THE OBSERVER'S HANDBOOK 1968

Sixtieth Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 — Royal Charter 1903

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, as well as a large room for the accommodation of telescope making groups.

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, Halifax, Quebec, Montreal, Ottawa, Kingston, Hamilton, Niagara Falls, London, Windsor, Winnipeg, 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 $7.50 are payable October 1 and include the publications for the following year.

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Planetariums :

Calgary Centennial Planetarium, Calgary, Alta., daily except Tuesday, 2:00, 3:15, 7:00, 8:15 p.m.

Dow Planetarium, Montreal, P.Q. Performances in English: Monday through Saturday, 3:30 p.m.; also Saturday, 1:00 and Sunday, 2:15 p.m. Evenings (except Monday) 8:15.
In French: Monday through Saturday, 2:15 p.m. Sunday, 1:00 and 3:30 p.m. Evenings (except Monday) 9:30.

Manitoba Planetarium, Winnipeg, Man., daily, Monday through Friday, 3:00, 8:00 p.m., Saturdays, 11:00 a.m., 1:00, 2:30, 4:00, 8:00 p.m., Sundays, 1:00, 2:30, 4:00 p.m.

McLaughlin Planetarium, Toronto, Ont., expected opening at time of going to press, late 1968.

McMaster University, Hamilton, Ont. (group reservations only).

Nova Scotia Museum, Halifax, Tuesday only, 8:00 p.m.

Queen Elizabeth Planetarium, Edmonton, Alta., Monday–Wednesday, 7:30 p.m. (closed Thursday), Friday, 7:30 p.m., Saturday, 3:30 p.m., Sunday, 2:00–4:00 p.m.

University of Manitoba, Winnipeg, Man., Tuesdays, 8:30 p.m., Thursdays, 7:30 and 9:00 p.m. (closed April and May).

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EDITOR
RUTH J. NORTHCOTT

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THE OBSERVER'S HANDBOOK for 1968 is the 60th edition. The table of contents has been replaced by an alphabetical listing. It is hoped that this will prove of greater usefulness. Certain changes among the miscellaneous astronomical data have been made in accord with the conversion of the *Astronomical Ephemeris* and *American Ephemeris* to the I.A.U. system of astronomical constants. The tenth satellite of Saturn has been added to the table of satellites of the solar system. The times of sunrise and sunset, and of twilight, are again the values for the current year. A table of the objects in Messier's catalogue has been added.

During 1968 the range of the moon's declination is approaching its greatest value, so that the moon occults stars of the Pleiades. Jupiter, Saturn and the stars Antares and Spica are also occulted this year (p. 64). The asteroid Icarus approaches closest to the earth on June 15 (p. 69).

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 David Crampton, Barbara Gaizauskas, Gretchen Hagen, Helen Sawyer Hogg, David Lindop, Eleanor Parmenter, Michael Scherk, Maude Town 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

ANNIVERSARIES AND FESTIVALS, 1968

New Year's Day	Mon.	Jan. 1
Epiphany	Sat.	Jan. 6
Accession of Queen Elizabeth (1952)	Tues.	Feb. 6
Septuagesima Sunday		Feb. 11
Quinquagesima (Shrove Sunday)		Feb. 25
Ash Wednesday		Feb. 28
St. David	Fri.	Mar. 1
St. Patrick	Sun.	Mar. 17
Palm Sunday		Apr. 7
Good Friday		Apr. 12
Easter Sunday		Apr. 14
Birthday of Queen Elizabeth (1926)	Sun.	Apr. 21
St. George	Tues.	Apr. 23
Rogation Sunday		May 19
Victoria Day	Mon.	May 20
Ascension Day	Thur.	May 23
Pentecost (Whit Sunday)		June 2
Trinity Sunday		June 9
Corpus Christi	Thur.	June 13
St. John Baptist (Midsummer Day)	Mon.	June 24
Dominion Day	Mon.	July 1
Birthday of Queen Mother Elizabeth (1900)	Sun.	Aug. 4
Labour Day	Mon.	Sept. 2
Hebrew New Year (Rosh Hashanah)	Mon.	Sept. 23
St. Michael (Michaelmas Day)	Sun.	Sept. 29
Thanksgiving	Mon.	Oct. 14
All Saints' Day	Fri.	Nov. 1
Remembrance Day	Mon.	Nov. 11
St. Andrew	Sat.	Nov. 30
First Sunday in Advent		Dec. 1
Christmas Day	Wed.	Dec. 25

JULIAN DAY CALENDAR, 1968

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

Jan. 1	39,857	May 1	39,978	Sept. 1	40,101
Feb. 1	39,888	June 1	40,009	Oct. 1	40,131
Mar. 1	39,917	July 1	40,039	Nov. 1	40,162
Apr. 1	39,948	Aug. 1	40,070	Dec. 1	40,192

The Julian Day commences at noon. Thus J.D. 2,439,857.0 = 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 English Names with Abbreviations

Andromeda, (*Chained Maiden*)	And	Andr
Antlia, *Air Pump*	Ant	Antl
Apus, *Bird of Paradise*	Aps	Apus
Aquarius, *Water-bearer*	Aqr	Aqar
Aquila, *Eagle*	Aql	Aquil
Ara, *Altar*	Ara	Arae
Aries, *Ram*	Ari	Arie
Auriga, (*Charioteer*)	Aur	Auri
Bootes, (*Herdsman*)	Boo	Boot
Caelum, *Chisel*	Cae	Cael
Camelopardalis, *Giraffe*	Cam	Caml
Cancer, *Crab*	Cnc	Canc
Canes Venatici, *Hunting Dogs*	CVn	CVen
Canis Major, *Greater Dog*	CMa	CMaj
Canis Minor, *Lesser Dog*	CMi	CMin
Capricornus, *Sea-goat*	Cap	Capr
Carina, *Keel*	Car	Cari
Cassiopeia, (*Lady in Chair*)	Cas	Cass
Centaurus, *Centaur*	Cen	Cent
Cepheus, (*King*)	Cep	Ceph
Cetus, *Whale*	Cet	Ceti
Chamaeleon, *Chamaeleon*	Cha	Cham
Circinus, *Compasses*	Cir	Circ
Columba, *Dove*	Col	Colm
Coma Berenices, *Berenice's Hair*	Com	Coma
Corona Austrina, *Southern Crown*	CrA	CorA
Corona Borealis, *Northern Crown*	CrB	CorB
Corvus, *Crow*	Crv	Corv
Crater, *Cup*	Crt	Crat
Crux, (*Southern*) *Cross*	Cru	Cruc
Cygnus, *Swan*	Cyg	Cygn
Delphinus, *Dolphin*	Del	Dlph
Dorado, *Swordfish*	Dor	Dora
Draco, *Dragon*	Dra	Drac
Equuleus, *Little Horse*	Equ	Equl
Eridanus, *River Eridanus*	Eri	Erid
Fornax, *Furnace*	For	Forn
Gemini, *Twins*	Gem	Gemi
Grus, *Crane*	Gru	Grus
Hercules, (*Kneeling Giant*)	Her	Herc
Horologium, *Clock*	Hor	Horo
Hydra, *Water-snake*	Hya	Hyda
Hydrus, *Sea-serpent*	Hyi	Hydi
Indus, *Indian*	Ind	Indi
Lacerta, *Lizard*	Lac	Lacr
Leo, *Lion*	Leo	Leon
Leo Minor, *Lesser Lion*	LMi	LMin
Lepus, *Hare*	Lep	Leps
Libra, *Scales*	Lib	Libr
Lupus, *Wolf*	Lup	Lupi
Lynx, *Lynx*	Lyn	Lync
Lyra, *Lyre*	Lyr	Lyra
Mensa, *Table* (*Mountain*)	Men	Mens
Microscopium, *Microscope*	Mic	Micr
Monoceros, *Unicorn*	Mon	Mono
Musca, *Fly*	Mus	Musc
Norma, *Square*	Nor	Norm
Octans, *Octant*	Oct	Octn
Ophiuchus, *Serpent-bearer*	Oph	Ophi
Orion, (*Hunter*)	Ori	Orio
Pavo, *Peacock*	Pav	Pavo
Pegasus, (*Winged Horse*)	Peg	Pegs
Perseus, (*Champion*)	Per	Pers
Phoenix, *Phoenix*	Phe	Phoe
Pictor, *Painter*	Pic	Pict
Pisces, *Fishes*	Psc	Pisc
Piscis Austrinus, *Southern Fish*	PsA	PscA
Puppis, *Poop*	Pup	Pupp
Pyxis, *Compass*	Pyx	Pyxi
Reticulum, *Net*	Ret	Reti
Sagitta, *Arrow*	Sge	Sgte
Sagittarius, *Archer*	Sgr	Sgtr
Scorpius, *Scorpion*	Sco	Scor
Sculptor, *Sculptor*	Scl	Scul
Scutum, *Shield*	Sct	Scut
Serpens, *Serpent*	Ser	Serp
Sextans, *Sextant*	Sex	Sext
Taurus, *Bull*	Tau	Taur
Telescopium, *Telescope*	Tel	Tele
Triangulum, *Triangle*	Tri	Tria
Triangulum Australe, *Southern Triangle*	TrA	TrAu
Tucana, *Toucan*	Tuc	Tucn
Ursa Major, *Greater Bear*	UMa	UMaj
Ursa Minor, *Lesser Bear*	UMi	UMin
Vela, *Sails*	Vel	Velr
Virgo, *Virgin*	Vir	Virg
Volans, *Flying Fish*	Vol	Voln
Vulpecula, *Fox*	Vul	Vulp

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

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit	= 10^{-8} cm.	1 micron, μ	= 10^{-4} cm. = 10^4A.
1 inch	= exactly 2.54 centimetres	1 cm.	= 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 = 1.496×10^{13} cm. = 1.496×10^8 km. = 9.2957×10^7 mi.
1 light-year = 9.461×10^{17} cm. = 5.88×10^{12} mi. = 0.3068 parsecs
1 parsec = 3.084×10^{18} cm. = 1.916×10^{13} mi. = 3.260 l.y.
1 megaparsec = 10^6 parsecs

Units of Time

Sidereal day = $23h$ $56m$ $04.09s$ 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 = 5.98×10^{24} kgm. = 13.2×10^{24} lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

Earth's Orbital Motion

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

Solar Motion

Solar apex, R.A. $18h$ $04m$, 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) ~ 2.2×10^8 years
Mass ~ 2×10^{11} solar masses

External Galaxies

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

Radiation Constants

Velocity of light, c = 299,792.50 ± 0.10 km./sec. = 186,282.1 mi./sec.;
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant = 5.6694×10^{-5} c.g.s. units

