	I	Te
	21	13	I	Se
11	4	46	I	OD
	4	53	II	OD
12	1	58	I	TI
	2	24	I	SI
	4	13	I	Te
	4	39	I	Se
	23	12	I	OD
	23	29	II	TI
13	0	21	II	SI
	0	29	III	TI
	1	51	I	ER
	2	10	II	Te
	2	15	III	SI
	3	03	II	Se
13	3	28	III	Te
	5	18	III	Se
	20	25	I	TI
	20	52	I	SI
	22	39	I	Te
	23	08	I	Se
14	20	20	I	ER
	21	50	II	ER
16	22	26	IV	SI
	23	03	IV	Se
19	3	44	I	TI
	4	19	I	SI
20	0	57	I	OD
	1	45	II	TI
	2	55	II	SI
	3	46	I	ER
	3	50	III	TI
	4	26	II	Te
	22	10	I	TI
	22	47	I	SI
21	0	25	I	Te
	1	03	I	Se
	20	21	II	OD
	22	14	I	ER
22	0	28	II	ER
23	23	12	III	ER
27	2	42	I	OD
	4	02	II	TI
	23	57	I	TI
28	0	43	I	SI
	2	11	I	Te
	2	58	I	Se
	21	09	I	OD
	22	41	II	OD
29	0	09	I	ER
	3	06	II	ER
	20	38	I	Te
	21	26	I	Se
30	19	53	II	Te
	20	49	III	OD
	21	30	II	Se
	23	50	III	OR
31	0	05	III	ED
	3	12	III	ER

AUGUST

d	h	m	Sat.	Phen.
4	1	44	I	TI
	2	38	I	SI
	3	59	I	Te
	22	56	I	OD
5	1	03	II	OD
	2	04	I	ER
	20	11	I	TI
	21	07	I	SI
	22	26	I	Te
	23	21	I	Se
6	19	32	II	TI
	20	32	I	ER
	21	22	II	SI
	22	13	II	Te
7	0	05	II	Se
	0	18	III	OD
	3	21	III	OR
	4	05	III	ED
10	21	19	III	Se
11	2	37	IV	ED
12	0	44	I	OD
	22	00	I	TI
	23	02	I	SI
13	0	15	I	Te
	1	17	I	Se
	19	11	I	OD
	21	54	II	TI
	22	27	I	ER
	23	57	II	SI
14	0	36	II	Te
	2	40	II	Se
	19	45	I	Se
15	21	40	II	ER
17	20	51	III	Te
17	22	13	III	SI
18	1	20	III	Se
19	2	33	I	OD
	23	50	I	TI
20	0	57	I	SI
	2	05	I	Te
	3	12	I	Se
	21	01	I	OD
21	0	19	II	TI
	0	22	I	ER
	2	32	II	SI
	3	00	II	Te
	19	26	I	SI
	20	32	I	Te
	21	41	I	Se
22	18	51	I	ER
	19	07	II	OD
23	0	17	II	ER
24	21	30	III	TI
25	0	32	III	Te
	2	13	III	SI
27	1	42	I	TI
	20	33	IV	ED
	22	38	IV	ER
	22	51	I	OD
28	19	15	III	ER
	20	09	I	TI
	21	21	I	SI
	22	23	I	Te
	23	36	I	Se
29	20	46	I	ER
	21	37	II	OD
30	2	55	II	ER
31	18	42	II	Te
	21	08	II	Se

SEPTEMBER

d	h	m	Sat.	Phen.
1	1	17	III	TI
4	0	43	I	OD
	20	04	III	ED
	22	02	I	TI
	23	15	III	ER
	23	17	I	SI
5	0	16	I	Te
	1	31	I	Se
	19	11	I	OD
	22	41	I	ER
6	0	09	II	OD
	18	44	I	Te
	20	00	I	Se
7	18	30	II	TI
	21	00	II	SI
	21	12	II	Te
	23	44	II	Se
9	18	51	II	ER
11	18	52	III	OD
	21	58	III	OR
	23	56	I	TI
12	0	04	III	ED
	1	12	I	SI
	21	04	I	OD
13	0	36	I	ER
	18	24	I	TI
	19	41	I	SI
	20	38	I	Te
	21	56	I	Se
14	19	05	I	ER
	21	03	II	TI
	23	36	II	SI
	23	45	II	Te
16	21	29	II	ER
18	22	48	III	OD
19	22	59	I	OD
20	20	19	I	TI
	21	37	I	SI
	22	33	I	Te
	23	51	I	Se
21	21	00	I	ER
	22	04	IV	SI
	23	37	II	TI
22	0	19	IV	Se
	18	14	III	SI
	18	20	I	Se
	21	24	III	Se
23	18	38	II	OD
24	0	06	II	ER
25	18	14	II	Se
27	22	15	I	TI
	23	32	I	SI
28	19	23	I	OD
	22	55	I	ER
29	18	01	I	SI
	18	58	I	Te
	20	08	III	Te
	20	15	I	Se
	20	44	IV	OD
	22	14	III	SI
	22	26	IV	OR
30	21	17	II	OD

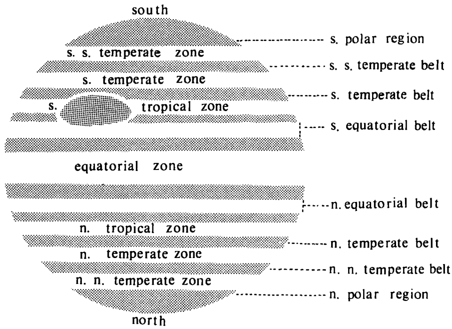
OCTOBER

d	h	m	Sat.	Phen.
2	18	05	II	SI
	18	17	II	Te
	20	51	II	Se
5	0	12	I	TI
	21	19	I	OD
6	18	41	I	TI
	19	56	I	SI
	20	55	I	Te
	21	08	III	TI
	22	11	I	Se
7	19	20	I	ER
	23	58	II	OD
8	18	34	IV	Se
9	18	13	II	TI
	20	41	II	SI
	20	57	II	Te
	23	27	II	Se
10	19	19	III	ER
11	18	38	II	ER
12	23	17	I	OD
13	20	39	I	TI
	21	52	I	SI
	22	53	I	Te
14	17	46	I	OD
	21	15	I	ER
15	17	22	I	Te
	18	35	I	Se
16	17	30	IV	OR
	20	54	II	TI
	23	18	II	SI
17	18	24	III	OR
	20	05	III	ED
	23	20	III	ER
18	21	15	II	ER
20	22	37	I	TI
21	19	45	I	OD
	23	10	I	ER
22	17	07	I	TI
	18	16	I	SI
	19	21	I	Te
	20	30	I	Se
24	19	28	III	OD
	22	39	III	OR
25	18	46	II	OD
27	18	00	II	Se
28	17	29	III	Se
	21	44	I	OD
29	19	06	I	TI
	20	11	I	SI
	21	20	I	Te
	22	25	I	Se
30	19	34	I	ER
31	16	54	I	Se

Jupiter being near the sun, phenomena are not given after Oct. 31.

JUPITER'S BELTS AND ZONES

Viewed through a telescope of 6-inch aperture or greater, Jupiter exhibits a variety of changing detail and colour in its cloudy atmosphere. Some features are of long duration, others are short-lived. The standard nomenclature of the belts and zones is given in the figure.



METEORS, FIREBALLS AND METEORITES

by Peter M. Millman

Meteoroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 15 to 75 kilometres per second they become luminous and appear as meteors or fireballs and in rare cases, if large enough to avoid complete vaporization, they may fall to the earth as meteorites.

Meteors are visible on any night of the year. At certain times of the year the earth encounters large numbers of meteors all moving together along the same orbit. Such a group is known as a meteor shower and the accompanying list gives the more important showers visible in 1972.

An observer located away from city lights and with perfect sky conditions will see an overall average of 7 sporadic meteors per hour apart from the shower meteors. These have been included in the hourly rates listed in the table. Slight haze or nearby lighting will greatly reduce the number of meteors seen. More meteors appear in the early morning hours than in the evening, and more during the last half of the year than during the first half.

The radiant is the position among the stars from which the meteors of a given shower seem to radiate. The appearance of any very bright fireball should be reported immediately to the nearest astronomical group or other organization concerned with the collection of such information. Where no local organization exists, reports should be sent to Meteor Centre, National Research Council, Ottawa, Ontario, K1A 0R8. Free fireball report forms and instructions for their use, printed in either French or English, may be secured at the above address. If sounds are heard accompanying a bright fireball there is a possibility that a meteorite may have fallen. Astronomers must rely on observations made by the general public to track down such an object.

Meteor Showers for 1972

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Velocity	Normal Duration to 1/4 strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.	Position at Max. Dec.	Daily Motion R.A.	Daily Motion Dec.			
		h		h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	21	F.M.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 21	21	F.Q.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 4	22	L.Q.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 28	—	F.M.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 11	23	N.M.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	01	F.M.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 4	—	N.M.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 16	19	F.Q.	10 08	+22	+2.8	−0.42	15	72	—
Geminids	Dec. 13	16	F.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	09	F.M.	14 28	+76	—	—	15	34	2

SATURN AND ITS SATELLITES

BY TERENCE DICKINSON

Saturn, with its system of rings, is a unique sight through a telescope. There are three rings. The outer ring A has an outer diameter 169,000 miles. It is separated from the middle ring B by Cassini's gap, which has an outer diameter 149,000 miles, and an inner diameter 145,000 miles. The inner ring C, also known as the dusky or crape ring, has an outer diameter 112,000 miles and an inner diameter 93,000 miles. Evidence for a fourth, innermost ring has been found; this ring is very faint.

Saturn exhibits a system of belts and zones with names and appearances similar to those of Jupiter (see diagram pg. 71).

Titan, the largest and brightest of Saturn's moons is seen easily in a 2-inch or larger telescope. At elongation Titan appears about 5 ring-diameters from Saturn. The satellite orbits Saturn in about 16 days and at magnitude 8.4* dominates the field around the ringed planet.

Rhea is considerably fainter than Titan at magnitude 9.8 and a good quality 3-inch telescope may be required to detect it. At elongation Rhea is about 2 ring-diameters from the centre of Saturn.

Iapetus is unique among the satellites of the solar system in that it is five times brighter at western elongation (mag. 10.1) than at eastern elongation (mag. 11.9). When brightest, Iapetus is located about 12 ring-diameters west of its parent planet.

Of the remaining moons only Dione and Tethys are seen in "amateur"-sized telescopes.

ELONGATIONS OF SATURN'S SATELLITES, E.S.T.

JANUARY

d	h	Sat.	Elong.
0	07.2	Rh	E
4	19.6	Rh	E
7	20.2	Ti	E
9	07.9	Rh	E
13	20.3	Rh	E
15	18.1	Ti	W
18	08.7	Rh	E
19	22.7	Ia	W
22	21.1	Rh	E
23	18.3	Ti	E
27	09.5	Rh	E
31	16.5	Ti	W
31	21.9	Rh	E

FEBRUARY

d	h	Sat.	Elong.
5	10.4	Rh	E
8	17.1	Ti	E
9	22.8	Rh	E
14	11.3	Rh	E
16	15.5	Ti	W
18	23.8	Rh	E
23	12.3	Rh	E
24	16.4	Ti	E
27	22.0	Ia	E
28	00.8	Rh	E

MARCH

d	h	Sat.	Elong.
3	13.3	Rh	E
3	15.0	Ti	W
8	01.8	Rh	E
11	16.2	Ti	E
12	14.3	Rh	E
17	02.9	Rh	E
19	15.0	Ti	W
21	15.4	Rh	E
26	04.0	Rh	E
27	16.5	Ti	E
30	16.5	Rh	E

APRIL

d	h	Sat.	Elong.
4	05.1	Rh	E
4	15.3	Ti	W
8	17.7	Rh	E
9	03.4	Ia	W
12	17.2	Ti	E
13	06.3	Rh	E
17	18.9	Rh	E
20	15.9	Ti	W
22	07.5	Rh	E
..	....	...	..

JULY

d	h	Sat.	Elong.
8	05.8	Rh	E
9	20.5	Ti	W
12	18.4	Rh	E
17	07.0	Rh	E
18	00.0	Ti	E
21	19.6	Rh	E
25	21.2	Ti	W
26	08.1	Rh	E
30	20.7	Rh	E

AUGUST

d	h	Sat.	Elong.
3	00.7	Ti	E
4	09.3	Rh	E
8	19.5	Ia	E
8	21.8	Rh	E
10	21.6	Ti	W
13	10.4	Rh	E
17	22.9	Rh	E
19	01.1	Ti	E
22	11.4	Rh	E
26	21.6	Ti	W
26	23.9	Rh	E
31	12.4	Rh	E

SEPTEMBER

d	h	Sat.	Elong.
4	01.0	Ti	E
5	00.9	Rh	E
9	13.4	Rh	E
11	21.1	Ti	W
14	01.9	Rh	E
18	09.7	Ia	W
18	14.3	Rh	E
20	00.4	Ti	E
23	02.8	Rh	E
27	15.2	Rh	E
27	20.2	Ti	W

OCTOBER

d	h	Sat.	Elong.
2	03.6	Rh	E
5	23.2	Ti	E
6	16.0	Rh	E
11	04.4	Rh	E
13	18.7	Ti	W
15	16.8	Rh	E
20	05.1	Rh	E
21	21.4	Ti	E
24	17.5	Rh	E
27	14.5	Ia	E
29	05.9	Rh	E
29	16.8	Ti	W

NOVEMBER

d	h	Sat.	Elong.
2	18.2	Rh	E
6	19.2	Ti	E
7	06.5	Rh	E
11	18.8	Rh	E
14	14.4	Ti	W
16	07.1	Rh	E
20	19.4	Rh	E
22	16.5	Ti	E
25	07.8	Rh	E
29	20.0	Rh	E
30	11.7	Ti	W

DECEMBER

d	h	Sat.	Elong.
4	08.3	Rh	E
6	01.7	Ia	W
8	13.6	Ti	E
8	20.6	Rh	E
13	08.9	Rh	E
16	09.0	Ti	W
17	21.2	Rh	E
22	09.5	Rh	E
24	10.7	Ti	E
26	21.8	Rh	E
31	10.2	Rh	E
32	06.3	Ti	W

Saturn being near the sun, elongations of the satellites are not given between April 22 and July 8.

