THE OBSERVER'S HANDBOOK 1970

Sixty-second Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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Incorporated 1890 — Royal Charter 1903
Federally Incorporated 1968

The National Office of the Royal Astronomical Society of Canada is located at 252 College Street, Toronto 2B, Ontario. The business office of the Society, reading rooms and astronomical library, are housed here.

Membership in the Society is open to anyone interested in astronomy. Applicants may affiliate with one of the Society's seventeen centres across Canada, or may join the National Society direct. Centres of the Society are established in St. John's, Quebec, Montreal, Ottawa, Kingston, Hamilton, Niagara Falls, London, Windsor, Winnipeg, Saskatoon, Edmonton, Calgary, Vancouver, Victoria, and Toronto. Addresses of the Centres' secretaries may be obtained from the National Office.

Publications of the Society are free to members, and include the JOURNAL (6 issues per year) and the OBSERVER'S HANDBOOK (published annually in November). Annual fees of $10.00 ($5.00 for full-time students) are payable October 1 and include the publications for the following year.

VISITING HOURS AT SOME CANADIAN OBSERVATORIES

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

Dominion Astrophysical Observatory, Victoria, B.C.
Monday to Friday, daytime, no program.
Saturday evenings, April through November.

Dominion Observatory, Ottawa, Ont.
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, Alta.
Winter: Wed. and Thurs. 7:15 p.m.; Fri. 7:15 and 8:45 p.m.; Sat. and Sun. 3:00, 7:15 and 8:45 p.m.
Summer: Daily (except Tues.) 3:00, 7:15 and 8:45 p.m.

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

H. R. MacMillan Planetarium, 1100 Chestnut St., Vancouver 9, B.C.
Tues. through Thurs. 4:00 and 8:00 p.m.; Fri. 4:00, 7:30 and 9:00 p.m.; Sat., Sun. and holidays 2:00, 4:00, 7:30 and 9:00 p.m. (closed on Mondays).

Manitoba Museum of Man and Nature Planetarium, 147 James Ave., Winnipeg 2.
Sept.-June: Sun. and holidays*: 1:00, 2:30, 4:00 p.m.; Tue. through Fri. 3:30, 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. through Fri. 11:00 a.m., 3:00, 7:30, 9:00 p.m.
*Christmas show 3:30, 7:30, 9:00 p.m. (Closed on Mondays except holidays.)

McLaughlin Planetarium, 100 Queen's Park, Toronto, Ont.
Tue. through Fri. 3:30, 8:00 p.m.; Sat. 11:00 a.m., 2:00, 3:30, 5:00, 8:00 p.m., Sun. 2:00, 3:30, 5:00 and 7:30 p.m. During July and August, additional weekday show at 2:00 p.m.

McMaster University, Dept. of Continuing Education, Hamilton, Ont.
Group reservations only.

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

The University of Manitoba Planetarium, 500 Dysart Rd., Winnipeg, Man.
Wed. and Thurs. 12:40, 8:30 p.m.; Fri. 12:40, 7:00, 8:30 p.m.

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EDITOR

RUTH J. NORTHCOTT

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252 COLLEGE STREET, TORONTO 2B, ONTARIO

PRINTED IN CANADA
BY THE UNIVERSITY OF TORONTO PRESS

THE OBSERVER'S HANDBOOK for 1970 is the 62nd edition. The time zone map has been supplied courtesy of the Department of Energy, Mines and Resources of Canada. The sections on Nearest Stars, Galactic Nebulae and Radio Sources have been rewritten.

Cordial thanks are offered to all individuals who assisted in the preparation of this edition, to those whose names appear in the various sections and to Barbara Gaizauskas, Gretchen Hagen, Anson Moorhouse, John Percy, Roslyn Shemilt, Maude Towne, and Isabel Williamson. Special thanks are extended to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of Algol and the variable stars and to Gordon E. Taylor and the British Astronomical Association for the prediction of planetary appulses and occultations. My deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

RUTH J. NORTHCOTT

POSTSCRIPT. Miss Ruth Northcott had finished most of the editorial work, including the gathering of material for the 1970 OBSERVER'S HANDBOOK before her untimely death on July 29, 1969. We have finished the preparation for this issue, and express the hope that the quality of the 1970 HANDBOOK will not be seriously impaired by the fact that the Editor of the past 13 years was not able to see it through to completion.

JOHN F. HEARD
HELEN S. HOGG

ANNIVERSARIES AND FESTIVALS, 1970

New Year's Day	Thur.	Jan. 1
Epiphany	Tues.	Jan. 6
Septuagesima Sunday		Jan. 25
Accession of Queen Elizabeth (1952)	Fri.	Feb. 6
Quinquagesima (Shrove Sunday)		Feb. 8
Ash Wednesday		Feb. 11
St. David	Sun.	Mar. 1
St. Patrick	Tues.	Mar. 17
Palm Sunday		Mar. 22
Good Friday		Mar. 27
Easter Sunday		Mar. 29
Birthday of Queen Elizabeth (1926)	Tues.	Apr. 21
St. George	Thur.	Apr. 23
Rogation Sunday		May 3
Ascension Day	Thur.	May 7
Pentecost (Whit Sunday)		May 17
Victoria Day	Mon.	May 18
Trinity Sunday		May 24
Corpus Christi	Thur.	May 28
St. John Baptist (Midsummer Day)	Wed.	June 24
Dominion Day	Wed.	July 1
Birthday of Queen Mother Elizabeth (1900)	Tues.	Aug. 4
Labour Day	Mon.	Sept. 7
St. Michael (Michaelmas Day)	Tues.	Sept. 29
Hebrew New Year (Rosh Hashanah)	Thur.	Oct. 1
Thanksgiving	Mon.	Oct. 12
All Saints' Day	Sun.	Nov 1
Remembrance Day	Wed.	Nov. 11
First Sunday in Advent		Nov. 29
St. Andrew	Mon.	Nov. 30
Christmas Day	Fri.	Dec. 25

JULIAN DAY CALENDAR, 1970

J.D. 2,400,000 plus the following:

Jan. 1	40,588	May 1	40,708	Sept. 1	40,831
Feb. 1	40,619	June 1	40,739	Oct. 1	40,861
Mar. 1	40,647	July 1	40,769	Nov. 1	40,892
Apr. 1	40,678	Aug. 1	40,800	Dec. 1	40,922

The Julian Day commences at noon. Thus J.D. 2 440,588.0 = Jan. 1.5 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 and French Names with Abbreviations

The approximate position of the centre of each constellation is indicated by the right ascension in hours and the declination as follows: on the zodiac, Z; on the equator, E; northern hemisphere, N; southern hemisphere, S; italics are used for constellations completely within 45° of a pole.

Andromeda, *Andromède*	And	1	N
Antlia, *La Machine Pneumatique*	Ant	10	S
Apus, *L'Oiseau de Paradis*	Aps	16	*S*
Aquarius, *Le Verseau*	Aqr	22	Z
Aquila, *L'Aigle*	Aql	19	E
Ara, *L'Autel*	Ara	17	*S*
Aries, *Le Bélier*	Ari	2	Z
Auriga, *Le Cocher*	Aur	5	N
Boötes, *Le Bouvier*	Boo	14	N
Caelum, *Le Burin du Graveur*	Cae	4	S
Camelopardalis, *La Girafe*	Cam	6	*N*
Cancer, *Le Cancer*	Cnc	8	Z
Canes Venatici, *Les Chiens de Chasse*	CVn	13	N
Canis Major, *Le Grand Chien*	CMa	6	S
Canis Minor, *Le Petit Chien*	CMi	7	N
Capricornus, *Le Capricorne*	Cap	21	Z
Carina, *La Carène du Navire*	Car	8	*S*
Cassiopeia, *Cassiopée*	Cas	1	*N*
Centaurus, *Le Centaure*	Cen	12	S
Cepheus, *Céphée*	Cep	23	*N*
Cetus, *La Baleine*	Cet	1	E
Chamaeleon, *Le Caméléon*	Cha	10	*S*
Circinus, *Le Compas*	Cir	14	*S*
Columba, *La Colombe*	Col	5	S
Coma Berenices, *La Chevelure de Bérénice*	Com	12	N
Corona Australis, *La Couronne Australe*	CrA	18	S
Corona Borealis, *La Couronne Boréale*	CrB	15	N
Corvus, *Le Corbeau*	Crv	12	S
Crater, *La Coupe*	Crt	11	S
Crux, *La Croix du Sud*	Cru	12	*S*
Cygnus, *Le Cygne*	Cyg	20	N
Delphinus, *Le Dauphin*	Del	20	N
Dorado, *La Dorade*	Dor	5	*S*
Draco, *Le Dragon*	Dra	16	*N*
Equuleus, *Le Petit Cheval*	Equ	21	N
Eridanus, *Eridan*	Eri	3	S
Fornax, *Le Fourneau*	For	2	S
Gemini, *Les Gémeaux*	Gem	7	Z
Grus, *La Grue*	Gru	22	S
Hercules, *Hercule*	Her	17	N
Horologium, *L'Horloge*	Hor	3	S
Hydra, *L'Hydre Femelle*	Hya	11	S
Hydrus, *L'Hydre Mâle*	Hyi	2	*S*
Indus, *Indien (l'Oiseau)*	Ind	21	*S*
Lacerta, *Le Lézard*	Lac	22	N
Leo, *Le Lion*	Leo	10	Z
Leo Minor, *Le Petit Lion*	LMi	10	N
Lepus, *Le Lièvre*	Lep	5	S
Libra, *La Balance*	Lib	15	Z
Lupus, *Le Loup*	Lup	15	S
Lynx, *Le Lynx*	Lyn	7	N
Lyra, *La Lyre*	Lyr	18	N
Mensa, *La Table*	Men	5	*S*
Microscopium, *Le Microscope*	Mic	20	S
Monoceros, *La Licorne*	Mon	6	E
Musca, *La Mouche*	Mus	12	*S*
Norma, *La Règle*	Nor	15	S
Octans, *L'Octant*	Oct	—	*S*
Ophiuchus, *Ophiuchus*	Oph	17	E
Orion, *Orion*	Ori	5	E
Pavo, *Le Paon*	Pav	19	*S*
Pegasus, *Pégase*	Peg	22	N
Perseus, *Persée*	Per	3	N
Phoenix, *Le Phénix*	Phe	0	S
Pictor, *Peintre (le Chevalet du)*	Pic	5	S
Pisces, *Les Poissons*	Psc	0	Z
Piscis Austrinus, *Le Poisson Austral*	PsA	22	S
Puppis, *La Poupe du Navire*	Pup	7	S
Pyxis, *La Boussole*	Pyx	8	S
Reticulum, *Le Réticule*	Ret	3	*S*
Sagitta, *La Flèche*	Sge	19	N
Sagittarius, *Le Sagittaire*	Sgr	18	Z
Scorpius, *Le Scorpion*	Sco	16	Z
Sculptor, *Sculpteur (l'Atelier du)*	Scl	0	S
Scutum, *L'Ecu*	Sct	18	S
Serpens, *Le Serpent*	Ser	16	E
Sextans, *Le Sextant*	Sex	10	E
Taurus, *Le Taureau*	Tau	4	Z
Telescopium, *Le Télescope*	Tel	19	*S*
Triangulum, *Le Triangle*	Tri	2	N
Triangulum Australe, *Le Triangle Austral*	TrA	16	*S*
Tucana, *Le Toucan*	Tuc	23	*S*
Ursa Major, *La Grande Ourse*	UMa	11	N
Ursa Minor, *La Petite Ourse*	UMi	—	*N*
Vela, *Les Voiles du Navire*	Vel	9	S
Virgo, *La Vierge*	Vir	13	Z
Volans, *Le Poisson Volant*	Vol	7	*S*
Vulpecula, *Le Renard*	Vul	20	N

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit	$= 10^{-8}$ cm.	1 micron, μ	$= 10^{-4}$ cm. $= 10^4$A.
1 inch	= exactly 2.54 centimetres	1 cm. = 10 mm.	= 0.39370 . . . in.
1 yard	= exactly 0.9144 metre	1 m. $= 10^2$ cm.	= 1.0936 . . . . yd.
1 mile	= exactly 1.609344 kilometres	1 km. $= 10^5$ cm.	= 0.62137 . . . mi.

1 astronomical unit $= 1.496\times10^{13}$ cm. $= 1.496\times10^{8}$ km. $= 9.2957\times10^{7}$ mi.
1 light-year $= 9.461\times10^{17}$ cm. $= 5.88\times10^{12}$ mi. = 0.3068 parsecs
1 parsec $= 3.084\times10^{18}$ cm. $= 1.916\times10^{13}$ mi. = 3.260 l.y.
1 megaparsec $= 10^6$ parsecs

Units of Time

Sidereal day = $23h$ $56m$ $04.09s$ of mean solar time
Mean solar day = $24h$ $03m$ $56.56s$ of mean sidereal time
Synodic month = $29d$ $12h$ $44m$ $03s$ Sidereal month = $27d$ $07h$ $43m$ $12s$
Tropical year (ordinary) = $365d$ $05h$ $48m$ $46s$
Sidereal year = $365d$ $06h$ $09m$ $10s$
Eclipse year = $346d$ $14h$ $52m$ $52s$

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 $= 5.98\times10^{24}$ kgm. $= 13.2\times10^{24}$ lb.
Velocity of escape from $\oplus$ = 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. $18h$ $04m$, Dec. + 30°; solar velocity = 19.4 km./sec. = 12.1 mi./sec.

The Galactic System

North pole of galactic plane R.A. $12h$ $49m$, Dec. + 27.°4 (1950)
Centre of galaxy R.A. $17h$ $42.4m$, 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) $\sim 2.2\times10^{8}$ years
Mass $\sim 2\times10^{11}$ solar masses

External Galaxies

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

Radiation Constants

Velocity of light, $c = 2.997925\times10^{10}$ cm./sec. = 186,282.1 mi./sec.
Frequency, $\nu = c/\lambda$; ν 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 $= 5.6694\times10^{-5}$ c.g.s. units

Miscellaneous

Constant of gravitation, $G = 6.670\times10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083\times10^{-28}$ gm.; mass of the proton $= 1.6724\times10^{-24}$ gm.
Planck's constant, $h = 6.625\times10^{-27}$ erg. sec.
Absolute temperature = T° K = T° C + 273° = 5/9 (T° F + 459°)

1 radian = 57°.2958	π = 3.141,592,653,6
= 3437′.75	No. of square degrees in the sky = 41,253
= 206,265″	1 gram = 0.03527 oz.

SUN—EPHEMERIS AND CORRECTION TO SUN-DIAL

Date		Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
		h m s	m s	° ′
Jan.	1	18 44 12	+ 3 30	−23 03.4
	4	18 57 25	+ 4 54	−22 47.4
	7	19 10 36	+ 6 14	−22 27.2
	10	19 23 42	+ 7 30	−22 03.1
	13	19 36 43	+ 8 41	−21 35.1
	16	19 49 39	+ 9 46	−21 03.4
	19	20 02 28	+10 44	−20 28.0
	22	20 15 10	+11 36	−19 49.2
	25	20 27 46	+12 20	−19 07.0
	28	20 40 15	+12 58	−18 21.7
	31	20 52 36	+13 29	−17 33.5
Feb.	3	21 04 50	+13 52	−16 42.3
	6	21 16 57	+14 08	−15 48.6
	9	21 28 57	+14 17	−14 52.4
	12	21 40 49	+14 18	−13 54.0
	15	21 52 35	+14 13	−12 53.5
	18	22 04 14	+14 01	−11 51.2
	21	22 15 46	+13 43	−10 47.2
	24	22 27 13	+13 19	− 9 41.6
	27	22 38 34	+12 50	− 8 34.8
Mar.	2	22 49 50	+12 16	− 7 26.8
	5	23 01 02	+11 37	− 6 17.8
	8	23 12 10	+10 55	− 5 08.0
	11	23 23 15	+10 09	− 3 57.7
	14	23 34 17	+ 9 21	− 2 46.8
	17	23 45 16	+ 8 30	− 1 35.8
	20	23 56 13	+ 7 37	− 0 24.6
	23	0 07 08	+ 6 43	+ 0 46.4
	26	0 18 03	+ 5 48	+ 1 57.3
	29	0 28 58	+ 4 53	+ 3 07.7
Apr.	1	0 39 53	+ 3 59	+ 4 17.7
	4	0 50 50	+ 3 06	+ 5 26.9
	7	1 01 47	+ 2 14	+ 6 35.3
	10	1 12 47	+ 1 24	+ 7 42.7
	13	1 23 49	+ 0 37	+ 8 48.9
	16	1 34 53	− 0 08	+ 9 53.8
	19	1 46 01	− 0 49	+10 57.2
	22	1 57 12	− 1 27	+11 58.9
	25	2 08 27	− 2 01	+12 58.9
	28	2 19 46	− 2 30	+13 57.0
May	1	2 31 11	− 2 55	+14 53.0
	4	2 42 40	− 3 15	+15 46.8
	7	2 54 14	− 3 29	+16 38.3
	10	3 05 53	− 3 39	+17 27.3
	13	3 17 38	− 3 44	+18 13.6
	16	3 29 27	− 3 43	+18 57.2
	19	3 41 21	− 3 38	+19 37.9
	22	3 53 20	− 3 28	+20 15.6
	25	4 05 24	− 3 13	+20 50.1
	28	4 17 33	− 2 53	+21 21.5
	31	4 29 46	− 2 29	+21 49.5
June	3	4 42 02	− 2 01	+22 14.2
	6	4 54 23	− 1 30	+22 35.3
	9	5 06 46	− 0 56	+22 52.9
	12	5 19 11	− 0 20	+23 06.8
	15	5 31 38	+ 0 18	+23 17.1
	18	5 44 06	+ 0 56	+23 23.7
	21	5 56 35	+ 1 35	+23 26.6
	24	6 09 03	+ 2 14	+23 25.7
	27	6 21 31	+ 2 52	+23 21.2
	30	6 33 58	+ 3 29	+23 12.9
July	3	6 46 23	+ 4 03	+23 01.0
	6	6 58 45	+ 4 36	+22 45.5
	9	7 11 04	+ 5 04	+22 26.4
	12	7 23 20	+ 5 30	+22 03.8
	15	7 35 31	+ 5 50	+21 37.9
	18	7 47 38	+ 6 06	+21 08.6
	21	7 59 39	+ 6 18	+20 36.1
	24	8 11 36	+ 6 24	+20 00.5
	27	8 23 28	+ 6 25	+19 21.8
	30	8 35 15	+ 6 21	+18 40.3
Aug.	2	8 46 56	+ 6 12	+17 56.0
	5	8 58 32	+ 5 57	+17 09.1
	8	9 10 02	+ 5 37	+16 19.6
	11	9 21 27	+ 5 11	+15 27.9
	14	9 32 47	+ 4 40	+14 33.9
	17	9 44 01	+ 4 05	+13 37.8
	20	9 55 11	+ 3 24	+12 39.8
	23	10 06 17	+ 2 39	+11 40.0
	26	10 17 18	+ 1 51	+10 38.5
	29	10 28 17	+ 0 59	+ 9 35.4
Sept.	1	10 39 12	+ 0 04	+ 8 31.0
	4	10 50 04	− 0 54	+ 7 25.4
	7	11 00 54	− 1 54	+ 6 18.6
	10	11 11 42	− 2 56	+ 5 11.0
	13	11 22 29	− 3 59	+ 4 02.6
	16	11 33 15	− 5 03	+ 2 53.5
	19	11 44 00	− 6 07	+ 1 44.0
	22	11 54 46	− 7 11	+ 0 34.1
	25	12 05 33	− 8 14	− 0 36.0
	28	12 16 21	− 9 15	− 1 46.2
Oct.	1	12 27 11	−10 14	− 2 56.3
	4	12 38 04	−11 10	− 4 06.1
	7	12 48 59	−12 04	− 5 15.4
	10	12 59 58	−12 54	− 6 24.1
	13	13 11 01	−13 40	− 7 32.0
	16	13 22 09	−14 21	− 8 39.0
	19	13 33 22	−14 57	− 9 44.9
	22	13 44 40	−15 27	−10 49.6
	25	13 56 04	−15 52	−11 52.8
	28	14 07 35	−16 09	−12 54.4
	31	14 19 13	−16 20	−13 54.2
Nov.	3	14 30 58	−16 24	−14 52.0
	6	14 42 50	−16 20	−15 47.6
	9	14 54 49	−16 09	−16 40.8
	12	15 06 56	−15 51	−17 31,5
	15	15 19 10	−15 25	−18 19.5
	18	15 31 32	−14 52	−19 04.6
	21	15 44 02	−14 11	−19 46.6
	24	15 56 39	−13 22	−20 25.4
	27	16 09 23	−12 27	−21 00.8
	30	16 22 14	−11 24	−21 32.7
Dec.	3	16 35 10	−10 16	−22 00.8
	6	16 48 13	− 9 03	−22 25.2
	9	17 01 20	− 7 45	−22 45.6
	12	17 14 31	− 6 23	−23 02.0
	15	17 27 45	− 4 58	−23 14.3
	18	17 41 02	− 3 30	−23 22.4
	21	17 54 20	− 2 01	−23 26.3
	24	18 07 40	− 0 31	−23 26.0
	27	18 20 59	+ 0 58	−23 21.4
	30	18 34 17	+ 2 27	−23 12.7

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

Planet	Mean Distance from Sun (a)		Period of Revolution		Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. at Epoch (L)
	A. U.	millions of miles	Sidereal (P)	Synodic					
				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	3.34	0.16	$27^d\ 07^h\ 43^m$	6.7	0.067
☿ Mercury	3,025	0	0.055	5.46	0.38	58.65^d	?	0.056
♀ Venus	7,526	0	0.815	5.23	0.90	244^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	27,700	1/50	17.3	2.27	1.41	14 ?	28.8	0.84
♇ Pluto	3,500?	?	0.06?	4?	0.3?	6.387^d	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 61; the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag.	Diam. miles	Mean Distance from Planet		Revolution Period			Orbit Incl.	Discovery
	* †	†	miles	″ *	d	h	m	° ‡	
Satellite of the Earth									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
Satellites of Mars									
Phobos	11.6	(10)	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.

A sun-dial 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 sun-dial* 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 of Aries is on the meridian. As the earth makes one more revolution 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 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. Sidereal time = Standard time (0h at midnight) – correction for longitude (p. 12) + 12 h + R.A. sun (p. 7) – correction to sun-dial (p. 7). (Note that it is necessary to obtain R.A. of the sun at the standard time involved.)