Miscellaneous

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.; mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.
Loschmidt's number = 2.6872×10^{19} molecules/cu. cm. of gas at S.T.P.
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 41 54	+ 3 16	−23 05.8
4	18 55 09	+ 4 40	−22 50.4
7	19 08 20	+ 6 01	−22 31.0
10	19 21 27	+ 7 17	−22 07.6
13	19 34 28	+ 8 29	−21 40.2
16	19 47 25	+ 9 34	−21 09.1
19	20 00 15	+10 34	−20 34.4
22	20 12 59	+11 27	−19 56.2
25	20 25 36	+12 13	−19 14.6
28	20 38 06	+12 52	−18 29.8
31	20 50 29	+13 25	−17 42.0
Feb. 3	21 02 45	+13 49	−16 51.3
6	21 14 53	+14 06	−15 58.0
9	21 26 54	+14 16	−15 02.3
12	21 38 47	+14 19	−14 04.2
15	21 50 33	+14 14	−13 04.1
18	22 02 13	+14 04	−12 02.1
21	22 13 47	+13 47	−10 58.3
24	22 25 15	+13 24	− 9 53.0
27	22 36 37	+12 56	− 8 46.4
Mar. 1	22 47 55	+12 23	− 7 38.5
4	22 59 08	+11 45	− 6 29.7
7	23 10 16	+11 04	− 5 20.0
10	23 21 21	+10 18	− 4 09.8
13	23 32 23	+ 9 30	− 2 59.1
16	23 43 22	+ 8 39	− 1 48.1
19	23 54 19	+ 7 46	− 0 36.9
22	0 05 15	+ 6 52	+ 0 34.2
25	0 16 11	+ 5 58	+ 1 45.1
28	0 27 06	+ 5 04	+ 2 55.7
31	0 38 01	+ 4 09	+ 4 05.8
Apr. 3	0 48 57	+ 3 16	+ 5 15.2
6	0 59 55	+ 2 24	+ 6 23.7
9	1 10 53	+ 1 33	+ 7 31.2
12	1 21 54	+ 0 45	+ 8 37.6
15	1 32 58	0 00	+ 9 42.7
18	1 44 05	− 0 42	+10 46.3
21	1 55 16	− 1 21	+11 48.4
24	2 06 30	− 1 55	+12 48.7
27	2 17 49	− 2 25	+13 47.2
30	2 29 13	− 2 50	+14 43.6
May 3	2 40 41	− 3 11	+15 37.8
6	2 52 14	− 3 27	+16 29.7
9	3 03 52	− 3 38	+17 19.0
12	3 15 35	− 3 43	+18 05.8
15	3 27 23	− 3 44	+18 49.9
18	3 39 17	− 3 40	+19 31.1
21	3 51 15	− 3 30	+20 09.3
24	4 03 19	− 3 15	+20 44.4
27	4 15 27	− 2 56	+21 16.4
30	4 27 39	− 2 33	+21 45.0
June 2	4 39 55	− 2 06	+22 10.2
5	4 52 15	− 1 35	+22 31.9
8	5 04 37	− 1 02	+22 50.1
11	5 17 02	− 0 27	+23 04.7
14	5 29 28	+ 0 10	+23 15.6
17	5 41 56	+ 0 48	+23 22.8
20	5 54 25	+ 1 28	+23 26.4
23	6 06 54	+ 2 07	+23 26.2
26	6 19 22	+ 2 45	+23 22.3
29	6 31 49	+ 3 22	+23 14.7

Date	Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
	h m s	m s	° ′
July 2	6 44 14	+ 3 57	+23 03.4
5	6 56 37	+ 4 30	+22 48.5
8	7 08 56	+ 4 59	+22 30.0
11	7 21 12	+ 5 24	+22 08.0
14	7 33 24	+ 5 46	+21 42.7
17	7 45 31	+ 6 03	+21 14.0
20	7 57 34	+ 6 15	+20 42.0
23	8 09 32	+ 6 23	+20 06.9
26	8 21 25	+ 6 25	+19 28.8
29	8 33 13	+ 6 22	+18 47.7
Aug. 1	8 44 55	+ 6 14	+18 03.9
4	8 56 31	+ 6 00	+17 17.4
7	9 08 02	+ 5 40	+16 28.4
10	9 19 28	+ 5 15	+15 37.1
13	9 30 48	+ 4 45	+14 43.5
16	9 42 04	+ 4 10	+13 47.8
19	9 53 15	+ 3 31	+12 50.1
22	10 04 21	+ 2 47	+11 50.5
25	10 15 24	+ 1 59	+10 49.2
28	10 26 23	+ 1 08	+ 9 46.4
31	10 37 19	+ 0 13	+ 8 42.3
Sept. 3	10 48 11	− 0 44	+ 7 36.8
6	10 59 01	− 1 44	+ 6 30.3
9	11 09 49	− 2 46	+ 5 22.9
12	11 20 36	− 3 49	+ 4 14.6
15	11 31 22	− 4 53	+ 3 05.6
18	11 42 08	− 5 57	+ 1 56.1
21	11 52 54	− 7 00	+ 0 46.2
24	12 03 41	− 8 03	− 0 23.9
27	12 14 29	− 9 04	− 1 34.1
30	12 25 18	−10 04	− 2 44.2
Oct. 3	12 36 10	−11 01	− 3 54.0
6	12 47 05	−11 55	− 5 03.4
9	12 58 03	−12 46	− 6 12.2
12	13 09 06	−13 33	− 7 20.3
15	13 20 13	−14 15	− 8 27.5
18	13 31 25	−14 52	− 9 33.6
21	13 42 42	−15 23	−10 38.5
24	13 54 06	−15 48	−11 42.0
27	14 05 36	−16 06	−12 43.9
30	14 17 12	−16 19	−13 44.0
Nov. 2	14 28 55	−16 24	−14 42.1
5	14 40 46	−16 22	−15 38.1
8	14 52 43	−16 13	−16 31.8
11	15 04 49	−15 56	−17 22.9
14	15 17 02	−15 31	−18 11.4
17	15 29 23	−14 58	−18 57.0
20	15 41 52	−14 18	−19 39.6
23	15 54 28	−13 31	−20 19.0
26	16 07 11	−12 36	−20 55.0
29	16 20 00	−11 35	−21 27.5
Dec. 2	16 32 55	−10 29	−21 56.2
5	16 45 56	− 9 17	−22 21.3
8	16 59 02	− 7 59	−22 42.4
11	17 12 13	− 6 38	−22 59.5
14	17 25 27	− 5 13	−23 12.5
17	17 38 44	− 3 46	−23 21.3
20	17 52 02	− 2 16	−23 26.0
23	18 05 22	− 0 46	−23 26.4
26	18 18 41	+ 0 43	−23 22.6
29	18 31 59	+ 2 11	−23 14.5

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	Oblateness	Mass	Mean Density	Surface Gravity	Rotation Period	Inclination of Equator to Orbit	Albedo
	miles		⊕ = 1	water = 1	⊕ = 1		°	
☉ 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	3,100	0	0.056	5.13	0.36	58.65^d	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	244^d(retro.)	10	0.76
⊕ Earth	7,926	1/298	1.000	5.52	1.00	$23^h\ 56^m\ 04^s$	23.4	0.36
♂ Mars	4,200	1/192	0.108	3.94	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. 63, 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.

SOLAR, SIDEREAL AND EPHEMERIS 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, sidereal time gains on mean time 3^m56^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.

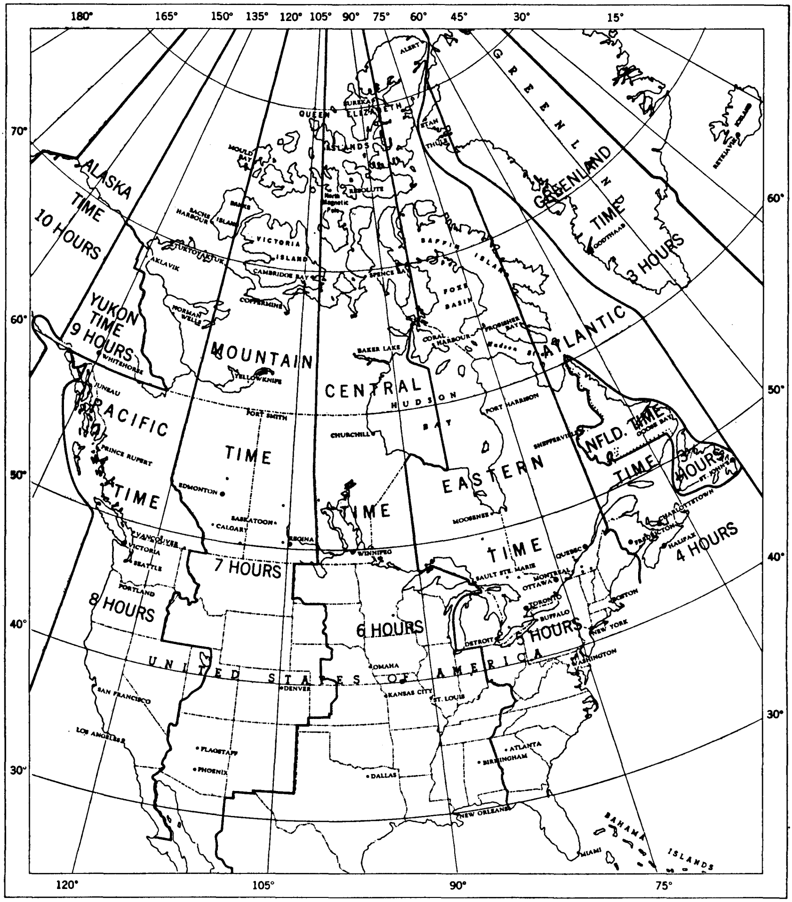
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 8 standard time zones as follows: Newfoundland (N), 3^h30^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 than Greenwich.*

Universal time, even after the corrections mentioned have been applied, is still somewhat variable, as shown by atomic clocks or the orbital motion of the moon. *Ephemeris Time* (ET) is used when these irregularities must be avoided. The second, formerly defined as 1/86,400 of the mean solar day, is now defined as 1/31,556,925.9747 of the tropical year for 1900 Jan. 0 at 12 hours E.T. 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 tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1968 will be about 37 seconds.

**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.

MAP OF STANDARD TIME ZONES



In the Yukon, the region east of longitude 138° is 8 hours, to the west is 9 hours behind Greenwich. (Commissioner's Order 1967-59.)

RADIO TIME SIGNALS

Many national observatories and some standards laboratories transmit time signals. A complete listing of stations emitting time signals may be found in the "List of Radiodetermination and Special Service Stations" prepared by the General Secretariat of the International Telecommunication Union, Geneva. For use in Canada and adjacent areas, the following is a brief list of controlled frequency stations.

CHU Ottawa, Canada—3330, 7335, 14670 kilocycles
WWV Beltsville, Maryland—2.5, 5, 10, 15, 20, 25 megacycles
WWVH Maui, Hawaii—5, 10, 15 megacycles
NBA Balboa, Canal Zone—18 kilocycles.

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 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

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

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

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

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

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

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

TWILIGHT—BEGINNING OF MORNING AND ENDING OF EVENING

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

The above table gives the local mean time of the beginning of morning twilight, and of the ending of evening twilight, for various latitudes. To obtain the corresponding standard time, the method used is the same as for correcting the sunrise and sunset tables, as described on page 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, 1968 (Local Mean Time)

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

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

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

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

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

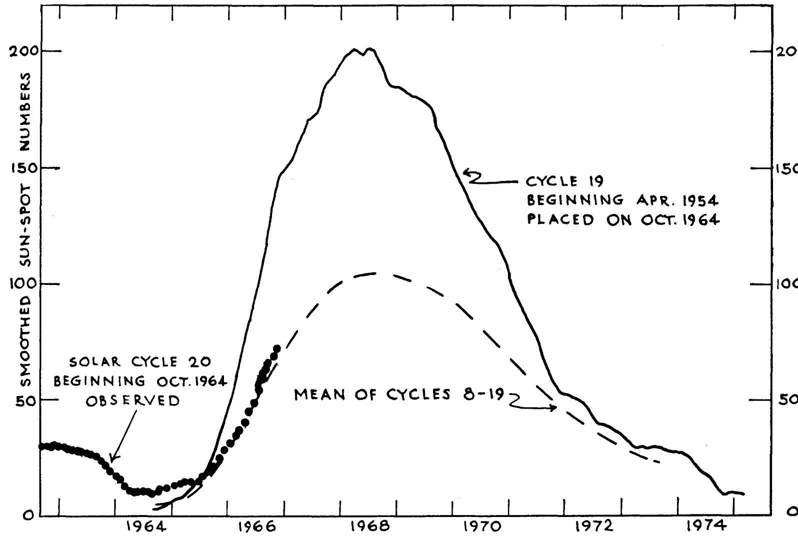
DATE	Latitude 30° Moon Rise	Latitude 30° Moon Set	Latitude 35° Moon Rise	Latitude 35° Moon Set	Latitude 40° Moon Rise	Latitude 40° Moon Set	Latitude 45° Moon Rise	Latitude 45° Moon Set	Latitude 50° Moon Rise	Latitude 50° Moon Set	Latitude 54° Moon Rise	Latitude 54° Moon Set
Nov.	h m	h m	h m	h m	h m	h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

THE SUN AND PLANETS FOR 1968

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 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 1968

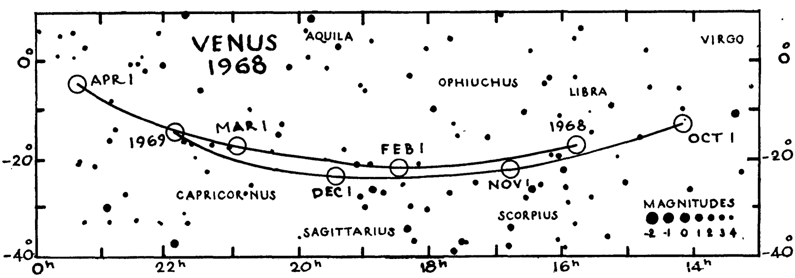
Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Jan. 30	18°	−0.3	Mar. 12	28°	+0.4
May 23	23°	+0.7	July 11	21°	+0.6
Sept. 20	26°	+0.3	Oct. 31	19°	−0.3

The most favourable elongations are: in the evening, May 23; in the morning, October 31. The apparent diameter of the planet ranges from about 5″ to 12″.