TABLE OF PRECESSION FOR 50 YEARS

If Declination is positive, use inner R.A. scale; if declination is *negative*, use *outer* R.A. scale, and *reverse the sign of the precession in declination*

R.A. for Dec. −	R.A. for Dec. +	Prec. in Dec.	Precession in right ascension											Prec. in Dec.	R.A. for Dec. +	R.A. for Dec. −
			δ=85°	80°	75°	70°	60°	50°	40°	30°	20°	10°	0°			
h m	h m	′	m	m	m	m	m	m	m	m	m	m	m	′	h m	h m
12 00	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	−16.7	12 00	*24 00*
12 30	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	−16.6	11 30	*23 30*
13 00	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	−16.1	11 00	*23 00*
13 30	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	−15.4	10 30	*22 30*
14 00	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	−14.5	10 00	*22 00*
14 50	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	−13.2	9 30	*21 30*
15 00	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	−11.8	9 00	*21 00*
15 30	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	−10.2	8 30	*20 30*
16 00	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	− 8.3	8 00	*20 00*
16 30	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	− 6.4	7 30	*19 30*
17 00	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	− 4.3	7 00	*19 00*
17 30	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	− 2.2	6 30	*18 30*
18 00	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	0.0	6 00	*18 00*
0 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	+16.7	24 00	*12 00*
0 30	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	+16.6	23 30	*11 30*
1 00	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	+16.1	23 00	*11 00*
1 30	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	+15 4	22 30	*10 30*
2 00	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	+14.5	22 00	*10 00*
2 30	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	+13 2	21 30	*9 30*
3 00	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	+11.8	21 00	*9 00*
3 30	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	+10.2	20 30	*8 30*
4 00	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	+ 8.3	20 00	*8 00*
4 30	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	+ 6.4	19 30	*7 30*
5 00	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	+ 4.3	19 00	*7 00*
5 30	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	+ 2.2	18 30	*6 30*
6 00	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	0.0	18 00	*6 00*

FINDING LIST OF NAMED STARS

Name	Con.	R.A.	Name	Con.	R.A.
Acamar, ā'kȧ-mär	θ Eri	02	Gienah, jē'na	γ Crv	12
Achernar, ā'kĕr-när	α Eri	01	Hadar, hăd'är	β Cen	14
Acrux, ā'krŭks	α Cru	12	Hamal, hăm'ăl	α Ari	02
Adhara, ȧ-dā'rȧ	ε CMa	06	Kaus Australis,		
Al Na'ir, ăl-nâr'	α Gru	22	kôs ôs-trā'lĭs	ε Sgr	18
Albireo, ăl-bĭr'ē-ō	β Cyg	19	Kochab, kō'kăb	β UMi	14
Alcyone, ăl-sī'ō-nē	η Tau	03	Markab, mär'kăb	α Peg	23
Aldebaran, ăl-dĕb'ȧ-rȧn	α Tau	04	Megrez, mē'grĕz	δ UMa	12
Alderamin, ăl-dĕr'ȧ-mĭn	α Cep	21	Menkar, mĕn'kär	α Cet	03
Algenib, ăl-jē'nĭb	γ Peg	00	Menkent, mĕn'kĕnt	θ Cen	14
Algol, ăl'gŏl	β Per	03	Merak, mē'răk	β UMa	10
Alioth, ăl'ĭ-ŏth	ε UMa	12	Miaplacidus,		
Alkaid, ăl-kād'	η UMa	13	mī'ȧ-plăs'ĭ-dus	β Car	09
Almach, ăl'măk	γ And	02	Mira, mī'rȧ	o Cet	02
Alnilam, ăl-nī'lăm	ε Ori	05	Mirach, mī'răk	β And	01
Alphard, ăl'färd	α Hya	09	Mirfak, mĭr'făk	α Per	03
Alphecca, ăl-fĕk'ȧ	α CrB	15	Mizar, mī'zär	ζ UMa	13
Alpheratz, ăl-fē'răts	α And	00	Nunki, nŭn'kē	σ Sgr	18
Altair, ăl-târ'	α Aql	19	Peacock	α Pav	20
Ankaa	α Phe	00	Phecda, fĕk'dȧ	γ UMa	11
Antares, ăn-tā'rēs	α Sco	16	Polaris	α UMi	01
Arcturus, ärk-tū'rŭs	α Boo	14	Pollux, pŏl'ŭks	β Gem	07
Atria, ā'trĭ-ȧ	α TrA	16	Procyon, prō'sĭ-ŏn	α CMi	07
Avior, ă-vĭ-ôr'	ε Car	08	Ras-Algethi, rȧs'ăl-jē'the	α Her	17
Bellatrix, bĕ-lā'trĭks	γ Ori	05	Rasalhague, rȧs'ăl-hā'gwē	α Oph	17
Betelgeuse, bĕt'ĕl-jūz	α Ori	05	Regulus, rĕg'ū-lŭs	α Leo	10
Canopus, kȧ-nō'pŭs	α Car	06	Rigel, rī'jĕl	β Ori	05
Capella, kȧ-pĕl'ȧ	α Aur	05	Rigil Kentaurus		
Caph, kăf	β Cas	00	rī'jĭl kĕn-tô'rŭs	α Cen	14
Castor, kȧs'tĕr	α Gem	07	Sabik, sā'bĭk	η Oph	17
Deneb, dĕn'ĕb	α Cyg	20	Scheat, shē'ăt	β Peg	23
Denebola, dĕ-nĕb'ō-lȧ	β Leo	11	Schedar, shĕd'ȧr	α Cas	00
Diphda, dĭf'dȧ	β Cet	00	Shaula, shô'lȧ	λ Sco	17
Dubhe, dŭb'ē	α UMa	11	Sirius, sĭr'ĭ-ŭs	α CMa	06
Elnath, ĕl'năth	β Tau	05	Spica, spī'kȧ	α Vir	13
Eltanin, ĕl-tā'nĭn	γ Dra	17	Suhail, sŭ-hāl'	λ Vel	09
Enif, ĕn'ĭf	ε Peg	21	Vega, vē'gȧ	α Lyr	18
Fomalhaut, fō'măl-ôt	α PsA	22	Zubenelgenubi,		
Gacrux, gă'krŭks	γ Cru	12	zōō-bĕn'ĕl-jĕ-nū'bē	α Lib	14

Pronunciations are generally as given by G. A. Davis, *Popular Astronomy*, **52**, 8 (1944). Key to pronunciation on p. 5.

THE BRIGHTEST STARS

BY DONALD A. MACRAE

The 286 stars brighter than apparent magnitude 3.55.

Star. If the star is a visual double the letter *A* indicates that the data are for the brighter component. The brightness and separation of the second component *B* are given in the last column. Sometimes the double is too close to be conveniently resolved and the data refer to the combined light, *AB*; in interpreting such data the magnitudes of the two components must be considered.

Visual Magnitude (*V*). These magnitudes are based on *photoelectric observations*, with a few exceptions, which have been adjusted to match the yellow colour-sensitivity of the eye. The photometric system is that of Johnson and Morgan in *Ap. J.*, vol. 117, p. 313, 1953. It is as likely as not that the true magnitude is within 0.03 mag. of the quoted figure, on the average. Variable stars are indicated with a "v". The type of variability, range, *R*, in magnitudes, and period in days are given.

Colour index (*B–V*). The blue magnitude, *B*, is the brightness of a star as observed photoelectrically through a blue filter. The difference *B–V* is therefore a measure of the colour of a star. The table reveals a close relation between *B–V* and spectral type. Some of the stars are slightly reddened by interstellar dust. The probable error of a value of *B–V* is only 0.01 or 0.02 mag.

Type. The customary spectral (temperature) classification is given first. The Roman numerals are indicators of *luminosity class.* They are to be interpreted as follows: Ia—most luminous supergiants; Ib—less luminous supergiants; II—bright giants; III—normal giants; IV—subgiants; V—main sequence stars. Intermediate classes are sometimes used, e.g. Iab. Approximate absolute magnitudes can be assigned to the various spectral and luminosity class combinations. Other symbols used in this column are: p—a peculiarity; e—emission lines; v—the spectrum is variable; m—lines due to metallic elements are abnormally strong; f—the O-type spectrum has several broad emission lines; n or nn—unusually wide or diffuse lines. A composite spectrum, e.g. M1 Ib+B, shows up when a star is composed of two nearly equal but unresolved components. In the far southern sky, spectral types in italics were provided through the kindness of Prof. R. v. d. R. Woolley, Australian Commonwealth Observatory. Types in parentheses are less accurately defined (g—giant, d—dwarf, c—exceptionally high luminosity). All other types were very kindly provided especially for this table by Dr. W. W. Morgan, Yerkes Observatory.

Parallax (π). From "General Catalogue of Trigonometric Stellar Parallaxes" by Louise F. Jenkins, Yale Univ. Obs., 1952.

Absolute visual magnitude (M_V), and *distance in light-years* (D). If π is greater than 0.030″ the distance corresponds to this trigonometric parallax and the absolute magnitude was computed from the formula $M_V = V + 5 + 5 \log \pi$. Otherwise a generally more accurate absolute magnitude was obtained from the luminosity class. In this case the formula was used to *compute* π and the distance corresponds to this "spectroscopic" parallax. The formula is an expression of the inverse square law for decrease in light intensity with increasing distance. The effect of absorption of light by interstellar dust was neglected, except for three stars, ζ Per, σ Sco and ζ Oph, which are significantly reddened and would therefore be about a magnitude brighter if they were in the clear.

Annual proper motion (μ), and *radial velocity* (R). From "General Catalogue of Stellar Radial Velocities" by R. E. Wilson, Carnegie Inst. Pub. 601, 1953. Italics indicate an average value of a variable radial velocity.

The star names are given for all the officially designated navigation stars and a few others. Throughout the table, a *colon* (:) indicates an uncertainty.

Star	Right Ascension R.A. 1970	Declination Dec.	Visual Magnitude V	Colour Index $B-V$	Spectral Classification Type		Parallax π	Absolute Magnitude M_V	Distance light-years D	Proper Motion μ	Radial Velocity R		
	h m	° ′					″		l.y.	″	km./sec.		
SUN			-26.73	+0.63	G2	V		+4.84					***Sun***
α And	00 06.8	+28 55	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.6	+58 59	2.26	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.7	+15 01	2.84v	−0.23	B2	IV	−.004	−3.4	570	0.010	+04.1	β CMa type, R in V 2.83–2.85, 0.15^d	
β Hyi	24.2	−77 25	2.78	+0.62	*G1*	*IV*	0.153	+3.7	21	2.255	+22.8		γ Peg = *Algenib*
α Phe	24.8	−42 28	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.7	+30 42	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.8	+56 22	2.16	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	42.1	−18 09	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	47.3	+57 39	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.9	+60 33	2.13v	−0.16v	B0	IV:pe	0.034	−0.3:	96:	0.026	−06.8	Var. *B* 8.18^m 2″	
β Phe *AB*	01 04.7	−46.53	3.30	+0.88	*G8*	*III*	0.017	+0.3	190	0.035	−01.1	*A* 4.1^m *B* 4.1^m 2″	
η Cet	07.1	−10 20	3.47	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	08.0	+35 28	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.8	+60 05	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* 0.08:^{m} 759^d	
γ Phe	27.1	−43 28	3.44	+1.56	*K5*	*Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.6	−57 23	0.51	−0.16	*B5*	*IV*:	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.7	−16 06	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1970	Dec.	V	$B–V$	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
α Tri	01 51.4	+29 26	3.45	+0.46	F6	IV	0.050	+2.0	65	0.230	*−12.6*		
ε Cas	52.2	+63 31	3.33	−0.15	B3	IV:p	0.007	−2.7	520	0.038	−08.1		
β Ari	53.0	+20 40	2.68	+0.14	A5	V	0.063	+1.7	52	0.147	*−01.9*		
α Hyi	57.8	−61 43	2.84	+0.28	*F0*	*V*		+2.9	31	0.265	+07		
γ And *A*	02 02.1	+42 11	2.14:	+1.16:	K3	II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″	γ And = *Almach*
α UMi *A*	02.5	+89 08	1.99v	+0.60v	F8	Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11^m 4.0^d, *B* 8.9^m 18″	*Polaris*
α Ari	05.5	+23 19	2.00	+1.15	K2	III	0.043	+0.2	76	0.241	−14.3		*Hamal*
β Tri	07.8	+34 51	3.00	+0.13	A5	III	0.012	−0.1	140	0.156	*+09.9*		
o Cet *A*	17.8	−03 07	2.0v			(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332^d, *B* 10^m 1″	*Mira*
γ Cet *AB*	41.7	+03 07	3.48	+0.11	A2	V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″	
θ Eri *AB*	57.1	−40 25	2.92	+0.13	*A3*	*V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″	*Acamar*
α Cet	03 00.7	+03 58	2.54	+1.63	M2	III	0.003	−0.5	130	0.075	−25.9		*Menkar*
γ Per	02.6	+53 23	2.91:	+0.72:	G8 III: +A3:		0.011	+0.3	113	0.004	*+02.5*		
ρ Per	03.1	+38 43	3.5v		M4	II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8	
β Per	06.0	+40 50	2.06v	−0.07	B8	V	0.031	−0.5	105	0.006	*+04.0*	Ecl. *R* 2.06–3.28, 2.87^d	*Algol*
α Per	22.2	+49 45	1.80	+0.48	F5	Ib	0.029	−4.4	570	0.035	−02.4		*Mirfak*
δ Per	40.8	+47 42	3.03	−0.14	B5	III	0.007	−3.3	590	0.046	−09		
η Tau	45.7	+24 01	2.86	−0.09	B7	III	0.005	−3.2	541	0.050	+10.1	in Pleiades	*Alcyone*
γ Hyi	47.7	−74 20	3.30	+1.61	*M2*	*II–III*	−.001	−1.5	300	0.125	+16.0		
ζ Per *A*	52.1	+31 48	2.83	+0.13	B1	Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″	
ε Per *A*	55.8	+39 55	2.88	−0.17	B0.5	V	−.001	−3.7	680	0.036	−01	*B* 7.99^m 9″	
γ Eri	56.6	−13 36	3.01	+1.58	M0	III	0.003	−0.5	160	0.126	+61.7		
α Ret *A*	04 14.0	−62 33	3.33	+0.91	*G6*	*II*	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″	
ε Tau	26.9	+19 07	3.54	+1.02	K0	III	0.018	+0.1	160	0.118	+38.6		
θ^2 Tau	26.9	+15 48	3.42	+0.17	A7	III	0.025	+0.2	140	0.108	*+39.5*		
α Dor	33.3	−55 06	3.28	−0.08	*A0*	*IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star	
α Tau *A*	34.2	+16 27	0.86v	+1.52	K5	III	0.048	−0.7	68	0.202	+54.1	Irr.? *R* 0.78–0.93, *B* 13^m 31″	***Aldebaran***
π^3 Ori	48.2	+06 55	3.17	+0.45	F6	V	0.125	+3.65	26	0.468	+24.3		
ι Aur	55.0	+33 07	2.64:	+1.49	K3	II	0.015	−2.4	330	0.021	+17.5		