The foregoing refers to *local* time, in general different in different places on the earth. 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, UT 1 and UT 2 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 centred on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 8 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; and 150th meridian or Alaska (AL), 10 hours slower then 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 now has two definitions. In terms of Ephemeris Time (ET) it is 1/31, 556, 925.9747 of the tropical year 1900 January 0 at 12 hrs ET. In terms of the caesium beam frequency standard at zero magnetic field, it is defined as 9, 192, 631, 770 cycles. Ephemeris Time is required in celestial mechanics, while the caesium 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 $\Delta T = ET - UT$. The moon's position is

**Note:* According to the Saskatchewan Time Act 1966, the time zone boundary between C.S.T. and M.S.T. is defined by the 106th meridian of west longitude. Communities to the west of this boundary may elect to adopt C.S.T., and except for Lloydminster the cities have done so.

tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1970 will be about 40 seconds.

RADIO TIME SIGNALS

National time services distribute co-ordinated time called UTC, which approximates UT2. It is derived from the 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.

Radio time signals readily available in Canada include:

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

CALENDAR 1970

January

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

February

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

March

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

April

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

May

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

June

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

July

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

August

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

September

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

October

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

November

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

December

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

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

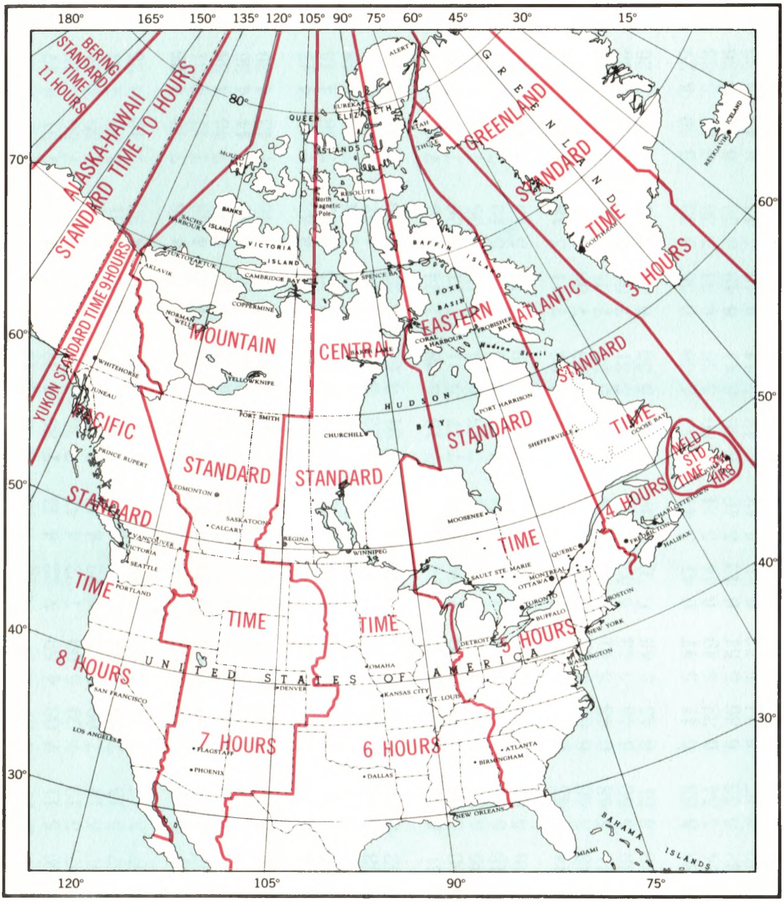
To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired 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	Penticton	49°	−02P	Atlanta	34°	+37E
Baker Lake	64	+24C	Peterborough	44	+13E	Baltimore	39	+06E
Brandon	50	+40C	Port Harrison	59	+13E	Birmingham	33	−13C
Brantford	43	+21E	Port Arthur	48	+57E	Boston	42	−16E
Calgary	51	+36M	Prince Albert	53	+63C	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	59	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	+58C	Cleveland	42	+26E
Edmonton	54	+34M	St. Catharines	43	+17E	Dallas	33	+27C
Fort William	48	+57E	St. Hyacinthe	46	−08E	Denver	40	00M
Fredericton	46	+27A	Saint John, N.B.	45	+24A	Detroit	42	+32E
Gander	49	+ 8N	St. John's, Nfld.	48	+01N	Fairbanks	65	−10AL
Glace Bay	46	00A	Sarnia	43	+29E	Flagstaff	35	+27M
Goose Bay	53	+ 2A	Saskatoon	52	+67C	Indianapolis	40	−15C
Granby	45	−09E	Sault Ste. Marie	47	+37E	Juneau	58	+58P
Guelph	44	+21E	Shawinigan	47	−09E	Kansas City	39	+18C
Halifax	45	+14A	Sherbrooke	45	−12E	Los Angeles	34	−07P
Hamilton	43	+20E	Stratford	43	+24E	Louisville	38	−17C
Hull	45	+03E	Sudbury	47	+24E	Memphis	35	00C
Kapuskasing	49	+30E	Sydney	46	+01A	Miami	26	+21E
Kingston	44	+06E	The Pas	54	+45C	Milwaukee	43	−09C
Kitchener	43	+22E	Timmins	48	+26E	Minneapolis	45	+13C
London	43	+25E	Toronto	44	+18E	New Orleans	30	00C
Medicine Hat	50	+23M	Three Rivers	46	−10E	New York	41	−04E
Moncton	46	+19A	Trail	49	−09P	Omaha	41	+24C
Montreal	46	−06E	Truro	45	+13A	Philadelphia	40	+01E
Moosonee	51	+23E	Vancouver	49	+12P	Phoenix	33	+28M
Moose Jaw	50	+62C	Victoria	48	+13P	Pittsburgh	40	+20E
Niagara Falls	43	+16E	Whitehorse	61	00Y	St. Louis	39	+01C
North Bay	46	+18E	Windsor	42	+32E	San Francisco	38	+10P
Ottawa	45	+03E	Winnipeg	50	+29C	Seattle	48	+09P
Owen Sound	45	+24E	Yellowknife	62	+38M	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).

MAP OF STANDARD TIME ZONES



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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT
1970

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

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).

MOONRISE AND MOONSET, 1970 (Local Mean Time)

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

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

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

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

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

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

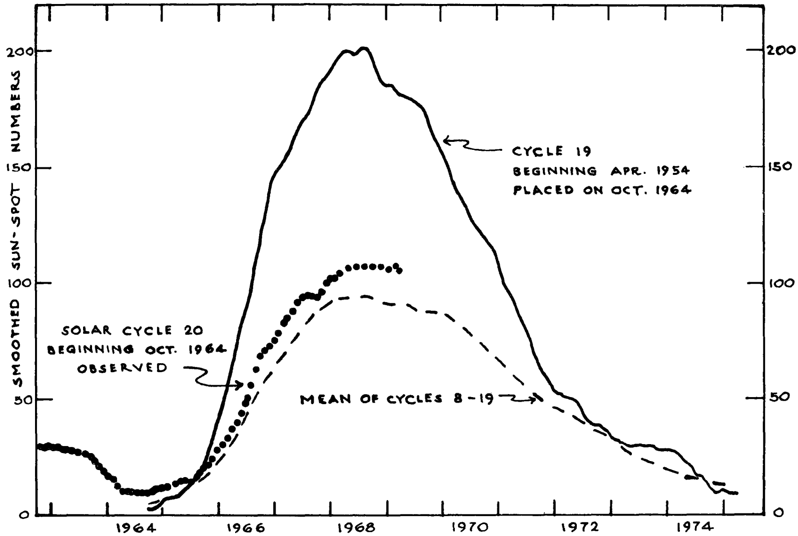
DATE	Latitude 30° Moon Rise	Set	Latitude 35° Moon Rise	Set	Latitude 40° Moon Rise	Set	Latitude 45° Moon Rise	Set	Latitude 50° Moon Rise	Set	Latitude 54° Moon Rise	Set
Nov.	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
1	08 38	18 45	08 53	18 30	09 12	18 12	09 33	17 49	10 00	17 22	10 29	16 52
2	09 40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

THE SUN AND PLANETS FOR 1970

THE SUN

The diagram represents the sun-spot activity of 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. The sun-spot number of 1968 remained constant near 110.

The observations for sun-spot numbers may be performed by devoted amateur astronomers with small-sized telescopes (suitably protected). Here is a field for amateurs who wish to make a valuable contribution to solar astronomy.



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 1970

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Apr. 18	20°	+0.3	Feb. 5	26°	+0.1
Aug. 16	27°	+0.6	Jun. 5	24°	+0.7
Dec. 10	21°	−0.3	Sept. 28	18°	0.0

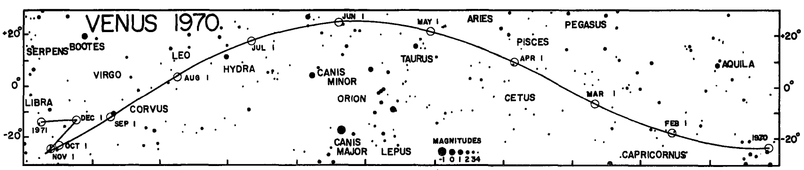
The most favourable elongations are: in the evening, April 18; in the morning, Sept. 28. The apparent diameter of the planet ranges from about 4.6″ to 12.0″. A transit of Mercury occurs on May 9; it is visible, in part, over all of North America.

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.

In Jan. 1970, Venus is close to the sun, reaching superior conjunction on Jan. 24. Greatest eastern elongation, 46°, occurs on Sept. 1, at which time its stellar magnitude is −4.0. Greatest brilliancy, −4.4, is reached on Oct. 6 and again on Dec. 16, inferior conjunction occurring on Nov. 10. Throughout late autumn, Venus is quite far south of the celestial equator, and is not favourably placed for viewing. On May 9, Venus passes 0.2° N. of Mars; this phenomenon will be visible low in the evening sky. The apparent diameter of Venus increases from 10″ on Jan. 1 to nearly 63″ at inferior conjunction.

Its brilliance is due to its nearness and dense clouds enshrouding the planet. On Dec. 14, 1962, the American spacecraft, Mariner II, passed within 21,700 mi. of Venus, sending back over 90 million bits of information. Among its notable discoveries were: surface temperatures up to 800° F.; an atmosphere 10 to 20 times denser than earth's; no magnetic field or radiation belt. The rotation period is now quoted as 244 days in a retrograde direction.

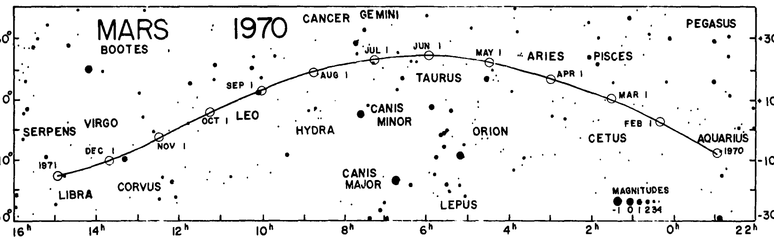


MARS

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 24h. 37m. 22.6689s. 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.

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 Sept. 10, 1956, the planet was closer to the earth than it will be for some years. In contrast, the opposition distance on Mar. 9, 1965, was almost a maximum.

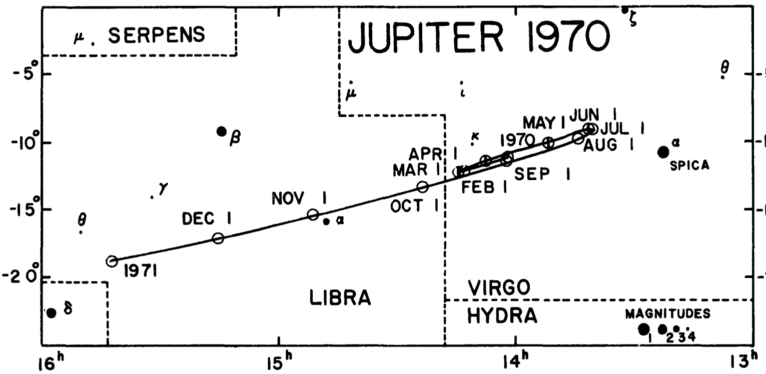
No opposition of Mars occurs in 1970. Its motion is direct all year, and conjunction occurs on Aug. 2. On Jan. 1, Mars is an evening star in Aquarius; on Dec. 31, it is to be found in Libra (see map). The size of the disc ranges from 6″ to 3.5″ during the year. The distance increases from 146 million miles on Jan. 1, to 247 million miles at conjunction. Mars passes 0.2° S. of Venus on May 9, and 0.5° N. of Uranus on Nov. 7.



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.

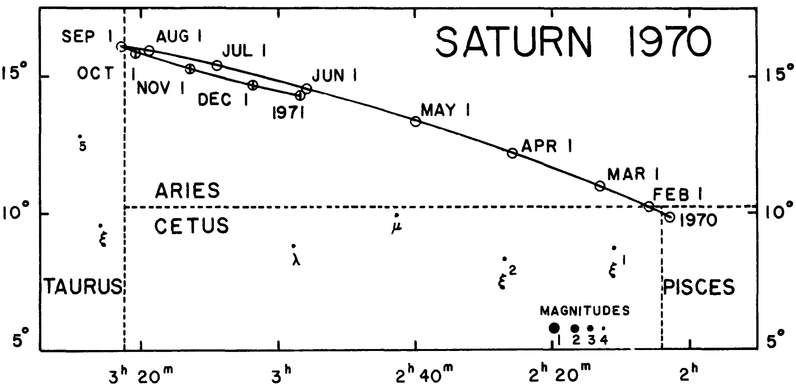
Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.



On Jan. 1, 1970, Jupiter is a morning star in Virgo (see map). Its stellar magnitude at that time is −1.4. In Sept., it moves into Libra, where it remains throughout the rest of the year. It retrogrades from Feb. 20 to June 24. Opposition occurs on Apr. 21, when the planet moves into the evening sky and is visible all night; its magnitude is then −2.0. On Nov. 9, it is in conjunction with the sun and moves into the morning sky for the rest of the year. The apparent polar diameter ranges from a maximum of 41″ near opposition to a minimum of 29″ in Nov.

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



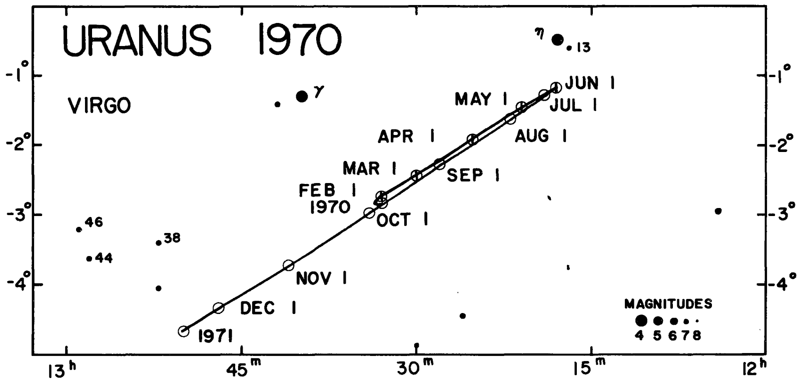
the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, and were again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. **See p. 59.** **(The tenth satellite was discovered in 1966.)**

On Jan. 1, 1970, Saturn is in Pisces (see map), well up in the east at sunset. At that time, its stellar magnitude is +0.4. On May 2, it is in conjunction with the sun and moves into the morning sky. On May 17, Saturn is 0.2° N. of Mercury, though both are close to the sun at the time. On Nov. 11 it is in opposition, and is visible all night; its magnitude is then 0.1. (Throughout most of the year, Saturn is in Aries, with brief forays into Taurus and Cetus.) The apparent diameter of the ball of the planet ranges from 15″ to 18″. The rings are open to nearly two-thirds of the maximum, with the southern face visible.

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.

During 1970 Uranus is in Virgo (see map). At the beginning of the year it rises about midnight. It retrogrades from Jan. 13 to June 12, with opposition on Mar. 27 when its stellar magnitude is +5.7 and its apparent diameter is 4.0″. When conjunction occurs on Oct. 2, its magnitude is +5.9; it is in the morning sky for the rest of the year. On Nov. 7, Uranus is less than 0.5° from Mars.

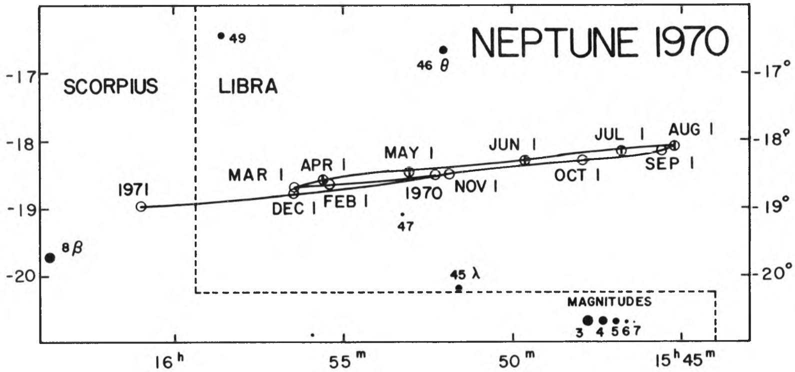


NEPTUNE

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.

During most of 1970 Neptune is in Libra (see map). It retrogrades from Mar. 3 to Aug. 10. Opposition occurs on May 18 when it is above the horizon all night;

its stellar magnitude is then +7.7 and during the year it fades slightly to +7.8. Thus it is too faint to be seen with the naked eye. In the telescope it shows a greenish tint and an apparent diameter of 2.3″ to 2.5″. It is in conjunction with the sun on Nov. 23 and moves into the morning sky for the rest of the year.



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 15th mag. star in the constellation Coma. It is in opposition to the sun on Mar. 17 at which time its astrometric position is R.A. 12h 12m, Dec. +16°26′, and its distance from the earth is 2,850,000,000 mi.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1970

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

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

The Sun—During January the sun's R.A. increases from 18h 44m to 20h 57m and its Decl. changes from 23° 03′ S. to 17° 17′ S. The equation of time changes from −3m 36s to −13m 30s. 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 1st at a distance of 91,405,000 mi. 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. 20h 05m, Decl. 20° 51′ S., and on the 15th is in R.A. 19h 27m, Decl. 18° 38′ S. On the first few evenings of the month it may be seen very low in the south-west just after sunset. On the 1st it is only 12° above the horizon at sunset, and lower on successive evenings. Inferior conjunction is on the 13th.

Venus on the 1st is in R.A. 18h 19m, Decl. 23° 38′ S., and on the 15th is in R.A. 19h 36m, Decl. 22° 24′ S., mag. −3.5, and transits at 12h 01m. Being close to the sun it is not easily observed. Superior conjunction is on the 24th.

Mars on the 15th is in R.A. 23h 34m, Decl. 3° 26′ S., mag. +1.1, and transits at 15h 57m. Moving from Aquarius into Pisces, it is past the meridian at sunset and sets about five hours later.

Jupiter on the 15th is in R.A. 14h 09m, Decl. 11° 41′ S., mag. −1.5, and transits at 6h 31m. In Virgo, it rises about an hour after midnight and passes the meridian before sunrise. It is in western quadrature on the 25th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 2h 03m, Decl. 9° 55′ N., mag. +0.5, and transits at 18h 23m. In Aries, it is approaching the meridian at sunset. On the 4th it is stationary in R.A. and resumes direct, or eastward motion among the stars. It is in eastern quadrature on the 22nd.

Uranus on the 15th is in R.A. 12h 33m, Decl. 2° 49′ S. and transits at 4h 56m.

Neptune on the 15th is in R.A. 15h 54m, Decl. 18° 35′ S. and transits at 8h 16m.

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

1970			JANUARY E.S.T.	Min of Algol	Config. of Jupiter's Sat. 4h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1			Earth at perihelion		d3O4*	187.64
	20		Spica 1° N. of moon			
Fri. 2			Mercury at ascending node	14 10	321O4	199.80[l]
	15		Jupiter 5° N. of moon			
Sat. 3			Quadrantid meteors		3O124	211.97[l]
	19		Mercury stationary			
Sun. 4	14		Neptune 7° N. of moon		13O24	224.14
	15		Saturn stationary			
Mon. 5	3		Antares 0.5° N. of moon	11 00	2O134	236.32
Tue. 6	17		Pluto stationary		12O34	248.51[b]
Wed. 7			Mercury at perihelion		O1423	260.70
	15	36	🌑 New Moon			
Thu. 8	5		Moon at perigee, 222,000 mi.	7 50	d13O2	272.89
Fri. 9					d342O	285.08
Sat. 10					43O12	297.27
Sun. 11	23		Mars 1° S. of moon	4 40	431O2	309.45
Mon.12					42O13	321.63
Tue. 13	4		Mercury in inferior conjunction		412O3	333.80
	8		Uranus stationary			
Wed.14	8	18	☽ First Quarter	1 30	4O123	345.97
Thu.15	4		Saturn 7° S. of moon		41O32	358.13[l]
Fri. 16				22 20	324O1	10.28
Sat. 17			Mercury greatest hel. lat. N.		3O4**	22.43
Sun. 18					31O24	34.57[b]
Mon.19				19 10	2O134	46.71
Tue. 20					21O34	58.85
Wed.21					O1234	70.98
Thu.22			Saturn in quadrature E.	16 00	1O324	83.11
	7	55	🌕 Full Moon			
	15		Moon at apogee, 252,500 mi.			
Fri. 23					23O14	95.24
Sat. 24	9		Mercury stationary		31O4*	107.37
	15		Venus in superior conjunction			
	15		Regulus 0.8° S. of moon			
Sun. 25			Jupiter in quadrature W.	12 50	314O2	119.51
Mon.26					42O31	131.64
Tue. 27	18		Pallas in conjunction with sun		421O3	143.78
Wed.28			Venus at aphelion	9 40	4O123	155.93
	0		Uranus 3° N. of moon			
Thu. 29					41O32	168.08
Fri. 30	4		Jupiter 6° N. of moon		432O1	180.24
	9	39	☾ Last Quarter			
Sat. 31				6 30	4312O	192.40[l]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]Jan. 2, 3, −7.77°; Jan. 15, +7.31°; Jan. 31, −7.88°.

[b]Jan. 6, +6.56°; Jan. 18, −6.66°.

THE SKY FOR FEBRUARY 1970

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

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

The Sun—During February the sun's R.A. increases from 20h 57m to 22h 46m and its Decl. changes from 17° 17′ S. to 7° 50′ S. The equation of time changes from −13m 39s to a maximum of −14m 19s on the 11th and then to −12m 37s at the end of the month. For changes in the length of the day, see p. 13.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 20. There is a partial eclipse of the moon, visible in North America, on the night of the 20th–21st.

Mercury on the 1st is in R.A. 19h 12m, Decl. 20° 50′ S., and on the 15th is in R.A. 20h 17m, Decl. 20° 24′ S. On the 5th it is in greatest western elongation and so is to be seen low in the south-east just before sunrise. This is an unfavourable elongation, however, Mercury being only 11° above the horizon at sunrise.