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.

On Jan. 1, 1968, Venus is low in the south-south-eastern sky at dawn, and crosses the meridian almost 3 hours before the sun; its declination is −18° and its stellar magnitude is −3.6. Its western elongation decreases until it reaches superior conjunction with the sun on June 20; it is in the evening sky for the rest of the year. By Dec. 31 it is approaching greatest eastern elongation and is



low in the southern sky at sunset (see map). The apparent diameter of the planet ranges from 16″ on Jan. 1 to a minimum of 10″ in June, and increases to 19″ at the end of the year.

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.

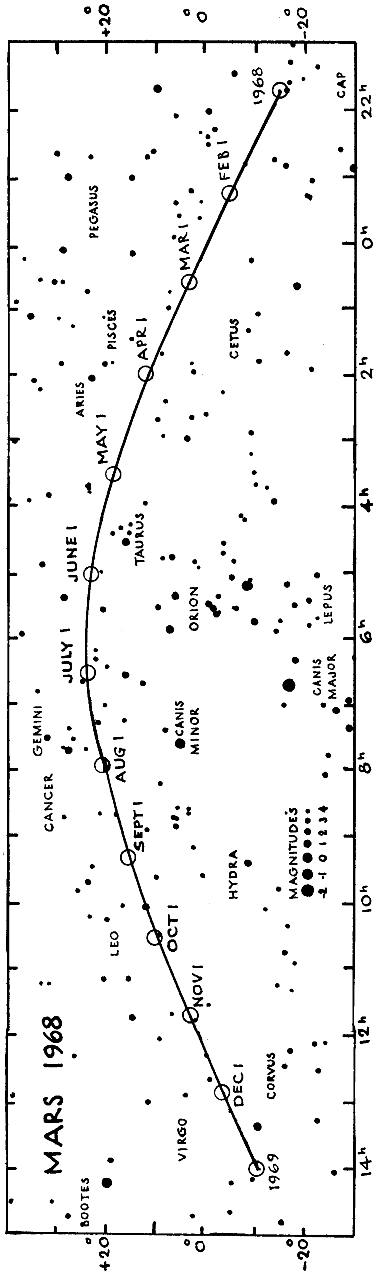
On Jan. 1, 1968, Mars is in Capricornus, near Aquarius, and is low in the south-south-west at sunset; its declination is $-15°$ and its stellar magnitude is $+1.3$. Conjunction with the sun occurs on June 21. Mars gradually emerges into the morning sky and by the end of the year is in Virgo, crossing the meridian nearly 5 hours before the sun (see map). Its stellar magnitude fades to $+2.0$ in the autumn and brightens slightly to $+1.5$ by Dec. 31. The apparent diameter ranges from 3.6″ to 5.4″ during 1968.

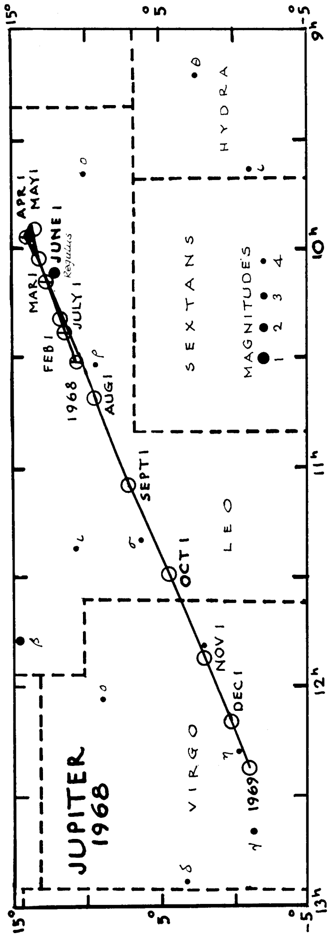
JUPITER

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.

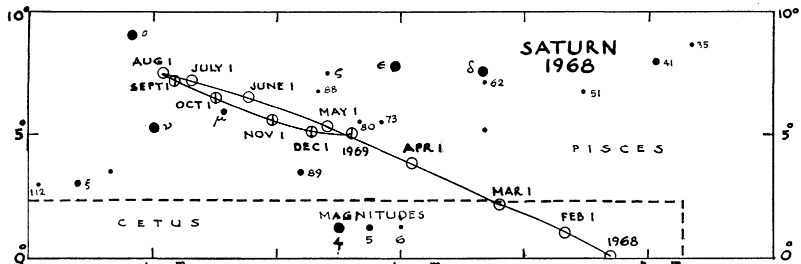
On Jan. 1, 1968, Jupiter is retrograding in Leo (direct motion resumes on Apr. 22); it rises over 4 hours after sunset and is in the south-west at dawn. Its stellar magnitude is -1.9 and its declination $+10°$. Opposition occurs on Feb. 20 when it is visible all night; its stellar magnitude is -2.1. On Sept. 8 it is in conjunction with the sun and moves into the morning sky for the rest of the year (see map; circles with vertical lines denote retrograde motion). On Dec. 31 Jupiter is in Virgo in the south-south-west at dawn; its stellar magnitude is -1.6. The apparent polar diameter is a maximum of 42″ in Feb. and a minimum of 29″ in Sept.


MARS 1968
1968
FEB 1
MAR 1
APR 1
MAY 1
JUNE 1
JULY 1
AUG 1
SEPT 1
OCT 1
NOV 1
DEC 1
1969
PEGASUS
PISCES
ARIES
CETUS
TAURUS
ORION
LEPUS
GEMINI
CANIS MINOR
CANIS MAJOR
CANCER
HYDRA
LEO
VIRGO
CORVUS
BOOTES
CAP
MAGNITUDES
-2 -1 0 1 2 3 4
+20°
0°
-20°
22h
0h
2h
4h
6h
8h
10h
12h
14h


JUPITER 1968
1968
FEB 1
MAR 1
APR 1
MAY 1
JUNE 1
JULY 1
AUG 1
SEPT 1
OCT 1
NOV 1
DEC 1
1969
Regulus
HYDRA
SEXTANS
LEO
VIRGO
MAGNITUDES
1 2 3 4
15°
5°
-5°
9h
10h
11h
12h
13h

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

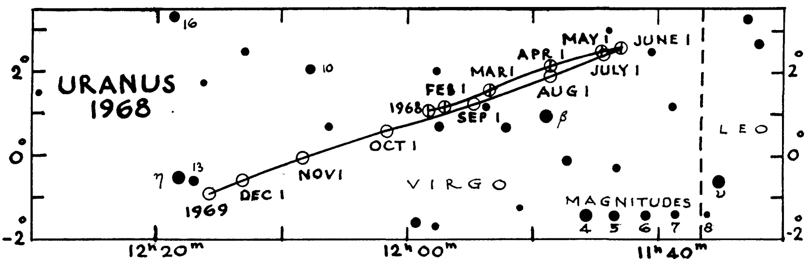


the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, 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, 1968, Saturn is in Cetus, near Pisces, and just east of the meridian at sunset; its stellar magnitude is +1.1 and it is close to the equator. On Apr. 4 it is in conjunction with the sun and moves into the morning sky. It reaches opposition on Oct. 15 when it is visible all night and its stellar magnitude brightens to +0.3. It retrogrades from Aug. 7 to Dec. 22 (see map; circles with vertical lines denote retrograde motion). At the end of the year it has stellar magnitude +0.7 and is in the south-east at sunset. The apparent diameter of the ball of the planet ranges from 14″ in Apr. to 18″ in Oct.

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

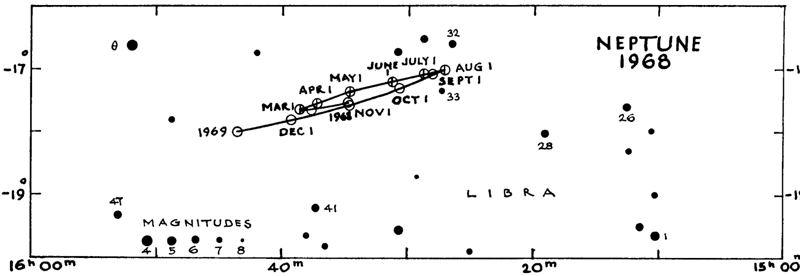


sun as Saturn. Its period of revolution is 84 years and it rotates on its axis in about 11 hours. Its five satellites are visible only in a large telescope.

During 1968 Uranus is in Virgo (see map). At the beginning of the year it rises before midnight. It retrogrades from Jan. 4 to June 2. It is in opposition on Mar. 17 when it is above the horizon all night; its stellar magnitude is +5.7 and its apparent diameter 4.0″. When conjunction occurs on Sept. 22 its magnitude has faded to +5.9. It is in the morning sky the rest of the year.

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 1968 Neptune is in Libra (see map). It is in opposition on May 15, 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 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 18 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 27 to Aug. 5.

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 Leo. It is in opposition to the sun on Mar. 11, at which time its astrometric position is R.A. 11h 54m, Dec. +17° 48′, and its distance from the earth is 2,886,000,000 mi.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1968

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 42m to 20h 55m and its Decl. changes from 23° 06′ S. to 17° 25′ S. The equation of time changes from −3m 22s to −13m 26s. 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 4th at a distance of 91,348,000 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. 18h 50m, Decl. 24° 49′ S. and on the 15th is in R.A. 20h 29m, Decl. 21° 06′ S. Early in the month it is too close to the sun for observation, but during the last week it is a good evening star, greatest eastern elongation being on the 30th, at which time Mercury is about 15 degrees above the south-western horizon at sunset.

Venus on the 1st is in R.A. 15h 49m, Decl. 17° 43′ S. and on the 15th is in R.A. 16h 59m, Decl. 20° 54′ S., mag. −3.6, and transits at 9h 25m. It is a prominent morning star visible in the south-east for about two or three hours before sunrise.

Mars on the 15th is in R.A. 22h 26m, Decl. 10° 48′ S., mag. +1.3, and transits at 14h 51m. Moving into Aquarius, it is low in the south-west at sunset and sets about three hours later.

Jupiter on the 15th is in R.A. 10h 29m. Decl. 10° 45′ N., mag. −2.0, and transits at 2h 53m. In Leo, it rises late in the evening and is visible all night. It is retrograding, that is, moving 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. 0h 29m, Decl. 0° 32′ N., mag. +1.1, and transits at 16h 51m. In Cetus, near Pisces, it is near the meridian at sunset and sets before midnight. A daylight occultation occurs on the 6th.

Uranus on the 15th is in R.A. 11h 58m, Decl. 1° 02′ N. and transits at 4h 23m.

Neptune on the 15th is in R.A. 15h 36m, Decl. 17° 37′ S. and transits at 8h 00m.