α UMi, *Polaris:* R.A. 2h 02.5m; Dec. +89° 07′ (1969).

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
ε Aur	04 59.8	+43 47	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. *R* 0.81^m 9886^d
ε Lep	05 04.2	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
η Aur	04.4	+41 12	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
β Eri	06.4	−05 07	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	11.6	−16 14	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	13.1	−08 14	0.14v	−0.04	B8 Ia	−.003	−7.1	900	0.001	*+20.7*	Irr. ? *R* 0.08–0.20, *B* 6.65^m 9″ ***Rigel***
α Aur	14.5	+45 58	0.05	+0.80	G8 III: +F	0.073	−0.6	45	0.435	*+30.2*	***Capella***
η Ori *AB*	23.0	−02 25	3.32v	−0.18	B0.5 V	0.004	−3.7	940	0.008	*+19.8*	Ecl. *R* 3.32–3.50, 8.0^d, *A* 3.59^m *B* 4.98^m 1″
γ Ori	23.5	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	***Bellatrix***
β Tau	24.4	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	***Elnath***
β Lep *A*	27.0	−20 47	2.81	+0.82	G5 III	0.014	+0.1	113	0.090	−13.5	*B* 9.4^m 3″
δ Ori *A*	30.5	−00 19	2.20v	−0.20	O9.5 II	0.004	−6.1	1500	0.002	*+16.0*	Ecl. *R* 2.20–2.35 5.7^d, B 6.74^m 53″
α Lep	31.4	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	33.5	+09 55	3.40	−0.18	O8	0.006	−5.1	1800	0.006	+33.5	*A* 3.56^m *B* 5.54^m 4″ *C* 10.92^m 29″
ι Ori *AB*	34.0	−05 56	2.76	−0.24	O9 III	0.021	−6.1	2000	0.005	*+21.5*	*A* 2.78^m *B* 7.31^m 11″
ε Ori	34.7	−01 13	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	***Alnilam***
ζ Tau	35.9	+21 08	3.07:	−0.13:	B2 III:p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col *A*	38.6	−34 05	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^m 12″
ζ Ori *AB*	39.2	−01 57	1.79	−0.22	O9.5 Ib	0.022	−6.6	1600	0.004	+18.1	*A* 1.91^m *B* 4.05^m 3″
κ Ori	46.3	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.9	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.5	+07 24	0.41v	+1.87:	M2 Iab	0.005	−5.6	520	0.028	*+21.0*	Irr. ? *R* 0.06:–0.75:^{m} ***Betelgeuse***
β Aur	57.3	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur *AB*	57.7	+37 13	2.65	−0.07	B9.5pv	0.018	+0.1	108	0.097	+29.3	Silicon star *A* 2.67^m *B* 7.14^m 3″
η Gem *A*	06 13.1	+22 31	3.33v	+1.58	M3 III	0.013	−0.6	200	0.066	*+19.0*	*R* 0.27^m, *B* 6.70^m 1″
ζ CMa	19.2	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	21.1	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^m
β CMa	21.4	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.3	−52 41	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	***Canopus***
γ Gem	36.0	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1970	Dec.	V	$B–V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ν Pup	06 36.8	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ε Gem	42.1	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	43.6	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	43.8	−16 41	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, θ = 90°	***Sirius***
α Pic	48.1	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6		
τ Pup	49.2	−50 35	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*		
ε CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
σ² CMa	07 01.8	−23 47	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	07.2	−26 21	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.6	−44 36			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	16.1	−37 03	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.9	−29 14	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.7	+08 21	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.3	−43 14	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	32.7	+31 57	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	} 5″, *B–V* +0.02, *C* 9.08v^m 73″	***Castor***
α Gem *B*	32.7	+31 57	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.7	+05 18	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7^m 5″	***Procyon***
β Gem	43.5	+28 06	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	48.0	−24 48	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	56.0	−52 54	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.5	−39 55	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	06.3	−24 13	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.6	−47 16	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ε Car	21.9	−59 24	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		***Avior***
o UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″	
ε Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A* 3.7^m *B* 5.2^m 0.2″ 15^y, *C* 6.8^m 3″ *D* 12^m 20″	
ζ Hya	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″	

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
λ Vel	09 06.9	−43 19	2.24	+1.64:	*K5 Ib*	0.015	−4.6	750	0.026	+18.4	*Suhail*
a Car	10.2	−58 50	3.43	−0.17	*B3 IV*		−2.9	590	0.028	+*23.3*	
β Car	12.9	−69 36	1.67	+0.01	*A0 III*	0.038	−0.4	86	0.183	−05	*Miaplacidus*
ι Car	16.3	−59 08	2.25	+0.17	*F0 Ib*		−4.6	750	0.019	+13.3	
α Lyn	19.3	+34 *32*	3.17	+1.54	M0 III	0.021	−0.5	180	0.217	+37.6	
κ Vel	21.2	−54 53	2.45	−0.15	*B2 IV*	0.007	−3.4	470	0.012	+*21.9*	
α Hya	26.1	−08 32	1.98	+1.44	K4 III	0.017	−0.3	94	0.034	−04.3	*Alphard*
N Vel	30.3	−56 54	3.19	+1.56	(gK5)	0.015	−0.4	170	0.036	−13.9	
θ UMa *A*	30.8	+51 49	3.19	+0.46	F6 IV	0.052	+1.8	63	1.094	+15.4	*B* 14^m 5″
ε Leo	44.1	+23 54	2.99	+0.81	G0 II	0.002	−2.1	340	0.048	+05.0	
l Car	44.4	−62 23	4.1		(cG0)	0.019	−5.5	2700	0.016	+*04.0*	Cep. max. 3.4^m min. 4.8^m, 35.52^d
υ Car *AB*	46.4	−64 56	2.95	+0.26	*A7 II*	0.020	−2.1	340	0.012	+13.6	*A* 3.02^m *B* 6.03^m 5″
α Leo *A*	10 06.8	+12 07	1.36	−0.11	B7 V	0.039	−0.7	84	0.248	+03.5	*B* 8.1^m 177″ ***Regulus***
ω Car	13.0	−69 53	3.33	−0.08	*B8.5 IV*		−1.5	300	0.029	+04	
ζ Leo	15.1	+23 34	3.46	+0.30	F0 III	0.009	+0.5	130	0.023	−15.0	
λ UMa	15.3	+43 04	3.45	+0.03	A2 IV	−.010	+0.1	150	0.170	+18.3	
q Car	16.1	−61 11	3.41v	+1.55	*K5 Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44
γ Leo *AB*	18.3	+20 00	1.99	+1.13	K0 IIIp	0.019	+0.1	90	0.350	−36.6	*A* 2.29^m *B* 3.54^m 4″
μ UMa	20.5	+41 39	3.05	+1.55	M0 III	0.031	+0.5	105	0.086	−*20.5*	
p Car	31.0	−61 32	3.30v	−0.11	*B5 IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39
θ Car	41.9	−64 14	2.74	−0.22	*B0 Vp*		−4.0	710	0.018	+24	
μ Vel *AB*	45.5	−49 16	2.67	+0.89	*G5 III*		+0.1	108	0.085	+06.9	*A* 2.7^m *B* 7.2^m 2″
ν Hya	48.1	−16 02	3.12	+1.25	K3 III	0.022	−0.2	150	0.221	−01.0	
β UMa	11 00.0	+56 33	2.37	−0.03	A1 V	0.042	+0.5	78	0.087	−12.0	*Merak*
α UMa *AB*	01.9	+61 55	1.81	+1.06	K0 III	0.031	−0.7	105	0.138	−08.9	*A* 1.88^m *B* 4.82^m 1″ *Dubhe*
ψ UMa	08.0	+44 39	3.00	+1.14	K1 III		+0.0	130	0.072	−03.8	
δ Leo	12.5	+20 41	2.57	+0.13	A4 V	0.040	+0.6	82	0.201	−20.6	
θ Leo	12.7	+15 36	3.34	0.00	A2 V	0.019	+1.1	90	0.104	+07.8	
λ Cen	34.4	−62 51	3.15	−0.05	*B9 III*		−2.1	370	0.039	+07.9	
β Leo	47.5	+14 44	2.14	+0.09	A3 V	0.076	+1.5	43	0.511	−00.1	*Denebola*