Venus on the 1st is in R.A. 21h 05m, Decl. 17° 59′ S., and on the 15th is in R.A. 22h 14m, Decl. 12° 28′ S., mag. −3.5, and transits at 12h 36m. Moving east of the sun, Venus is becoming visible as an evening star, and at the end of the month is about 5° above the western horizon at sunset and so may be seen for about half an hour in the twilight.

Mars on the 15th is in R.A. 0h 57m, Decl. 6° 02′ N., mag. +1.4, and transits at 15h 18m. In Pisces, it is well past the meridian at sunset and sets about four hours later.

Jupiter on the 15th is in R.A. 14h 16m, Decl. 12° 13′ S., mag. −1.7, and transits at 4h 36m. In Virgo, it rises before midnight and is well past the meridian at sunrise. On the 20th it is stationary in R.A. and begins to retrograde, i.e. to move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 2h 09m, Decl. 10° 34′ N., mag. +0.6, and transits at 16h 27m. In Aries, it is past the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 12h 32m, Decl. 2° 37′ S. and transits at 2h 52m.

Neptune on the 15th is in R.A. 15h 56m, Decl. 18° 41′ S. and transits at 6h 16m. It is in western quadrature on the 20th.

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

1970			FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1	0		Neptune 7° N. of moon		d34O2	204.57
	13		Antares 0.7° N. of moon			
Mon. 2					d43O1	216.75 [b]
Tue. 3				3 20	21O43	228.93
Wed. 4	6		Mercury 5° N. of moon		O2134	241.12
Thu. 5	15		Mercury greatest elong. W., 26°		1O234	253.31
Fri. 6	18		Moon at perigee, 221,800 mi.			
	2	13	● New Moon	0 00	23O14	265.51
Sat. 7					312O4	277.70
Sun. 8	0		Vesta at opposition	20 50	3O124	289.90
Mon. 9	22		Mars 3° S. of moon		3O24*	302.09
Tue. 10			Mercury at descending node		21O43	314.28
Wed. 11	13		Saturn 7° S. of moon	17 40	4O213	326.46
Thu. 12	3		Juno in conjunction with sun		41O23	338.64 [l]
	23	10	☽ First Quarter			
Fri. 13					423O1	350.81
Sat. 14				14 30	4321O	2.98
Sun. 15					43O12	15.14 [b]
Mon. 16					43O2*	27.30
Tue. 17				11 20	d42O3	39.45
Wed. 18	17		Moon at apogee, 252,400 mi.		4O13*	51.59
Thu. 19					1O423	63.74
Fri. 20			Mercury at aphelion	8 10	23O14	75.88
			Venus greatest hel. lat. S.			
			Mars at ascending node			
			Neptune in quadrature W.			
	2		Jupiter stationary			
	21		Regulus 0.7° S. of moon			
Sat. 21	3	19	○ Full Moon; eclipse of ☾, p. 64		321O4	88.02
Sun. 22					3O124	100.16
Mon. 23				5 00	31O24	112.31
Tue. 24	5		Uranus 3° N. of moon		2O134	124.45
Wed. 25					2O134	136.60
Thu. 26	11		Jupiter 6° N. of moon	1 50	1O243	148.75
Fri. 27					2O341	160.91
Sat. 28	8		Neptune 7° N. of moon	22 40	3241O	173.07 [l]
	20		Antares 0.7° N. of moon			
	21	33	☾ Last Quarter			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]Feb. 12, +7.43°; Feb. 28, −7.05°. [b]Feb. 2, +6.73°; Feb. 15, −6.80°.

THE SKY FOR MARCH 1970

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

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

The Sun—During March the sun's R.A. increases from 22h 46m to 0h 40m and its Decl. changes from 7° 50′ S. to 4° 18′ N. The equation of time changes from −12m 25s to −4m 13s. On the 20th at 19h 57m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. For changes in the length of the day, see p. 14. There is a total eclipse of the sun visible in North America on the 7th.

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. 21h 41m, Decl. 16° 00′ S., and on the 15th is in R.A. 23h 12m, Decl. 7° 24′ S. It is too close to the sun for observation, superior conjunction being on the 23rd.

Venus on the 1st is in R.A. 23h 20m, Decl. 5° 51′ S., and on the 15th is in R.A. 0h 24m, Decl. 1° 16′ N., mag. −3.4, and transits at 12h 55m. It is an evening star to be seen very low in the west for about an hour after sunset.

Mars on the 15th is in R.A. 2h 13m, Decl. 13° 41′ N., mag. +1.6, and transits at 14h 43m. Moving from Pisces into Aries, it is well down in the west at sunset and sets about three hours later.

Jupiter on the 15th is in R.A. 14h 13m, Decl. 11° 52′ S., mag. −1.9, and transits at 2h 43m. In Virgo, it rises two hours or more before midnight and is visible the rest of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 2h 18m, Decl. 11° 30′ N., mag. +0.6, and transits at 14h 47m. In Aries, it is well down in the west at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 12h 28m, Decl. 2° 13′ S. and transits at 0h 58m. Opposition is on the 27th.

Neptune on the 15th is in R.A. 15h 56m, Decl. 18° 40′ S. and transits at 4h 26m.

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

1970			MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 1h 45m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1					43O12	185.24 [b]
Mon. 2					431O2	197.42
Tue. 3	12		Neptune stationary	19 30	42O31	209.60
Wed. 4					421O3	221.79
Thu. 5					41O23	233.99
Fri. 6	5		Moon at perigee, 223,600 mi.	16 20	d4O13	246.20
	18		Ceres in conjunction with sun			
Sat. 7	12	43	🌑 New Moon; eclipse of ⊙, p. 64		3241O	258.40
Sun. 8					3O241	270.61
Mon. 9				13 10	31O24	282.82
Tue. 10	20		Mars 4° S. of moon		2O314	295.03
Wed.11	3		Saturn 7° S. of moon		21O34	307.23
Thu. 12			Mercury greatest hel. lat. S.	10 00	O1234	319.43 [l]
Fri. 13					dO134	331.63
Sat. 14	16	16	🌓 First Quarter		231O4	343.82 [b]
Sun. 15				6 50	3O214	356.00
Mon.16	21		Pluto at opposition		314O2	8.18
Tue. 17	3		Mars 3° N. of Saturn		42O1*	20.36
Wed.18	7		Moon at apogee, 251,900 mi.	3 30	421O3	32.53
Thu. 19					4O123	44.69
Fri. 20	4		Regulus 0.7° S. of moon		4O23*	56.85
	19	57	Equinox. Spring begins			
Sat. 21				0 20	4231O	69.01
Sun. 22	20	53	🌕 Full Moon		43O1*	81.17
Mon.23	9		Uranus 3° N. of moon	21 10	341O2	93.32
	10		Mercury in superior conjunction			
Tue. 24					234O1	105.48
Wed.25	14		Jupiter 6° N. of moon		21O43	117.63
Thu. 26				18 00	O1234	129.79
Fri. 27	13		Neptune 7° N. of moon		1O234	141.96 [l]
	16		Uranus at opposition			
Sat. 28	2		Antares 0.7° N. of moon		231O4	154.13 [b]
	6		Vesta stationary			
Sun. 29				14 50	32O14	166.30
Mon.30	6	05	🌗 Last Quarter		31O24	178.48
Tue. 31			Mercury at ascending node		32O14	190.67

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.
[l]Mar. 12, +6.75°; Mar. 27, −5.84°.
[b]Mar. 1, +6.80°; Mar. 14, −6.84°, Mar. 28, +6.71°.

THE SKY FOR APRIL 1970

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

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

The Sun—During April the sun's R.A. increases from 0h 40m to 2h 31m and its Decl. changes from 4° 18′ N. to 14° 53′ N. The equation of time changes from −3m 55s to +2m 49s, 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. 1h 12m, Decl. 7° 40′ N., on the 15th is in R.A. 2h 43m, Decl. 18° 20′ N. Greatest eastern elongation is early on the 18th, and this is a favourable one. On the evening of the 17th Mercury will stand about 20° above the western horizon at sunset. For about a week before and after elongation it will be easy to see the planet low in the west just after sunset.

Venus on the 1st is in R.A. 1h 41m, Decl. 9° 47′ N., and on the 15th is in R.A. 2h 47m, Decl. 16° 01′ N., mag. −3.3, and transits at 13h 17m. It is a prominent evening star visible low in the west at sunset and setting about two hours later.

Mars on the 15th is in R.A. 3h 40m, Decl. 20° 10′ N. and transits at 14h 08m. Moving from Aries into Taurus, it is well down in the west at sunset and sets about three hours later.

Jupiter on the 15th is in R.A. 14h 01m, Decl. 10° 45′ S., mag. −2.0, and transits at 0h 29m. In Virgo, it rises soon after sunset and is nearly setting by sunrise. Opposition is on the 21st at a distance of 412,400,000 mi. from earth. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 2h 32m, Decl. 12° 44′ N., and transits at 12h 59m. In Aries, it is very low in the west at sunset and sets within about an hour. Late in the month it is too close to the sun for observation.

Uranus on the 15th is in R.A. 12h 23m, Decl. 1° 41′ S. and transits at 22h 47m.

Neptune on the 15th is in R.A. 15h 55m, Decl. 18° 33′ S. and transits at 2h 22m.

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

1970			APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1				11 40	21043	202.87
Thu. 2					40123	215.07
Fri. 3	6		Moon at perigee, 226,800 mi.		41023	227.29
Sat. 4				8 30	42130	239.50
Sun. 5			Mercury at perihelion		43201	251.72
	23	09	● New Moon			
Mon. 6					43102	263.95
Tue. 7	4		Mercury 3° S. of moon	5 20	43201	276.17
	11		Venus 5° S. of moon			
	18		Saturn 7° S. of moon			
Wed. 8	18		Mars 5° S. of moon		42103	288.39
Thu. 9					40213	300.62 [l]
Fri. 10				2 10	10423	312.84 [b]
Sat. 11	8		Venus 2° N. of Saturn		dd204	325.05
Sun. 12	17		Mercury 5° N. of Saturn	23 00	3204*	337.26
Mon.13	10	44	☽ First Quarter		31024	349.46
Tue. 14					30214	1.66
Wed.15			Mercury greatest hel. lat. N.	19 50	21034	13.86
	1		Moon at apogee, 251,300 mi.			
Thu. 16	11		Regulus 0.6° S. of moon		02134	26.04
Fri. 17			Venus at ascending node		10234	38.23
Sat. 18	3		Mercury greatest elong. E., 20°	16 40	20341	50.41
Sun. 19	14		Uranus 3° N. of moon		34210	62.58
Mon.20					43102	74.76
Tue. 21	10		Jupiter at opposition	13 30	43021	86.93
	11	21	○ Full Moon			
	15		Jupiter 6° N. of moon			
Wed.22			Lyrid meteors		42103	99.10 [l]
Thu.23	18		Neptune 7° N. of moon		4013*	111.27
Fri. 24	8		Antares 0.5° N. of moon	10 10	41023	123.44
Sat. 25					42031	135.62 [b]
Sun. 26					32410	147.80
Mon.27				7 00	30142	159.99
Tue. 28	12	18	☾ Last Quarter		3024*	172.18
	16		Mercury stationary			
Wed.29	23		Moon at perigee, 229,600 mi.		2104*	184.38
Thu.30				3 50	20134	196.59

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]Apr. 9, +5.73°; Apr. 22, −5.31°. [b]Apr. 10, −6.72°; Apr. 25, +6.59°.

THE SKY FOR MAY 1970

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

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

The Sun—During May the sun's R.A. increases from 2h 31m to 4h 34m and its Decl. changes from 14° 53′ N. to 21° 58′ N. The equation of time changes from +2m 56s to a maximum of +3m 44s on the 14th and then to +2m 27s 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. 3h 17m, Decl. 20° 19′ N., and on the 15th is in R.A. 2h 52m, Decl. 14° 48′ N. It is too close to the sun for observation, inferior conjunction being on the 9th. On this date Mercury transits the sun's disk (see page 63).

Venus on the 1st is in R.A. 4h 07m, Decl. 21° 30′ N., and on the 15th is in R.A. 5h 20m, Decl. 24° 18′ N., mag. −3.4, and transits at 13h 52m. It is an evening star prominent in the west after sunset and setting north of the west point two hours or more after sunset. On the evening of the 8th it is very close to Mars.

Mars on the 15th is in R.A. 5h 07m, Decl. 23° 42′ N., and transits at 13h 37m. Moving through Taurus, it is low in the west at sunset and sets within two hours thereafter. (See Venus.)

Jupiter on the 15th is in R.A. 13h 47m, Decl. 9° 31′ S., mag. −2.0, and transits at 22h 13m. In Virgo, it is well up in the south-east at sunset and sets before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 2h 47m, Decl. 13° 55′ N., and transits at 11h 16m. It is too close to the sun all month for easy observation, conjunction being on the 2nd.

Uranus on the 15th is in R.A. 12h 20m, Decl. 1° 19′ S. and transits at 20h 46m.

Neptune on the 15th is in R.A. 15h 52m, Decl. 18° 23′ S. and transits at 0h 21m. Opposition is on the 20th.

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

1970			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h 45m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1					10234	208.81
Sat. 2	18		Saturn in conjunction with sun		20134	221.03
Sun. 3	16		Mars 6° N. of Aldebaran	0 40	23104	233.26
Mon. 4					30124	245.50
Tue. 5			η Aquarid meteors	21 30	34102	257.73
	9	51	● New Moon			
Wed. 6	2		Venus 6° N. of Aldebaran		42130	269.97
Thu. 7	12		Venus 4° S. of moon		42013	282.21[lb]
	14		Mars 4° S. of moon			
Fri. 8				18 20	41023	294.45
Sat. 9			Mercury at descending node		42013	306.68
	3		Mercury in inferior conjunction, transit over sun, p. 64			
	5		Venus 0.2° N. of Mars			
Sun. 10					42130	318.91
Mon. 11				15 10	43021	331.14
Tue. 12	21		Moon at apogee, 251,100 mi.		34102	343.36
Wed. 13	5	26	☽ First Quarter		d2340	355.58
	20		Regulus 0.4° S. of moon			
Thu. 14				12 00	20134	7.79
Fri. 15					10234	20.00
Sat. 16	21		Uranus 3° N. of moon		d0134	32.20
Sun. 17	13		Mercury 0.2° S. of Saturn	8 50	21304	44.39
Mon. 18	18		Jupiter 6° N. of moon		30214	56.58
Tue. 19			Mercury at aphelion		31024	68.77[l]
Wed. 20	19		Neptune at opposition	5 40	23104	80.95
	22	38	○ Full Moon			
Thu. 21			Venus at perihelion		20143	93.13
	1		Neptune 7° N. of moon			
	10		Mercury stationary			
	15		Antares 0.4° N. of moon			
Fri. 22					41023	105.32[b]
Sat. 23				2 20	40213	117.50
Sun. 24					d4210	129.69
Mon. 25	3		Moon at perigee, 228,700 mi.	23 10	43021	141.88
Tue. 26					43102	154.08
Wed. 27	17	32	☾ Last Quarter		43201	166.28
Thu. 28	22		Mercury 1.7° S. of Saturn	20 00	4203*	178.49
Fri. 29					41023	190.71
Sat. 30					04213	202.94
Sun. 31				16 50	21034	215.17

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]May 7, +4.93°; May 19, −5.75°. [b]May 7, −6.56°; May 22, +6.52°.

THE SKY FOR JUNE 1970

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

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

The Sun—During June the sun's R.A. increases from 4h 34m to 6h 38m and its Decl. changes from 21° 58′ N. to 23° 09′ N., reaching 23° 27′ N. on the 21st. The equation of time changes from +2m 18s to −3m 31s, being zero on the 13th. The summer solstice is on the 21st at 14h 43m E.S.T. 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. 3h 01m, Decl. 13° 14′ N., and on the 15th is in R.A. 4h 02m, Decl. 18° 14′ N. Greatest western elongation is on the 4th, but this is an unfavourable one, Mercury being only about 10° above the eastern horizon at sunrise. It will be difficult to see.

Venus on the 1st is in R.A. 6h 50m, Decl. 24° 40′ N., and on the 15th is in R.A. 8h 02m, Decl. 22° 27′ N., mag. −3.4, and transits at 14h 31m. It is prominent in the western evening sky, setting more than two hours after the sun.

Mars on the 15th is in R.A. 6h 37m, Decl. 24° 10′ N., and transits at 13h 04m. In Gemini, it is now so close to the horizon at sunset that it would be difficult to observe.

Jupiter on the 15th is in R.A. 13h 39m, Decl. 8° 52′ S., mag. −1.8, and transits at 20h 03m. In Virgo, near Spica, it is nearly to the meridian at sunset and sets about an hour after midnight. On the 23rd 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. 56.

Saturn on the 15th is in R.A. 3h 02m, Decl. 14° 58′ N., mag. +0.5, and transits at 9h 29m. In Aries, it is a morning star rising about two hours before the sun.

Uranus on the 15th is in R.A. 12h 18m, Decl. 1° 12′ S. and transits at 18h 43m. It is in eastern quadrature on the 26th.

Neptune on the 15th is in R.A. 15h 48m, Decl. 18° 13′ S. and transits at 22h 12m.

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

1970			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h 55m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	23		Saturn 7° S. of moon		3014*	227.41
Tue. 2	3		Mercury 9° S. of moon		31024	239.65
Wed. 3	21	21	🌑 New Moon	13 40	32014	251.90 [l]
Thu. 4	22		Mercury greatest elong. W., 24°		21034	264.15 [b]
Fri. 5	10		Mars 4° S. of moon		d0234	276.39
Sat. 6	17		Venus 2° S. of moon	10 30	01243	288.64
Sun. 7					21043	300.89
Mon. 8			Mercury greatest hel. lat. S.		43201	313.13
Tue. 9	15		Moon at apogee, 251,400 mi.	7 20	43102	325.37
Wed.10	4		Regulus 0.1° S. of moon		43201	337.61
Thu. 11	4		Venus 5° S. of Pollux		42103	349.83
	16		Pluto stationary			
	23	07	🌓 First Quarter			
Fri. 12			Venus greatest hel. lat. N.	4 10	40123	2.06
	13		Uranus stationary			
Sat. 13	5		Uranus 4° N. of moon		4023*	14.28
Sun. 14					42103	26.49
Mon.15	0		Jupiter 6° N. of moon	1 00	32401	38.69
Tue. 16			Pluto at quadrature E.		31042	50.89 [l]
Wed.17	9		Neptune 7° N. of moon	21 40	d3014	63.09
Thu. 18	1		Antares 0.5° N. of moon		2104*	75.28 [b]
Fri. 19	7	28	🌕 Full Moon		01234	87.47
	17		Mercury 4° N. of Aldebaran			
Sat. 20				18 30	10234	99.66
Sun. 21	13		Moon at perigee, 225,600 mi.		d2034	111.85
	14	43	Solstice. Summer begins			
Mon.22					32014	124.04
Tue. 23	19		Jupiter stationary	15 20	31042	136.24
Wed.24					34021	148.44
Thu. 25	23	01	🌗 Last Quarter		42130	160.65
Fri. 26			Uranus at quadrature E.	12 10	40213	172.86
Sat. 27			Mercury at ascending node		41023	185.09
Sun. 28					42013	197.32
Mon.29	8		Pallas stationary	9 00	4230*	209.55 [l]
	11		Saturn 7° S. of moon			
Tue. 30					43102	221.79

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]June 3, +4.85°; June 16, −6.60°; June 29, +5.82°.

[b]June 4, −6.53°; June 18, +6.57°.

THE SKY FOR JULY 1970

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

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

The Sun—During July the sun's R.A. increases from 6h 38m to 8h 43m and its Decl. changes from 23° 09′ N. to 18° 11′ N. The equation of time changes from −3m 43s to a maximum of −6m 26s on the 26th and then to −6m 18s at the end of the month. On the 4th the earth is in aphelion, or farthest from the sun, at a distance of 94,514,000 mi. 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. 6h 07m, Decl. 23° 59′ N., and on the 15th is in R.A. 8h 16m, Decl. 21° 39′ N. Superior conjunction is on the 6th, and Mercury is too close to the sun all month for observation.

Venus on the 1st is in R.A. 9h 19m, Decl. 17° 34′ N., and on the 15th is in R.A. 10h 21m, Decl. 11° 46′ N., mag. −3.6, and transits at 14h 52m. Passing close to Regulus it is prominent in the western sky from about two hours after sunset.

Mars on the 15th is in R.A. 8h 01m, Decl. 21° 39′ N., and transits at 12h 30m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 13h 41m, Decl. 9° 12′ S., mag. −1.7, and transits at 18h 08m. In Virgo, it is well past the meridian at sunset and sets about four hours later. It is in eastern quadrature on the 20th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 3h 14m, Decl. 15° 43′ N., mag. +0.5, and transits at 7h 43m. In Aries, it rises about four hours before the sun.

Uranus on the 15th is in R.A. 12h 20m, Decl. 1° 24′ S. and transits at 16h 47m.

Neptune on the 15th is in R.A. 15h 46m, Decl. 18° 07′ S. and transits at 20h 12m.

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

1970			JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 35m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1					34O21	234.04 [b]
Thu. 2			Mercury at perihelion	5 50	2134O	246.29
Fri. 3	10	18	New Moon		O134*	258.54
Sat. 4			Earth at aphelion		1O234	270.79
Sun. 5				2 40	2O134	283.05
Mon. 6	18		Mercury in superior conjunction		d21O4	295.30
Tue. 7	0		Venus 0.9° N. of moon	23 20	31O24	307.54
	7		Moon at apogee, 252,100 mi.			
	11		Regulus 0.1° N. of moon			
Wed. 8					3O124	319.79
Thu. 9					231O4	332.03
Fri. 10	14		Uranus 4° N. of moon	20 10	2O341	344.26
Sat. 11	11		Venus 1.1° N. of Regulus		14O23	356.49
	14	43	First Quarter			
Sun. 12			Mercury greatest hel. lat. N.		d4O13	8.72
	9		Jupiter 6° N. of moon			
Mon.13				17 00	421O3	20.93
Tue. 14	18		Neptune 7° N. of moon		d43O2	33.14 [l]
Wed.15	11		Antares 0.6° N. of moon		43O12	45.35 [b]
Thu. 16				13 50	4231O	57.55
Fri. 17					42O31	69.74
Sat. 18	14	59	Full Moon		41O23	81.93
Sun. 19	17		Moon at perigee, 223,000 mi.	10 40	dO413	94.12
Mon.20			Jupiter at quadrature E.		21O34	106.31
Tue. 21					3O124	118.50
Wed.22				7 30	3O124	130.69
Thu.23					321O4	142.89
Fri. 24					2O314	155.10
Sat. 25	6	00	Last Quarter	4 20	1O234	167.31
Sun. 26	20		Saturn 8° S. of moon		O2143	179.53
Mon.27					21O43	191.75 [l]
Tue. 28				1 10	43O12	203.99 [b]
Wed.29			δ Aquarid meteors		43O12	216.22
Thu.30	14		Mercury 0.3° N. of Regulus	21 50	4321O	228.46
Fri. 31					42O1*	240.71

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l] July 14, −7.35°; July 27, +7.03°.