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

JANUARY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 2h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1					d2104	276.41[b]
Tue. 2	8		Pluto stationary..............	10 10	30412	288.60
Wed. 3			Quadrantid meteors...........		3402*	300.79
	5		Mars 3° N. of moon...........			
Thu. 4			Earth at perihelion............		42310	312.97[l]
	9		Uranus stationary.............			
Fri. 5				7 00	42013	325.15
Sat. 6	14		Saturn 1° S. of moon; occ., p. 65		41023	337.32
Sun. 7	9	23	☽ First Quarter..............		d4013	349.48
Mon. 8				3 50	42103	1.64
Tue. 9	8		Moon at apogee, 251,400 mi. ...		43012	13.80
Wed. 10					3402*	25.94
Thu. 11			Mercury greatest hel. lat. S.....	0 40	32104	38.09
Fri. 12					20314	50.22
Sat. 13				21 30	10234	62.36
Sun. 14					02134	74.49
Mon. 15	11	12	○ Full Moon.................		21034	86.61
Tue. 16				18 20	3014*	98.74[l,b]
Wed. 17					31024	110.87
Thu. 18	10		Jupiter 3° S. of moon..........		32104	123.00
Fri. 19				15 10	24013	135.13
Sat. 20	5		Uranus 1° S. of moon..........		41023	147.27
Sun. 21					40213	159.41
Mon. 22	14	38	☾ Last Quarter...............	11 50	42103	171.56
Tue. 23					4301*	183.71
Wed. 24	10		Neptune 5° N. of moon........		43102	195.88
	19		Moon at perigee, 229,500 mi....			
Thu. 25			Antares occulted by moon, p. 65	8 40	43201	208.05
Fri. 26	17		Venus 6° N. of moon..........		420**	220.23
Sat. 27					10423	232.41
Sun. 28				5 30	02143	244.60[b]
Mon. 29	11	30	● New Moon................		21034	256.79
Tue. 30			Mercury at ascending node.....		32014	268.98
	20		Mercury 5° N. of moon........			
	23		Mercury greatest elong. E., 18°..			
Wed. 31				2 20	31024	281.17[l]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]Jan. 4, +6.40°; Jan. 16, −4.83°; Jan. 31, +5.32°.

[b]Jan. 1, +6.53°; Jan. 16, −6.51°; Jan. 28, +6.50°.

THE SKY FOR FEBRUARY 1968

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 55m to 22h 48m and its Decl. changes from 17° 25′ S. to 7° 39′ S. The equation of time changes from −13m 35s to a maximum of −14m 19s on the 11th and then to −12m 32s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 1st is in R.A. 22h 06m, Decl. 11° 14′ S. and on the 15th is in R.A. 21h 51m, Decl. 9° 10′ S. During the first week of the month it is visible as an evening star low on the south-western horizon just after sunset. By the 15th it is in inferior conjunction.

Venus on the 1st is in R.A. 18h 28m, Decl. 22° 18′ S. and on the 15th is in R.A. 19h 42m, Decl. 21° 07′ S., mag. −3.4, and transits at 10h 06m. It is a morning star visible low in the south-east for about two hours or less before sunrise.

Mars on the 15th is in R.A. 23h 55m, Decl. 1° 11′ S., mag. +1.4, and transits at 14h 18m. Moving into Pisces, it is low in the west at sunset and sets about three hours later.

Jupiter on the 15th is in R.A. 10h 16m, Decl. 12° 04′ N., mag. −2.1, and transits at 0h 39m. In Leo, it rises about at sunset and is visible all night. Opposition is on the 20th, the distance from the earth then being 408,100,000 mi. 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. 0h 38m, Decl. 1° 38′ N., mag. +1.1, and transits at 14h 59m. In Pisces, it is well down in the west at sunset and sets about four hours later.

Uranus on the 15th is in R.A. 11h 56m, Decl. 1° 20′ N. and transits at 2h 18m.

Neptune on the 15th is in R.A. 15h 38m, Decl. 17° 42′ S. and transits at 6h 00m.

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

			FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 0h 40m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thu. 1	9		Mars 2° N. of moon		d3014	293.36
Fri. 2				23 10	23104	305.55
Sat. 3			Mercury at perihelion		d0234	317.74
	3		Saturn 1° S. of moon			
	12		Pallas stationary			
Sun. 4					01423	329.92
Mon. 5	21		Mercury stationary	20 00	24103	342.09
Tue. 6	5		Moon at apogee, 251,200 mi.		42301	354.26
	7	21	☽ First Quarter			
Wed. 7					43102	6.42
Thu. 8	14		Vesta in conjunction with sun	16 50	d4301	18.58
Fri. 9					42310	30.73
Sat. 10					40123	42.88
Sun. 11				13 40	40123	55.02
Mon. 12					42103	67.16[lb]
Tue. 13					23041	79.30
Wed. 14			Mercury greatest hel. lat. N.	10 30	31024	91.43
	1	43	○ Full Moon			
	12		Jupiter 3° S. of moon			
Thu. 15			Neptune in quadrature W.		30214	103.57
	10		Mercury in inferior conjunction.			
Fri. 16	11		Uranus 1° S. of moon		23104	115.70
Sat. 17				7 20	01234	127.84
Sun. 18	11		Moon at perigee, 229,200 mi.		0234*	139.98
Mon. 19					21034	152.13
Tue. 20			Venus at descending node	4 10	d2014	164.28
	6		Jupiter at opposition			
	16		Neptune 5° N. of moon			
	22	28	☾ Last Quarter			
Wed. 21					d3102	176.45
Thu. 22					34021	188.62
Fri. 23				1 00	42310	200.80
Sat. 24					4013*	212.98
Sun. 25	14		Venus 5° N. of moon	21 50	41023	225.17[b]
Mon. 26	7		Mercury 7° N. of moon		d4203	237.37
Tue. 27	13		Mercury stationary		42031	249.57[l]
	13		Neptune stationary			
Wed. 28	1	56	● New Moon	18 40	43102	261.77
Thu. 29					34021	273.97

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]Feb. 12, −5.35°; Feb. 27, +4.96°. [b]Feb. 12, −6.62°; Feb. 25, +6.63°.

THE SKY FOR MARCH 1968

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 48m to 0h 42m and its Decl. changes from 7° 39′ S. to 4° 29′ N. The equation of time changes from −12m 20s to −4m 06s. On the 20th at 8h 22m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. This is the vernal equinox. For changes in the length of the day, see p. 14. There is a partial eclipse of the sun, not visible in North America, on the 28th.

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 17m, Decl. 14° 10′ S. and on the 15th is in R.A. 21h 59m, Decl. 13° 31′ S. On the 12th Mercury is at greatest western elongation; however, this is a poor elongation and the planet is less than 10 degrees above the south-eastern horizon at sunrise.

Venus on the 1st is in R.A. 20h 59m, Decl. 17° 37′ S. and on the 15th is in R.A. 22h 07m, Decl. 12° 40′ S., mag. −3.3, and transits at 10h 37 m. It is a morning star, rising south of east an hour or so before sunrise.

Mars on the 15th is in R.A. 1h 16m, Decl. 7° 44′ N., mag. +1.5, and transits at 13h 44m. Moving through Pisces into Aries, it is low in the west at sunset and sets about two hours later.

Jupiter on the 15th is in R.A. 10h 02m, Decl. 13° 21′ N., mag. −2.0, and transits at 22h 27m. In Leo near Regulus, it is well up at sunset and sets before dawn. 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. 0h 50m, Decl. 2° 58′ N., and transits at 13h 17m. It is too close to the sun for easy observation.

Uranus on the 15th is in R.A. 11h 51m, Decl. 1° 48′ N., mag. +5.7, and transits at 0h 20m. Opposition is on the 17th, when its distance from the earth is 1671,000,000 mi.

Neptune on the 15th is in R.A. 15h 38m, Decl. 17° 40′ S. and transits at 4h 06m.

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

d	h	m	MARCH E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 23h 45m	Sun's Selen. Colong. 0h U.T. °
Fri. 1	14		Mars 0.4° N. of moon.........		20314	286.18
	17		Saturn 2° S. of moon..........			
Sat. 2				15 30	10234	298.38
Sun. 3					20134	310.58
Mon. 4	0		Mars 2° N. of Saturn..........		2034*	322.77
Tue. 5	1		Juno stationary...............	12 10	31024	334.96
	1		Ceres stationary..............			
	2		Moon at apogee, 251,400 mi.....			
Wed. 6					30124	347.15
Thu. 7	0		Mercury 1.0° N. of Venus......		32104	359.33
	4	21	☽ First Quarter...............			
Fri. 8			Mercury at descending node....	9 00	4201*	11.50
Sat. 9					41023	23.67
Sun. 10					d4013	35.84 [b]
Mon. 11	20		Pluto at opposition...........	5 50	4203*	48.00 [l]
Tue. 12	16		Jupiter 3° S. of moon..........		43102	60.15
	20		Mercury greatest elong. W., 28°.			
Wed. 13	15		Pallas at opposition...........		43012	72.30
Thu. 14	13	53	○ Full Moon................	2 40	43210	84.45
	18		Uranus 1° S. of moon..........			
Fri. 15					4201*	96.60
Sat. 16	21		Moon at perigee, 225,800 mi....	23 30	1023*	108.74
Sun. 17	12		Uranus at opposition..........		02143	120.90
Mon. 18			Mercury at aphelion..........		21034	133.05
	22		Neptune 5° N. of moon........			
Tue. 19				20 20	31024	145.21
Wed. 20	8	22	Equinox. Spring begins........		30124	157.38
Thu. 21	6	08	☾ Last Quarter...............		32104	169.55
Fri. 22				17 10	23014	181.74
Sat. 23					10234	193.93 [b]
Sun. 24					02413	206.12 [l]
Mon. 25				14 00	24103	218.33 [l]
Tue. 26			Venus at aphelion.............		4301*	230.53
	14		Mercury 1° N. of moon........			
	17		Venus 2° N. of moon..........			
Wed. 27					4302*	242.75
Thu. 28	17	49	● New Moon; eclipse of ☉, p. 64	10 50	43210	254.96
Fri. 29					42301	267.18
Sat. 30	18		Mars 1° S. of moon...........		41023	279.40
Sun. 31	6		Mercury 1.1° S. of Venus......	7 40	40213	291.62

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Mar. 11, −6.42°; Mar. 24, 25, +5.78°. [b]Mar. 10, −6.78°; Mar. 23, +6.77°.

THE SKY FOR APRIL 1968

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 42m to 2h 33m and its Decl. changes from 4° 29′ N. to 15° 02′ N. The equation of time changes from −3m 48s to +2m 52s, being zero on the 14th. 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. There is a total eclipse of the moon, visible in North America, on the night of the 12th–13th.

Mercury on the 1st is in R.A. 23h 27m, Decl. 6° 10′ S. and on the 15th is in R.A. 0h 56m, Decl. 4° 05′ N. Superior conjunction is on the 24th and Mercury is thus too close to the sun for observation at any time of this month.

Venus on the 1st is in R.A. 23h 26m, Decl. 5° 10′ S. and on the 15th is in R.A. 0h 30m, Decl. 1° 35′ N., mag. −3.3, and transits at 10h 57m. Rapidly approaching the sun, it can still be seen low in the east for less than an hour before sunrise.

Mars on the 15th is in R.A. 2h 43m, Decl. 15° 54′ N., mag. +1.6, and transits at 13h 09m. In Aries, it is visible very low in the west in the evening, setting about an hour after sunset.

Jupiter on the 15th is in R.A. 9h 54m, Decl. 14° 01′ N., mag. −1.9, and transits at 20h 17m. In Leo, it is approaching the meridian at sunset and sets about two hours before dawn. On the 22nd it is stationary in right ascension and resumes direct (i.e. 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. 1h 05m, Decl. 4° 28′ N., and transits at 11h 29m. It is too close to the sun for observation, conjunction being on the 4th.

Uranus on the 15th is in R.A. 11h 47m, Decl. 2° 18′ N. and transits at 22h 09m.

Neptune on the 15th is in R.A. 15h 36m, Decl. 17° 32′ S. and transits at 2h 02m.