Star	R.A. 1970	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
γ UMa	11 52.2	+53 52	2.44	0.00	A0 V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.8	−50 33	2.59v	−0.15:	*B2 Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.6	−22 27	3.04	+1.33	K3 III		−0.2	140	0.069	+04.9		
δ Cru	13.5	−58 35	2.81v	−0.23	*B2 IV*		−3.4	570	0.041	+26.4	Var *R* 2.78–2.84	
δ UMa	13.9	+57 12	3.30	+0.07	A3 V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	14.3	−17 22	2.59	−0.10	B8 III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.9	−62 56	1.39	−0.25	*B1 IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90ᵐ 89″	*Acrux*
α Cru *B*	24.9	−62 56	1.86	−0.25	(B3)		−3.4	370	0.042	*−00.6*	}	
δ Crv *A*	28.3	−16 21	2.97	−0.04	B9.5 V:n	0.018	+0.1	124	0.255	+09	*B* 8.26ᵐ 24″	
γ Cru	29.5	−56 57	1.69	+1.55	*M3 II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.8	−23 14	2.66	+0.89	G5 III	0.027	+0.1	108	0.059	−07.7		
α Mus	35.4	−68 58	2.70v	−0.20	*B3 IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.9	−48 48	2.17	+0.00	*A0 IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9ᵐ *B* 2.9ᵐ 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0 V	0.101	+3.5	32	0.567	−19.7	*A* 3.50ᵐ *B* 3.52ᵐ 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3 V*		−2.1	470	0.041	+42	*A* 3.7ᵐ *B* 4.0ᵐ 1″	
β Cru	46.0	−59 32	1.28	−0.25	*B0 III*		−4.6	490	0.049	+20.0		***Beta Crucis***
ε UMa	52.7	+56 07	1.79	−0.03	A0pv	0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.6	+38 29	2.90	−0.10	B9.5pv	0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61ᵐ 20″	
ε Vir	13 00.7	+11 08	2.86	+0.93	G9 II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	17.3	−23 01	2.98	+0.92	G8 III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.9	−36 33	2.76	+0.05	*A2 V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.7	+55 05	2.26	+0.02	A2 V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94ᵐ 14″ (Alcor, 224″)	*Mizar*
α Vir	23.6	−11 00	0.91v	−0.24	B1 V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0ᵈ	***Spica***
ζ Vir	33.2	−00 27	3.40	+0.10	A3 Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	38.0	−53 19	2.33	−0.23	*B1 IV*		−3.9	570	0.033	+05.6		
η UMa	46.4	+49 28	1.87	−0.20	B3 V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.7	−41 32	3.42	−0.22	B2 IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.8	−42 20	3.12v	−0.13:	B2 V:pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	53.3	+18 33	2.69	+0.59	G0 IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.7	−47 09	2.56	−0.23:	*B2 IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1970	Dec.	*V*	*B–V*	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
β Cen *AB*	14 01.7	−60 13	0.63	−0.23:	*B1*	*II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7^{m} *B* 3.9^{m} 1″	***Hadar***
π Hya	04.7	−26 32	3.25	+1.13	K2	III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.9	−36 14	2.04	+1.03	K0	III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	14.3	+19 20	−0.06	+1.23	K2	IIIp	0.090	−0.3	36	2.284	−05.2		*Arcturus*
γ Boo	30.9	+38 27	3.05	+0.19	A7	III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.6	−42 01	2.39v	−0.21	B1.5	V:ne		−3.0	390	0.049	−00.2	Var, *R* 2.33–2.45	
α Cen *A*	37.6	−60 43	0.01	+0.68	*G2*	*V*	} .751	+4.39	4.3	} 3.676	−24.6	} 18″	***Rigil Kentaurus***
α Cen *B*	37.6	−60 43	1.40:	+0.73:	(dK1)			+5.8	4.3		−20.7		
α Lup	40.0	−47 16	2.32	−0.22	B1	V		−3.3	430	0.033	+07.3		
α Cir *AB*	40.1	−64 50	3.18	+0.25	*F0*	*Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19^{m} *B* 8.61^{m} 16″	
ε Boo *AB*	43.7	+27 12	2.37	+0.96	K1:	III:+A	0.013	+0.0	103	0.051	−16.5	*A* 2.47^{m} *B* 5.04^{m} 3″	
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m		0.049	+1.2	66	0.130	−10	*B* 5.15^{m} 231″	*Zubenelgenubi*
β UMi	50.8	+74 16	2.04	+1.47	K4	III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	56.6	−43 01	2.69	−0.23	B2	IV		−3.4	540	0.066	−00.3		
κ Cen	57.1	−41 59	3.15	−0.21	B2	V		−2.7	470	0.033	+09.1		
β Boo	15 00.8	+40 30	3.48	+0.95	G8	III	0.022	+0.3	140	0.059	−19.9		
σ Lib	02.3	−25 10	3.31	+1.65	M4	III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	10.1	−51 59	3.42	+0.90:	*K0*	*III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8^{m} 71″	
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8	III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^{m} 105″	
β Lib	15.4	−09 16	2.61	−0.11	B8	V	−.012	−0.6	140	0.101	−35.2		
γ TrA	16.1	−68 34	2.94	−0.01	*A0*	*Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	19.4	−40 32	3.24	−0.23	B2	IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 56	3.08	+0.06	A3	II–III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.3	+59 04	3.28	+1.18	K2	III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	33.1	−41 04	2.80	−0.22	B2	Vn		−2.7	570	0.037	+06	*A* 3.5^{m} *B* 3.7^{m} 1″	
α CrB	33.4	+26 49	2.23v	−0.02	A0	V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^{m}, 17.4^{d}	*Alphecca*
α Ser	42.8	+06 31	2.65	+1.17	K2	III	0.046	+1.0	71	0.139	+02.9		
β TrA	52.5	−63 20	2.87	+0.28:	*F2*	*V*	0.078	+2.3	42	0.448	−00.3		
π Sco	57.0	−26 02	2.92	−0.19	B1	V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	58.1	−38 19	3.45	−0.23	B2	V		−2.7	570	0.042	+07	*A* 3.47^{m} *B* 7.70^{m} 15″	
δ Sco	58.6	−22 32	2.34	−0.13	B0	V		−4.0	590	0.032	−14		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Sco *AB*	16 03.7	−19 43	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−06.6*	*A* 2.78ᵐ *B* 5.04ᵐ 1″, *C* 4.93ᵐ 14″	
δ Oph	12.8	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9		
ε Oph	16.7	−04 38	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3		
σ Sco *A*	19.4	−25 31	2.86v	+0.14	B1 III		−4.4	570	0.030	*−00.4*	β CMa *R* 2.82–2.90, 0.25ᵈ, *B* 8.49ᵐ 20″	
η Dra *A*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7ᵐ 6″	
α Sco *A*	27.6	−26 22	0.92v	+1.84	M1 Ib+B	0.019	−5.1	520	0.029	−03.2	*A* 0.86ᵐ–1.02ᵐ *B* 5.07ᵐ 3″	***Antares***
β Her	28.9	+21 33	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*		
τ Sco	34.0	−28 09	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7		
ζ Oph	35.5	−10 30	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19		
ζ Her *AB*	40.2	+31 39	2.81	+0.64	G0 IV	0.110	+3.1	30	0.608	*−69.9*	*A* 2.91ᵐ *B* 5.46ᵐ 1″	
η Her	41.9	+38 59	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	45.5	−68 59	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6		*Atria*
ε Sco	48.2	−34 15	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5		
μ¹ Sco	49.8	−38 00	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4ᵈ	
ζ Ara	56.1	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0		
κ Oph	56.3	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6		
ζ Dra	17 08.7	+65 45	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1		
η Oph *AB*	08.7	−15 41	2.46	+0.06	A2.5 V	0.047	+1.4	69	0.097	−00.9	*A* 3.0ᵐ *B* 3.4ᵐ 1″	*Sabik*
η Sco	10.0	−43 12	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4		
α Her *AB*	13.3	+14 25	3.10v	+1.41	M5 II	−.007	−2.3	410	0.032	−33.1	*A* 3.2ᵐ ± 0.3 *B* 5.4ᵐ 5″	*Ras-Algethi*
δ Her	13.8	+24 52	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41		
π Her	14.0	+36 50	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7		
θ Oph	20.2	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6		
β Ara	22.8	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4		
γ Ara *A*	22.9	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10ᵐ 18″	
υ Sco	28.7	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*		
α Ara	29.5	−49 52	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*		
β Dra *A*	29.7	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49ᵐ 4″	
λ Sco	31.6	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00		*Shaula*
α Oph	33.5	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		*Rasalhague*
θ Sco	35.2	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
ι^1 Sco	45.5	−40 06	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
G Sco	47.7	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.9	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	***Eltanin***
ν Oph	57.4	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.9	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	15.6	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	19.1	−29 50	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.7	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	22.2	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	***Kaus Australis***
λ Sgr	26.1	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.9	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
φ Sgr	43.8	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	49.0	+33 20	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	*−19.2*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″
*i*σ Sgr	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11	***Nunk***
ξ^2 Sgr	55.9	−21 08	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.8	+32 39	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.7	−29 55	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m 1″
ζ Aql *A*	04.0	+13 49	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.7	−04 56	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.1	−27 43	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.0	−21 04	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.5	+67 37	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.0	+03 03	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.5	+27 54	3.07	+1.12	K3 II:+B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ ***Albireo***
δ Cyg *AB*	44.0	+45 04	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	44.8	+10 32	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.3	+08 47	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1970	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
θ Aql	20 09.8	−00 54	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	19.3	−14 53	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97^m 205″	
γ Cyg	21.1	+40 09	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	23.3	−56 50	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	35.5	−47 23	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.4	+45 10	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6		***Deneb***
β Pav	42.3	−66 19	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8		
η Cep	44.7	+61 43	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	45.0	+33 51	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 11.7	+30 06	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	17.9	+62 28	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.3	+70 25	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19^d	
β Aqr	30.0	−05 43	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	42.7	+09 45	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11^m 82″	*Enif*
δ Cap	45.4	−16 16	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95	
γ Gru	52.1	−37 30	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 04.2	−00 28	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	06.3	−47 07	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	09.8	+58 03	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	16.4	−60 24	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	28.1	+58 16	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4^d, *B* 6.19^m 41″	
ζ Peg	40.0	+10 41	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	40.9	−47 02	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	41.6	+30 04	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	53.1	−15 59	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	56.0	−29 47	1.19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 02.3	+27 55	2.5 v	+1.67	M2 II–III	0.015	−1.5	210	0.234	+08.7	Var. *R* 2.4–2.7	*Scheat*
α Peg	03.3	+15 02	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	38.1	+77 27	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

THE NEAREST STARS

By Alan H. Batten and Russell O. Redman

The accompanying table is similar to one that has been published in the Handbook for several years past. Like its predecessor, it has been based on the work of Professor van de Kamp who published in the *Publications of the Astronomical Society of the Pacific* for 1969 a revision of his list of the nearest stars. The new list contains three new stars (two of them forming a binary system) and three new unseen companions of stars already in the list. In addition, many distances have been revised, and this has changed the order of stars in the list. The relative luminosities in the last column have also been changed a little, partly because of the revisions of distances, but also because of a small change in the adopted absolute magnitude of the sun.

Measuring the distances of the stars is one of the most difficult and most important tasks of the observational astronomer. As the earth travels around the sun each year, the directions of the nearer stars seem to change very slightly when measured against the background of the more distant stars. This change is called annual parallax. Even for the nearest star, the parallax is less than one second of arc—which is the angle subtended by a penny at a distance of about 2.5 miles. That explains the difficulty of the task. Its importance stems from the fact that all our knowledge of the luminosities of stars, and hence of the structure of the galaxy, depends on the relatively few stellar distances that can be directly and accurately measured. To describe these vast distances, astronomers have invented new units. The most familiar is the light-year—the distance light travels in a year, nearly six million million miles. More convenient in many calculations is the parsec, which is about 3.26 light-years. The distance in parsecs is simply the reciprocal of the parallax.

The table gives the name and position of each star, the annual parallax π, the distance in light-years D, the spectral type, the proper motion μ in seconds of arc per year (that is the apparent motion of the star across the sky each year—nearby stars often have large proper motions), the total space velocity W in km./sec., if known, the visual apparent magnitude and the luminosity in terms of the sun. In column 6, *wd* stands for white dwarf, and *e* indicates the presence of emission lines in the spectrum. Note how very few stars in our neighbourhood are brighter than the sun. There are no very luminous or very hot stars at all. Most stars in this part of the galaxy are small, cool, and insignificant objects.

The list contains 59 stars, including the sun, and seven unseen companions. Thirty-one of these objects are either single stars or have only unseen companions. There are eleven double-star systems and two triple systems. Of the unseen companions, one of the most interesting is that of Barnard's Star. Van de Kamp has shown that the observed perturbations in the motion of Barnard's Star can be explained on the assumption that the star is accompanied by a body about twice the size of Jupiter. Alternatively, two objects each about the size of Jupiter could produce the observed perturbations. Perhaps this star has the first planetary system to be discovered outside our own system.