[b] July 1, −6.62°; July 15, +6.69°; July 28, −6.76°.

THE SKY FOR AUGUST 1970

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

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

The Sun—During August the sun's R.A. increases from 8h 43m to 10h 39m and its Decl. changes from 18° 11′ N. to 8° 31′ N. The equation of time changes from −6m 15s to −0m 19s. For changes in the length of the day, see p. 16. There is an annular eclipse of the sun, not visible in North America, on August 31–Sept. 1.

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. There is a partial eclipse of the moon, visible in North America, on the night of the 16th.

Mercury on the 1st is in R.A. 10h 14m, Decl. 11° 37′ N., and on the 15th is in R.A. 11h 17m, Decl. 2° 49′ N. Greatest eastern elongation is on the 16th, but this is a very poor one, Mercury standing only about 8° above the western horizon at sunset. It will be very difficult to see at this time.

Venus on the 1st is in R.A. 11h 31m, Decl. 3° 38′ N., and on the 15th is in R.A. 12h 25m, Decl. 3° 23′ S., mag. −3.8, and transits at 14h 53m. It may be seen low in the western sky for about an hour and a half after sunset. On the evening of the 30th it passes within a fraction of a degree south of Spica.

Mars on the 15th is in R.A. 9h 22m, Decl. 16° 36′ N., and transits at 11h 49m. It is too close to the sun for observation, conjunction being on the 2nd.

Jupiter on the 15th is in R.A. 13h 53m, Decl. 10° 26′ S., mag. −1.5, and transits at 16h 18m. In Virgo, it is well down in the south-west at sunset and sets about two hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 3h 22m, Decl. 16° 06′ N., mag. +0.4, and transits at 5h 48m. Moving into Taurus, it rises about midnight. It is in western quadrature on the 15th.

Uranus on the 15th is in R.A. 12h 24m, Decl. 1° 54′ S. and transits at 14h 49m.

Neptune on the 15th is in R.A. 15h 45m, Decl. 18° 06′ S. and transits at 18h 09m. It is in eastern quadrature on the 22nd.

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

AUGUST
E.S.T.

d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 20h 30m	Sun's Selen. Colong. 0h U.T. °
Sat. 1					41023	252.96
Sun. 2	0	58	🌑 New Moon	18 40	40213	265.21
	7		Mars in conjunction with sun			
Mon. 3	17		Moon at apogee, 252,500 mi.		42103	277.45
	18		Regulus 0.2° N. of moon			
Tue. 4	8		Mercury 0.5° N. of moon		43201	289.70
Wed. 5			Mercury at descending node	15 30	31042	301.95
Thu. 6	5		Venus 3° N. of moon		d3204	314.19
	23		Uranus 4° N. of moon			
Fri. 7			Venus at descending node		23014	326.43
Sat. 8	21		Jupiter 6° N. of moon	12 20	10234	338.66
Sun. 9					01234	350.89
Mon.10	3	50	☽ First Quarter		21034	3.11
	7		Neptune stationary			
Tue. 11	3		Neptune 7° N. of moon	9 10	23014	15.32 [l]
	20		Antares 0.7° N. of moon			
Wed.12			Perseid meteors		31024	27.53 [b]
Thu.13					d3201	39.73
Fri. 14	16		Venus 1.4° S. of Uranus	6 00	2430*	51.93
Sat. 15			Mercury at aphelion		41023	64.12
			Saturn at quadrature W.			
Sun. 16	10		Mercury greatest elongation E., 27°		40123	76.30
	22	15	○ Full Moon; eclipse of ☾, p. 64			
Mon.17	2		Moon at perigee, 221, 900 mi.	2 50	42103	88.48
Tue. 18					d4201	100.66
Wed.19				23 30	43102	112.85
Thu.20					34021	125.03
Fri. 21					23410	137.22
Sat. 22			Neptune at quadrature E.	20 20	d0234	149.42
Sun. 23	5		Saturn 8° S. of moon		01234	161.62
	15	34	☾ Last Quarter			
Mon.24			Mars greatest hel. lat. N.		21034	173.83 [l,b]
Tue. 25				17 10	20314	186.04
Wed.26					31024	198.26
Thu.27					30214	210.49
Fri. 28	20		Pallas at opposition	14 00	23104	222.72
Sat. 29	14		Mercury stationary		034**	234.95
Sun. 30	20		Moon at apogee, 252,500 mi.		4023*	247.19
Mon.31	0		Venus 0.2° S. of Spica	10 50	42103	259.42
	17	01	🌑 New Moon; eclipse of ☉, p. 64			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.
[l]Aug. 11, −7.60°; Aug. 24, +7.74°. [b]Aug. 12, +6.78°; Aug. 24, −6.83°.

THE SKY FOR SEPTEMBER 1970

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

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

The Sun—During September the sun's R.A. increases from 10h 39m to 12h 27m and its Decl. changes from 8° 31′ N. to 2° 56′ S. The equation of time changes from 0m 00s to +9m 58s. On the 23rd at 5h 59m E.S.T. the sun crosses the equator moving south, enters the sign of Libra and autumn commences. 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. 11h 45m, Decl. 3° 01′ S., and on the 15th is in R.A. 11h 09m, Decl. 2° 24′ N. Inferior conjunction is on the 12th, but by the 28th Mercury has reached greatest western elongation and at that time stands about 16° above the eastern horizon at sunrise. For about five mornings before and after this date it should be possible to see it low in the east just before sunrise.

Venus on the 1st is in R.A. 13h 26m, Decl. 11° 33′ S., and on the 15th is in R.A. 14h 13m, Decl. 17° 26′ S., mag. −4.2, and transits at 14h 39m. It is at greatest eastern elongation on the 1st, but nonetheless it is close to the horizon at sunset and sets within an hour. It is now becoming much brighter.

Mars on the 15th is in R.A. 10h 38m, Decl. 9° 50′ N., and transits at 11h 03m. It is a morning star but too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 14h 12m, Decl. 12° 15′ S., mag. −1.3, and transits at 14h 35m. In Virgo, it is very low in the south-west at sunset and sets about two hours later. For the configurations of Jupiter's satellites see opposite page.

Saturn on the 15th is in R.A. 3h 23m, Decl. 16° 04′ N., mag. +0.3, and transits at 3h 47m. In Taurus, it rises about two hours before midnight. On the 4th it is stationary in R.A. and begins to retrograde or move westward among the stars.

Uranus on the 15th is in R.A. 12h 31m, Decl. 2° 36′ S. and transits at 12h 54m.

Neptune on the 15th is in R.A. 15h 46m, Decl. 18° 12′ S. and transits at 16h 09m.

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

1970			SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 35m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1	2		Venus greatest elong. E., 46°		42O31	271.66
Wed. 2	6		Mercury 2° S. of moon		431O2	283.90
Thu. 3	8		Uranus 4° N. of moon	7 40	43O21	296.14
Fri. 4			Mercury greatest hel. lat. S.		4321O	308.37
	21		Saturn stationary			
	23		Venus 2° N. of moon			
Sat. 5	11		Jupiter 6° N. of moon		42O1*	320.60
	15		Ceres stationary			
Sun. 6				4 30	41O23	332.82
Mon. 7	10		Neptune 7° N. of moon		421O3	345.04
Tue. 8	3		Antares 0.7° N. of moon			357.26[lb]
	14	38	☽ First Quarter			
Wed. 9				1 10		9.46
Thu. 10			Venus at aphelion			21.66
Fri. 11				22 00		33.85
Sat. 12	13		Mercury in inferior conjunction			46.03
Sun. 13						58.21
Mon. 14	5		Venus 5° S. of Jupiter	18 50		70.38
	12		Moon at perigee, 222,500 mi.			
Tue. 15	6	10	○ Full Moon. Harvest Moon			82.55
Wed. 16						94.72
Thu. 17				15 40		106.89
Fri. 18						119.06
Sat. 19	13		Saturn 8° S. of moon			131.24
Sun. 20	10		Pluto in conjunction with sun	12 30		143.42[b]
Mon. 21	0		Mercury stationary			155.60[l]
Tue. 22	4	42	☾ Last Quarter			167.79
Wed. 23			Mercury at ascending node	9 20		179.99
	5	59	Equinox. Autumn begins			
Thu. 24						192.19
Fri. 25						204.40
Sat. 26				6 10		216.61
Sun. 27	3		Moon at apogee, 252,200 mi.			228.83
	6		Regulus 0.2° N. of moon			
Mon. 28			Mercury at perihelion			241.05
	9		Mercury greatest elong. W., 18°			
	18		Mars 3° N. of moon			
	21		Mercury 3° N. of moon			
Tue. 29				2 50		253.27
Wed. 30			Mars at aphelion			265.49
	9	32	● New Moon			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.
[l]Sept. 8, −7.14°; Sept. 21, +7.72°. [b]Sept. 8, +6.81°; Sept. 20, −6.76°.

THE SKY FOR OCTOBER 1970

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

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

The Sun—During October the sun's R.A. increases from 12h 27m to 14h 23m and its Decl. changes from 2° 56′ S. to 14° 14′ S. The equation of time changes from +10m 18s to +16m 20s. 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. 11h 25m, Decl. 5° 22′ N., and on the 15th is in R.A. 12h 48m, Decl. 3° 21′ S. Except for the first few days (see September) the planet is too close to the sun for observation, superior conjunction being on the 27th.

Venus on the 1st is in R.A. 14h 59m, Decl. 22° 38′ S., and on the 15th is in R.A. 15h 22m, Decl. 25° 11′ S., mag. −4.3, and transits at 13h 47m. Greatest brilliancy is on the 6th, but Venus is now so low on the south-western horizon at sunset (about 6° altitude on the 15th) that it will not be easily seen, especially later in the month.

Mars on the 15th is in R.A. 11h 49m, Decl. 2° 25′ N., mag. +2.0, and transits at 10h 16m. Moving from Leo into Virgo, it is a morning star rising in the east about two hours before the sun.

Jupiter on the 15th is in R.A. 14h 35m, Decl. 14° 15′ S., mag. −1.3, and transits at 13h 01m. It is too close to the sun for easy observation.

Saturn on the 15th is in R.A. 3h 18m, Decl. 15° 40′ N., mag. 0.0, and transits at 1h 44m. Moving back into Aries, it rises about an hour after sunset and is visible all night.

Uranus on the 15th is in R.A. 12h 38m, Decl. 3° 20′ S. and transits at 11h 03m. Conjunction with the sun is on the 2nd.

Neptune on the 15th is in R.A. 15h 50m, Decl. 18° 24′ S. and transits at 14h 14m.

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

1970			OCTOBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1				23 40		277.72
Fri. 2	15		Uranus in conjunction with sun			289.94
Sat. 3			Venus greatest hel. lat. S.			302.16
	3		Jupiter 6° N. of moon			
	21		Venus 0.7° S. of moon			
Sun. 4	16		Neptune 7° N. of moon	20 30		314.38
Mon. 5	9		Antares 0.6° N. of moon			326.59 [b]
Tue. 6	5		Venus at greatest brilliancy			338.79 [l]
Wed. 7	23	43	◑ First Quarter	17 20		350.99
Thu. 8			Mercury greatest hel. lat. N.			3.19
Fri. 9						15.37
Sat. 10				14 10		27.55
Sun. 11						39.72
Mon. 12	20		Moon at perigee, 224,700 mi.			51.88
Tue. 13	0		Mercury 1.2° N. of Uranus	11 00		64.04
	9		Juno stationary			
Wed. 14	15	21	○ Full Moon. Hunter's Moon			76.19
Thu. 15						88.35
Fri. 16	21		Saturn 8° S. of moon	7 50		100.50
Sat. 17	2		Pallas stationary			112.65
Sun. 18						124.81 [b]
Mon. 19				4 40		136.97 [l]
Tue. 20	10		Venus stationary			149.13
Wed. 21	21	47	☾ Last Quarter			161.31
			Orionid meteors			
Thu. 22				1 20		173.48
Fri. 23						185.66
Sat. 24	8		Ceres at opposition	22 10		197.85
	13		Regulus 0.3° N. of moon			
	17		Moon at apogee, 251,600 mi.			
Sun. 25						210.05
Mon. 26						222.24
Tue. 27	5		Mercury in superior conjunction	19 00		234.44
	5		Vesta in conjunction with sun			
	15		Mars 4° N. of moon			
Wed. 28	3		Uranus 4° N. of moon			246.65
Thu. 29						258.86
Fri. 30	1	28	● New Moon	15 50		271.06
Sat. 31	8		Venus 1° S. of moon			283.27

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.
[l]Oct. 6, −6.03°; Oct. 19, +6.99°. [b]Oct. 5, +6.71°; Oct. 18. −6.62°.

THE SKY FOR NOVEMBER 1970

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

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

The Sun—During November the sun's R.A. increases from 14h 23m to 16h 27m and its Decl. changes from 14° 14′ S. to 21° 42′ S. The equation of time changes from +16m 22s to a maximum of +16m 24s on the 3rd and then to +11m 19s 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. 14h 35m, Decl. 15° 08′ S., and on the 15th is in R.A. 16h 03m, Decl. 22° 11′ S. It is too close to the sun for observation.

Venus on the 1st is in R.A. 15h 14m, Decl. 24° 16′ S., and on the 15th is in R.A. 14h 45m, Decl. 19° 26′ S., mag. −3.3, and transits at 11h 07m. Inferior conjunction is on the 10th, so that it will be difficult to see Venus until later in the month when it begins to be prominent as a morning star low in the south-east just before sunrise.

Mars on the 15th is in R.A. 13h 01m, Decl. 5° 25′ S., mag. +1.9, and transits at 9h 26m. In Virgo, it is a morning star rising about three hours before the sun.

Jupiter on the 15th is in R.A. 15h 02m, Decl. 16° 16′ S., mag. −1.2, and transits at 11h 25m. It is too close to the sun for observation, conjunction being on the 9th. For the configurations of Jupiter's satellites see opposite page.

Saturn on the 15th is in R.A. 3h 09m, Decl. 15° 01′ N., mag. −0.1, and transits at 23h 29m. In Aries, it rises before sunset and is visible all night. Opposition is on the 11th, when its distance from earth is 757,900,000 mi.

Uranus on the 15th is in R.A. 12h 44m, Decl. 4° 02′ S. and transits at 9h 07m.

Neptune on the 15th is in R.A. 15h 54m, Decl. 18° 38′ S. and transits at 12h 17m. Conjunction with the sun is on the 23rd.

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

1970			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 6h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1			Mercury at descending node			295.48[l,b]
	0		Neptune 7° N. of moon			
	15		Antares 0.4° N. of moon			
Mon. 2				12 40		307.68
Tue. 3						319.88
Wed. 4						332.07
Thu. 5			Taurid meteors	9 30		344.26
Fri. 6	7	47	☽ First Quarter			356.44
	19		Mars 0.5° N. of Uranus			
Sat. 7						8.61
Sun. 8				6 20		20.77
Mon. 9	2		Jupiter in conjunction with sun			32.93
	15		Moon at perigee, 228,100 mi.			
Tue. 10	4		Venus in inferior conjunction			45.08
Wed. 11			Mercury at aphelion	3 10		57.22
	18		Saturn at opposition			
Thu. 12						69.36
Fri. 13	2	28	● Full Moon			81.50
	4		Saturn 8° S. of moon			
	20		Juno at opposition			
Sat. 14				0 00		93.64[b]
Sun. 15						105.78
Mon. 16				20 40		117.92[l]
Tue. 17			Leonid meteors			130.06
Wed. 18	17		Mercury 3° N. of Antares			142.21
Thu. 19				17 30		154.36
Fri. 20	18	13	☾ Last Quarter			166.52
	21		Regulus 0.6° N. of moon			
Sat. 21	13		Moon at apogee, 251,200 mi.			178.68
Sun. 22				14 20		190.85
Mon. 23	3		Neptune in conjunction with sun			203.03
Tue. 24	5		Mars 3° N. of Spica			215.21
	15		Uranus 5° N. of moon			
Wed. 25	12		Mars 6° N. of moon	11 10		227.39
Thu. 26	19		Venus 5° N. of moon			239.58
Fri. 27	15		Jupiter 6° N. of moon		d43O2	251.78
Sat. 28			Venus at ascending node	8 00	432O1	263.97[lb]
	16	14	● New Moon			
Sun. 29	1		Venus stationary		431O*	276.17
Mon. 30	3		Mercury 2° N. of moon		4O312	288.36

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]Nov. 1, −4.89°; Nov. 16, +5.92°; Nov. 28, −4.89°.

[b]Nov. 1, +6.58°; Nov. 14, −6.54°; Nov. 28, +6.54°.

THE SKY FOR DECEMBER 1970

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

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

The Sun—During December the sun's R.A. increases from 16h 27m to 18h 43m and its Decl. changes from 21° 42′ S. to 23° 04′ S., reaching 23° 27′ S. on the 22nd. The equation of time changes from +10m 57s to −3m 02s, being zero on the 25th. The winter solstice occurs on the 22nd at 1h 36m E.S.T. 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. 17h 45m, Decl. 25° 48′ S., and on the 15th is in R.A. 18h 55m, Decl. 24° 15′ S. Greatest eastern elongation is on the 10th, but this is an unfavourable one, Mercury standing only 9° above the south-western horizon at sunset. On the 28th it is in inferior conjunction.

Venus on the 1st is in R.A. 14h 30m, Decl. 14° 12′ S., and on the 15th is in R.A. 14h 47m, Decl. 13° 14′ S., mag. −4.4, and transits at 9h 13m. It is now a morning star, very bright (greatest brilliancy on the 16th), and rising near the south-east between two and three hours before the sun.

Mars on the 15th is in R.A. 14h 13m, Decl. 12° 25′ S., mag. +1.8, and transits at 8h 39m. Moving from Virgo into Libra, it rises four hours before sunrise.

Jupiter on the 15th is in R.A. 15h 28m, Decl. 17° 59′ S., mag. −1.3, and transits at 9h 53m. In Libra, it is a morning star rising about two hours before the sun. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 3h 00m, Decl. 14° 30′ N., mag. +0.1, and transits at 21h 22m. In Aries, it is well up at sunset and sets before sunrise.

Uranus on the 15th is in R.A. 12h 49m, Decl. 4° 31′ S. and transits at 7h 14m.

Neptune on the 15th is in R.A. 15h 59m, Decl. 18° 52′ S. and transits at 10h 23m.

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

1970			DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 6h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1			Mercury greatest hel. lat. S.	4 50	12O43	300.55
Wed. 2					2O134	312.74
Thu. 3					1O324	324.92
Fri. 4				1 40	3O124	337.10
Sat. 5	1		Moon at perigee, 230,100 mi.		32O4*	349.27
	15	36	☽ First Quarter			
Sun. 6				22 30	312O4	1.44
Mon. 7					O124*	13.59
Tue. 8					d1O43	25.74
Wed. 9				19 20	24O13	37.88
Thu. 10	9		Saturn 8° S. of moon		41O23	50.02
	18		Mercury greatest elong. E., 21°			
Fri. 11					43O12	62.15[b]
Sat. 12	16	03	○ Full Moon	16 10	4321O	74.28
Sun. 13					4312O	86.41[l]
Mon. 14			Geminid meteors		43O12	98.54
Tue. 15				12 50	41O23	110.67
Wed. 16	9		Venus at greatest brilliancy		42O13	122.80
Thu. 17					1O423	134.94
Fri. 18	4		Ceres stationary	9 40	3O124	147.08
	6		Regulus 0.9° N. of moon			
	21		Mercury stationary			
Sat. 19	10		Moon at apogee, 251,300 mi.		32O4*	159.22
Sun. 20			Mercury at ascending node		321O4	171.37
	16	09	☾ Last Quarter			
Mon. 21				6 30	3O124	183.53
Tue. 22			Ursid meteors		1O234	195.70
			Pluto in quadrature W.			
	1		Uranus 5° N. of moon			
	1	36	Solstice. Winter begins			
Wed. 23	15		Juno stationary		2O134	207.86
Thu. 24	8		Mars 6° N. of moon	3 20	1O34*	220.04
Fri. 25			Mercury at perihelion		3O412	232.22[l,b]
	0		Venus 9° N. of moon			
	10		Jupiter 6° N. of moon			
	20		Neptune 7° N. of moon			
Sat. 26	7		Antares 0.4° N. of moon		3412O	244.40
Sun. 27				0 10	d432O	256.59
Mon. 28	5	43	● New Moon		43O12	268.78
	9		Mercury at inferior conjunction			
Tue. 29				21 00	41O23	280.97
Wed. 30					42O13	293.16
Thu. 31	5		Moon at perigee, 227,300 mi.		412O3	305.34

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 62.

[l]Dec. 13, +5.13°; Dec. 25, −5.79°. [b]Dec. 11, −6.56°; Dec. 25, +6.62°.