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

d	h	m	APRIL E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 23h 00m	Sun's Selen. Colong. 0h U.T. °
Mon. 1	18		Moon at apogee, 252,000 mi.....		24103	303.84
Tue. 2					d201*	316.05
Wed. 3				4 30	31024	328.26
Thu. 4			Mars at ascending node........		32104	340.46
	21		Saturn in conjunction with sun..			
Fri. 5	22	28	☽ First Quarter..............		23014	352.67
Sat. 6				1 20	10234	4.86 [b]
Sun. 7					02134	17.05
Mon. 8			Mercury greatest hel. lat. S.....	22 10	21034	29.23 [l]
	22		Jupiter 3° S. of moon..........			
Tue. 9					20314	41.41
Wed. 10					d3102	53.58
Thu. 11	3		Uranus 1° S. of moon..........	18 50	d3420	65.75
Fri. 12	23	52	☺ Full Moon. Eclipse of ☾, p. 64		4230*	77.92
Sat. 13					41032	90.08
Sun. 14	2		Moon at perigee, 223,000 mi....	15 40	40123	102.24
Mon. 15	6		Neptune 5° N. of moon........		42103	114.41
Tue. 16			Antares occulted by moon, p. 67		42031	126.58
Wed. 17			Venus greatest hel. lat. S.......	12 30	43102	138.75
Thu. 18					34021	150.94
Fri. 19	5		Ceres at opposition...........		3204*	163.12 [b]
	14	35	☾ Last Quarter..............			
Sat. 20				9 20	1024*	175.32
Sun. 21			Lyrid meteors................		01234	187.52 [l]
	6		Pallas stationary.............			
Mon. 22	1		Jupiter stationary............		21034	199.73
Tue. 23	7		Venus 0.8° N. of Saturn........	6 10	20314	211.95
Wed. 24	18		Mercury in superior conjunction.		31024	224.17
Thu. 25	10		Juno at opposition...........		30124	236.40
	21		Saturn 2° S. of moon..........			
Fri. 26	4		Venus 2° S. of moon...........	3 00	32104	248.63
Sat. 27			Mercury at ascending node.....		410**	260.86
	10	22	● New Moon................			
Sun. 28	20		Mars 3° S. of moon...........	23 50	40123	273.10
Mon. 29	4		Moon at apogee, 252,500 mi....		41203	285.33
Tue. 30					42013	297.56

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Apr. 8, −7.32°; Apr. 21, +7.04°. [b]Apr. 6, −6.83°; Apr. 19, +6.80°.

THE SKY FOR MAY 1968

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 33m to 4h 36m and its Decl. changes from 15° 02′ N. to 22° 02′ N. The equation of time changes from +2m 59s to a maximum of +3m 44s on the 14th and then to +2m 22s 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 00m, Decl. 17° 47′ N. and on the 15th is in R.A. 4h 50m, Decl. 24° 49′ N. On the 23rd Mercury is at greatest eastern elongation, at which time it stands about 19 degrees above the western horizon at sunset. The planet should be seen with ease low in the western sky after sunset from about the 15th till the end of the month.

Venus on the 1st is in R.A. 1h 43m, Decl. 9° 12′ N. and on the 15th is in R.A. 2h 49m, Decl. 15° 10′ N., mag. −3.4, and transits at 11h 18m. Though approaching conjunction, it is still to be seen as a morning star very low in the east just before sunrise.

Mars on the 15th is in R.A. 4h 10m, Decl. 21° 28′ N., and transits at 12h 38m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 9h 57m, Decl. 13° 42′ N., mag. −1.7, and transits at 18h 22m. In Leo near Regulus, it is past the meridian at sunset and sets shortly after midnight. 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. 1h 18m, Decl. 5° 47′ N., mag. +0.9, and transits at 9h 45m. In Pisces, it is a morning star rising an hour or so before the sun.

Uranus on the 15th is in R.A. 11h 44m, Decl. 2° 37′ N. and transits at 20h 08m.

Neptune on the 15th is in R.A. 15h 33m, Decl. 17° 20′ S., mag. +7.7, and transits at 23h 57m. Opposition is on the 15th, at which time its distance from the earth is 2723,000,000 mi.

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

d	h	m	MAY E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 22h 30m	Sun's Selen. Colong. 0h U.T. °
Wed. 1			Mercury at perihelion.........	20 40	43102	309.79
Thu. 2					43021	322.02
Fri. 3					43210	334.25
Sat. 4			η Aquarid meteors............	17 30	d4320	344.46[b]
Sun. 5	12	55	☽ First Quarter..............		023**	358.68
Mon. 6	1		Mercury 1.2° N. of Mars.......		21043	10.89
	7		Jupiter 3° S. of moon..........			
Tue. 7				14 20	20134	23.09[l]
Wed. 8	11		Uranus 1° S. of moon..........		13024	35.28
Thu. 9					30124	47.47
Fri. 10				11 10	32104	59.66
Sat. 11					23014	71.84
Sun. 12			Mercury greatest hel. lat. N....		0324*	84.01
	8	05	◯ Full Moon.................			
	12		Moon at perigee, 221,800 mi.....			
	15		Neptune 5° N. of moon........			
Mon. 13				7 50	d1043	96.19
Tue. 14					24013	108.37
Wed. 15	19		Neptune at opposition.........		41302	120.55
Thu. 16				4 40	43012	132.74[b]
Fri. 17			Jupiter in quadrature east......		43210	144.93
Sat. 18					43201	157.13
Sun. 19	0	45	☾ Last Quarter..............	1 30	41032	169.34[l]
Mon. 20					d4023	181.55
Tue. 21				22 20	24013	193.77
Wed. 22					1034*	206.00
Thu. 23	10		Saturn 3° S. of moon..........		30124	218.23
	20		Mercury greatest elong. E., 23°.			
Fri. 24				19 10	32104	230.47
Sat. 25					32014	242.71
Sun. 26	7		Moon at apogee, 252,600 mi.....		10324	254.95
Mon. 27	2	30	● New Moon................	16 00	01234	267.19
Tue. 28					2034*	279.44
Wed. 29	2		Mercury 4° S. of moon........		1034*	291.69
Thu. 30				12 50	30412	303.93
Fri. 31					34120	316.17[b]

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]May 7, −7.67°; May 19, +7.72°.
[b]May 4, −6.77°; May 16, +6.68°; May 31, −6.65°.

THE SKY FOR JUNE 1968

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 36m to 6h 40m and its Decl. changes from 22° 02′ N. to 23° 08′ N. The equation of time changes from +2m 13s to −3m 37s, being zero on the 13th. The summer solstice is on the 21st at 3h 13m 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. 6h 04m, Decl. 24° 15′ N. and on the 15th is in R.A. 5h 58m, Decl. 20° 33′ N. For the first few days of the month Mercury will be visible as an evening star (see May), but then it rapidly approaches inferior conjunction, which occurs on the 18th.

Venus on the 1st is in R.A. 4h 14m, Decl. 20° 44′ N. and on the 15th is in R.A. 5h 27m, Decl. 23° 20′ N., mag. −3.5, and transits at 11h 55m. Early in the month it is still to be seen very low in the north-east just before sunrise, but by the 20th it is in superior conjunction and is too close to the sun for easy observation during the rest of the month.

Mars on the 15th is in R.A. 5h 42m, Decl. 24° 04′ N., and transits at 12h 08m. It is too close to the sun for observation; conjunction is on the 21st.

Jupiter on the 15th is in R.A. 10h 10m, Decl. 12° 30′ N., mag. −1.5, and transits at 16h 33m. In Leo very near Regulus (0.7° north of it on the night of the 8th–9th) it is well down in the west at sunset and sets about three 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. 1h 30m, Decl. 6° 50′ N., mag. +0.8, and transits at 7h 54m. In Pisces, it is a morning star rising in the east about three hours before the sun.

Uranus on the 15th is in R.A. 11h 43m, Decl. 2° 37′ N. and transits at 18h 06m.

Neptune on the 15th is in R.A. 15h 30m, Decl. 17° 09′ S. and transits at 21h 52m.

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

d	h	m	JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 40m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1					43201	328.41
Sun. 2	4		Uranus stationary.............	9 40	41032	340.64
	18		Jupiter 3° S. of moon..........			
Mon. 3	23	47	☽ First Quarter..............		40123	352.87
Tue. 4			Mercury at descending node....		42103	5.09 [l]
	19		Uranus 1° S. of moon..........			
Wed. 5	23		Mercury stationary...........	6 30	42103	17.30
Thu. 6	8		Pluto stationary..............		43012	29.51
Fri. 7					31420	41.71
Sat. 8				3 10	32041	53.91
Sun. 9			Antares occulted by moon, p. 67		1024*	66.10
	1		Neptune 5° N. of moon........			
	22		Moon at perigee, 222,400 mi....			
Mon. 10	15	14	○ Full Moon..................	0 00	01234	78.29
Tue. 11	21		Ceres stationary..............		21034	90.47
Wed. 12					d2034	102.66
Thu. 13			Venus at ascending node.......	20 50	30124	114.85 [b]
Fri. 14			Mercury at aphelion..........		d3104	127.04
Sat. 15			Icarus closest to earth, p. 69....		32014	139.24
Sun. 16			Uranus in quadrature E........	17 40	d1302	151.45 [l]
Mon. 17	13	14	☾ Last Quarter...............		40123	163.66
Tue. 18	11		Mercury in inferior conjunction.		42103	175.88
Wed. 19	21		Saturn 3° S. of moon..........	14 30	42013	188.10
Thu. 20	5		Venus in superior conjunction...		4302*	200.33
Fri. 21	3	13	Solstice. Summer begins.......		43102	212.57
	11		Mars in conjunction with sun...			
Sat. 22	14		Moon at apogee, 252,300 mi....	11 20	43201	224.81
Sun. 23	20		Juno stationary...............		4310*	237.05
Mon. 24					40123	249.30
Tue. 25	17	25	● New Moon................	8 10	21043	261.55
Wed. 26					20134	273.80
Thu. 27					d1024	286.06 [b]
Fri. 28				5 00	d3024	298.31
Sat. 29					32014	310.55
Sun. 30	2		Mercury stationary...........		3104*	322.80
	7		Jupiter 3° S. of moon..........			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]June 4, −7.31°; June 16, +7.65°. [b]June 13, +6.53°; June 27, −6.56°.

THE SKY FOR JULY 1968

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 40m to 8h 45m and its Decl. changes from 23° 08′ N. to 18° 04′ N. The equation of time changes from −3m 48s to −6m 17s. On the 2nd the earth is in aphelion, or farthest from the sun, at a distance of 94,455,000 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. 5h 32m, Decl. 18° 49′ N. and on the 15th is in R.A. 6h 09m, Decl. 21° 23′ N. On July 11 Mercury is at greatest western elongation, at which time it stands about 15° above the eastern horizon at sunrise. The planet may be seen just before sunrise for about a week before and after elongation.

Venus on the 1st is in R.A. 6h 53m, Decl. 23° 36′ N. and on the 15th is in R.A. 8h 07m, Decl. 21° 24′ N., mag. −3.4, and transits at 12h 36m. During this month it will begin to be seen as an evening star visible very low in the north-west just after sunset.

Mars on the 15th is in R.A. 7h 09m, Decl. 23° 24′ N. and transits at 11h 37m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 10h 28m, Decl. 10° 41′ N., mag. −1.3, and transits at 14h 54m. In Leo, it is low in the west at sunset and sets after about an hour. 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. 1h 37m, Decl. 7° 24′ N., mag. +0.7, and transits at 6h 03m. In Pisces, it is a morning star rising just before midnight and about on the meridian at dawn.

Uranus on the 15th is in R.A. 11h 46m, Decl. 2° 19′ N. and transits at 16h 11m.

Neptune on the 15th is in R.A. 15h 28m, Decl. 17° 03′ S. and transits at 19h 52m.