THE NEAREST STARS

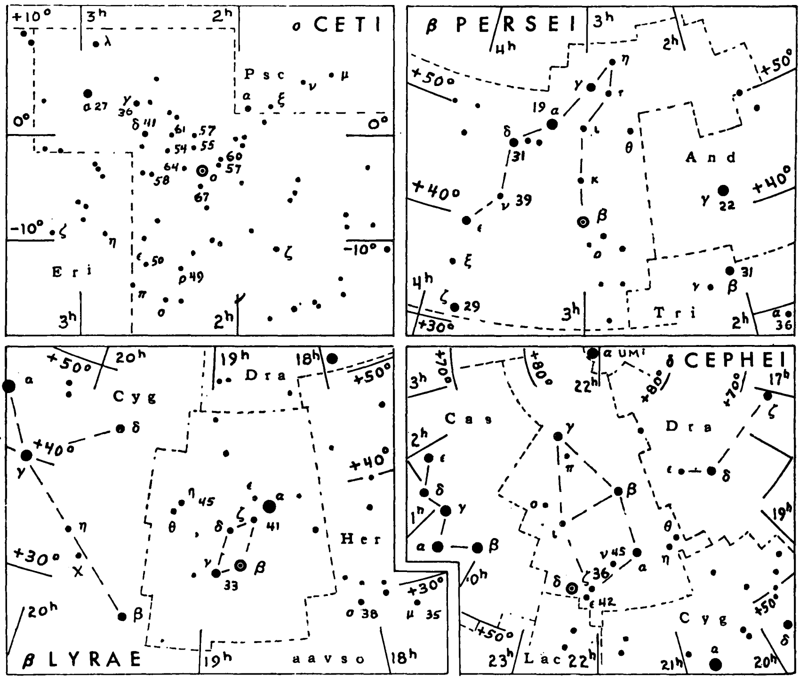
Name	1970								
	α	δ	π	D	Sp.		W	m	L
	h m	° ′	″	l.y.		″	km./sec.		
Sun					G2			−26.8	1.0
α Cen A	14 37	−60 43	0.760	4.3	G2	3.68	32	0.1	1.3
B					K5			1.5	0.36
C	14 27	−62 33			M5*e*			11.0	0.00006
Barnard's*	17 56	+04 36	.552	5.9	M5	10.30	140	9.5	0.00044
Wolf 359	10 55	+07 13	.431	7.6	M6*e*	4.84	55	13.5	0.00002
Lal. 21185*	11 02	+36 10	.402	8.1	M2	4.78	103	7.5	0.0052
Sirius A	6 44	−16 41	.377	8.6	A1	1.32	18	−1.5	23.
B					*wd*			7.2	0.008
Luy. 726–8A	1 37	−18 07	.365	8.9	M6*e*	3.35	52	12.5	0.00006
B					M6*e*			13.0	0.00004
Ross 154	18 48	−23 51	.345	9.4	M5*e*	0.74	12	10.6	0.0004
Ross 248	23 40	+44 01	.317	10.3	M6*e*	1.82	86	12.2	0.00011
ε Eri	03 32	−09 34	.305	10.7	K2	0.97	22	3.7	0.30
Luy. 789–6	22 37	−15 31	.302	10.8	M6	3.27	79	12.2	0.00012
Ross 128	11 46	+01 01	.301	10.8	M5	1.40	26	11.1	0.00033
61 Cyg A	21 06	+38 36	.292	11.2	K5	5.22	106	5.2	0.083
B*					K7			6.0	0.040
ε Ind	22 02	−56 55	.291	11.2	K5	4.67	86	4.7	0.13
Procyon A	07 38	+05 18	.287	11.4	F5	1.25	21	0.3	7.6
B					*wd*			10.8	0.0005
Σ 2398 A	18 42	+59 35	.284	11.5	M3.5	2.29	39	8.9	0.0028
B					M4			9.7	0.0013
Groom. 34 A	00 17	+43 51	.282	11.6	M1	2.91	52	8.1	0.0058
B					M6			11.0	0.00040
Lacaille 9352	23 04	−36 02	.279	11.7	M2	6.87	117	7.4	0.012
τ Ceti	01 43	−16 06	.273	11.9	G8	1.92	37	3.5	0.44
BD+5°1668*	07 26	+05 28	.266	12.2	M4	3.73	71	9.8	0.0014
Lacaille 8760	21 15	−39 00	.260	12.5	M1	3.46	67	6.7	0.025
Kapteyn's	05 11	−45 00	.256	12.7	M0	8.79	292	8.8	0.0040
Kruger 60 A	22 27	+57 33	.254	12.8	M4	0.87	31	9.7	0.0017
B					M6			11.2	0.00044
Ross 614 A	06 28	−02 48	.249	13.1	M5*e*	0.97	30	11.3	0.0004
B					?			14.8	0.00002
BD−12°4523	16 29	−12 35	.249	13.1	M5	1.18	38	10.0	0.0013
van Maanen's	00 47	+05 16	.234	13.9	*wd*F	2.98	270	12.4	0.00017
Wolf 424 A	12 32	+09 12	.229	14.2	M6*e*	1.87	39	12.6	0.00014
B					M6*e*			12.6	0.00014
CD−37°15492	00 03	−37 30	.225	14.5	M3	6.09	130	8.6	0.0058
Groom. 1618	10 09	+49 36	.217	15.0	M0	1.45	40	6.6	0.040
CD−46°11540	17 27	−46 53	.216	15.1	M4	1.15		9.4	0.0030
CD−49°13515	21 31	−49 08	.214	15.2	M3	0.78		8.7	0.0058
CD−44°11909	17 36	−44 17	.213	15.3	M5	1.14		11.2	0.00063
Luy. 1159–16	01 58	+12 57	.212	15.4	(M7)	2.08		12.3	0.00023
Lal. 25372	13 44	+15 04	.208	15.7	M3.5	2.30	55	8.5	0.0076
AOe 17415–6*	17 37	+68 22	.207	15.7	M3.5	1.31	34	9.1	0.0044
CC 658	11 44	−64 39	.206	15.8	*wd*	2.69		11.0	0.0008
Ross 780	22 51	−14 25	.206	15.8	M5	1.17	28	10.2	0.0016
o^2 Eri A	04 14	−07 42	.205	15.9	K0	4.08	104	4.4	0.33
B					*wd*A			9.9	0.0027
C					M4*e*			11.2	0.00063
BD+20°2465*	10 18	+20 01	.202	16.1	M4.5	0.49	15	9.4	0.0036
Altair	19 49	+08 47	.196	16.6	A7	0.66	31	0.8	10.
70 Oph. A	18 04	+02 31	.195	16.7	K1	1.13	29	4.2	0.44
B					K6			6.0	0.083
AC+79°3888	11 45	+78 50	.194	16.8	M4	0.87	121	11.0	0.0009
BD+43°4305*	22 46	+44 11	.193	16.9	M5*e*	0.84	21	10.1	0.0021
Stein 2051 A	04 29	+58 56	.192	17.0	(M5)	2.37		11.1	0.0008
B					*wd*			12.4	0.0003

*Star has an unseen component.

VARIABLE STARS

The systematic observation of variable stars is an area in which an amateur can make a valuable contribution to astronomy. For beginning observers, maps of the fields of four bright variable stars are given below. In each case, the magnitudes (with decimal point omitted) of several suitable comparison stars are given. Using two comparison stars, one brighter, one fainter than the variable, estimate the brightness of the variable in terms of these two stars. Record also the date and time of observation. When a number of observations have been made, a graph of magnitude versus date may be plotted. The shape of this "light curve" depends on the type of variable. Further information about variable star observing may be obtained from the American Association of Variable Star Observers, 187 Concord Ave., Cambridge, Mass. 02138.

In the tables the first column, the Harvard designation of the star, gives the 1900 position: the first four figures give the hours and minutes of R.A., the last two figures give the Dec. in degrees, italicised for southern declinations. The column headed *Max.* gives the mean maximum magnitude. The *Period* is in days. The *Epoch* gives the predicted date of the *earliest* maximum occurring this year; by adding the period to this epoch other dates of maximum may be found. The list of long-period variables has been prepared by the American Association of Variable Star Observers and includes the variables with maxima brighter than mag. 8.0, and north of Dec. −20°. These variables may reach maximum two or three weeks before or after the listed epoch and may remain at maximum for several weeks. The second table contains stars which are representative of other types of variable. The data are taken from "The General Catalogue of Variable Stars" by Kukarkin and Parenago and for eclipsing binaries from *Rocznik Astronomiczny Obserwatorium Krakowskiego*, 1971, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1972	Variable	Max. m	Per d	Epoch 1972
001755 T Cas	7.8	445	May 26	142539 V Boo	7.9	258	Apr. 13
001838 R And	7.0	409	May 28	143227 R Boo	7.2	223	Mar. 15
021143 W And	7.4	397	Aug. 3	151731 S CrB	7.3	361	Feb. 2
0214*03* o Cet	3.4	332	May 30	154639 V CrB	7.5	358	Nov. 20
0228*13* U Cet	7.5	235	Apr. 25	154615 R Ser	6.9	357	Oct. 16
023133 R Tri	6.2	266	May 31	160625 RU Her	8.0	484	Aug. 20
043065 T Cam	8.0	374	Dec. 3	162119 U Her	7.5	406	Jan. 3
0455*14* R Lep	6.8	432	Dec. 6	1621*12* V Oph	7.5	298	July 8
050953 R Aur	7.7	459	—	163266 R Dra	7.6	245	Jan. 9
054920 U Ori	6.3	372	July 31	164715 S Her	7.6	307	Feb. 28
0617*02* V Mon	7.0	335	Aug. 30	1702*15* R Oph	7.9	302	Aug. 12
065355 R Lyn	7.9	379	Feb. 10	171723 RS Her	7.9	219	Apr. 25
070122aR Gem	7.1	370	May 27	180531 T Her	8.0	165	Feb. 7
070310 R CMi	8.0	338	Jan. 5	181136 W Lyr	7.9	196	Jan. 1
072708 S CMi	7.5	332	Aug. 16	183308 X Oph	6.8	334	June 1
081112 R Cnc	6.8	362	Dec. 1	190108 R Aql	6.1	300	July 5
081617 V Cnc	7.9	272	Sept. 9	1910*17* T Sgr	8.0	392	Feb. 5
084803 S Hya	7.8	257	Apr. 19	1910*19* R Sgr	7.3	269	June 1
0850*08* T Hya	7.8	288	Feb. 4	193449 R Cyg	7.5	426	Oct. 10
093934 R LMi	7.1	372	Feb. 1	194048 RT Cyg	7.3	190	Feb. 1
094211 R Leo	5.8	313	Feb. 25	194632 χ Cyg	5.2	407	—
103769 R UMa	7.5	302	Mar. 6	201647 U Cyg	7.2	465	Jan. 13
1214*18* R Crv	7.5	317	July 2	2044*05* T Aqr	7.7	202	Jan. 23
122001 SS Vir	6.8	355	Jan. 28	210868 T Cep	6.0	390	Apr. 13
123160 T UMa	7.7	257	July 11	213753 RU Cyg	8.0	234	May 19
123307 R Vir	6.9	146	Jan. 8	230110 R Peg	7.8	378	Jan. 3
123961 S UMa	7.8	226	June 1	230759 V Cas	7.9	228	Feb. 21
131546 V CVn	6.8	192	Apr. 9	231508 S Peg	8.0	319	May 24
1327*06* S Vir	7.0	378	Dec. 20	2338*15* R Aqr	6.5	387	Oct. 29
134440 R CVn	7.7	328	Oct. 9	235350 R Cas	7.0	431	May 8
142584 R Cam	7.9	270	Aug. 19	2357*15* W Cet	7.6	351	Mar. 18

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1972 E.S.T.
005381 U Cep	6.7	9.8	Ecl.	B8+gG2	2.49302	Jan. 1.32*
025838 ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	—
030140 β Per	2.1	3.3	Ecl.	B8+G	2.86731	Jan. 3.77*
035512 λ Tau	3.5	4.0	Ecl.	B3	3.952952	Jan. 2.33*
060822 η Gem	3.1	3.9	Semi R	M3	233.4	—
061907 T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 7.54
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.63
154428 R Cr B	5.8	14.8	R Cr B	cFpep		—
171014 α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	—
1842*05* R Sct	6.3	8.6	RVTau	G0e-K0p	144	—
184633 β Lyr	3.4	4.3	Ecl.	B8	12.931163	Jan. 2.96*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.49
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 6.71
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 1.68

*Minimum.

DOUBLE AND MULTIPLE STARS

By Charles E. Worley

Many stars can be separated into two or more components by use of a telescope The larger the aperture of the telescope, the closer the stars which can be separated under good seeing conditions. With telescopes of moderate size and average optical quality, and for stars which are not unduly faint or of large magnitude difference, the minimum angular separation is given by 4.6/D, where D is the diameter of the telescope's objective in inches.

The following lists contain some interesting examples of double stars. The first list presents pairs whose orbital motions are very slow. Consequently, their angular separations remain relatively fixed and these pairs are suitable for testing the performance of small telescopes. In the second list are pairs of more general interest, including a number of binaries of short period for which the position angles and separations are changing rapidly.

In both lists the columns give, successively: the star designation in two forms; its right ascension and declination for 1970; the combined visual magnitude of the pair and the individual magnitudes; the apparent separation and position angle for 1972. 0; and the period, if known.

Many of the components are themselves very close visual or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars, p. 75, and of The Nearest Stars, p. 86.)

Star	A.D.S.	R.A. 1970 h	m	Dec. 1970 °	′	Magnitudes comb.	A	B	Sep. 1972.0 ″	P.A. 1972.0 °	P (app.) years
λ Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	180	640
α Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.8	287	720
33 Ori	4123	05	29.6	+03	16	5.7	6.0	7.3	1.8	27	—
OΣ 156	5447	06	45.7	+18	14	6.1	6.8	7.0	0.5	249	1100
Σ 1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	242	220
35 Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.9	161	670
Σ 2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	355	—
ε^1 Lyr†	11635	18	43.4	+39	39	5.1	5.4	6.5	2.7	357	1200
ε^2 Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.3	87	600
π Aql	12962	19	47.4	+11	44	5.6	6.0	6.8	1.4	110	—
σ Cas	17140	23	57.4	+55	36	5.2	5.4	7.5	3.0	326	—
η Cas	671	00	47.3	+57	39	3.5*	3.5	7.2	11.6	302	480
Σ 186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	56	160
γ And AB	1630	02	02.0	+42	12	2.1*	2.1	5.4	9.8	64	—
α C Ma	5423	06	43.9	−16	41	−1.4	−1.4	8.5	11.3	64	50
α Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	123	420
ζ Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.0	321	60
ζ Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.9	84	1150
+42° 1956	KUI	08	58.7	+41	53	3.9	4.1	6.2	0.5	182	22
γ Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.4	122	620
ξ U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	3.1	121	60
γ Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.4	302	170
Σ 1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.3	154	155
ζ Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.1	307	125
ξ Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.1	338	150
ζ Her	10157	16	40.2	+31	39	2.8	2.9	5.5	1.1	207	35
α Her AB	10418	17	13.3	+14	26	3.1*	3.2	5.4	4.6	108	—
Σ 2173	10598	17	28.8	−01	02	5.3	6.0	6.1	0.5	134	46
70 Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	2.1	39	88
β 648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.4	114	60
4 Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	8	150
τ Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	1.0	178	50
Σ 3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.6	299	800

*There is a marked colour difference between the components.

†The separation of the two pairs of ε Lyr is 208″.

This table lists the 103 objects in Messier's original catalogue. The columns contain: Messier's number (M), the number in Dreyer's New General Catalogue (NGC), the constellation, the 1970 position, the integrated visual magnitude (m_v), and the class of object. OC means open cluster, GC, globular cluster, PN, planetary nebula, DN, diffuse nebula, and G, galaxy. The type of galaxy is also indicated, as explained in the table of external galaxies. An asterisk indicates that additional information about the object may be found elsewhere in the *Handbook*, in the appropriate table.