JUPITER—PHENOMENA OF BRIGHTEST SATELLITES (E. S. T.) 1970

JANUARY

d	h	m	Sat.	Phen.
1	3	37	I	ED
	5	04	II	Te
2	2	59	I	Se
	4	07	I	Te
8	2	36	III	TI
	2	53	II	SI
	4	48	III	Te
	5	13	II	TI
	5	24	II	Se
	5	30	I	ED
9	2	41	I	SI
	3	53	I	TI
	4	53	I	Se
	6	03	I	Te
10	3	19	I	OR
15	4	04	III	Se
	5	26	II	SI
16	4	35	I	SI
	5	48	I	TI
17	4	59	II	OR
	5	13	I	OR
18	2	26	I	Te
22	5	37	III	SI
23	6	28	I	SI
24	2	28	II	ED
	3	43	I	ED
25	2	11	I	TI
	3	08	I	Se
	4	20	I	Te
26	1	34	I	OR
	2	08	II	Te
	2	47	III	OR
31	5	04	II	ED
	5	36	I	ED

FEBRUARY

d	h	m	Sat.	Phen.
1	2	50	I	SI
	4	04	I	TI
	5	01	I	Se
	6	13	I	Te
2	1	55	III	ER
	2	12	II	TI
	2	18	II	Se
	3	26	I	OR
	4	35	III	OD
	4	39	II	Te
8	4	43	I	SI
	5	56	I	TI
9	1	57	I	ED
	2	20	II	SI
	3	25	III	ED
	4	42	II	TI
	4	50	II	Se
	5	18	I	OR
	5	51	III	ER
10	1	23	I	Se
	2	33	I	Te
11	1	57	II	OR
16	3	50	I	ED
	4	52	II	SI
17	1	05	I	SI
	2	14	I	TI
	3	16	I	Se
	4	23	I	Te
18	1	35	I	OR
	4	26	II	OR
20	2	14	III	TI
	4	07	III	Te
23	5	43	I	ED
24	2	59	I	SI
	4	04	I	TI
	5	10	I	Se
25	0	11	I	ED

d	h	m	Sat.	Phen.
25	2	08	II	ED
	3	24	I	OR
	23	38	I	Se
26	0	40	I	Te
27	1	12	II	Te
	1	26	III	SI
	3	47	III	Se

MARCH

d	h	m	Sat.	Phen.
3	4	52	I	SI
4	2	04	I	ED
	4	44	II	ED
	5	11	I	OR
	23	21	I	SI
5	0	19	I	TI
	1	32	I	Se
	2	28	I	Te
	23	14	II	SI
	23	38	I	OR
6	1	08	II	TI
	1	45	II	Se
	3	34	II	Te
	5	24	III	SI
9	23	08	III	OD
10	1	00	III	OR
11	3	57	I	ED
12	1	14	I	SI
	2	07	I	TI
	3	25	I	Se
	4	16	I	Te
13	1	25	I	OR
	1	47	II	SI
	3	29	II	TI
	4	18	II	Se
	22	42	I	Te
15	0	51	II	OR
16	23	13	III	ED
17	1	36	III	ER
	2	37	III	OD
	4	28	III	OR
19	3	08	I	SI
	3	53	I	TI
20	0	18	I	ED
	3	10	I	OR
	4	19	II	SI
	22	19	I	TI
	23	47	I	Se
21	0	28	I	Te
	23	14	II	ED
22	3	10	II	OR
24	3	11	III	ED
27	2	12	I	ED
	21	38	III	Te
	23	30	I	SI
28	0	04	I	TI
	1	41	I	Se
	2	13	I	Te
	23	22	I	OR
29	1	49	II	ED
30	22	41	II	Se
	23	37	II	Te

APRIL

d	h	m	Sat.	Phen.
3	4	05	I	ED
	21	16	III	SI
	23	11	III	TI
	23	34	III	Se
4	0	59	III	Te
	1	23	I	SI
	1	49	I	TI
	3	35	I	Se
	3	58	I	Te
	22	33	I	ED

d	h	m	Sat.	Phen.
5	1	06	I	OR
	4	25	II	ED
	22	03	I	Se
	22	24	I	Te
6	22	43	II	SI
	23	26	II	TI
7	1	15	II	Se
	1	52	II	Te
8	20	52	II	OR
11	1	14	III	SI
	2	28	III	TI
	3	18	I	SI
	3	32	III	Se
	3	33	I	TI
	4	17	III	Te
12	0	27	I	ED
	2	50	I	OR
	21	46	I	SI
	21	59	I	TI
	23	57	I	Se
13	0	09	I	Te
	21	16	I	OR
14	1	16	II	SI
	1	40	II	TI
	3	49	II	Se
	4	07	II	Te
15	20	18	II	ED
	23	08	II	OR
19	2	21	I	ED
	23	40	I	SI
	23	43	I	TI
20	1	51	I	Se
	1	52	I	Te
	20	49	I	ED
	22	59	I	OR
21	3	50	II	SI
	3	53	II	TI
	20	18	I	Te
	20	20	I	Se
	21	22	III	ER
22	22	52	II	OD
23	1	30	II	ER
27	1	27	I	TI
	1	34	I	SI
	3	37	I	Te
	3	46	I	Se
	22	34	I	OD
28	0	53	I	ER
	20	03	I	SI
	22	03	I	Te
	22	14	I	Se
	22	28	III	OD
29	1	20	III	ER
30	1	07	II	OD

MAY

d	h	m	Sat.	Phen.
1	21	43	II	Te
	22	15	II	Se
4	3	11	I	TI
	3	29	I	SI
5	0	18	I	OD
	2	47	I	ER
	21	37	I	TI
	21	57	I	SI
	23	47	I	Te
6	0	08	I	Se
	1	44	III	OD
	21	16	I	ER
8	21	29	II	TI
	22	17	II	SI
	23	58	II	Te
9	0	50	II	Se

d	h	m	Sat.	Phen.
12	2	03	I	OD
	23	22	I	TI
	23	52	I	SI
13	1	32	I	Te
	2	02	I	Se
	20	29	I	OD
	23	10	I	ER
14	20	31	I	Se
15	23	45	II	TI
16	0	52	II	SI
	2	15	II	Te
	20	54	III	Te
	21	07	III	SI
	23	22	III	Se
17	22	34	II	ER
20	1	08	I	TI
	1	46	I	SI
	22	15	I	OD
21	1	05	I	ER
	21	44	I	Te
	22	25	I	Se
23	2	03	II	TI
	22	13	III	TI
24	0	20	III	Te
	1	06	III	SI
	21	07	II	OD
25	1	10	II	ER
28	0	01	I	OD
	21	21	I	TI
	22	10	I	SI
	23	31	I	Te
29	0	20	I	Se
	21	28	I	ER
31	1	39	III	TI
	23	27	II	OD

JUNE

d	h	m	Sat.	Phen.
2	21	54	II	Se
3	21	11	III	ER
4	23	09	I	TI
5	0	05	I	SI
	1	19	I	Te
	23	23	I	ER
6	20	43	I	Se
9	21	56	II	SI
	22	28	II	Te
10	0	29	II	Se
	21	03	III	OR
	22	55	III	ED
12	0	58	I	TI
	1	59	I	SI
	22	04	I	OD
13	21	35	I	Te
	22	37	I	Se
16	22	21	II	TI
17	0	32	II	SI
	0	54	II	Te
	22	23	III	OD
18	0	43	III	OR
	22	13	II	ER
19	23	54	I	OD
20	21	15	I	TI
	22	23	I	SI
	23	25	I	Te
21	21	42	I	ER
27	23	07	I	TI
28	21	01	III	SI
	23	13	III	Se
	23	37	I	ER
29	20	55	I	Se

JULY

d	h	m	Sat.	Phen
2	22	23	II	OD

JULY

d	h	m	Sat.	Phen.
4	21	37	II	Se
5	22	05	I	OD
	22	17	III	Te
6	21	37	I	Te
	22	50	I	Se
11	21	40	II	SI
	21	43	II	Te
13	21	21	I	TI
	22	36	I	SI
14	21	56	I	ER
16	21	04	III	ER
18	21	42	II	TI
20	21	51	II	ER
22	21	08	I	Se
29	20	54	I	SI
30	21	36	III	OD

AUGUST

d	h	m	Sat.	Phen.
10	20	56	III	SI
13	20	42	I	OD
14	20	12	I	Te
17	20	06	III	TI
21	20	00	I	TI
30	19	38	I	Se

Jupiter being near the sun, phenomena of the satellites are not given between Aug. 30 and Dec. 12.

DECEMBER

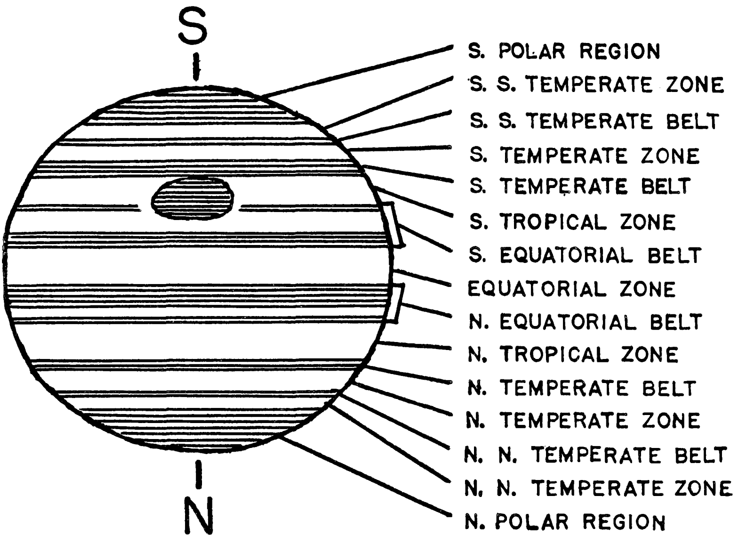
d	h	m	Sat.	Phen.
12	6	23	I	ED
13	6	15	I	Te
14	6	27	III	ED
20	6	05	I	TI
25	5	38	III	Te
31	6	28	II	ED

E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress; E.S.T. (For other times see p. 10.)

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.

***Note*: 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 east side from May to September, and on the west side during the rest of the year.

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.

SATURN'S SATELLITES TITAN, RHEA AND IAPETUS (E.S.T.)

By Terence Dickinson

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.

*All magnitudes given are at mean opposition.

Titan

Elong. E.	d	h	Elong. W.	d	h
Jan.	3	00.3	Jan.	11	01.9
	18	23.2		27	01.0
Feb.	3	22.6	Feb.	12	00.6
	19	22.5		28	00.6
Mar.	7	22.8	Mar.	16	00.9
	..	....		..	....
June	12	04.2	June	4	04.3
	28	04.9		20	04.9
July	14	05.3	July	6	05.2
	30	05.3		22	05.3
Aug.	15	04.9	Aug.	7	05.0
	31	04.0		23	04.3
Sept.	16	02.5	Sept.	8	03.1
Oct.	2	00.6		24	01.4
	17	22.1	Oct.	9	23.3
Nov.	2	19.4		25	20.8
	18	16.6	Nov.	10	18.2
Dec.	4	13.9		26	15.6
	20	11.5	Dec.	12	13.1
				28	11.0

Iapetus

Elong. E.	d	h	Elong. W.	d	h
Mar.	10	03.1	Jan.	30	01.1
	..	....		..	....
May	30	19.2	July	11	12.9
Aug.	19	17.3	Sept.	29	07.1
Nov.	6	09.0	Dec.	16	10.3

Rhea

Elong. E.	d	h	Elong. E.	d	h
Jan.	2	14.9	Aug.	3	04.7
	7	03.3		7	17.2
	11	15.8		12	05.6
	16	04.2		16	18.1
	20	16.7		21	06.6
	25	05.2		25	19.0
	29	17.7		30	07.4
Feb.	3	06.2	Sept.	3	19.9
	7	18.7		8	08.3
	12	07.2		12	20.7
	16	19.7		17	09.0
	21	08.2		21	21.4
	25	20.8		26	09.8
Mar.	2	09.3		30	22.1
	6	22.9	Oct.	5	10.5
	11	10.4		9	22.8
	15	23.0		14	11.1
	20	11.6		18	23.5
	25	00.2		23	11.8
	..	....		28	00.1
June	5	09.6	Nov.	1	12.4
	9	22.2		6	00.7
	14	10.8		10	13.0
	18	23.4		15	01.3
	23	11.9		19	13.6
	28	00.5		24	01.9
July	2	13.0		28	14.2
	7	01.6	Dec.	3	02.6
	11	14.1		7	14.9
	16	02.7		12	03.2
	20	15.2		16	15.6
	25	03.7		21	03.9
	29	16.2		25	16.3
				30	04.7

SATURN'S SATELLITES, 1970

Name	Greatest E. Elongation E.S.T.*		Mean Synodic Period	
	d	h	d	h
Janus (discovered 1966, orbital elements not available)				
Mimas	Nov. 11	04.6	0	22.6
Enceladus	Nov. 11	20.3	1	08.9
Tethys	Nov. 11	04.5	1	21.3
Dione	Nov. 11	22.1	2	17.7
Rhea	Nov. 10	13.0†	4	12.5
Titan	Nov. 18	16.6†	15	23.3
Hyperion	Nov. 21	14.2	21	07.6
Iapetus	Nov. 6	09.0†	79	22.1
Phoebe			523	15.6

*Near opposition of Saturn, 1970 Nov. 11.
†See p. 58 for more information.

DIMENSIONS OF SATURN'S RINGS

Diameter		Miles	At Mean Opposition Distance	Ratio
			″	
Outer Ring, A	— outer	169,100	44.0	2.252
	— inner	148,800	38.7	1.982
Inner Ring, B	— outer	145,400	37.8	1.936
	— inner	112,400	29.2	1.498
Dusky Ring	— inner	92,700	24.1	1.236
Saturn	— equatorial	75,100	19.5	1.000

SATURN'S RINGS, 1970

Date (19h E.S.T.)	Major Axis	Minor Axis	Inclination*
	″	″	°
Jan. 1	42.6	12.0	16.4
Feb. 2	40.2	11.6	16.8
Mar. 2	38.5	11.7	17.6
July 4	38.3	14.3	21.9
Aug. 1	40.2	15.4	22.5
Sept. 2	42.6	16.4	22.6
Oct. 4	44.9	17.0	22.3
Nov. 1	46.0	17.1	21.8
Dec. 3	45.6	16.5	21.2
Dec. 31	44.1	15.7	20.9

*During 1970 the south face of the rings is turned earthward at the inclinations indicated. Maximum inclination of about 28° will occur in 1973.

JUPITER—LONGITUDE OF CENTRAL MERIDIAN

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

	SYSTEM I						SYSTEM II					
Month U.T.	Jan. 9^h	Feb. 8^h	March 7^h	April 5^h	May 5^h	Dec. 11^h	Jan. 9^h	Feb. 8^h	March 7^h	April 5^h	May 5^h	Dec. 11^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	304.3	122.1	188.3	333.6	34.6	173.8	3.7	305.2	158.0	67.5	259.5	204.1
2	102.1	280.1	346.3	131.7	192.6	331.5	153.9	95.5	308.4	217.9	49.9	354.2
3	260.0	78.0	144.3	289.7	350.6	129.2	304.1	245.8	98.8	8.3	200.3	144.3
4	57.8	235.9	302.3	87.7	148.6	286.9	94.3	36.1	249.1	158.7	350.7	294.4
5	215.7	33.9	100.3	245.8	304.6	84.6	244.6	186.4	39.5	309.1	141.0	84.4
6	13.5	191.8	258.3	43.8	104.6	242.4	34.8	336.7	189.9	99.5	291.4	234.5
7	171.4	349.7	56.3	201.9	262.6	40.1	185.0	127.0	340.2	249.9	81.8	24.6
8	329.2	147.7	214.3	359.9	60.6	197.8	335.3	277.3	130.6	40.4	232.1	174.7
9	127.1	305.6	12.3	157.9	218.5	355.5	125.5	67.6	281.0	190.8	379.9	324.8
10	285.0	103.8	170.3	316.0	16.5	153.3	275.7	217.9	71.4	341.2	172.8	14.9
11	82.8	261.5	328.3	114.0	174.5	311.0	66.0	8.3	221.7	131.6	323.2	265.0
12	240.7	59.4	126.3	272.0	332.5	108.7	216.2	158.6	12.1	282.0	113.5	55.1
13	38.6	217.4	284.3	70.1	130.5	266.5	6.4	308.9	162.5	72.4	263.9	205.2
14	196.5	15.3	82.4	228.1	288.4	64.2	156.7	99.2	312.9	222.8	54.2	355.3
15	354.3	173.3	240.4	26.2	86.4	221.9	306.9	249.5	103.3	13.2	204.5	145.4
16	152.2	331.3	38.4	184.2	244.4	19.7	97.2	39.9	253.6	163.6	354.9	295.5
17	310.1	129.2	196.4	342.2	42.3	177.4	247.4	190.2	44.0	314.0	145.2	85.7
18	108.0	287.2	354.4	140.3	200.3	335.2	37.7	340.5	194.4	104.4	295.5	235.8
19	265.9	85.1	152.5	298.3	358.2	132.9	187.9	130.9	344.8	254.8	85.9	25.9
20	63.8	243.1	310.5	96.3	156.2	290.6	338.2	281.2	135.2	45.2	236.2	176.0
21	221.7	41.1	108.5	254.4	314.1	88.4	128.5	71.5	285.6	195.6	26.5	326.1
22	19.6	199.1	266.5	52.4	112.1	246.1	278.7	221.9	76.0	346.0	176.8	116.2
23	177.4	357.0	64.6	210.4	270.0	43.9	69.0	12.2	226.4	136.4	327.1	266.4
24	335.3	155.0	222.6	8.4	67.9	201.7	219.3	162.6	16.8	286.8	117.4	56.5
25	133.3	313.0	20.6	166.5	225.9	359.4	9.5	312.9	167.2	77.2	267.7	206.6
26	291.2	111.0	178.6	324.5	23.8	157.2	159.8	103.3	317.6	227.6	58.0	356.7
27	89.1	269.0	336.7	122.5	181.7	314.9	310.1	253.6	108.0	18.0	208.3	146.9
28	247.0	66.9	134.7	280.5	339.6	112.7	100.4	44.0	258.4	168.4	358.6	297.0
29	44.9		292.7	78.5	137.6	270.5	250.7		48.8	318.8	148.9	87.1
30	202.8		90.8	236.6	295.5	68.2	40.9		199.2	109.2	299.2	237.3
31	0.7		248.8		93.4	226.0	191.2		349.6		89.5	27.4

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1970
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.21	−3.04	267.19	July 5	− 1.06	+3.31	345.47
6	− 0.22	−3.61	201.34	10	+ 1.21	+3.83	279.29
11	− 2.63	−4.15	135.50	15	+ 3.45	+4.33	213.12
16	− 5.00	−4.66	69.66	20	+ 5.65	+4.80	146.96
21	− 7.30	−5.14	3.82	25	+ 7.80	+5.23	80.81
26	− 9.53	−5.57	297.98	30	+ 9.87	+5.63	14.67
31	−11.65	−5.96	232.15	Aug. 4	+11.86	+6.00	308.55
Feb. 5	−13.67	−6.30	166.32	9	+13.76	+6.32	242.43
10	−15.56	−6.59	100.49	14	+15.55	+6.59	176.33
15	−17.33	−6.83	34.65	19	+17.23	+6.82	110.24
20	−18.95	−7.02	328.81	24	+18.79	+7.00	44.17
25	−20.42	−7.15	262.95	29	+20.22	+7.14	338.10
Mar. 2	−21.74	−7.23	197.09	Sept. 3	+21.51	+7.22	272.06
7	−22.91	−7.25	131.22	8	+22.67	+7.25	206.03
12	−23.91	−7.21	65.34	13	+23.68	+7.23	140.00
17	−24.74	−7.12	359.44	18	+24.53	+7.15	73.99
22	−25.40	−6.98	293.52	23	+25.23	+7.03	7.99
27	−25.89	−6.79	227.59	28	+25.77	+6.85	302.00
Apr. 1	−26.21	−6.54	161.63	Oct. 3	+26.13	+6.62	236.03
6	−26.34	−6.25	95.66	8	+26.32	+6.34	170.06
11	−26.29	−5.91	29.67	13	+26.32	+6.01	104.09
16	−26.06	−5.53	323.66	18	+26.14	+5.64	38.14
21	−25.65	−5.11	257.62	23	+25.77	+5.23	332.19
26	−25.05	−4.65	191.57	28	+25.21	+4.77	266.25
May 1	−24.26	−4.17	125.50	Nov. 2	+24.45	+4.27	200.32
6	−23.30	−3.65	59.41	7	+23.49	+3.75	134.40
11	−22.16	−3.11	353.30	12	+22.34	+3.19	68.48
16	−20.85	−2.55	287.18	17	+20.99	+2.61	2.56
21	−19.38	−1.97	221.04	22	+19.47	+2.00	296.65
26	−17.75	−1.38	154.89	27	+17.76	+1.38	230.75
31	−15.99	−0.78	88.72	Dec. 2	+15.89	+0.75	164.86
June 5	−14.09	−0.18	22.56	7	+13.87	+0.11	98.97
10	−12.09	+0.42	316.38	12	+11.73	−0.53	33.08
15	− 9.99	+1.02	250.20	17	+ 9.48	−1.17	327.21
20	− 7.82	+1.62	184.01	22	+ 7.15	−1.79	261.34
25	− 5.60	+2.20	117.83	27	+ 4.76	−2.41	195.48
30	− 3.34	+2.76	51.64				

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, 1970

No.	Commences	No.	Commences	No.	Commences
1557	Jan. 21.29	1562	June 6.70	1567	Oct. 20.89
1558	Feb. 17.63	1563	July 3.90	1568	Nov. 17.19
1559	Mar. 16.96	1564	July 31.11	1569	Dec. 14.51
1560	Apr. 13.25	1565	Aug. 27.34		
1561	May 10.49	1566	Sept. 23.61		

THE OBSERVATION OF THE MOON

During 1970 the ascending node of the moon's orbit regresses from Aquarius into Capricornus (☊ from 345° to 326°). At the beginning of the year the range of the moon's declination is still near its maximum, but the range decreases by about a degree at the end of the year. See p. 64 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 ½° 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 0h 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.

ECLIPSES DURING 1970

In 1970 there will be four eclipses, two of the sun and two of the moon. Of these, the total eclipse of the sun on March 7 and both partial eclipses of the moon, on the nights of February 20–21 and August 16–17, will be visible in North America.

1. A partial eclipse of the moon on the night of February 20–21, visible in North America.

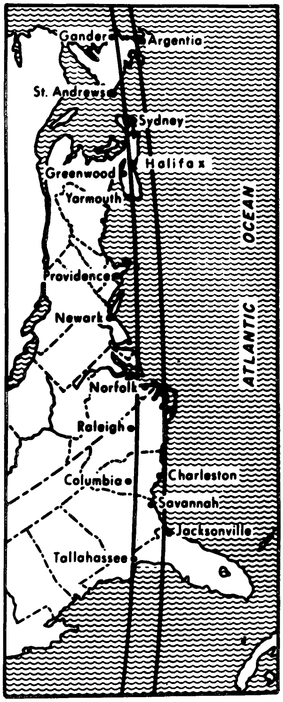
Moon enters penumbra..........February 21, 0h 59m E.S.T.
Moon enters umbra........................3h 02m E.S.T.
Middle of eclipse..........................3h 30m E.S.T.
Moon leaves umbra........................3h 58m E.S.T.
Moon leaves penumbra....................6h 01m E.S.T.
Magnitude of the eclipse 0.051.

2. A total eclipse of the sun on March 7. The band of totality closely follows the east coast of the United States and Canada, crossing the eastern parts of Nova Scotia and Newfoundland where totality lasts about two minutes and occurs between 14h 50m and 15h 00m A.S.T. depending upon locality. All the rest of North America except Alaska will experience a partial eclipse. See map.

3. A partial eclipse of the moon on the night of August 16–17, visible in North America except the extreme north-western part.

Moon enters penumbra..........August 16, 20h 06m E.S.T.
Moon enters umbra.......................21h 17m E.S.T.
Middle of eclipse.........................22h 23m E.S.T.
Moon leaves umbra.......................23h 30m E.S.T.
Moon leaves penumbra..........August 17, 0h 40m E.S.T.
Magnitude of the eclipse 0.413.

4. An annular eclipse of the sun, August 31–September 1, visible only in the South Pacific Ocean.



Path of totality for the March 7 eclipse of the sun
(Adapted from map, courtesy of
Mr. H.C.S. THOM, NASA, Washington, D.C.)