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

JULY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 21h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1				1 40	O1324	335.04
Tue. 2			Earth at aphelion..............		12O43	347.27 [l]
	2		Uranus 1° S. of moon..........			
Wed. 3	7	42	☽ First Quarter..............	22 30	24O13	359.50
Thu. 4					41O32	11.72
Fri. 5			Mercury greatest hel. lat. S.....		43O12	23.93
Sat. 6	9		Neptune 5° N. of moon........	19 20	432O*	36.14
Sun. 7					4312O	48.34
Mon. 8	4		Moon at perigee, 224,600 mi....		4O312	60.53
Tue. 9	22	18	Full Moon..................	16 10	412O3	72.73
Wed. 10						84.91 [b]
Thu. 11	7		Mercury greatest elong. W., 21°.			97.10
Fri. 12				13 00		109.30
Sat. 13						121.49
Sun. 14						133.69 [l]
Mon. 15				9 50		145.89
Tue. 16			Venus at perihelion............			158.10
Wed. 17			Saturn in quadrature W........			170.32
	4	12	☾ Last Quarter..............			
	8		Saturn 4° S. of moon..........			
Thu. 18				6 40		182.54
Fri. 19						194.77
Sat. 20	4		Moon at apogee, 251,700 mi.....			207.00
Sun. 21				3 30		219.24
Mon. 22						231.48
Tue. 23	22		Mercury 5° S. of moon........	0 10		243.73
Wed. 24			Mercury at ascending node.....			255.97 [b]
Thu. 25	6	50	New Moon................			268.22
Fri. 26				21 00		280.48
Sat. 27	22		Jupiter 2° S. of moon..........			292.73
Sun. 28			Mercury at perihelion.........			304.97 [l]
	12		Mercury 0.2° S. of Mars.......			
Mon. 29			δ Aquarid meteors............	17 50		317.22 [l]
	10		Uranus 0.7° S. of moon........			
Tue. 30						329.46
Wed. 31						341.69

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]July 2, −6.24°; July 14, +6.96°; July 28, 29, −4.99°.

[b]July 10, +6.51°; July 24, −6.59°.

Jupiter being near the sun, configurations of the satellites are not given between July 10 and October 8.

THE SKY FOR AUGUST 1968

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 45m to 10h 41m and its Decl. changes from 18° 04′ N. to 8° 21′ N. The equation of time changes from −6m 13s to −0m 10s. 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. 8h 16m, Decl. 21° 04′ N. and on the 15th is in R.A. 10h 10m, Decl. 13° 01′ N. Superior conjunction is on the 7th and Mercury is too close to the sun all month for observation.

Venus on the 1st is in R.A. 9h 33m, Decl. 16° 05′ N. and on the 15th is in R.A. 10h 39m, Decl. 10° 06′ N., mag. −3.3, and transits at 13h 06m. It is to be seen very low in the west for about half an hour after sunset.

Mars on the 15th is in R.A. 8h 35m, Decl. 19° 49′ N. and transits at 11h 00m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 10h 51m, Decl. 8° 22′ N., mag. −1.2, and transits at 13h 15m. It is near to setting at sunset and so not easily observed.

Saturn on the 15th is in R.A. 1h 38m, Decl. 7° 25′ N., mag. +0.6, and transits at 4h 03m. In Pisces, it rises in the late evening and is well past the meridian at dawn. On the 7th it is stationary in right ascension and begins to retrograde (move westward) among the stars.

Uranus on the 15th is in R.A. 11h 51m, Decl. 1° 44′ N. and transits at 14h 14m.

Neptune on the 15th is in R.A. 15h 27m, Decl. 17° 03′ S. and transits at 17h 50m.

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

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Aug. 11, +6.02°; Aug. 24, −4.64°. [b]Aug. 6, +6.58°; Aug. 20, −6.71°.

Jupiter being near the sun, configurations of the satellites are not given between July 10 and October 8.

			AUGUST E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1	13	35	☽ First Quarter..............	14 40		353.92
Fri. 2	16		Neptune 5° N. of moon........			6.13
Sat. 3						18.35
Sun. 4	22		Moon at perigee, 227,600 mi....	11 30		30.55
Mon. 5	8		Neptune stationary...........			42.75
Tue. 6						54.94 [b]
Wed. 7			Venus greatest hel. lat. N.......	8 20		67.13
	6		Mercury in superior conjunction.			
	22		Saturn stationary.............			
Thu. 8			Mercury greatest hel. lat. N.....			79.32
	6	33	Full Moon.................			
Fri. 9						91.50
Sat. 10				5 10		103.69
Sun. 11			Perseid meteors...............			115.88 [l]
Mon. 12						128.07
Tue. 13	17		Saturn 4° S. of moon..........	1 50		140.26
Wed. 14						152.46
Thu. 15	21	14	☾ Last Quarter...............	22 40		164.67
Fri. 16			Neptune in quadrature E.......			176.88
	22		Moon at apogee, 251,200 mi.....			
Sat. 17						189.10
Sun. 18	2		Venus 0.5° N. of Jupiter.......	19 30		201.32
Mon. 19						213.55
Tue. 20						225.78 [b]
Wed. 21	16		Mercury 0.1° N. of Jupiter.....	16 20		238.02
Thu. 22	4		Mars 4° S. of moon...........			250.26
Fri. 23	18	57	New Moon...............			262.50
Sat. 24				13 10		274.74 [l]
Sun. 25	1		Mercury 1° S. of moon........			286.99
	5		Venus 0.5° S. of moon.........			
	19		Uranus 0.4° S. of moon........			
Mon. 26						299.23
Tue. 27			Spica occulted by moon, p. 65..	10 00		311.46
Wed. 28						323.70
Thu. 29	22		Neptune 6° N. of moon........			335.92
Fri. 30	18	35	☽ First Quarter..............	6 50		348.14
	21		Moon at perigee, 229,800 mi....			
Sat. 31			Mercury at descending node....			0.35
	12		Venus 0.5° N. of Uranus.......			
	14		Mercury 0.8° S. of Uranus......			
	23		Mercury 1.4° S. of Venus.......			

THE SKY FOR SEPTEMBER 1968

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 41m to 12h 29m and its Decl. changes from 8° 21′ N. to 3° 07′ S. The equation of time changes from +0m 09s to +10m 08s. On the 22nd at 18h 26m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra and autumn commences. For changes in the length of the day, see p. 17. There is a total eclipse of the sun, not visible in North America, on the 22nd.

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 56m, Decl. 0° 22′ N. and on the 15th is in R.A. 13h 03m, Decl. 8° 53′ S. Greatest eastern elongation is on the 20th, but this elongation is very unfavourable, Mercury being only about 3 degrees above the western horizon at sunset.

Venus on the 1st is in R.A. 11h 56m, Decl. 1° 42′ N. and on the 15th is in R.A. 12h 59m, Decl. 5° 29′ S., mag. −3.3, and transits at 13h 23m. It is visible low down in the west for about an hour after sunset.

Mars on the 15th is in R.A. 9h 54m, Decl. 14° 05′ N. and transits at 10h 17m. It is a morning star in Leo, rising in the east about two hours before sunrise; it is close to Regulus on the 20th.

Jupiter on the 15th is in R.A. 11h 16m, Decl. 5° 48′ N., and transits at 11h 38m. It is too close to the sun for observation, conjunction being on the 8th.

Saturn on the 15th is in R.A. 1h 34m, Decl. 6° 53′ N., mag. +0.4, and transits at 1h 57m. In Pisces it rises soon after sunset and is visible during the rest of the night.

Uranus on the 15th is in R.A. 11h 58m, Decl. 0° 59′ N. and transits at 12h 19m.

Neptune on the 15th is in R.A. 15h 29m, Decl. 17° 11′ S. and transits at 15h 50m.

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

			SEPTEMBER E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1						12.56
Mon. 2				3 30		24.75 [b]
Tue. 3						36.94
Wed. 4	7		Vesta stationary..............			49.13
Thu. 5				0 20		61.31
Fri. 6	17	08	Full Moon................			73.48
Sat. 7				21 10		85.66 [l]
Sun. 8	19		Jupiter in conjunction with sun..			97.84
Mon. 9						110.01
Tue. 10			Mercury at aphelion...........	18 00		122.19
	0		Saturn 5° S. of moon..........			
Wed. 11						134.37
Thu. 12						146.56
Fri. 13	17		Moon at apogee, 251,300 mi.....	14 50		158.75
Sat. 14	15	32	Last Quarter...............			170.95
Sun. 15	6		Pluto in conjunction with sun...			183.15
Mon. 16				11 40		195.35 [b]
Tue. 17						207.57
Wed. 18						219.78
Thu. 19	23		Mars 2° S. of moon...........	8 30		232.00
Fri. 20	11		Mercury greatest elong. E., 26°..			244.23 [l]
	22		Mercury 4° S. of Venus........			
Sat. 21						256.46
Sun. 22	6	09	New Moon. Eclipse of ☉, p. 64	5 10		268.69
	9		Uranus in conjunction with sun..			
	18	26	Equinox. Autumn begins.......			
Mon. 23						280.91
Tue. 24	4		Mercury 2° S. of moon........			293.14
	6		Venus 2° N. of moon..........			
Wed. 25	15		Moon at perigee, 227,800 mi.....	2 00		305.37
Thu. 26	5		Neptune 6° N. of moon........			317.59
Fri. 27				22 50		329.80
Sat. 28						342.01
Sun. 29	0	07	First Quarter..............			354.21 [b]
Mon. 30				19 40		6.40

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]Sept. 7, +5.36°; Sept. 20, −5.31°.

[b]Sept. 2, +6.70°; Sept. 16, −6.82°; Sept. 29, +6.74°.

Jupiter being near the sun, configurations of the satellites are not given between July 10 and October 8.

THE SKY FOR OCTOBER 1968

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 29m to 14h 25m and its Decl. changes from 3° 07′ S. to 14° 23′ S. The equation of time changes from +10m 27s to +16m 22s. 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. There is a total eclipse of the moon, visible in North America, on the night of the 5th–6th.

Mercury on the 1st is in R.A. 13h 50m, Decl. 15° 09′ S. and on the 15th is in R.A. 13h 23m, Decl. 10° 36′ S. Inferior conjunction is on the 15th, but by the 31st Mercury is at greatest western elongation, at which time it stands about 16 degrees above the eastern horizon at sunrise. For the last week of the month it should be possible to see Mercury as a morning star.

Venus on the 1st is in R.A. 14h 12m, Decl. 13° 14′ S. and on the 15th is in R.A. 15h 19m, Decl. 18° 59′ S., mag. −3.4, and transits at 13h 46m. It is about ten degrees above the south-western horizon at sunset and sets within about an hour.

Mars on the 15th is in R.A. 11h 05m, Decl. 7° 19′ N., mag. +2.0, and transits at 9h 30m. It is a morning star in Leo, rising in the east about three hours before sunrise.

Jupiter on the 15th is in R.A. 11h 40m, Decl. 3° 20′ N., mag. −1.3, and transits at 10h 03m. In Leo, and Virgo, it is a morning star rising in the east about two hours before the sun. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57. It is occulted by the moon on the 19th, see p. 66.

Saturn on the 15th is in R.A. 1h 26m, Decl. 6° 02′ N., mag. +0.3, and transits at 23h 47m. In Pisces, it is risen by sunset and is visible during the rest of the night. Opposition is on the 15th when its distance from the earth is 774,600,000 mi.

Uranus on the 15th is in R.A. 12h 05m, Decl. 0° 15′ N. and transits at 10h 28m.

Neptune on the 15th is in R.A. 15h 32m, Decl. 17° 24′ S. and transits at 13h 55m.