M	NGC	Con	α 1970	δ 1970	m_V	Type
1	1952	Tau	5 32.7	+22 01	11.3	DN*
2	7089	Aqr	21 31.9	−00 57	6.27	GC*
3	5272	CVn	13 40.8	+28 32	6.22	GC*
4	6121	Sco	16 21.8	−26 26	6.07	GC*
5	5904	Ser	15 17.0	+02 13	5.99	GC*
6	6405	Sco	17 38.1	−32 11	6	OC*
7	6475	Sco	17 51.9	−34 48	5	OC*
8	6523	Sgr	18 01.8	−24 23		DN*
9	6333	Oph	17 17.5	−18 29	7.58	GC
10	6254	Oph	16 55.5	−04 04	6.40	GC*
11	6705	Sct	18 49.5	−06 19	7	OC*
12	6218	Oph	16 45.6	−01 54	6.74	GC*
13	6205	Her	16 40.6	+36 31	5.78	GC*
14	6402	Oph	17 36.0	−03 14	7.82	GC
15	7078	Peg	21 28.6	+12 02	6.29	GC*
16	6611	Ser	18 17.2	−13 48	7	OC*
17	6618	Sgr	18 19.1	−16 12	7	DN*
18	6613	Sgr	18 18.2	−17 09	7	OC
19	6273	Oph	17 00.7	−26 13	6.94	GC
20	6514	Sgr	18 00.6	−23 02		DN*
21	6531	Sgr	18 02.8	−22 30	7	OC
22	6656	Sgr	18 34.6	−23 56	5.22	GC*
23	6494	Sgr	17 55.1	−19 00	6	OC*
24	6603	Sgr	18 16.7	−18 27	6	OC
25	4725†	Sgr	18 29.9	−19 16	6	OC*
26	6694	Sct	18 43.6	−09 26	9	OC
27	6853	Vul	19 58.4	+22 38	8.2	PN*
28	6626	Sgr	18 22.6	−24 52	7.07	GC
29	6913	Cyg	20 22.9	+38 25	8	OC
30	7099	Cap	21 38.6	−23 18	7.63	GC
31	224	And	0 41.1	+41 06	3.7	G-Sb*
32	221	And	0 41.1	+40 42	8.5	G-E*
33	598	Tri	1 32.2	+30 30	5.9	G-Sc*
34	1039	Per	2 40.1	+42 40	6	OC
35	2168	Gem	6 07.0	+24 21	6	OC*
36	1960	Aur	5 34.3	+34 05	6	OC
37	2099	Aur	5 50.4	+32 33	6	OC*
38	1912	Aur	5 26.6	+35 48	6	OC
39	7092	Cyg	21 31.1	+48 18	6	OC
40	—	UMa	—	—		2 stars
41	2287	CMa	6 45.8	−20 42	6	OC*
42	1976	Ori	5 33.9	−05 24		DN*
43	1982	Ori	5 34.1	−05 18		DN
44	2632	Cnc	8 38.2	+20 06	4	OC*
45	—	Tau	3 45.7	+24 01	2	OC*
46	2437	Pup	7 40.4	−14 45	7	OC*
47	2422	Pup	7 35.1	−14 26	5	OC
48	2548	Hya	8 12.0	−05 41	6	OC
49	4472	Vir	12 28.3	+08 10	8.9	G-E*
50	2323	Mon	7 01.5	−08 18	7	OC
51	5194	CVn	13 28.6	+47 21	8.4	G-Sc*
52	7654	Cas	23 22.9	+61 26	7	OC
53	5024	Com	13 11.5	+18 20	7.70	GC
54	6715	Sgr	18 53.2	−30 31	7.7	GC
55	6809	Sgr	19 38.1	−31 01	6.09	GC*
56	6779	Lyr	19 15.4	+30 07	8.33	GC
57	6720	Lyr	18 52.5	+33 00	9.0	PN*
58	4579	Vir	12 36.2	+11 59	9.9	G-SBb
59	4621	Vir	12 40.5	+11 50	10.3	G-E
60	4649	Vir	12 42.1	+11 44	9.3	G-E
61	4303	Vir	12 20.3	+04 39	9.7	G-Sc
62	6266	Sco	16 59.3	−30 04	7.2	GC
63	5055	CVn	13 14.4	+42 11	8.8	G-Sb*
64	4826	Com	12 55.2	+21 51	8.7	G-Sb*
65	3623	Leo	11 17.3	+13 16	9.6	G-Sa
66	3627	Leo	11 18.6	+13 10	9.2	G-Sb
67	2682	Cnc	8 49.5	+11 56	7	OC*
68	4590	Hya	12 37.8	−26 35	8.04	GC
69	6637	Sgr	18 29.4	−32 23	7.7	GC
70	6681	Sgr	18 41.3	−32 19	8.2	GC
71	6838	Sge	19 52.4	+18 42	6.9	GC
72	6981	Aqr	20 51.8	−12 41	9.15	GC
73	6994	Aqr	20 57.3	−12 46		OC
74	628	Psc	1 35.1	+15 38	9.5	G-Sc
75	6864	Sgr	20 04.3	−22 01	8.31	GC
76	650	Per	1 40.3	+51 25	11.4	PN*
77	1068	Cet	2 41.1	−00 07	9.1	G-Sb
78	2068	Ori	5 45.3	+00 02		DN
79	1904	Lep	5 22.9	−24 33	7.3	GC
80	6093	Sco	16 15.2	−22 55	7.17	GC
81	3031	UMa	9 53.4	+69 12	6.9	G-Sb*
82	3034	UMa	9 53.6	+69 50	8.7	G-Irr*
83	5236	Hya	13 35.3	−29 43	7.5	G-Sc*
84	4374	Vir	12 23.6	+13 03	9.8	G-E
85	4382	Com	12 23.8	+18 21	9.5	G-SO
86	4406	Vir	12 24.6	+13 06	9.8	G-E
87	4486	Vir	12 29.2	+12 33	9.3	G-Ep
88	4501	Com	12 30.4	+14 35	9.7	G-Sb
89	4552	Vir	12 34.1	+12 43	10.3	G-E
90	4569	Vir	12 35.3	+13 19	9.7	G-Sb
91	—	—	—	—		M58?
92	6341	Her	17 16.2	+43 11	6.33	GC*
93	2447	Pup	7 43.2	−23 48	6	OC
94	4736	CVn	12 49.6	+41 17	8.1	G-Sb*
95	3351	Leo	10 42.3	+11 52	9.9	G-SBb
96	3368	Leo	10 45.1	+11 59	9.4	G-Sa
97	3587	UMa	11 13.1	+55 11	11.1	PN*
98	4192	Com	12 12.2	+15 04	10.4	G-Sb
99	4254	Com	12 17.3	+14 35	9.9	G-Sc
100	4321	Com	12 21.4	+15 59	9.6	G-Sc
101	5457	UMa	14 02.1	+54 30	8.1	G-Sc*
102	—	—	—	—		M101?
103	581	Cas	1 31.2	+60 32	7	OC

†Index Catalogue Number.

STAR CLUSTERS

By T. Schmidt-Kaler

The star clusters for this list have been selected to include those most conspicuous. Two types of clusters can be recognized: open (or galactic), and globular. Globulars appear as highly symmetrical agglomerations of very large numbers of stars, distributed throughout the galactic halo but concentrated toward the centre of the Galaxy. Their colour-magnitude diagrams are typical for the old stellar population II. Open clusters appear usually as irregular aggregates of stars, sometimes barely distinguished from random fluctuations of the general field. They are concentrated to the galactic disk, with colour-magnitude diagrams typical for the stellar population I of the normal stars of the solar neighbourhood.

The first table includes all well-defined open clusters with diameters greater than 40′ or integrated magnitudes brighter than 5.0, as well as the richest clusters and some of special interest. *NGC* indicates the serial number of the cluster in Dreyer's *New General Catalogue of Clusters and Nebulae*, *M*, its number in Messier's catalogue, α and δ denote right ascension and declination, *P*, the apparent integrated photographic magnitude according to Collinder (1931), *D*, the apparent diameter in minutes of arc according to Trumpler (1930) when possible, in one case from Collinder; *m*, the photographic magnitude of the fifth-brightest star according to Shapley (1933) when possible or from new data, in italics; *r*, the distance of the cluster in kpcs (1 kpc = 3263 light-years), as a mean from the values given by Johnson, Hoag *et al.* (1961), and by Becker (1963/64), in a few cases from other sources, with values in italics from Trumpler; *Sp*, the earliest spectral type of cluster stars as determined from three-colour photometry, or from spectral types in italics. The spectral type also indicates the age of the cluster, expressed in millions of years, thus: O5 = 0.5; b0 = 5; b5 = 50; a0 = 300; a5 = 1000; f0 = 3000; f5 = 10,000.

The second table includes all globular clusters with a total apparent photographic magnitude brighter than 7.6. The first three columns are as in the first table, followed by *B*, the total photographic magnitude; *D*, the apparent diameter in minutes of arc containing 90 per cent of the stars, and in italics, total diameters from miscellaneous sources; *Sp*, the integrated spectral type; *m*, the mean blue magnitude of the 25 brightest stars (excluding the five brightest); *N*, the number of known variables; *r*, the distance in kpcs (absolute magnitude of RR Lyrae variables taken as $M_B = +0.5$); *V*, the radial velocity in km/sec. The data are taken from a compilation by Arp (1965); in case no data were available there, various other sources have been used, especially H. S. Hogg's Bibliography (1963).

Open Clusters

NGC	α 1970 δ h m	° ′	P	D	m	r	Sp	Remarks
188	00 41.0	+85 11	9.3	14	14.6	1.55	f5	oldest known
752	01 56.0	+37 32	6.6	45	9.6	0.38	f0	
869	02 16.9	+57 01	4.3	30	9.5	2.26	b0	h Per
884	02 20.3	+56 59	4.4	30	9.5	2.41	b0	χ Per, M supergiants
Perseus	03 20	+48 30	2.3	240	5	0.17	b3	moving cl., α Per
Pleiades	03 45.3	+24 02	1.6	120	4.2	0.125	b7	M45, best known
Hyades	04 18	+15 34	0.8	400	*1.5*	0.040	a2	moving cl. in Tau*
1912	05 26.6	+35 49	7.0	18	9.7	1.37	b8	
1976/80	05 33.9	−05 24	2.5	50	*5.5*	0.40	O5	Trapezium, very young
2099	05 50.4	+32 32	6.2	24	9.7	1.28	b8	M37
2168	06 07.0	+24 21	5.6	29	9.0	0.87	b5	M35
2232	06 25.0	−04 44	4.1	*20*	*7*	*0.49*	*b3*	
2244	06 30.8	+04 53	5.2	27	*8.0*	1.65	O5	Rosette, very young
2264	06 39.4	+09 55	4.1	30	*8.0*	0.73	O9	S Mon
2287	06 45.8	−20 42	5.0	32	*8.8*	0.67	b3	M41
2362	07 17.6	−24 53	3.8	7	9.4	1.53	b0	τ CMa

***Basic for distance determination.**

NGC	α 1970 h m	δ ° ′	P	D	m	r	Sp	Remarks
2422	07 34.2	−14 26	4.3	30	9.8	0.48	b4	
2437	07 40.4	−14 45	6.6	27	10.8	1.66	b3	M46
2451	07 44.3	−37 54	3.7	37	6	0.30	b5	
2516	07 57.8	−60 49	3.3	50	10.1	0.37	b9	
2546	08 11.4	−37 33	5.0	45	7	0.74	b0	
2632	08 38.4	+20 06	3.9	90	7.5	0.158	a5	Praesepe, M44
IC2391	08 39.4	−52 57	2.6	45	3.5	0.15	b3	
IC2395	08 40.1	−48 05	4.6	20	10.1	0.90	b2	
2682	08 48.8	+11 56	7.4	18	10.8	0.83	f2	M67, old cl.
3114	10 01.7	−59 58	4.5	37	7	0.85	b6	
IC2602	10 42.2	−64 14	1.6	65	6	0.16	b2	θ Car
Tr 16	10 44.0	−59 33	6.7	10	10	1.95	b0	η Car and Nebula
3532	11 05.1	−58 30	3.4	55	8.1	0.42	b9	
3766	11 34.7	−61 27	4.4	12	8.1	1.63	b0	
Coma	12 23.6	+26 16	2.9	300	5.5	0.08	a2	Very sparse cl.
4755	12 51.8	−60 10	5.2	12	7	1.34	b3	κ Cru, "jewel box"
6067	16 10.9	−54 08	6.5	16	10.9	2.10	b3	G and K supergiants
6231	16 51.9	−41 45	8.5	16	7.5	1.82	O5	Osupergiants, WR-stars
Tr 24	16 54.9	−40 37	8.5	60	*7.3*	*0.58*	*O5*	
6405	17 38.1	−32 12	4.6	26	8.3	0.57	b4	M6
IC4665	17 45.2	+05 44	5.4	50	7	0.33	b5	
6475	17 51.9	−34 48	3.3	50	7.4	0.24	b8	M7
6494	17 55.1	−19 01	5.9	27	10.2	0.55	b9	M23
6523	18 01.3	−24 23	5.2	45	*7*	1.47	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18 17.2	−13 48	6.6	8	10.6	1.90	O5	M16, nebula
IC4725	18 29.9	−19 16	6.2	35	9.3	0.60	b3	M25, Cepheid, U Sgr
IC4756	18 37.8	+05 25	5.4	50	8.5	0.44	a3	
6705	18 49.5	−06 19	6.8	12.5	12	1.72	b8	M11, very rich cl.
Mel 227	20 06.7	−79 25	5.2	60	*9*	*0.24*	*b9*	
IC1396	21 38.0	+57 22	5.1	60	*8.5*	*0.73*	*O6*	Tr 37
7790	23 56.9	+61	7.1	4.5	11.7	3.39	b4	C Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970 h m	δ ° ′	B	D	Sp	m	N	r	V
104	47 Tuc	00 22.6	−72 14	4.35	*44*	G3	13.54	11	5	−24
1851		05 13.0	−40 03	7.72:	*11.5*	F7		3	14.0	+309
2808		09 11.3	−64 44	7.4	*18.8*	F8	15.09	4	9.1	+101
5139	ω Cen	13 25.0	−47 09	4.5	*65.4*	F7	13.01	165	5.2	+230
5272	3	13 40.8	+28 32	6.86	9.3	F7	14.35	189	10.6	−153
5904	5	15 17.0	+02 12	6.69	10.7	F6	14.07	97	8.1	+49
6121	4	16 21.8	−26 27	7.05	22.6	*G0*	13.21	43	4.3	+65
6205	13	16 40.6	+36 31	6.43	12.9	F6	13.85	10	6.3	−241
6218	12	16 45.6	−01 54	7.58	21.5	F8	14.07	1	7.4	−16
6254	10	16 55.5	−04 04	7.26	16.2	G1	14.17	3	6.2	+71
6341	92	17 16.2	+43 11	6.94	12.3	F1	13.96	16	7.9	−118
6397		17 38.4	−53 40	6.9	*19*	F5	12.71	3	2.9	+11
6541		18 05.8	−43 45	7.5	*23.2*	F6	13.45	1	4.0	−148
6656	22	18 34.5	−23 57	6.15	26.2	F7	13.73	24	3.0	−144
6723		18 57.6	−36 40	7.37	11.7	G4	14.32	19	7.4	−3
6752		19 08.2	−60 02	6.8	*41.9*	F6	13.36	1	5.3	−39
6809	55	19 38.2	−31 00	6.72	21.1	F5	13.68	6	6.0	+170
7078	15	21 28.6	+12 02	6.96	9.4	F2	14.44	103	10.5	−107
7089	2	21 31.9	−00 58	6.94	6.8	F4	14.77	22	12.3	−5