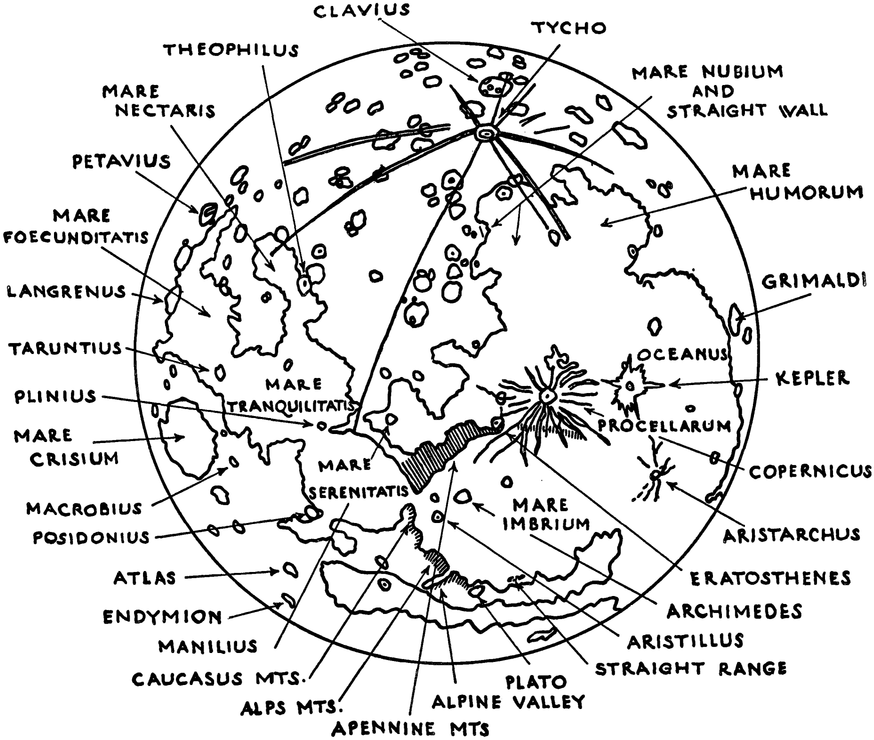
TRANSIT OF MERCURY

On the morning of May 9th Mercury will transit the sun's disk. The event will be seen in its entirety in eastern Europe and Africa and in western Asia. Farther to the west the transit will already be in progress at sunrise. In eastern and central North America the egress will be seen after sunrise, but in the far west the transit will be ended before sunrise. The time of egress in latitude 45° will be approximately as shown below, and will be about 10 seconds earlier (later) per 5° of latitude farther north (south).

Interior egress 7h 10m 20s E.S.T.
Exterior egress 7h 13m 20s E.S.T.

The position angle (reckoned from the north limb of the sun toward the east) of egress is 237°.

MAP OF THE MOON



South appears at the top.

OCCULTATIONS BY THE MOON

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation. The passage of the star behind the east limb of the moon is called the immersion and its re-appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, 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. 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.

In 1970 the moon will still occult some of the stars in the Pleiades, but the number of stars occulted is markedly less than in 1969.

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, 1970

Date	Star	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. 1	ψ Vir	4.9	E	275	5 04.4	—	—	251	No Occ.	...	...	...
2	85 Vir	6.2	E	288	Sun	...	...	...	6 09.8	−3.0	+1.3	249
3	9 G. Lib	6.5	E	299	5 30.3	−1.3	+0.8	281	4 18.9	−1.2	+1.5	266
10	54 Aqr	7.0	I	43	Low	...	...	...	18 52.3	−0.9	−1.5	92
11	316 B. Aqr	6.6	I	57	Low	...	...	...	19 58.7	−0.2	+0.8	26
15	μ Ari	5.7	I	108	23 16.0	−0.8	−2.4	109	22 04.1	−1.2	−2.3	107
18	+26° 731*m*	6.5	I	134	Low	...	...	...	3 30.3	−0.5	+0.2	34
18	354 B. Tau	6.3	I	142	21 47.7	−2.1	−0.1	91	20 28.2	−1.9	+0.7	84
25	45 Leo	5.9	E	210	3 18.5	−1.9	−1.1	285	1 56.3	−2.5	+0.2	268
26	9 B. Vir	6.2	E	231	22 38.1	—	—	8	Low	...	...	...
Feb. 8	−01° 4485	7.3	I	37	18 20.1	−0.8	−0.6	70	Sun	...	...	...
12	161 B. Ari	7.0	I	89	20 39.6	−1.4	+0.3	54	19 25.0	−1.6	+0.9	50
14	38 B. (Aur)	6.5	I	112	21 16.2	−1.6	−2.2	118	19 56.3	−2.0	−1.8	117
14	47 B. (Aur)	6.1	I	113	No Occ.	...	...	...	23 14.8	—	—	29
14/15	+27° 734	6.9	I	113	0 30.1	+0.5	−3.4	146	23 34.1	—	—	167
16	+27° 1270	7.0	I	135	22 24.3	—	—	50	21 00.2	−2.4	+2.1	57
18	5 B. Cnc	6.4	I	149	Low	...	...	...	4 33.4	+0.2	−1.4	97
Mar. 11	134 B. Ari	6.7	I	58	Low	...	...	...	21 46.1	−0.1	−0.8	69
12	+24° 571	6.8	I	69	20 05.2	−1.1	−0.9	78	18 51.5	−1.5	−0.7	79
12	+24° 583	6.9	I	70	21 49.3	−0.6	−0.6	62	20 41.4	−0.9	−0.7	69
12	+24° 587	6.8	I	70	22 09.8	−0.5	−0.7	66	21 03.5	−0.7	−0.9	73
15	406 B. Tau	5.6	I	95	1 21.6	+0.1	−0.9	70	0 20.7	−0.1	−1.2	81
18	80 Cnc	6.8	I	138	23 10.0	−0.6	−2.7	155	22 02.8	−0.2	−3.7	173
20	α Leo	1.3	I	151	Low	...	...	...	4 41.9	+0.1	−1.1	67
25	85 Vir	6.2	E	207	2 45.8	−1.0	−1.6	335	1 33.7	−1.2	−1.0	321
26	9 G. Lib	6.5	E	219	Graze	...	...	...	0 14.9	+0.1	−1.3	350
28	τ Sco	2.9	I	245	5 24.6	−1.8	−0.5	90	4 05.9	−1.9	0.0	92
Apr. 10	354 B. Tau	6.3	I	62	20 56.8	−1.1	−0.3	54	19 45.2	−1.2	−0.6	66
12	+26° 1481	6.8	I	84	20 28.8	−1.7	−0.8	80	19 10.6	−1.8	−0.8	92
14	+20° 2232	6.8	I	107	21 29.3	—	—	52	19 59.1	−2.6	+0.3	77
16	45 Leo	5.9	I	129	23 20.8	−2.5	−0.6	73	21 57.8	−2.1	−0.9	94
19	χ Vir	4.8	I	163	23 18.9	−0.8	−1.7	156	22 11.8	−0.2	−2.1	175
May 7	+27° 716	6.8	I	30	Low	...	...	...	20 04.9	−0.3	−0.6	58
8	+27° 943	6.8	I	43	Low	...	...	...	21 35.6	+1.3	−2.7	161
8	415 B. (Tau)	6.1	I	43	Low	...	...	...	21 39.6	+0.1	−1.0	75
10	κ Gem	3.7	I	64	20 13.2	−0.8	−1.8	109	Sun	...	...	...
10	+24° 1755	6.8	I	64	20 16.2	+0.1	−2.9	154	Sun	...	...	...
11/12	109 B. Cnc	6.6	I	77	0 00.2	−0.5	−0.3	47	22 54.3	−0.6	−1.0	62
12	+17° 2065	6.8	I	86	20 25.8	—	—	191	No Occ.	...	...	...
13	α Leo	1.3	I	98	No Occ.	...	...	...	19 30.5	−2.8	0.0	78
13	α Leo	1.3	E	98	No Occ.	...	...	...	20 22.3	+0.2	−3.3	358
24	τ Sgr	3.4	I	222	3 06.2	−2.0	−0.2	108	1 47.9	−1.7	+0.3	103
24	τ Sgr	3.4	E	222	Sun	...	...	...	2 58.3	−1.5	+0.4	233
26	η Cap	4.9	E	248	2 09.3	−1.3	+1.2	272	Low	...	...	...
28	λ Aqr	3.8	I	275	2 14.3	−0.4	+2.6	5	Low	...	...	...
28	λ Aqr	3.8	E	275	2 50.5	−1.1	+0.9	296	Low	...	...	...
June 8	78 Cnc	7.4	I	57	22 04.0	+0.2	−1.8	128	21 03.8	+0.1	−2.0	136
15	−19° 3880	6.4	I	136	21 58.3	−2.3	−0.1	74	20 35.7	−2.1	+0.1	88
22	17 Cap	5.9	E	217	2 06.5	−1.2	+1.3	210	0 55.2	−1.3	+1.4	219
30	η Tau	3.0	E	321	2 49.7	+1.2	+2.7	186	Low	...	...	...
July 26	μ Ari	5.7	E	280	No Occ.	...	...	...	2 49.7	+0.4	+3.0	190
Aug. 11	−27° 10967	6.8	I	109	21 37.3	−1.3	−0.5	64	20 22.2	−1.7	−0.2	59
13	82 G. Sgr	6.8	I	135	20 52.3	−1.8	+0.2	92	Sun	...	...	...
13	−28° 14871	7.5	I	136	23 46.9	—	—	359	No Occ.	...	...	...
Sept. 9	−28° 14268	6.4	I	103	20 47.2	−1.6	−0.7	87	19 30.4	−1.7	−0.2	78
10	−27° 13699	7.0	I	116	20 40.1	—	—	3	No Occ.	...	...	...
12	30 Cap	5.4	I	144	21 37.9	−0.3	+1.9	5	No Occ.	...	...	...
19	17 Tau	3.8	E	240	21 27.1	—	—	180	Low	...	...	...
19	16 Tau	5.4	E	240	21 47.5	+0.4	+1.7	234	Low	...	...	...
19	19 Tau	4.4	E	240	22 02.9	+0.1	+1.4	263	21 05.2	+0.2	+1.2	274
19	20 Tau	4.0	E	240	22 12.5	+0.3	+1.8	232	21 17.1	+0.3	+1.5	243
19	21 Tau	5.8	E	240	22 20.7	−0.1	+1.3	269	21 21.4	0.0	+1.1	282
19	22 Tau	6.5	E	240	22 24.0	0.0	+1.4	261	21 25.4	+0.1	+1.2	273

Date	Star	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	°
Sept. 22	406 B. Tau	5.6	E	266	2 24.7	−1.7	−0.4	311	No Occ.	...	...	...
22	136 Tau	4.5	I	267	2 50.2	—	—	143	1 33.0	−1.2	+0.4	122
22	136 Tau	4.5	E	267	3 29.0	—	—	204	2 28.4	−0.5	+3.0	224
24	176 B. Gem	6.3	E	289	1 26.3	+0.6	+2.5	231	Low	...	...	...
24	181 B. Gem	6.0	E	289	No Occ.	...	...	...	0 44.4	—	—	205
24	κ Gem	3.7	I	290	3 34.1	−0.8	+1.4	92	2 30.0	−0.3	+1.8	81
24	κ Gem	3.7	E	290	4 49.7	−1.4	+0.6	287	3 37.6	−1.1	+0.5	295
Oct. 7	−27° 13319*m*	7.4	I	85	19 20.4	−1.6	−0.4	80	18 03.9	−1.7	+0.1	70
11	213 B. Aqr	6.8	I	138	19 10.4	−0.9	+1.7	37	18 04.0	−0.7	+2.0	27
20	+27° 1122	6.5	E	247	3 03.0	—	—	209	1 56.9	−0.9	+3.4	224
21	57 Gem	5.1	E	259	1 35.3	—	—	218	1 32.8	−0.5	+3.1	233
Nov. 5	−21° 5782	7.3	I	81	20 43.3	0.0	+0.9	19	19 50.0	—	—	347
6	131 B. Cap	7.1	I	94	20 06.7	−1.8	−0.6	87	18 49.9	−1.6	+0.2	68
7	−10° 5904	7.3	I	106	18 51.8	−0.3	+2.2	4	No Occ.	...	...	...
9	72 G. Psc	7.0	I	136	23 59.8	—	—	122	22 36.6	−2.0	−1.3	97
13	η Tau	3.0	E	186	18 27.9	+0.6	+2.1	208	17 35.0	+0.5	+1.7	221
15/16	415 B. (Tau)	6.1	E	214	0 56.9	−1.9	−0.8	302	23 36.8	−2.0	−1.2	316
16/17	39 Gem	6.1	E	226	0 58.9	−1.5	+0.8	278	23 46.1	−1.2	+0.7	287
17	40 Gem	6.3	E	227	1 18.7	−1.4	+2.3	243	0 08.2	−1.1	+1.9	252
18	39 Cnc	6.5	E	249	22 55.4	−0.3	+0.2	311	Low	...	...	...
18	40 Cnc	6.5	E	249	23 00.4	−0.3	+0.5	303	Low	...	...	...
18	102 B. Cnc	6.5	E	249	23 03.5	+0.5	+3.1	230	Low	...	...	...
19	139 B. Cnc	6.1	E	251	6 00.6	−2.2	−0.4	268	4 36.5	−2.6	+1.1	254
Dec. 3	31 Cap	6.3	I	63	19 01.9	−1.7	−1.3	97	17 45.0	−1.5	−0.4	77
3	ι Cap	4.3	I	64	Low	...	...	...	20 06.7	−0.7	−0.9	75
4	38 Aqr	5.4	I	76	18 23.0	−1.1	+0.6	46	17 13.7	−0.9	+1.3	28
4	135 B. Aqr	7.4	I	77	19 54.9	0.0	+1.6	9	No Occ.	...	...	...
5	−05° 5917	6.6	I	90	19 38.7	−1.1	+0.7	46	18 29.9	−0.8	+1.4	27
8	104 Psc	6.9	I	130	No Occ.	...	...	...	19 12.9	−2.4	−0.1	106
11	19 Tau	4.4	I	159	4 03.5	−0.1	−1.6	102	2 59.9	−0.3	−2.0	110
11	16 Tau	5.4	I	159	4 09.3	—	—	154	No Occ.	...	...	...
11	20 Tau	4.0	I	159	4 25.8	+0.4	−2.6	131	3 27.7	+0.5	−3.8	144
21	78 B. Vir	6.5	E	275	6 13.6	−1.5	−1.0	310	4 57.7	−1.6	−0.2	295
23	83 Vir	5.7	E	298	5 56.5	−0.3	−1.3	344	4 51.9	−0.5	−0.5	328
30	20 Cap	6.2	I	32	Low	...	...	...	17 08.8	−1.3	−1.3	94
31	μ Cap	5.2	I	45	17 02.2	−2.0	−1.0	96	Sun	...	...	...

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1970

Date	Star	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. 10	54 Aqr	7.0	I	43	18 49.1	−1.1	−1.3	90	17 28.8	−0.8	+0.2	47
10	σ Aqr	4.9	I	44	Low	...	...	...	19 36.7	−0.5	−0.8	68
11	316 B. Aqr	6.6	I	57	19 55.6	−0.3	+0.8	27	No Occ.	...	...	...
13	180 B. Psc	6.7	I	84	No Occ.	...	...	...	20 32.6	—	—	131
13	198 B. Psc	6.9	I	85	Low	...	...	...	23 44.4	0.0	−3.1	119
15	μ Ari	5.7	I	108	22 00.7	−1.6	−2.9	115	20 21.5	−1.7	0.0	79
17	16 Tau	5.4	I	122	Low	...	...	...	2 13.9	+0.2	−2.2	115
17	19 Tau	4.4	I	122	Low	...	...	...	2 23.2	−0.1	−1.2	76
17	20 Tau	4.0	I	122	Low	...	...	...	2 39.7	+0.2	−1.7	102
17	21 Tau	5.8	I	122	Low	...	...	...	2 45.1	−0.2	−0.8	60
17	22 Tau	6.5	I	123	Low	...	...	...	2 47.2	−0.1	−0.9	67
17	+23° 523	7.0	I	123	Low	...	...	...	3 06.1	+0.9	−3.0	140
17	+24° 562	6.7	I	123	Low	...	...	...	3 10.5	+0.1	−1.1	75
18	+26° 731*m*	6.5	I	134	3 28.0	−0.4	−0.3	50	2 15.2	−0.7	−0.6	57
18	354 B. Tau	6.3	I	142	20 15.9	−1.8	+0.9	86	19 05.8	−0.6	+2.6	48
19	107 B. (Aur)	6.5	I	145	4 39.7	+0.5	−1.6	115	3 33.9	+0.2	−2.2	125
25	45 Leo	5.9	E	210	1 37.0	—	—	246	0 07.1	—	—	242
25	ρ Leo	3.8	I	211	4 32.9	—	—	62	2 45.1	−2.1	0.0	90
25	ρ Leo	3.8	E	211	5 03.2	—	—	15	3 47.7	−0.4	−2.5	346
25	49 Leo	5.8	E	212	Sun	...	...	...	6 00.8	−0.8	−1.9	299
31	−23° 12133	6.4	E	281	Sun	...	...	...	5 03.9	−2.2	+1.8	244
Feb. 12	161 B. Ari	7.0	I	89	19 13.7	−1.7	+1.0	53	Sun	...	...	...
14	38 B. (Aur)	6.5	I	112	19 47.5	−2.3	−2.1	124	Sun	...	...	...
14	47 B (Aur)	6.1	I	113	23 01.5	−1.8	+0.6	49	21 34.9	−1.9	+2.0	39
16	+27° 1270	7.0	I	135	20 43.7	−2.2	+1.6	68	19 32.7	—	—	34
18	5 B. Cnc	6.4	I	149	4 37.4	+0.2	−1.5	104	3 27.1	−0.1	−1.9	115
Mar. 11	134 B. Ari	6.7	I	58	21 47.1	−0.2	−1.0	79	20 33.2	−0.7	−1.0	73

Date	Star	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	°
Mar. 12	+24° 583	6.9	I	70	20 37.6	−1.0	−1.0	79	19 11.9	−1.4	−0.1	66
12	+24° 587	6.8	I	70	21 01.2	−0.8	−1.2	84	19 36.5	−1.3	−0.6	74
14	+27° 716	6.8	I	84	Low	...	...	...	1 08.6	+0.4	−1.3	95
14/15	406 B. Tau	5.6	I	95	0 22.6	−0.1	−1.4	91	23 08.0	−0.5	−1.7	100
16	+27° 1236	6.6	I	107	No Occ.	...	...	...	1 07.5	—	—	33
17	κ Gem	3.7	I	118	Low	...	...	...	2 31.4	+0.4	−2.0	139
20	α Leo	1.3	I	151	4 44.2	0.0	−1.2	73	3 29.5	−0.6	−1.6	81
20	α Leo	1.3	E	151	Low	...	...	...	4 16.7	+0.3	−2.2	340
25	85 Vir	6.2	E	207	1 27.8	−1.4	−0.7	309	0 04.2	−1.1	+0.4	293
26	9 G. Lib	6.5	E	219	0 15.6	−0.4	−0.7	333	Low	...	...	...
28	τ Sco	2.9	I	245	3 54.9	−1.8	+0.2	98	Low	...	...	...
28	τ Sco	2.9	E	245	5 17.1	−1.9	−0.6	286	3 46.4	−1.5	+0.3	282
Apr. 10	354 B. Tau	6.3	I	62	19 39.3	−1.3	−0.9	79	Sun	...	...	...
14	+20° 2232	6.8	I	107	19 45.1	−2.3	−0.2	93	Sun	...	...	...
16	45 Leo	5.9	I	129	21 48.1	−1.9	−1.1	109	20 13.4	−1.4	−0.6	121
17	49 Leo	5.8	I	131	Low	...	...	...	1 48.2	−0.9	−1.5	71
19	χ Vir	4.8	I	163	22 19.9	—	—	200	No Occ.	...	...	...
May 7	+27° 716	6.8	I	30	20 04.7	−0.3	−0.9	71	Sun	...	...	...
8	415 B. (Tau)	6.1	I	43	21 42.3	+0.1	−1.1	85	Sun	...	...	...
9	39 Gem	6.1	I	55	Low	...	...	...	21 54.2	+0.7	−2.5	156
10	+24° 1806	6.7	I	67	Low	...	...	...	23 50.5	0.0	−1.1	64
11	109 B. Cnc	6.6	I	77	22 53.0	−0.6	−1.2	74	21 30.8	−0.9	−1.6	90
12	12 B. Leo	6.3	I	87	21 11.0	−2.3	−0.6	69	Sun	...	...	...
13	α Leo	1.3	I	98	19 16.4	−2.3	−0.5	96	17 40.9	−1.6	+0.2	105
13	α Leo	1.3	E	98	20 26.5	−0.5	−2.7	341	18 57.7	−1.0	−1.7	325
24	τ Sgr	3.4	I	222	1 37.5	−1.6	+0.5	105	Low	...	...	...
24	τ Sgr	3.4	E	222	2 47.9	−1.7	+0.7	234	Low	...	...	...
June 8	78 Cnc	7.4	I	57	21 08.2	+0.1	−2.2	144	Sun	...	...	...
9	ν Leo	5.2	I	68	Low	...	...	...	21 53.3	−0.4	−1.8	101
11	79 Leo	5.5	I	90	23 21.1	−0.2	−2.2	146	22 01.2	−0.4	−2.2	153
15/16	−20° 4043	7.1	I	137	0 04.1	−1.3	−1.6	120	22 31.2	−1.4	−0.9	123
22	17 Cap	5.9	E	217	0 44.8	−1.3	+1.6	220	Low	...	...	...
July 26	μ Ari	5.7	E	280	2 46.3	+0.3	+2.7	198	2 01.0	0.0	+1.9	230
Aug. 11	−27° 10967	6.8	I	109	20 11.5	−2.0	+0.1	62	Sun	...	...	...
Sept. 9	−28° 14268	6.4	I	103	19 20.1	−1.9	+0.1	78	Sun	...	...	...
22	136 Tau	4.5	I	267	1 25.8	−1.0	+0.6	118	0 26.6	0.0	+1.6	82
22	136 Tau	4.5	E	267	2 21.0	−0.3	+2.8	226	1 27.7	−0.3	+1.6	265
24	κ Gem	3.7	I	290	2 25.5	−0.1	+1.7	80	1 46.3	+1.0	+3.7	35
24	κ Gem	3.7	E	290	3 30.6	−0.9	+0.6	294	2 14.8	−1.1	−1.2	339
Oct. 11	−13° 6074	7.1	I	127	Low	...	...	...	0 02.6	−0.3	+0.4	29
17	7 Tau	5.9	E	211	4 01.5	—	—	320	No Occ.	...	...	...
18	+26° 731*m*	6.5	E	224	Sun	...	...	...	4 56.0	−1.4	−1.4	285
19	107 B. (Aur)	6.5	E	236	5 04.0	−2.1	+0.8	244	3 35.4	−1.6	+0.5	265
20	+27° 1122	6.5	E	247	1 46.2	−0.6	+3.5	222	0 50.1	−0.6	+1.7	262
21	57 Gem	5.1	E	259	1 25.0	−0.2	+3.0	232	0 33.4	−0.2	+1.5	270
26	79 Leo	5.5	E	316	Sun	...	...	...	6 08.2	−1.3	+2.5	257
Nov. 6	131 B. Cap	7.1	I	94	18 39.9	−1.6	+0.6	62	Sun	...	...	...
9	11 Psc	6.6	I	123	Low	...	...	...	0 08.7	−0.9	−1.0	78
9	72 G. Psc	7.0	I	136	22 26.5	−2.1	−0.8	93	21 01.6	−1.1	+1.2	49
15	415 B. (Tau)	6.1	E	214	23 27.3	−1.9	−1.0	316	No Occ.	...	...	...
16	39 Gem	6.1	E	226	23 38.1	−1.0	+0.8	287	22 21.9	−1.2	−0.8	332
16	40 Gem	6.3	E	227	23 58.9	−0.8	+2.0	251	22 56.0	−0.6	+1.1	286
19	139 B. Cnc	6.1	E	251	4 14.6	—	—	232	2 55.2	−1.5	+2.5	249
20	7 Leo	6.2	E	262	No Occ.	...	...	...	1 47.0	−0.6	+4.2	234
21	44 Leo	5.9	E	274	Sun	...	...	...	5 33.3	−1.6	0.0	290
Dec. 1	224 B. Sgr	7.4	I	37	17 32.4	−1.6	−1.4	103	Sun	...	...	...
3	31 Cap	6.3	I	63	17 36.2	−1.6	0.0	71	Sun	...	...	...
3	ι Cap	4.3	I	64	20 03.6	−0.9	−0.7	72	18 50.2	−0.5	+0.5	30
4	38 Aqr	5.4	I	76	17 06.2	−0.8	+1.6	21	No Occ.	...	...	...
5	−05° 5917	6.6	I	90	18 22.7	−0.7	+1.7	21	No Occ.	...	...	...
7	+02° 4752	6.9	I	106	Low	...	...	...	0 04.3	−0.3	+1.4	13
8	104 Psc	6.9	I	130	18 59.4	−2.0	+0.6	98	17 46.5	−0.7	+1.8	60
11	19 Tau	4.4	I	159	3 02.3	−0.3	−2.6	122	1 34.6	−1.1	−2.0	110
11	20 Tau	4.0	I	159	No Occ.	...	...	...	2 12.1	—	—	155
16	η Cnc	5.5	E	220	4 36.1	+0.1	−4.1	354	3 06.4	−0.7	−3.3	344
19	37 (Sex)	6.3	E	252	1 18.7	—	—	5	No Occ.	...	...	...
20	υ Leo	4.5	I	265	Sun	...	...	...	6 05.1	−1.9	−0.3	100
20	υ Leo	4.5	E	265	Sun	...	...	...	7 15.4	−0.7	−2.0	338
21	78 B. Vir	6.5	E	275	4 47.2	−1.9	+0.6	280	3 27.1	−1.1	+1.5	273
23	83 Vir	5.7	E	298	4 49.2	−0.6	−0.1	314	Low	...	...	...