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

OCTOBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 5h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1			Mercury greatest hel. lat. S.....			18.59
Wed. 2			Venus at descending node......			30.76
Thu. 3	8		Mercury stationary...........	16 30		42.94
Fri. 4						55.10 [l]
Sat. 5						67.27
Sun. 6			Mars greatest hel. lat. N.......	13 20		79.43
	6	47	◯ Full Moon. Harvest Moon.... Eclipse of ☾, p. 64..........			
Mon. 7	4		Saturn 4° S. of moon..........			91.59
Tue. 8						103.75
Wed. 9				10 10	30124	115.91
Thu. 10					10234	128.08
Fri. 11	12		Moon at apogee, 251,700 mi.....		20134	140.25
Sat. 12				6 50	0243*	152.42
Sun. 13					41032	164.59
Mon. 14	10	06	☾ Last Quarter...............		43201	176.77 [b]
Tue. 15	4		Saturn at opposition...........	3 40	43210	188.96
	11		Mercury at inferior conjunction.			
Wed. 16					43012	201.15
Thu. 17	12		Venus 2° S. of Neptune........		4102*	213.35
Fri. 18	18		Mars 0.8° S. of moon..........	0 30	42013	225.55 [l]
Sat. 19	8		Jupiter 0.3° S. of moon; occ., p. 66		4103*	237.76
	19		Uranus 0.1° S. of moon........			
Sun. 20			Mercury at ascending node.....	21 20	41032	249.97
			Orionid meteors...............			
	12		Vesta at opposition...........			
Mon. 21	16	45	● New Moon................		3201*	262.18
Tue. 22					32104	274.40
Wed. 23	10		Moon at perigee, 224,500 mi....	18 10	30124	286.61
	14		Neptune 6° N. of moon........			
	21		Mercury stationary...........			
Thu. 24			Mercury at perihelion.........		13024	298.82
	3		Venus 3° N. of moon..........			
Fri. 25					20134	311.03
Sat. 26				15 00	12034	323.23
Sun. 27					01234	335.42 [b]
Mon. 28	7	40	☽ First Quarter...............		3204*	347.61
Tue. 29				11 50	32104	359.79
Wed. 30					34021	11.96 [l]
Thu. 31	3		Mercury greatest elong. W., 19°.		41302	24.13

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.

[l]Oct. 4, +5.57°; Oct. 18, −6.40°; Oct. 30, +6.73°.

[b]Oct. 14, −6.83°; Oct. 27, +6.72°.

THE SKY FOR NOVEMBER 1968

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 25m to 16h 29m and its Decl. changes from 14° 23′ S. to 21° 47′ S. The equation of time changes from +16m 23s to +11m 09s. 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. 13h 18m, Decl. 5° 52′ S. and on the 15th is in R.A. 14h 33m, Decl. 13° 31′ S. For the first week of the month Mercury can be seen low in the south-east just before sunrise; it is 5° N. of Spica on the 2nd.

Venus on the 1st is in R.A. 16h 46m, Decl. 23° 47′ S. and on the 15th is in R.A. 18h 00m, Decl. 25° 23′ S., mag. −3.5, and transits at 14h 25m. It is about fifteen degrees above the south-western horizon at sunset and sets within two hours.

Mars on the 15th is in R.A. 12h 15m, Decl. 0° 07′ S., mag. +1.8, and transits at 8h 37m. Moving from Leo into Virgo, it is a morning star rising in the east about four hours before sunrise.

Jupiter on the 15th is in R.A. 12h 01m, Decl. 1° 06′ N., mag. −1.4, and transits at 8h 23m. In Virgo, it is a morning star rising about four 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. 1h 17m, Decl. 5° 14′ N., mag. +0.5, and transits at 21h 36m. In Pisces, it is well up in the east at sunset and is visible during most of the night.

Uranus on the 15th is in R.A. 12h 11m, Decl. 0° 25′ S. and transits at 8h 32m.

Neptune on the 15th is in R.A. 15h 37m, Decl. 17° 41′ S. and transits at 11h 58m.

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

NOVEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 4h 35m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1				8 40	42013	36.28
Sat. 2					41203	48.44
Sun. 3			Mercury greatest hel. lat. N....		40123	60.59
	7		Saturn 4° S. of moon..........			
Mon. 4	23	25	Full Moon. Hunter's Moon..	5 30	dd40*	72.74
Tue. 5			Taurid meteors...............		43210	84.88
			Venus at aphelion............			
Wed. 6	3		Mars 0.3° N. of Jupiter........		34021	97.03
Thu. 7				2 10	31042	109.17
Fri. 8	4		Moon at apogee, 252,300 mi.....		20134	121.32
Sat. 9				23 00	12034	133.47
Sun. 10	7		Pallas in conjunction with sun..		01234	145.62 [b]
Mon. 11					10324	157.78
Tue. 12			Mars at aphelion..............	19 50	d2304	169.94
	20		Mars 0.7° N. of Uranus........			
Wed. 13	3	54	Last Quarter...............		30214	182.11
Thu. 14					31024	194.28
Fri. 15				16 40	20431	206.46 [l]
Sat. 16			Leonid meteors...............		42103	218.64
	4		Jupiter 0.4° N. of moon........			
	8		Uranus 0.2° N. of moon........			
	12		Mars 1° N. of moon...........			
Sun. 17					40123	230.83
Mon. 18	8		Neptune in conjunction with sun	13 30	41023	243.02
Tue. 19					42301	255.22
Wed. 20	3	02	New Moon................		430**	267.42
	19		Moon at perigee, 222,100 mi....			
Thu. 21				10 20	43102	279.62
Fri. 22	21		Venus 3° N. of moon..........		4201*	291.82
Sat. 23					24103	304.01 [b]
Sun. 24				7 10	04123	316.20
Mon. 25					10234	328.39
Tue. 26	18	31	First Quarter..............		23014	340.56
Wed. 27			Mercury at descending node....	4 00	31204	352.73 [l]
			Venus greatest hel. lat. S.......			
Thu. 28	3		Juno in conjunction with sun...		d3024	4.89
Fri. 29					32014	17.05
Sat. 30	9		Saturn 4° S. of moon..........	0 50	21034	29.20

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Nov. 15, −7.32°; Nov. 27, +7.76°. [b]Nov. 10, −6.73°; Nov. 23, +6.60°.

THE SKY FOR DECEMBER 1968

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 29m to 18h 45m and its Decl. changes from 21° 47′ S. to 23° 02′ S. The equation of time changes from +10m 47s to −3m 15s, being zero on the 24th. The winter solstice occurs on the 21st, at 14h 00m 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. 16h 14m, Decl. 21° 37′ S. and on the 15th is in R.A. 17h 49m, Decl. 25° 07′ S. On the 6th Mercury is in superior conjunction and is too close to the sun all month for observation.

Venus on the 1st is in R.A. 19h 25m, Decl. 24° 16′ S. and on the 15th is in R.A. 20h 36m, Decl. 20° 55′ S., mag. −3.7, and transits at 15 h 02m. It is about twenty degrees above the south-western horizon at sunset and sets about three hours later.

Mars on the 15th is in R.A. 13h 21m, Decl. 7° 02′ S., mag. +1.6, and transits at 7h 45m. In Virgo, it is a morning star rising in the east about two hours after midnight; it is 4° N. of Spica on the 15th.

Jupiter on the 15th is in R.A. 12h 17m, Decl. 0° 28′ S., mag. −1.5, and transits at 6h 40m. In Virgo, it rises an hour after midnight and is near the meridian at dawn. 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. 1h 13m, Decl. 4° 55′ N., mag. +0.7, and transits at 19h 34m. In Pisces, it is well up in the east at sunset, and is visible until well past midnight. Direct (eastward) motion resumes on the 22nd.

Uranus on the 15th is in R.A. 12h 15m, Decl. 0° 49′ S. and transits at 6h 38m.

Neptune on the 15th is in R.A. 15h 41m, Decl. 17° 56′ S. and transits at 10h 04m.

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

DECEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 4h 10m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1					02143	41.34
Mon. 2				21 40	10423	53.49
Tue. 3					42301	65.62
Wed. 4	18	08	Full Moon.................		43120	77.76
Thu. 5	10		Moon at apogee, 252,600 mi....	18 20	43012	89.89
Fri. 6	22		Mercury in superior conjunction.		43021	102.02
Sat. 7			Mercury at aphelion...........		42103	114.16 [b]
Sun. 8				15 10	40213	126.29
Mon. 9	3		Jupiter 0.5° N. of Uranus......		41023	138.43
Tue. 10	4		Vesta stationary..............		24301	150.57
Wed. 11				12 00	31204	162.72
Thu. 12	17		Ceres in conjunction with sun...		30124	174.87
	19	50	☾ Last Quarter...............			
Fri. 13			Geminid meteors..............		3024*	187.03
	19		Uranus 0.6° N. of moon........			
	20		Jupiter 1° N. of moon.........			
Sat. 14				8 50	21034	199.19 [l]
Sun. 15	4		Mars 3° N. of moon...........		0134*	211.36
			Spica occulted by moon, p. 66...			
Mon. 16					10234	223.54
Tue. 17	15		Neptune 6° N. of moon........	5 40	d2014	235.72
Wed. 18					32104	247.91
Thu. 19	7		Moon at perigee, 221,600 mi....		34012	260.10
	13	19	New Moon................			
Fri. 20				2 30	43102	272.29 [b]
Sat. 21	14	00	Solstice. Winter begins.........		d4203	284.48
Sun. 22			Ursid meteors................	23 20	4013*	296.67
	8		Saturn stationary.............			
	16		Venus 2° N. of moon..........			
Mon. 23					41023	308.85
Tue. 24					42031	321.03
Wed. 25			Uranus in quadrature W.......	20 10	43210	333.20 [l]
Thu. 26			Jupiter in quadrature W.......		34012	345.37
	9	15	☽ First Quarter..............			
Fri. 27	15		Saturn 4° S. of moon..........		31402	357.53
Sat. 28			Mercury greatest hel. lat. S.....	17 00	20134	9.69
Sun. 29					20134	21.83
Mon. 30					10234	33.98
Tue. 31				13 50	20314	46.11

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Dec. 14, −7.59°; Dec. 25, +7.90°. [b]Dec. 7, −6.60°; Dec. 20, +6.48°.

JANUARY

d	h	m	Sat.	Phen.
1	0	20	III	TI
	3	50	III	Te
	5	04	I	ED
	22	17	IV	Se
2	2	26	I	SI
	3	14	IV	TI
	3	26	I	TI
	4	43	I	Se
	5	42	I	Te
	23	33	I	ED
3	2	51	I	OR
	21	53	I	TI
	23	11	I	Se
4	0	09	I	Te
5	5	50	II	ED
6	23	59	II	SI
7	1	53	II	TI
	2	50	II	Se
	4	42	II	Te
8	0	06	III	SI
	3	42	III	Se
	3	53	III	TI
	23	46	II	OR
9	4	19	I	SI
	5	13	I	TI
	6	36	I	Se
10	1	26	I	ED
	2	27	II	ED
	4	38	I	OR
	22	47	I	SI
	23	40	I	TI
11	1	04	I	Se
	1	56	I	Te
	23	04	I	OR
14	2	34	II	SI
	4	14	II	TI
	5	25	II	Se
15	4	04	III	SI
	21	41	II	ED
16	2	05	II	OR
	6	12	I	SI
17	3	20	I	ED
	6	24	I	OR
18	0	41	I	SI
	1	26	I	TI
	2	58	I	Se
	3	42	I	Te
	21	48	I	ED
	22	51	IV	Te
19	0	32	III	OR
	0	50	I	OR
	21	26	I	Se
	22	08	I	Te
21	5	09	II	SI
23	0	16	II	ED
	4	23	II	OR
24	5	13	I	ED
	21	17	II	Se
	22	31	II	Te
25	2	34	I	SI
	3	11	I	TI
	4	51	I	Se
	5	27	I	Te
	21	57	III	ED
	23	42	I	ED
26	2	35	I	OR
	3	54	III	OR
	20	28	IV	ED
	21	03	I	SI
	21	37	I	TI
	23	20	I	Se
	23	53	I	Te
27	1	09	IV	ER
	2	08	IV	OD
	6	25	IV	OR
	21	01	I	OR
30	2	50	II	ED
31	21	01	II	SI
	21	59	II	TI
	23	53	II	Se