GALACTIC NEBULAE

By René Racine

The following objects were selected from the brightest and largest of the various classes to illustrate the different types of interactions between stars and interstellar matter in our galaxy. *Emission regions* (HII) are excited by the strong ultraviolet flux of young, hot stars and are characterized by the lines of hydrogen in their spectra. *Reflection nebulae* (Ref) result from the diffusion of starlight by clouds of interstellar dust. At certain stages of their evolution stars become unstable and explode, shedding their outer layers into what becomes a *planetary nebula* (Pl) or a *supernova remnant* (SN). Protostellar nebulae (PrS) are objects still poorly understood; they are somewhat similar to the reflection nebulae, but their associated stars, often variable, are very luminous infrared stars which may be in the earliest stages of stellar evolution. Also included in the selection are four *extended complexes* (Compl) of special interest for their rich population of dark and bright nebulosities of various types. In the table S is the optical surface brightness in magnitude per square second of arc of representative regions of the nebula, and m* is the magnitude of the associated star.

NGC	M	Con	α 1970 δ		Type	Size	S mag.	m	Dist. 10^3	Remarks
			h ′	° ′		′	sq″	*	l.y.	
650/1	76	Per	01 40.3	+51 25	Pl	1.5	20	17	15	
IC348		Per	03 42.6	+32 05	Ref	3	21	8	0.5	Nebulous cluster
1435		Tau	03 45.7	+23 59	Ref	15	20	4	0.4	Merope nebula
1535		Eri	04 12.8	−12 49	Pl	0.5	17	12		
1952	1	Tau	05 32.7	+22 05	SN	5	19	16v	4	"Crab" + pulsar
1976	42	Ori	05 33.8	−05 25	HII	30	18	4	1.5	Orion nebula
1999		Ori	05 35.0	−06 45	PrS	1		10v	1.5	
ζ Ori		Ori	05 39.3	−01 57	Comp	2°			1.5	Incl. "Horsehead"
2068	78	Ori	05 45.3	+00 02	Ref	5	20		1.5	
IC443		Gem	06 15.8	+22 36	SN	40			2	
2244		Mon	06 30.8	+04 53	HII	50	21	7	3	Rosette neb.
2247		Mon	06 31.5	+10 20	PrS	2	20	9	3	
2261		Mon	06 37.5	+08 45	PrS	2		12v	4	Hubble's var. neb.
2392		Gem	07 27.4	+20 58	Pl	0.3	18	10	10	Clown face neb.
3587	97	UMa	11 13.0	+55 11	Pl	3	21	13	12	Owl nebula
ρOph		Oph	16 23.8	−23 23	Comp	4°			0.5	Bright + dark neb.
θOph		Oph	17 20.1	−24 58	Comp	5°				Incl. "S" neb.
6514	20	Sgr	18 00.6	−23 02	HII	15	19		3.5	Trifid nebula
6523	8	Sgr	18 01.8	−24 23	HII	40	18		4.5	Lagoon nebula
6543		Dra	17 58.6	+66 37	Pl	0.4	15	11	3.5	
6611	16	Ser	18 17.2	−13 48	HII	15	19	10	6	
6618	17	Sgr	18 19.1	−16 12	HII	20	19		3	Horseshoe neb.
6720	57	Lyr	18 52.5	+33 00	Pl	1.2	18	15	5	Ring nebula
6826		Cyg	19 44.1	+50 27	Pl	0.7	16	10	3.5	
6853	27	Vul	19 58.2	+22 38	Pl	7	20	13	3.5	Dumb-bell neb.
6888		Cyg	20 11.2	+38 19	HII	15				
γCyg		Cyg	20 21.1	+40 10	Comp	6°				HII + dark neb.
6960/95		Cyg	20 44.4	+30 36	SN	150			2.5	Cygnus loop
7000		Cyg	20 57.8	+44 12	HII	100	22		3.5	N. America neb.
7009		Aqr	21 02.5	−11 30	Pl	0.5	16	12	3	Saturn nebula
7023		Cep	21 01.3	+68 03	Ref	5	21	7	1.3	
7027		Cyg	21 06.0	+42 07	Pl	0.2	15	13		
7129		Cep	21 42.3	+65 57	Ref	3	21	10	2.5	Small cluster
7293		Aqr	22 28.0	−20 57	Pl	13	22	13		Helix nebula
7662		And	23 24.5	+42 22	Pl	0.3	16	12	4	

RADIO SOURCES

BY JOHN GALT

Although several thousand radio sources have been catalogued most of them are only observable with the largest radio telescopes. This list contains the few strong sources which could be detected with amateur radio telescopes as well as representative examples of astronomical objects which emit radio waves.

Name	α (1970) h m	δ ° ′	Remarks
Tycho's s'nova	00 24.0	+63 58	Remnant of supernova of 1572
Andromeda gal.	00 41.0	+41 06	Closest normal spiral galaxy
IC 1795, W3	02 23.1	+61 58	Multiple HII region, OH emission
PKS 0237–23	02 38.7	−23 17	Quasar with large red shift Z = 2.2
NGC 1275, 3C 84	03 17.8	+41 24	Seyfert galaxy, radio variable
Fornax A	03 21.2	−37 17	10th mag. SO galaxy
CP 0328	03 30.5	+54 27	Pulsar, period = 0.7145 sec., H abs'n.
Crab neb, M1	05 32.6	+22 00	Remnant of supernova of 1054
NP 0527	05 32.6	+22 00	Radio, optical & X-ray pulsar
V 371 Orionis	05 32.2	+01 54	Red dwarf, radio & optical flare star
Orion neb, M42	05 33.8	−05 24	HII region, OH emission, IR source
IC 443	06 15.5	+22 36	Supernova remnant (date unknown)
Rosette neb	06 30.4	+04 53	HII region
YV CMa	07 21.8	−20 41	Optical var. IR source, OH, H_2O emission
3C 273	12 27.5	+02 13	Nearest, strongest quasar
Virgo A, M87	12 29.3	+12 33	EO galaxy with jet
Centaurus A	13 23.6	−42 52	NGC 5128 peculiar galaxy
3C 295	14 10.3	+52 21	21st mag. galaxy, 4,500,000 light years
Scorpio X-1	16 18.2	−15 34	X-ray, radio optical variable
3C 353	17 19.0	−00 57	Double source, probably galaxy
Kepler's s'nova	17 27.0	−21 16	Remnant of supernova of 1604
Galactic nucleus	17 43.7	−28 56	Complex region OH, NH_3 em., H_2CO abs'n.
Omega neb, M17	18 18.7	−16 10	HII region, double structure
W 49	19 08.9	+09 04	HII region s'nova remnant, OH emission
CP 1919	19 20.4	+21 49	First pulsar discovered, P = 1.337 sec.
Cygnus A	19 58.4	+40 39	Strong radio galaxy, double source
Cygnus X	20 21.5	+40 17	Complex region
NML Cygnus	20 45.4	+40 00	Infrared source, OH emission
Cygnus loop	20 51.0	+29 34	S'nova remnant (Network nebula)
N. America	20 54.0	+43 57	Radio shape resembles photographs
3C 446	22 24.2	−05 07	Quasar, optical mag. & spectrum var.
Cassiopeia A	23 22.0	+58 39	Strongest source, s'nova remnant
Sun			Continuous emission & bursts
Moon			Thermal source only
Jupiter			Radio bursts controlled by Io

EXTERNAL GALAXIES

By S. van den Bergh

Among the hundreds of thousands of systems far beyond our own Galaxy relatively few are readily seen in small telescopes. The first list contains the brightest galaxies. The first four columns give the catalogue numbers and position. In the column *Type*, *E* indicates elliptical, *I*, irregular, and *Sa*, *Sb*, *Sc*, spiral galaxies in which the arms are more open going from *a* to *c*. Roman numerals I, II, III, IV, and V refer to supergiant, bright giant, giant, subgiant and dwarf galaxies respectively; *p* means "peculiar". The remaining columns give the apparent photographic magnitude, the angular dimensions and the distance in millions of light-years.

The second list contains the nearest galaxies and includes the photographic distance modulus $(m - M)_{pg}$, and the absolute photographic magnitude, M_{pg}.

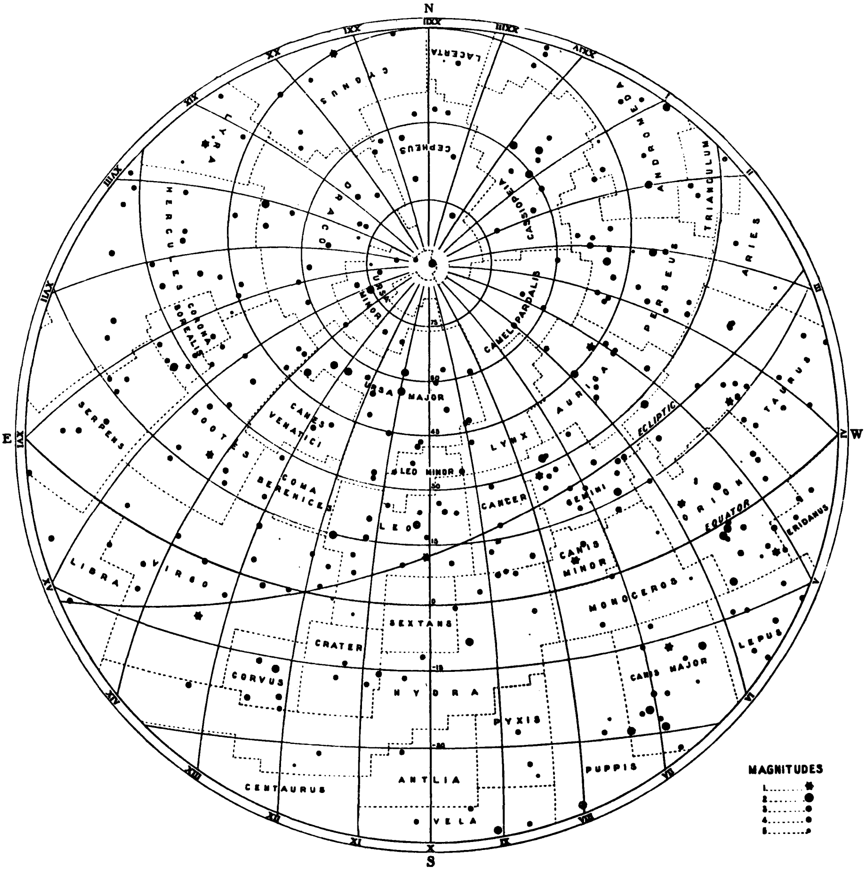
The Brightest Galaxies

NGC or name	M	α 1970 h m	δ ° ′	Type	m_{pg}	Dimensions ′ ′	Distance millions of l.y.
55		00 13.5	−39 23	Sc or Ir	7.9	30×5	7.5
205		00 38.7	+41 32	E6p	8.89	12×6	2.1
221	32	00 41.1	+40 43	E2	9.06	3.4×2.9	2.1
224	31	00 41.1	+41 07	Sb I–II	4.33	163×42	2.1
247		00 45.6	−20 54	S IV	9.47	21×8.4	7.5
253		00 46.1	−25 27	Scp	7.0:	22×4.6	7.5
SMC		00 51.7	−72 59	Ir IV or IV–V	2.86	216×216	0.2
300		00 53.5	−37 51	Sc III–IV	8.66	22×16.5	7.5
598	33	01 32.2	+30 30	Sc II–III	6.19	61×42	2.4
Fornax		02 38.3	−34 39	dE	9.1:	50×35	0.4
LMC		05 23.8	−69 47	Ir or Sc III–IV	0.86	432×432	0.2
2403		07 33.9	+65 40	Sc III	8.80	22×12	6.5
2903		09 30.4	+21 39	Sb I–II	9.48	16×6.8	19.0
3031	81	09 53.1	+69 12	Sb I–II	7.85	25×12	6.5
3034	82	09 53.6	+69 50	Scp:	9.20	10×1.5	6.5
4258		12 17.5	+47 28	Sbp	8.90	19×7	14.0
4472	49	12 28.3	+08 09	E4	9.33	9.8×6.6	37.0
4594	104	12 38.3	−11 28	Sb	9.18	7.9×4.7	37.0
4736	94	12 49.5	+41 16	Sbp II:	8.91	13×12	14.0
4826	64	12 55.3	+21 51	?	9.27	10×3.8	12.0:
4945		13 03.5	−49 19	Sb III	8.0	20×4	—
5055	63	13 14.4	+42 11	Sb II	9.26	8.0×3.0	14.0
5128		13 23.6	−42 51	E0p	7.87	23×20	—
5194	51	13 28.6	+47 21	Sc I	8.88	11×6.5	14.0
5236	83	13 35.4	−29 43	Sc I–II	7.0:	13×12	8.0:
5457	101	14 02.1	+54 29	Sc I	8.20	23×21	14.0
6822		19 43.2	−14 50	Ir IV–V	9.21	20×10	1.7