Date		Star	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	°
Jan.	10	σ Aqr	4.9	I	44	18 27.0	−0.5	0.0	41	17 20.4	−0.7	+0.4	38
	10	58 Aqr	6.4	I	44	18 56.1	—	—	126	17 48.4	—	—	122
	13	180 B. Psc	6.7	I	84	18 53.8	−1.6	−0.4	86	17 36.8	−1.8	+0.3	82
	13	198 B. Psc	6.9	I	85	22 29.7	−0.6	−2.3	104	21 33.7	−1.1	−4.1	122
	13	210 B. Psc.	6.6	I	86	Low	...	...	...	23 18.1	0.0	−3.6	123
	15	μ Ari	5.7	I	108	19 01.7	−1.1	+1.5	52	17 44.1	−1.0	+1.9	49
	17	16 Tau	5.4	I	122	1 05.1	−0.2	−2.7	119	0 20.0	—	—	153
	17	19 Tau	4.4	I	122	1 13.5	−0.5	−1.3	80	0 14.1	−0.7	−1.8	99
	17	20 Tau	4.0	I	122	1 33.0	−0.2	−2.1	108	0 42.4	0.0	−3.5	133
	17	21 Tau	5.8	I	122	1 36.6	−0.5	−1.0	66	0 35.8	−0.6	−1.4	85
	17	22 Tau	6.5	I	123	1 39.3	−0.4	−1.2	73	0 40.1	−0.5	−1.6	92
	17	+24° 562	6.7	I	123	2 05.1	−0.2	−1.4	81	1 09.1	−0.3	−1.9	101
	17	+23° 523	7.0	I	123	2 08.0	—	—	155	No Occ.	...	...	...
	17	+23° 540	6.8	I	123	2 35.7	—	—	154	No Occ.	...	...	...
	17	105 B. Tau	6.6	I	123	2 56.5	+0.8	−3.0	139	No Occ.	...	...	...
	17	+23° 561	6.6	I	123	3 17.3	+0.7	−2.6	135	No Occ.	...	...	...
	17/18	+26° 731*m*	6.5	I	134	0 58.9	−1.0	−0.6	63	23 50.9	−1.2	−1.0	82
	18	354 B. Tau	6.3	I	142	18 20.0	—	—	4	No Occ.	...	...	...
	19	107 B. (Aur)	6.5	I	145	2 26.4	0.0	−2.8	136	Graze	...	...	...
	24	45 Leo	5.9	E	210	22 56.0	−1.0	+3.1	248	No Occ.	...	...	...
	25	ρ Leo	3.8	I	211	1 17.4	−1.5	+0.4	102	0 03.7	−1.2	−0.1	125
	25	ρ Leo	3.8	E	211	2 29.6	−0.9	−1.6	329	1 23.0	−1.4	−0.7	305
	25	49 Leo	5.8	E	212	4 38.0	−1.3	−1.3	282	3 23.1	−2.5	0.0	257
	30	−19° 3880	6.4	E	270	Sun	...	...	...	6 22.7	−1.5	−0.6	297
Feb.	9	δ Psc	4.6	I	53	Low	...	...	...	20 45.2	—	—	131
	14	47 B. (Aur)	6.1	I	113	20 19.1	—	—	21	18 51.2	−1.2	+3.1	37
	15	354 B. Tau	6.3	I	116	2 12.0	—	—	25	1 04.3	−0.7	−0.7	57
	17	+26° 1481	6.8	I	138	No Occ.	...	...	...	2 15.7	−1.2	−0.6	55
	18	5 B. Cnc	6.4	I	149	2 15.8	−0.3	−2.2	129	1 22.7	−0.2	−2.7	150
Mar.	6	Mercury	−0.4	I	347	No Occ.	...	...	...	8 39.1	—	—	124
	6	Mercury	−0.4	E	347	No Occ.	...	...	...	9 10.3	—	—	172
	10	20 H¹. Ari	6.4	I	47	21 28.7	−0.3	−0.2	42	20 27.4	−0.4	−0.7	61
	11	134 B. Ari	6.7	I	58	19 16.8	−1.0	−0.5	66	Sun	...	...	...
	13/14	+27° 716	6.8	I	84	0 07.2	+0.1	−1.8	105	23 17.0	+0.2	−2.3	125
	14	406 B. Tau	5.6	I	95	21 51.1	−0.8	−1.9	108	20 51.4	−0.9	−2.7	130
	15	415 B. (Tau)	6.1	I	97	Low	...	...	...	1 45.6	+0.8	−2.0	142
	15	+27° 1236	6.6	I	107	23 44.8	−1.2	−0.7	58	22 36.9	−1.2	−1.2	83
	17	κ Gem	3.7	I	118	1 29.5	+0.4	−2.5	154	0 49.2	—	—	184
	18	83 Cnc	6.6	I	139	No Occ.	...	...	...	22 05.7	−2.3	+0.3	80
	19	12 B. Leo	6.3	I	141	3 33.7	−0.1	−1.8	97	2 38.9	−0.3	−1.8	109
	20	α Leo	1.3	I	151	2 11.1	−0.9	−1.7	96	1 08.3	−1.0	−1.8	113
	20	α Leo	1.3	E	151	3 10.4	−0.1	−2.2	330	2 17.1	−0.4	−2.1	316
Apr.	10/11	107 B. (Aur)	6.5	I	65	0 00.4	+0.3	−1.3	86	23 08.9	+0.3	−1.5	102
	16/17	49 Leo	5.8	I	131	0 25.4	−1.2	−1.5	88	23 19.2	−1.3	−1.6	170
May	9	39 Gem	6.1	I	55	20 59.0	—	—	184	No Occ.	...	...	94
	10	+24° 1806	6.7	I	67	22 43.4	−0.3	−1.5	77	21 46.4	−0.4	−1.6	...
	10	+23° 1863	6.9	I	68	Low	...	...	...	23 34.2	+0.4	−1.6	117
	13	α Leo	1.3	I	98	16 21.2	−1.1	+0.8	106	15 09.1	−0.9	+0.3	123
	13	α Leo	1.3	E	98	17 35.7	−1.1	−0.8	316	16 24.8	−1.3	+0.2	295
June	6	176 B. Gem	6.3	I	36	Low	...	...	...	21 30.5	+0.2	−1.3	86
	7	+21° 1844	7.0	I	47	22 08.3	0.0	−1.5	77	21 13.7	−0.1	−1.6	90
	10	37 (Sex)	6.3	I	80	Low	...	...	...	22 44.7	−0.1	−2.1	145
	14	83 Vir	5.7	I	126	Low	...	...	...	23 01.2	−1.2	−1.5	119
	18	τ Scr	2.9	I	164	Low	...	...	...	0 12.8	−1.5	−0.9	128
	29	ε Ari	4.6	E	310	Sun	...	...	...	2 03.9	+0.1	+1.2	287
July	14	−26° 11171	6.9	I	130	No Occ.	...	...	...	21 29.8	—	—	33
	26	μ Ari	5.7	E	280	1 08.1	+0.1	+1.7	247	Low	...	...	...
	27	19 Tau	4.4	I	294	Sun	...	...	...	3 00.7	−0.4	+1.6	81
	27	20 Tau	4.0	I	294	Sun	...	...	...	3 23.2	−1.2	+0.7	120
Aug.	11	τ Scr	2.9	E	110	Low	...	...	...	20 16.9	−1.6	−0.6	290
	13	−28° 14997	7.2	I	137	Low	...	...	...	20 43.6	−1.6	+0.3	100
Sept.	11	36 B. Cap	6.2	I	132	23 09.8	−0.8	−0.1	47	22 00.9	−0.9	+0.4	39
	18	20 H¹. Ari	6.4	E	218	3 22.9	−0.2	+3.5	182	2 07.4	−0.1	+3.4	184
	18	ε Ari	4.6	E	230	23 54.4	0.0	+2.3	209	22 45.8	+0.1	+2.1	216
	21	38 B. (Aur)	6.5	E	257	4 52.2	−1.8	−1.8	311	3 38.2	−2.0	−0.8	303
	21	136 Tau	4.5	I	267	23 36.9	+0.5	+1.8	59	Low	...	...	...
	21/22	136 Tau	4.5	E	267	0 28.2	−0.2	+1.2	290	23 22.5	0.0	+1.0	294

Date	Star	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	°
Sept. 22	415 B. (Tau)	6.1	E	268	4 11.0	−1.0	+1.9	248	2 53.9	−0.7	+2.2	244
Oct. 8	−24° 15814	7.5	I	101	Low	...	...	...	21 27.8	−1.0	−0.6	70
9	74 G. Cap	6.8	I	114	Low	...	...	...	22 22.9	−1.4	−1.2	93
10	−13° 6074	7.1	I	127	23 09.7	—	—	341	No Occ.	...	...	...
10/11	−13° 6085	7.4	I	128	0 02.0	−1.0	−1.1	86	22 54.0	−1.3	−0.7	82
17	19 Tau	4.4	I	213	5 51.2	−0.7	−2.2	112	4 54.2	−0.9	−4.0	136
17	19 Tau	4.4	E	213	Sun	...	...	...	5 33.2	−1.5	+2.1	203
18	+26° 731*m*	6.5	E	224	3 26.2	−1.7	−1.5	301	2 12.6	−1.8	−0.5	291
19	107 B. (Aur)	6.5	E	236	2 13.4	−1.4	+0.4	285	0 57.7	−1.2	+0.8	282
19	+27° 1122	6.5	E	247	23 48.0	−0.4	+1.2	287	22 40.6	−0.2	+1.1	289
20	57 Gem	5.1	E	259	23 35.4	−0.1	+1.0	294	Low	...	...	...
24	*ν* Leo	5.2	E	294	4 55.0	−0.8	0.0	312	3 45.6	−0.7	+0.7	296
26	79 Leo	5.5	E	316	5 02.2	−0.6	+2.3	261	Low	...	...	...
Nov. 6	45 Cap	5.9	I	96	22 20.6	−0.2	+0.2	30	21 16.1	−0.4	+0.5	27
8	11 Psc	6.6	I	123	22 53.1	−0.8	+0.1	51	21 42.6	−1.0	+0.5	48
8/9	13 Psc	6.5	I	124	1 03.1	—	—	341	23 51.3	+0.2	+2.7	356
9	14 Psc	6.0	I	125	1 26.7	−0.5	−1.8	94	0 27.7	−0.9	−2.2	103
9	72 G. Psc	7.0	I	136	19 55.0	−0.4	+1.9	20	18 43.5	−0.2	+2.3	10
16	40 Gem	6.3	E	227	21 51.1	−0.5	+0.5	313	20 45.5	−0.3	+0.4	315
18	9 Cnc	6.2	E	241	4 32.5	—	—	359	3 37.2	−1.3	−2.2	327
19	139 B. Cnc	6.1	E	251	1 45.4	−0.8	+1.9	263	0 30.4	−0.4	+2.4	251
20	7 Leo	6.2	E	262	0 52.1	−0.2	+2.2	257	Low	...	...	...
21	44 Leo	5.9	E	274	4 13.0	−1.1	+0.8	286	2 56.5	−1.0	+1.9	265
Dec. 3	*ι* Cap	4.3	I	64	17 53.0	—	—	347	No Occ.	...	...	...
5	293 B. Aqr	5.6	I	93	22 33.7	−0.9	−2.3	104	21 31.1	−1.6	−2.5	109
6	+02° 4752	6.9	I	106	No Occ.	...	...	...	22 00.3	—	—	345
10/11	19 Tau	4.4	I	159	0 08.3	−1.4	−0.9	97	22 55.8	−1.8	−1.0	107
11	16 Tau	5.4	I	159	0 10.5	—	—	144	No Occ.	...	...	...
11	20 Tau	4.0	I	159	0 39.0	−1.4	−3.6	134	No Occ.	...	...	...
15	82 Gem	6.2	E	210	6 42.9	−0.3	−2.0	298	5 44.4	−0.9	−1.6	280
16	*η* Cnc	5.5	E	220	1 41.6	−1.0	−2.8	344	0 37.4	−1.3	−1.1	322
16	102 B. Cnc	6.5	E	222	No Occ.	...	...	...	5 29.1	+0.5	−3.9	359
16	*ε* Cnc	6.3	E	222	6 43.6	+0.4	−3.1	353	5 54.2	−0.4	−2.5	328
20	*υ* Leo	4.5	I	265	4 39.9	−1.3	+0.1	115	3 29.7	−0.9	−0.4	138
20	*υ* Leo	4.5	E	265	5 56.1	−1.0	−1.1	320	4 46.9	−1.4	−0.3	298

PLANETARY APPULSES AND OCCULTATIONS

No planetary appulses or occultations are observable from Canada this year.

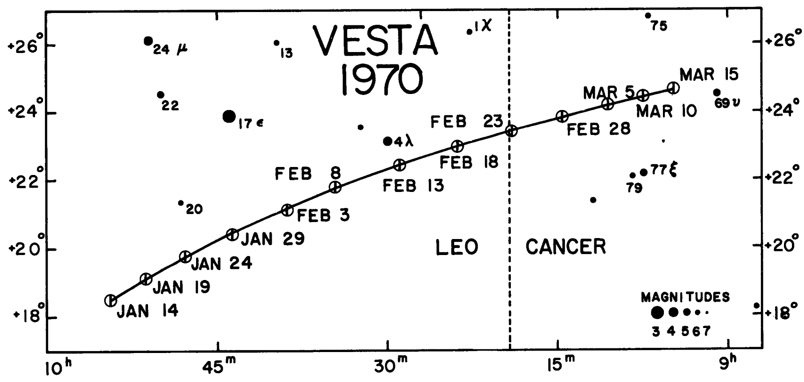
ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1970

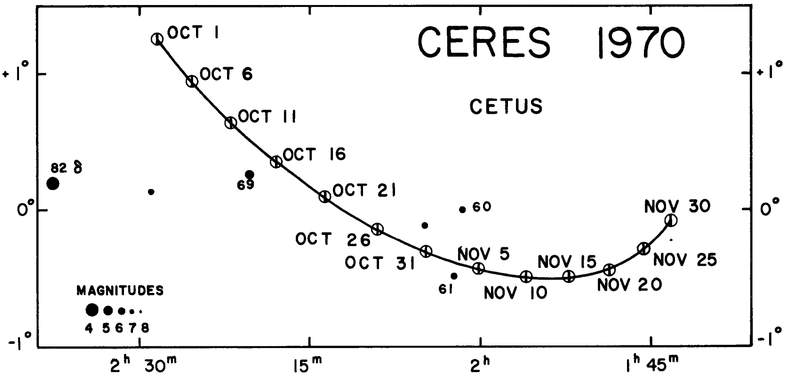
The asteroids are many small objects revolving around the sun mainly between the orbits of Mars and Jupiter. The largest, Ceres, is only 480 miles in diameter. Vesta, though half the diameter of Ceres, is brighter. The next brightest asteroids, Juno and Pallas, are 120 and 300 miles in diameter, respectively. 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 greatly at different oppositions.

The four brightest asteroids all come to opposition in 1970. Ephemerides near opposition are given for the three brightest, and maps for Ceres and Vesta. Dates and times of the table are for 0h E.T., and the positions are based on the equinox of 1950.0.

ASTEROIDS—EPHEMERIDES AT OPPOSITION, E.T.

VESTA (No. 4) Opp. Feb. 8 in Leo Mag. 6.3			CERES (No. 1) Opp. Oct. 24 in Cet Mag. 7.0			JUNO (No. 3) Opp. Nov. 14 in Eri Mag. 7.2		
	h m	° ′		h m	° ′		h m	° ′
Jan. 19	9 51.4	+19 06	Oct. 4	2 26.9	+1 04	Oct. 25	3 48.8	−0 08
24	9 47.8	+19 45	9	2 23.5	+0 46	30	3 46.6	−1 07
29	9 43.6	+20 26	14	2 19.6	+0 28	Nov. 4	3 43.8	−2 02
Feb. 3	9 39.0	+21 06	19	2 15.4	+0 12	9	3 40.6	−2 52
8	9 34.0	+21 46	24	2 11.0	−0 03	14	3 37.0	−3 35
13	9 28.9	+22 23	29	2 06.5	−0 15	19	3 33.3	−4 09
18	9 23.9	+22 57	Nov. 3	2 02.0	−0 24	24	3 29.7	−4 35
23	9 19.1	+23 27	8	1 57.7	−0 29	29	3 26.2	−4 51
28	9 14.6	+23 53	13	1 53.7	−0 31	Dec. 4	3 23.2	−4 57





METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

Meteroids 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, if large enough to avoid complete vaporization, in rare cases 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 1970. Although in 1970 we are well past the Leonid peak of 1966, the shower may still be above average strength.

On the average an observer sees 7 meteors per hour which are not associated with any recognized shower. These have been included in the hourly rates listed in the table. 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 7, Ontario. 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 1970

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Velocity	Normal Duration to ¼ strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.	Dec.	Daily Motion R.A.	Dec.			
				h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	07h	L.Q.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 22	08	F.M.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 5	10	N.M.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	—	L.Q.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 12	10	F.Q.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 21	13	L.Q.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 5	—	F.Q.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 17	07	L.Q.	10 08	+22	+2.8	−0.42	25	72	—
Geminids	Dec. 14	03	F.M.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	21	L.Q.	14 28	+76	—	—	15	34	2

TABLE OF PRECESSION FOR 50 YEARS

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

FINDING LIST OF NAMED STARS

Name		R.A.	Name		R.A.
Acamar	θ Eri	02	Fomalhaut	α PsA	22
Achernar	α Eri	01	Gacrux	γ Cru	12
Acrux	α Cru	12	Gienah	γ Crv	12
Adhara	ε CMa	06	Hadar	β Cen	14
Al Na'ir	α Gru	22	Hamal	α Ari	02
Albireo	β Cyg	19	Kaus Australis	ε Sgr	18
Alcyone	η Tau	03	Kochab	β UMi	14
Aldebaran	α Tau	04	Markab	α Peg	23
Alderamin	α Cep	21	Megrez	δ UMa	12
Algenib	γ Peg	00	Menkar	α Cet	03
Algol	β Per	03	Menkent	θ Cen	14
Alioth	ε UMa	12	Merak	β UMa	10
Alkaid	η UMa	13	Miaplacidus	β Car	09
Almach	γ And	02	Mira	ο Cet	02
Alnilam	ε Ori	05	Mirach	β And	01
Alphard	α Hya	09	Mirfak	α Per	03
Alphecca	α CrB	15	Mizar	ζ UMa	13
Alpheratz	α And	00	Nunki	σ Sgr	18
Altair	α Aql	19	Peacock	α Pav	20
Ankaa	α Phe	00	Phecda	γ UMa	11
Antares	α Sco	16	Polaris	α UMi	01
Arcturus	α Boo	14	Pollux	β Gem	07
Atria	α TrA	16	Procyon	α CMi	07
Avior	ε Car	08	Ras-Algethi	α Her	17
Bellatrix	γ Ori	05	Rasalhague	α Oph	17
Betelgeuse	α Ori	05	Regulus	α Leo	10
Canopus	α Car	06	Rigel	β Ori	05
Capella	α Aur	05	Rigil Kentaurus	α Cen	14
Caph	β Cas	00	Sabik	η Oph	17
Castor	α Gem	07	Scheat	β Peg	23
Deneb	α Cyg	20	Schedar	α Cas	00
Denebola	β Leo	11	Shaula	λ Sco	17
Diphda	β Cet	00	Sirius	α CMa	06
Dubhe	α UMa	11	Spica	α Vir	13
Elnath	β Tau	05	Suhail	λ Vel	09
Eltanin	γ Dra	17	Vega	α Lyr	18
Enif	ε Peg	21	Zubenelgenubi	α Lib	14

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 relaton 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	
	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:	G8III: +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	G8III: +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***
o^2 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″
σ Sgr	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
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	

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 1970. 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. 74, and of The Nearest Stars, p. 86.)

Star		A.D.S.	R.A. 1970 h	m	Dec. °	′	Magnitudes comb.	A	B	Sep. 1970.0 ″	P.A. °	P (app.) years
λ	Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	179	640
α	Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.9	289	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	251	1100
Σ	1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	237	390
35	Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	1.0	152	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	358	1200
ϵ^2	Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.3	89	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	11.4	301	480
Σ	186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	50	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	11.0	70	50
α	Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.8	135	420
ζ	Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.1	333	60
ζ	Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.9	86	1150
+42° 1956		KUI	08	58.7	+41	53	3.9	4.1	6.2	0.5	228	22
γ	Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.2	122	620
ξ	U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	2.9	127	60
γ	Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.6	304	170
Σ	1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.2	151	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	341	150
ζ	Her	10157	16	40.2	+31	39	2.8	2.9	5.5	0.7	249	34
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	0.7	145	46
70	Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	2.6	61	88
β	648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.5	178	61
4	Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	0.9	8	150
τ	Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	0.9	190	50
Σ	3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.5	291	320

*There is a marked colour difference between the components.
†The separation of the two pairs of ε Lyr is 208″.

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

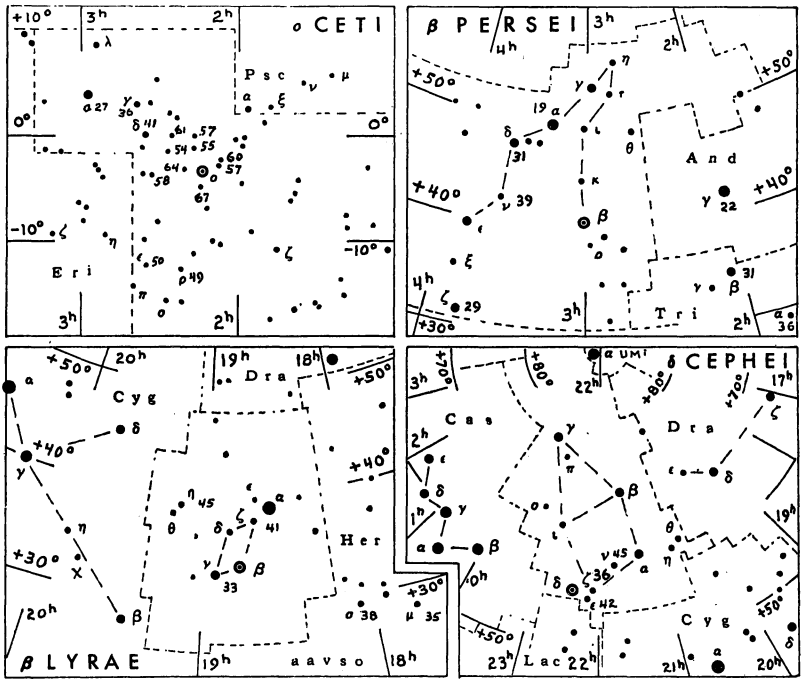
Name	1970 α	1970 δ	π	D	Sp.		W	m	L
	h m	° ′	″	l.y.		″	km./sec.		
Sun					G2			−26.8	1.0
α Cen A	14 37	−60 43	0.760	4.3	G2	3.68	32	0.1	1.3
B					K5			1.5	0.36
C	14 27	−62 33			M5*e*			11.0	0.00006
Barnard's*	17 56	+04 36	.552	5.9	M5	10.30	140	9.5	0.00044
Wolf 359	10 55	+07 13	.431	7.6	M6*e*	4.84	55	13.5	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

Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 36 is of mag. 3.6. Use two comparison stars, one brighter and one fainter than the variable, and estimate the brightness of the variable in terms of these two stars. Record the date and time of observation. When a number of observations have been made, a graph may be plotted showing the magnitude estimate as ordinates against the date (days and tenths of a day) as abscissae. Each type of variable has a distinctive shape of light curve.

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*, 1969, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1970	Variable	Max. m	Per d	Epoch 1970
001755 T Cas	7.8	445	. . .	142539 V Boo	7.9	258	Mar. 5
001838 R And	7.0	409	Feb. 20	143227 R Boo	7.2	223	May 23
021143 W And	7.4	397	June 5	151731 S CrB	7.3	361	Feb. 24
0214*03* o Cet	3.4	332	July 20	154639 V CrB	7.5	358	Dec. 14
0228*13* U Cet	7.5	235	May 26	154615 R Ser	6.9	357	Nov. 12
023133 R Tri	6.2	266	Mar. 19	160625 RU Her	8.0	484	. . .
043065 T Cam	8.0	374	Nov. 21	162119 U Her	7.5	406	Nov. 12
0455*14* R Lep	6.8	432	Aug. 7	1621*12* V Oph	7.5	298	Nov. 22
050953 R Aur	7.7	459	Sept. 4	163266 R Dra	7.6	245	Aug. 28
054920 U Ori	6.3	372	July 17	164715 S Her	7.6	307	June 22
0617*02* V Mon	7.0	335	Nov. 4	1702*15* R Oph	7.9	302	Feb. 23
065355 R Lyn	7.9	379	Jan. 20	171723 RS Her	7.9	219	June 30
070122aR Gem	7.1	370	May 21	180531 T Her	8.0	165	Apr. 23
070310 R CMi	8.0	338	Mar. 8	181136 W Lyr	7.9	196	May 16
072708 S CMi	7.5	332	Oct. 18	183308 X Oph	6.8	334	Aug. 14
081112 R Cnc	6.8	362	Jan. 9	190108 R Aql	6.1	300	Feb. 22
081617 V Cnc	7.9	272	June 29	1910*17* T Sgr	8.0	392	Dec. 29
084803 S Hya	7.8	257	Mar. 10	1910*19* R Sgr	7.3	269	Mar. 17
0850*08* T Hya	7.8	288	June 12	193449 R Cyg	7.5	426	June 13
093934 R LMi	7.1	372	Jan. 20	194048 RT Cyg	7.3	190	July 2
094211 R Leo	5.8	313	June 13	194632 χ Cyg	5.2	407	Oct. 23
103769 R UMa	7.5	302	July 11	201647 U Cyg	7.2	465	Oct. 11
1214*18* R Crv	7.5	317	Oct. 13	2044*05* T Aqr	7.7	202	May 23
122001 SS Vir	6.8	355	Feb. 2	210868 T Cep	6.0	390	Mar. 20
123160 T UMa	7.7	257	June 1	213753 RU Cyg	8.0	234	June 24
123307 R Vir	6.9	146	May 23	230110 R Peg	7.8	378	Dec. 20
123961 S UMa	7.8	226	July 20	230759 V Cas	7.9	228	Mar. 19
131546 V CVn	6.8	192	Feb. 24	231508 S Peg	8.0	319	Aug. 27
1327*06* S Vir	7.0	378	Nov. 21	2338*15* R Aqr	6.5	387	Sept. 22
134440 R CVn	7.7	328	Jan. 29	235350 R Cas	7.0	431	Jan. 18
142584 R Cam	7.9	270	May 23	2357*15* W Cet	7.6	351	Apr. 2

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1970 E.S.T.
005381 U Cep	6.7	9.8	Ecl	B8+gG2	2.49302	Jan. 3.35*
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. 2.59*
035512 λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 1.04*
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. 7.99
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.04
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. 8.72*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.38
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 4.69
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 1.87

*Minimum

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	P	D	m	r	Sp	Remarks
	h m	° ′						
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 δ h m	° ′	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
Tr24	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	3 Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970 δ h m	° ′	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:	*11.6*	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.

			α 1970 δ				S		Dist.	
NGC	M	Con	h m	° ′	Type	Size ′	mag sq″	m *	10^3 l.y.	Remarks
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	Nebular 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	SN	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	

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	ScII–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

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

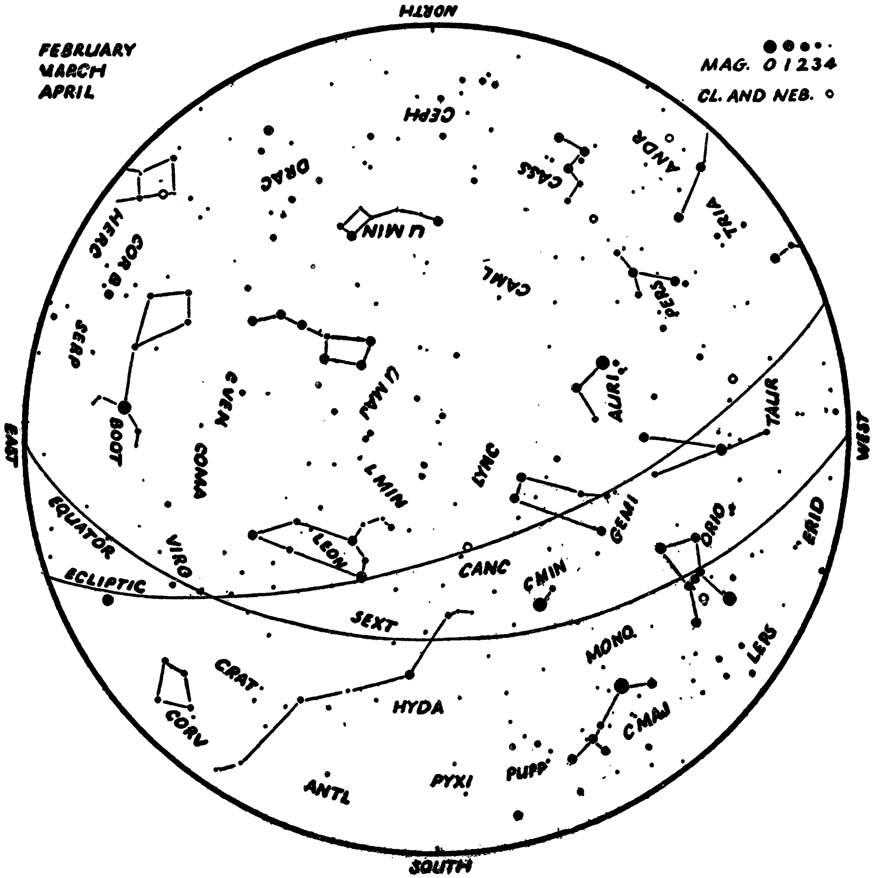
MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

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 MAP 1

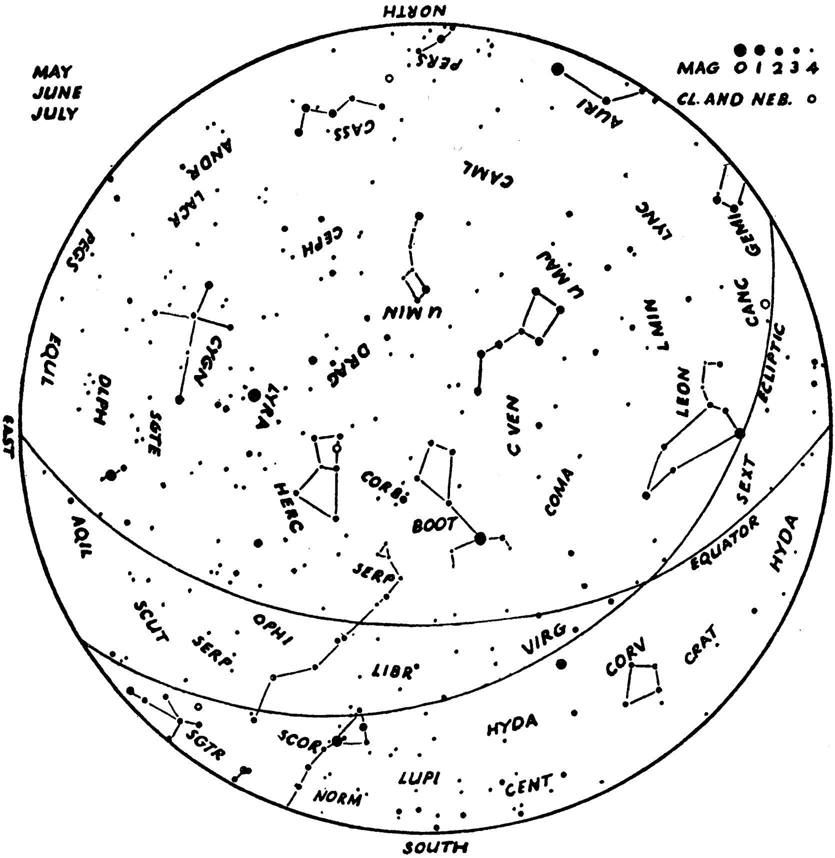


The above map represents the evening sky at

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

The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down. A set of four 8-inch horizon maps may be obtained by writing to the National Office.

STAR MAP 2

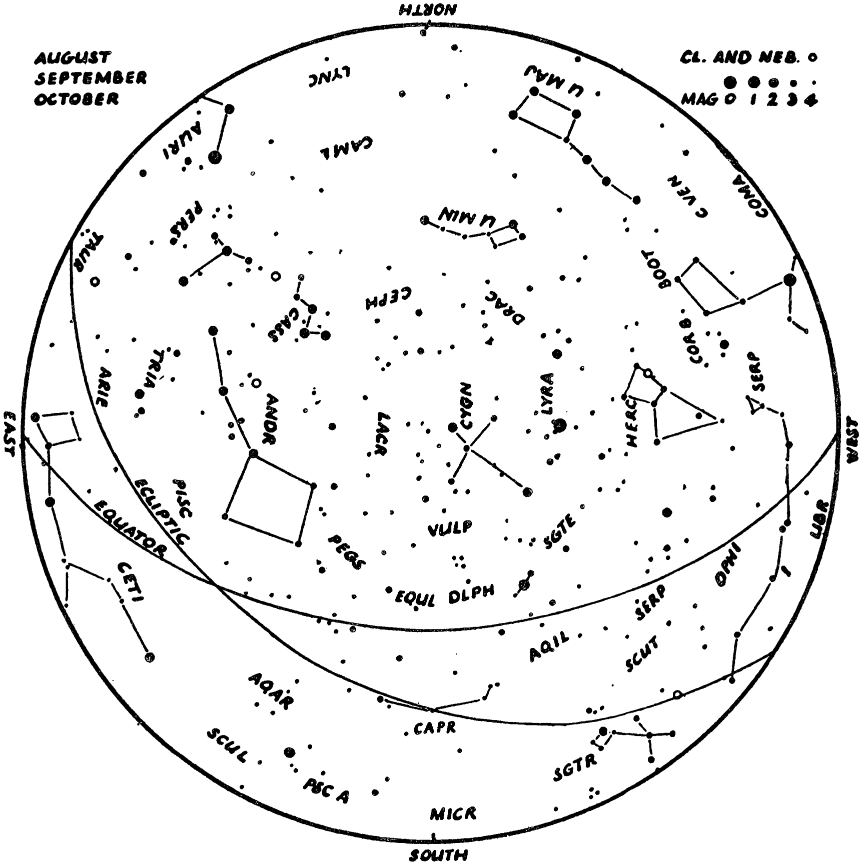


The above map represents the evening sky at

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

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

STAR MAP 3

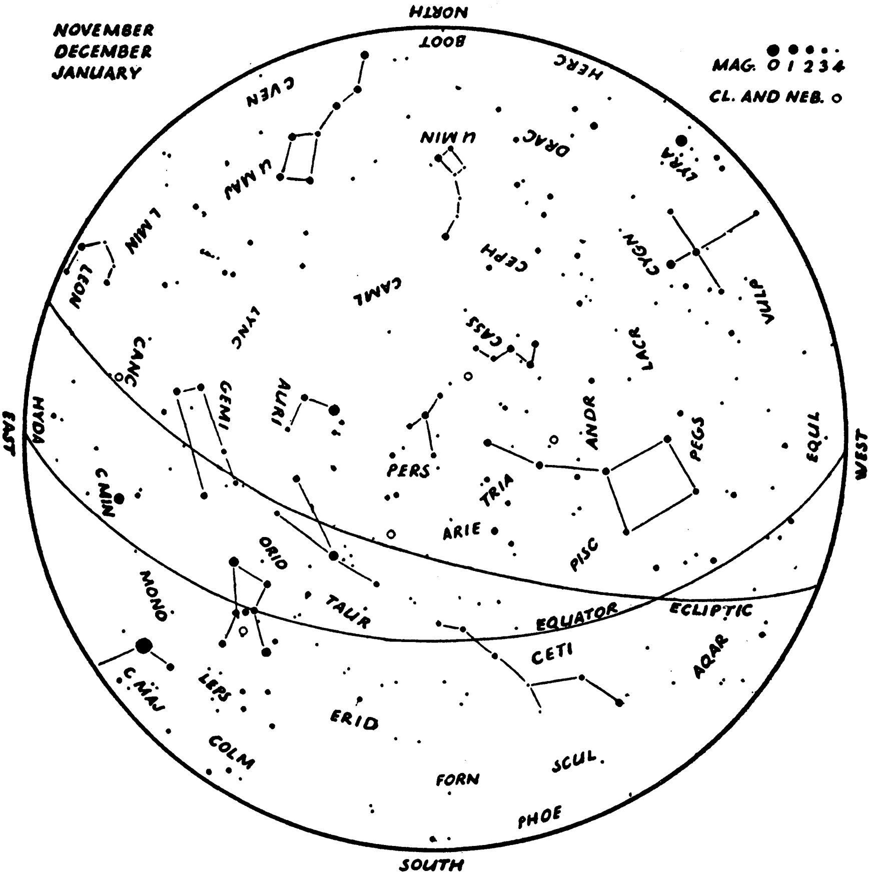


The above map represents the evening sky at

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

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

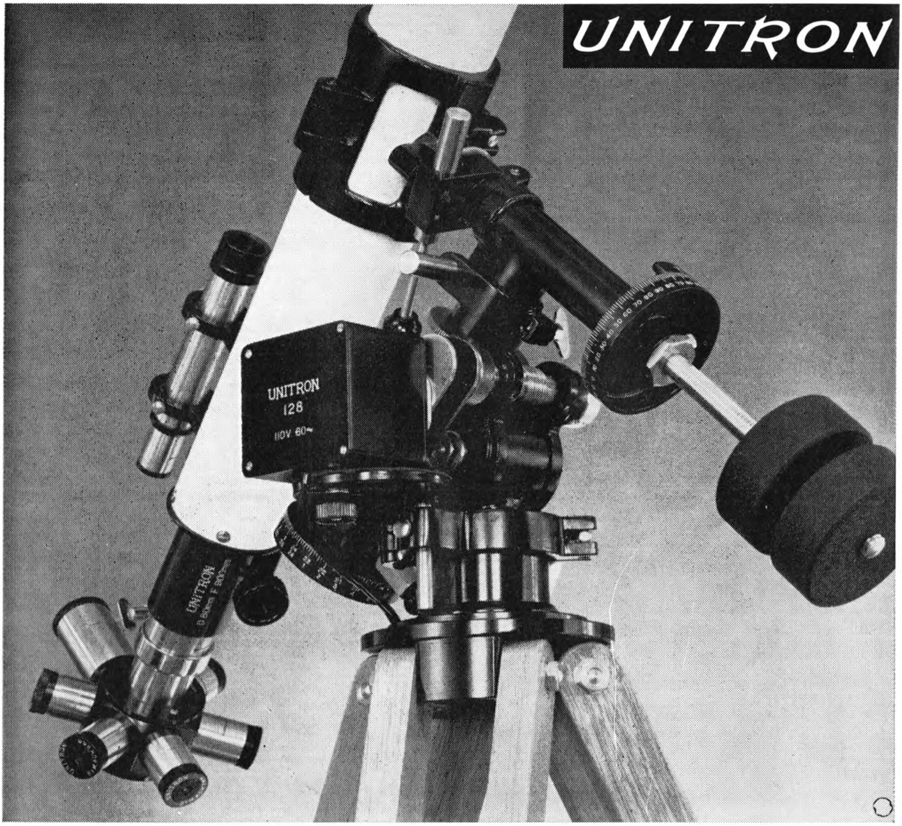
STAR MAP 4



The above map represents the evening sky at

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

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



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If this sounds like what you have been waiting for in a telescope, we have some good news indeed. These new feature—the circles and supplementary slow motion—are included at no extra charge. The price of $225 includes view finder, 5 eyepieces, UNIHEX Rotary Eyepiece Selector Achromatic Amplifier, sunglass, cabinets, etc. The accessory drive is priced at $50 extra. Write for complete details.

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NEW UNITRON CLOCK DRIVE MODELS

Synchronous motor clock drives are now available for all UNITRON Equatorial Models. The new drive, pictured on the back cover of this issue, is priced at $50 for the 2.4" and at $60 for the 3" and 4" models. The 4" refractors are also available with our popular weight-driven clock drive which operates independently of a source of electricity.

Each UNITRON comes complete with an assortment of eyepieces and accessories as standard equipment. In addition, our barlow-type Achromatic Amplifier is now included at no extra cost. A proven reputation for optical and mechanical quality plus unique features and extra value make a UNITRON Refractor the logical telescope for you to choose.

2.4" ALTAZIMUTH $125
with eyepieces for 100x, 72x, 50x, 35x

2.4" EQUATORIAL $225
with eyepieces for 129x, 100x, 72x, 50x, 35x

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with eyepieces for 171x, 131x, 96x, 67x, 48x

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with eyepieces for 200x, 131x, 96x, 67x, 48x

3" PHOTO-EQUATORIAL $550
with eyepieces for 200x, 171x, 131x, 96x, 67x, 48x

4" ALTAZIMUTH $465
with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x

4" EQUATORIAL $785
with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x

4" PHOTO-EQUATORIAL $890
with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x

4" EQUATORIAL with weight-driven $985
clock drive, eyepieces as above

4" EQUATORIAL with weight-driven $1075
clock drive, metal pier, eyepieces as above

4" PHOTO-EQUATORIAL with weight- $1175
driven clock drive and ASTRO-CAMERA, with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x, 25x

4" PHOTO-EQUATORIAL with weight- $1280
driven clock drive, pier, ASTRO-CAMERA, eyepieces for 375x, 300x, 250x, 214x, 167x, 120x, 83x, 60x, 38x, 25x

5" PHOTO-EQUATORIAL with clock $2275
drive and ASTRO-CAMERA with eyepieces for 500x, 400x, 333x, 286x, 222x, 160x, 111x, 80x, 50x, 33x

6" EQUATORIAL with clock drive, $5125
pier, 2.4" view finder, with 10 eyepieces

6" PHOTO-EQUATORIAL as above but $5660
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