THE NEAREST GALAXIES

Name	NGC	α 1970 h m	δ ° ′	m_{pg}	$(m-M)_{pg}$	M_{pg}	Type	Dist. thous. of l.y.
M31	224	00 41.1	+41 07	4.33	24.65	−20.3	Sb I–II	2,100
Galaxy		—	—	—	—	?	Sb or Sc	—
M33	598	01 32.2	+30 30	6.19	24.70	−18.5	Sc II–III	2,400
LMC		05 23.8	−69 47	0.86	18.65	−17.8	Ir or SBc III–IV	160
SMC		00 51.7	−72 59	2.86	19.05	−16.2	Ir IV or IV–V	190
NGC	205	00 38.7	+41 32	8.89	24.65	−15.8	E6p	2,100
M32	221	00 41.1	+40 43	9.06	24.65	−15.6	E2	2,100
NGC	6822	19 43.2	−14 50	9.21	24.55	−15.3	Ir IV-V	1,700
NGC	185	00 37.2	+48 11	10.29	24.65	−14.4	E0	2,100
IC1613		01 03.5	+01 58	10.00	24.40	−14.4	Ir V	2,400
NGC	147	00 31.5	+48 11	10.57	24.65	−14.1	dE4	2,100
Fornax		02 38.3	−34 39	9.1:	20.6:	−12:	dE	430
Leo I		10 06.9	+12 27	11.27	21.8:	−10:	dE	750:
Sculptor		00 58.4	−33 52	10.5	19.70	−9.2	dE	280:
Leo II		11 11.9	+22 19	12.85	21.8:	−9:	dE	750:
Draco		17 19.7	+57 57	—	19.50	?	dE	260
Ursa Minor		15 08.4	+67 13	—	19.40	?	dE	250

STAR MAP 1

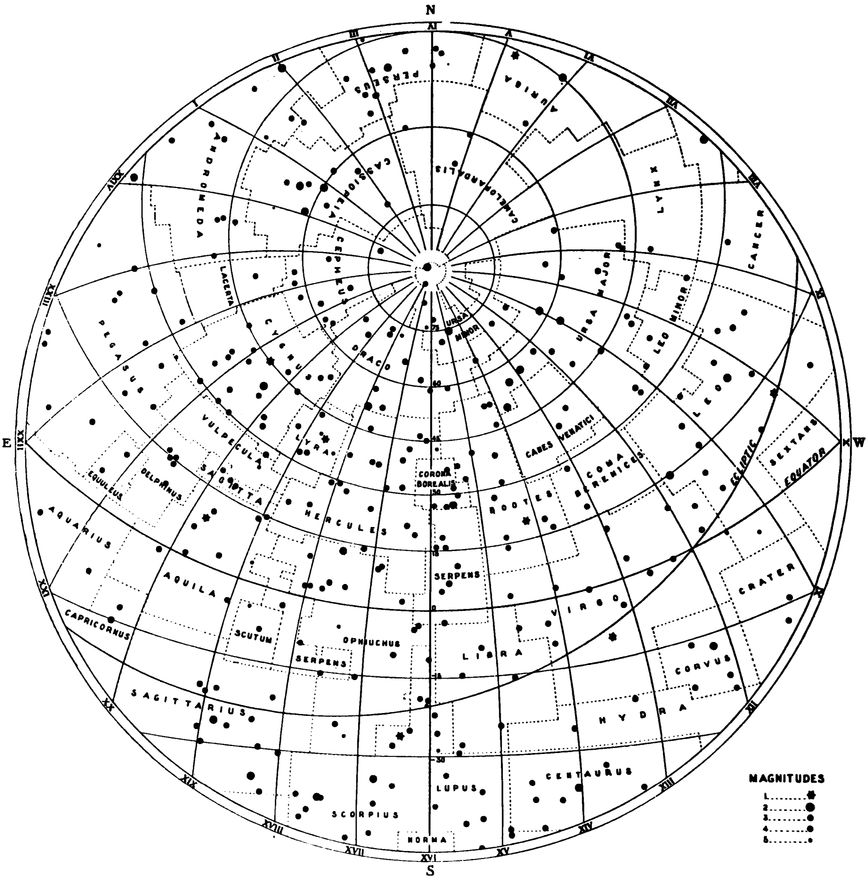


The above map represents the evening sky at

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

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. A set of four 8-inch horizon maps may be obtained by writing to the National Office.

STAR MAP 2

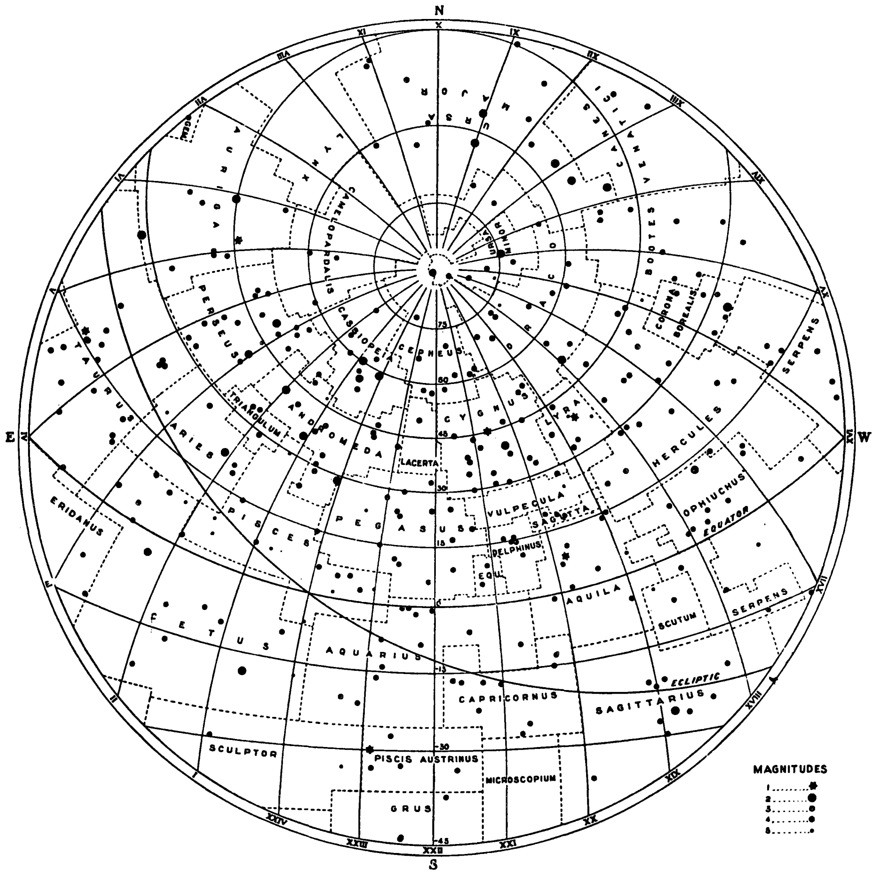


The above map represents the evening sky at

Midnight.........May 24
11 p.m...........June 7
10 " .... " 22
9 " ....July 6
8 " .... " 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 3

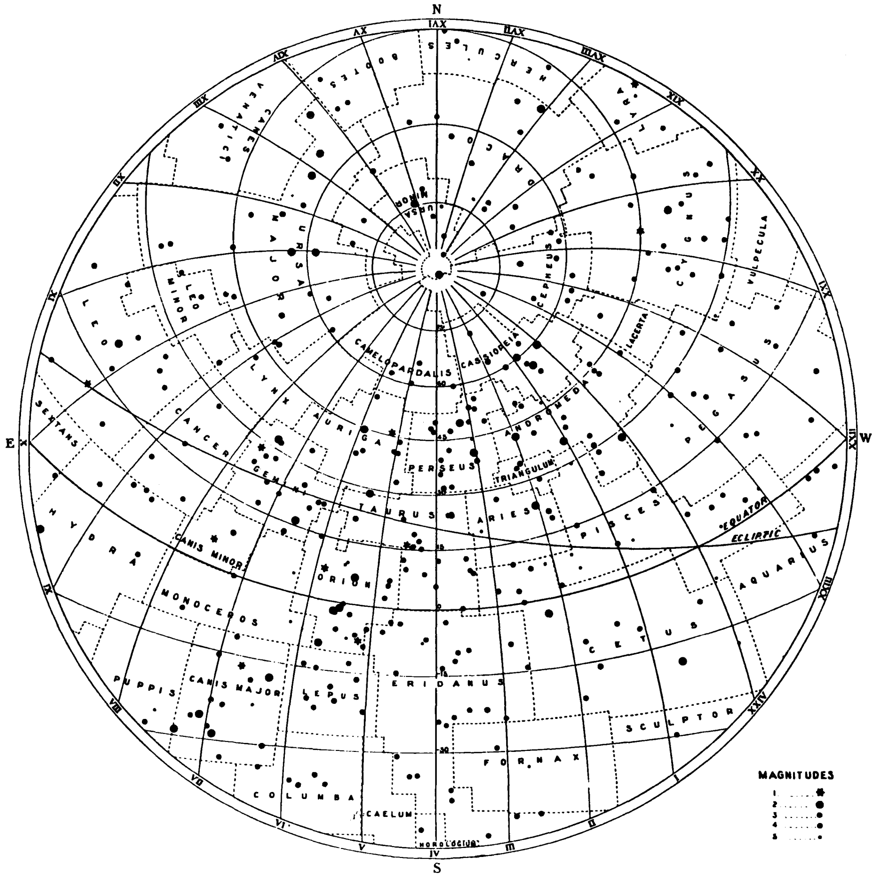


The above map represents the evening sky at

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

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.

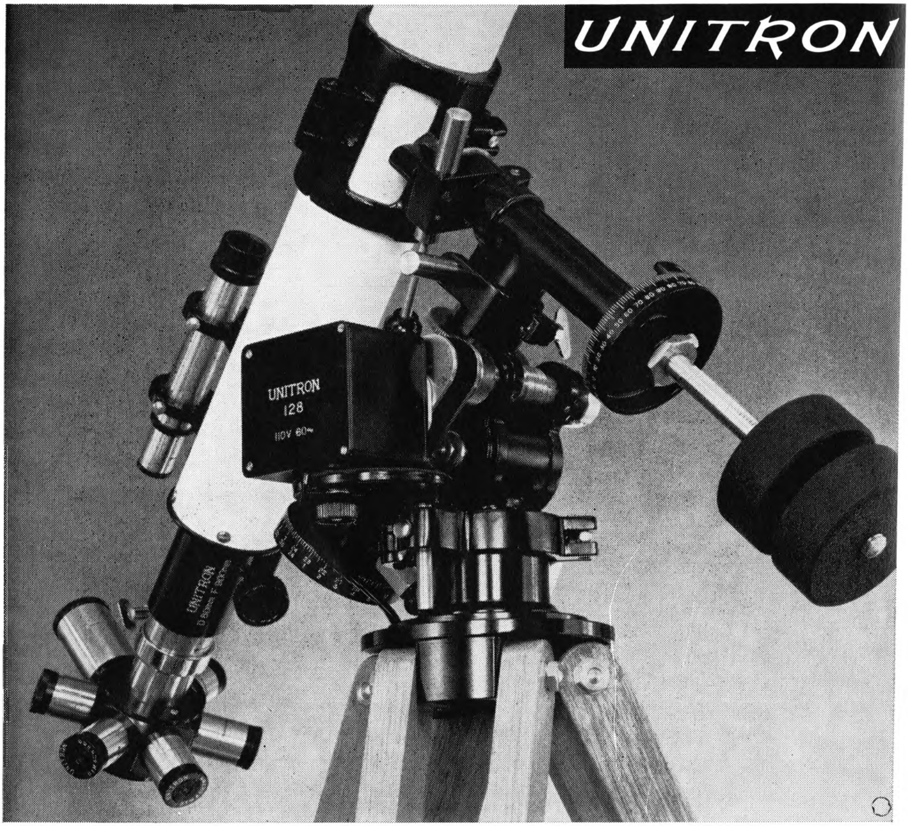
STAR MAP 4



The above map represents the evening sky at

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



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CALENDAR 1972

January

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

February

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29				

March

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

April

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

May

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

June

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

July

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

August

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

September

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

November

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						