FEBRUARY

d	h	m	Sat.	Phen.
1	0	48	II	Te
	4	28	I	SI
	4	55	I	TI
2	1	36	I	ED
	1	55	III	ED
	4	20	I	OR
	19	46	II	OR
	22	56	I	SI
	23	21	I	TI
3	1	13	I	Se
	1	38	I	Te
	20	04	I	ED
	22	46	I	OR
4	5	32	IV	SI
	19	42	I	Se
	20	03	I	Te
5	19	34	III	Se
	20	56	III	Te
6	5	24	II	ED
7	23	37	II	SI
8	0	14	II	TI
	2	29	II	Se
	3	04	II	Te
9	3	30	I	ED
	5	54	III	ED
	6	04	I	OR
	22	00	II	OR
10	0	50	I	SI
	1	05	I	TI
	3	07	I	Se
	3	21	I	Te
	21	58	I	ED
11	0	30	I	OR
	19	18	I	SI
	19	31	I	TI
	21	35	I	Se
	21	47	I	Te
12	19	56	III	SI
	20	42	III	TI
	20	43	IV	OR
	23	31	III	Se
13	0	12	III	Te
15	2	13	II	SI
	2	29	II	TI
	5	05	II	Se
	5	19	II	Te
16	5	24	I	ED
	21	15	II	ED
17	0	14	II	OR
	2	43	I	SI
	2	48	I	TI
	5	01	I	Se
	5	05	I	Te
	23	52	I	ED
18	2	14	I	OR
	21	12	I	SI
	21	14	I	TI
	23	29	I	Se
	23	31	I	Te
19	20	40	I	OR
	23	55	III	SI
	23	58	III	TI
20	3	28	III	Te
	3	29	III	Se
	23	27	IV	TI
	23	31	IV	SI
21	3	43	IV	Te
	4	03	IV	Se
22	4	44	II	TI
	4	49	II	SI
23	23	39	II	OD
24	2	39	II	ER
	4	32	I	TI
	4	37	I	SI
25	1	40	I	OD
	4	05	I	ER
	20	42	II	Te
	21	00	II	Se
	22	58	I	TI
	23	06	I	SI
26	1	14	I	Te
	1	23	I	Se
	20	06	I	OD
	22	34	I	ER
27	3	13	III	TI
	3	53	III	SI
	19	40	I	Te
	19	51	I	Se

MARCH

d	h	m	Sat.	Phen.
1	21	26	III	ER
2	1	53	II	OD
	5	13	II	ER
3	3	24	I	OD
	20	08	II	TI
	20	45	II	SI
	22	58	II	Te
	23	36	II	Se
4	0	41	I	TI
	1	00	I	SI
	2	58	I	Te
	3	17	I	Se
	21	50	I	OD
5	0	28	I	ER
	18	30	II	ER
	19	07	I	TI
	19	28	I	SI
	21	24	I	Te
	21	45	I	Se
6	18	57	I	ER
8	18	00	IV	Te
	20	07	III	OD
	21	59	IV	Se
9	1	24	III	ER
	4	07	II	OD
10	22	24	II	TI
	23	22	II	SI
11	1	15	II	Te
	2	13	II	Se
	2	26	I	TI
	2	54	I	SI
	4	42	I	Te
	23	35	I	OD
12	2	23	I	ER
	20	52	I	TI
	21	04	II	ER
	21	23	I	SI
	23	09	I	Te
	23	39	I	Se
13	20	52	I	ER
14	18	08	I	Se
15	23	27	III	OD
16	20	47	IV	OD
17	1	14	IV	OR
	2	33	IV	ED
18	0	43	II	TI
	1	59	II	SI
	3	33	II	Te
	4	11	I	TI
19	1	21	I	OD
	4	18	I	ER
	19	23	III	Se
	19	31	II	OD
	22	38	I	TI
	23	17	I	SI
	23	38	II	ER
20	0	54	I	Te
	1	33	I	Se
	19	47	I	OD
	22	46	I	ER
21	19	20	I	Te
	20	02	I	Se
23	2	50	III	OD
25	3	02	II	TI
26	3	07	I	OD
	19	49	III	SI
	20	08	III	Te
	21	49	II	OD
	23	21	III	Se
27	0	24	I	TI
	1	11	I	SI
	2	12	II	ER
	2	40	I	Te
	3	27	I	Se
	21	34	I	OD
28	0	41	I	ER
	19	03	II	Te
	19	40	I	SI
	20	45	II	Se
	21	07	I	Te
	21	56	I	Se
29	19	11	I	ER

APRIL

d	h	m	Sat.	Phen.
2	20	04	III	TI
	20	36	IV	ED
	23	37	III	Te
	23	48	III	SI
3	0	09	II	OD
	1	03	IV	ER
	2	11	I	TI
	3	06	I	SI
	3	19	III	Se
	23	22	I	OD
4	2	37	I	ER
	18	36	II	TI
	20	32	II	SI
	20	38	I	TI
	21	26	II	Te
	21	34	I	SI
	22	54	I	Te
	23	22	II	Se
	23	50	I	Se
5	21	06	I	ER
9	23	38	III	TI
10	2	31	II	OD
	19	49	IV	TI
11	0	17	IV	Te
	1	11	I	OD
	21	01	II	TI
	22	27	I	TI
	23	10	II	SI
	23	29	I	SI
	23	52	II	Te
12	0	43	I	Te
	1	45	I	Se
	1	59	II	Se
	19	38	I	OD
	23	01	I	ER
13	19	10	I	Te
	20	13	I	Se
	20	38	II	ER
	21	19	III	ER
18	23	29	II	TI
19	0	17	I	TI
	1	23	I	SI
	1	47	II	SI
	19	02	IV	ER
	21	29	I	OD
20	0	56	I	ER
	19	52	I	SI
	20	41	III	OR

d	h	m	Sat.	Phen.
20	21	00	I	Te
	21	46	III	ED
	22	08	I	Se
	23	13	II	ER
21	1	18	III	ER
	19	24	I	ER
26	23	21	I	OD
27	20	36	I	TI
	20	36	II	OD
	20	51	III	OD
	21	47	I	SI
	22	52	I	Te
	23	33	IV	SI
28	0	02	I	Se
	0	26	III	OR
	21	20	I	ER
29	20	33	II	Se

MAY

d	h	m	Sat.	Phen.
1	19	13	III	Se
4	1	14	I	OD
	22	28	I	TI
	23	06	II	OD
	23	41	I	SI
5	0	40	III	OD
	0	44	I	Te
	19	41	I	OD
	20	34	IV	OD
	23	15	I	ER
6	19	12	I	Te
	20	22	II	SI
	20	25	I	Se
	20	39	II	Te
	23	11	II	Se
8	19	44	III	SI
	23	13	III	Se
12	0	22	I	TI
	21	35	I	OD
13	20	05	I	SI
	20	24	II	TI
	21	06	I	Te
	22	20	I	Se
	23	00	II	SI
	23	15	II	Te
14	19	39	I	ER
14	21	43	IV	Se
15	20	14	II	ER
	22	06	III	Te
	23	43	III	SI
19	23	31	I	OD
20	20	45	I	TI
	22	00	I	SI
	23	00	I	Te
	23	02	II	TI
21	21	34	I	ER
22	22	33	III	TI
	22	49	II	ER
26	21	14	III	ER
27	22	40	I	TI
28	19	56	I	OD
	23	29	I	ER
29	20	07	II	OD
	20	38	I	Se
31	20	21	II	Se

JUNE

d	h	m	Sat.	Phen.
2	20	17	III	OR
	21	44	III	ED
4	21	53	I	OD
5	20	18	I	SI
	21	22	I	Te
	22	33	I	Se
	22	45	II	OD
6	19	54	I	ER
7	20	11	II	SI
	20	33	II	Te
	22	59	II	Se
8	20	52	IV	ED
9	20	50	III	OD
12	21	03	I	TI
	22	12	I	SI
13	21	49	I	ER
14	20	26	II	TI
16	19	51	II	ER
20	20	19	I	OD
21	20	51	I	Se
28	20	31	I	SI
	21	45	I	Te
29	20	08	I	ER
30	20	11	II	OD

JULY

d	h	m	Sat.	Phen.
2	20	08	II	Se
8	21	07	III	ER
9	20	55	II	Te

Jupiter being near the sun, phenomena of the satellites are not given between July 10 and Oct. 10.

OCTOBER

d	h	m	Sat.	Phen.
20	5	16	I	Se
24	5	19	III	ED
26	5	05	II	ED
27	4	54	I	SI
28	4	08	II	Te
	5	11	I	OR

NOVEMBER

d	h	m	Sat.	Phen.
4	4	04	I	ED
	4	10	II	TI
	5	11	II	Se
5	4	23	I	Te
11	5	01	II	SI
12	4	07	I	TI
	5	25	I	Se
13	3	37	I	OR
	4	19	II	OR
19	5	04	I	SI
20	5	34	I	OR
21	2	50	I	Te
22	4	36	III	OR
27	4	11	I	ED
	4	47	II	ED
28	2	33	I	TI
	3	41	I	Se
	4	47	I	Te
29	4	15	II	Te
	4	19	III	ER
	5	41	III	OD

DECEMBER

d	h	m	Sat.	Phen.
2	5	07	IV	TI
	6	12	IV	Te
4	6	04	I	ED
5	3	20	I	SI
	4	30	I	TI
	5	35	I	Se
6	3	56	I	OR
	4	15	II	TI
	4	37	II	Se
	5	04	III	ED
10	3	00	III	Te
	3	27	IV	ED
	5	56	IV	ER
12	5	13	I	SI
	6	25	I	TI
13	2	25	I	ED
	4	29	II	SI
	5	50	I	OR
14	1	56	I	Se
	3	07	I	Te
15	4	27	II	OR
17	2	14	III	Se
	4	05	III	TI
20	4	18	I	ED
21	1	35	I	SI
	2	49	I	TI
	3	50	I	Se
	5	02	I	Te
22	1	51	II	ED
	2	13	I	OR
24	1	22	II	Te
	3	02	III	SI
	6	11	III	Se
27	6	10	I	ED
28	0	57	III	OR
	3	29	I	SI
	4	43	I	TI
	5	43	I	Se
29	0	39	I	ED
	4	06	I	OR
	4	27	II	ED
30	1	24	I	Te
31	1	17	II	TI
	1	32	II	Se
	3	54	II	Te

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 March to July, and on the west side during the rest of the year.

SATURN'S SATELLITES, 1968

Name	Greatest E. Elongation E.S.T.*			Mean Synodic Period	
		d	h	d	h
Janus (discovered 1966)					
Mimas	Oct.	15	9.1	0	22.6
Enceladus	Oct.	15	17.5	1	08.9
Tethys	Oct.	15	16.7	1	21.3
Dione	Oct.	14	14.3	2	17.7
Rhea	Oct.	16	18.8	4	12.5
Titan	Oct.	13	2.6†	15	23.3
Hyperion	Oct.	14	14.7†	21	07.6
Iapetus	Nov.	15	12.2†	79	22.1
Phoebe				523	15.6

*Near opposition of Saturn, 1968 Oct. 15.
†See p. 58 for more information.

SATURN'S SATELLITES, TITAN, HYPERION, AND IAPETUS

Elongations and Conjunctions, E.S.T. 1968

Titan

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
			Jan.	3	14.5	Jan.	7	14.0	Jan.	11	8.9
Jan.	15	9.1		19	14.1		23	13.6		27	8.7
	31	9.0	Feb.	4	14.1	Feb.	8	13.6	Feb.	12	8.7
Feb.	16	9.2		20	14.4		24	13.8		28	9.0
	..	....		..	....		..	....		..	....
May	6	12.6	May	10	17.6	May	14	16.3	May	18	11.6
	22	13.1		26	18.0		30	16.5	June	3	11.9
June	7	13.4	June	11	18.3	June	15	16.6		19	11.9
	23	13.5		27	18.2	July	1	16.4	July	5	11.6
July	9	13.2	July	13	17.8		17	15.8		21	11.0
	25	12.5		29	16.9	Aug.	2	14.8	Aug.	6	9.9
Aug.	10	11.3	Aug.	14	15.6		18	13.4		22	8.4
	26	9.6		30	13.8	Sept.	3	11.5	Sept.	7	6.4
Sept.	11	7.6	Sept.	15	11.7		19	9.4		23	4.2
	27	5.2	Oct.	1	9.3	Oct.	5	7.0	Oct.	9	1.7
Oct.	13	2.6		17	6.7		21	4.5		24	23.2
	28	23.9	Nov.	2	4.1	Nov.	6	2.0	Nov.	9	20.8
Nov.	13	21.5		18	1.8		21	23.8		25	18.6
	29	19.3	Dec.	3	23.7	Dec.	7	22.0	Dec.	11	16.8
Dec.	15	17.6		19	22.2		23	20.5		27	15.5
	31	16.4									

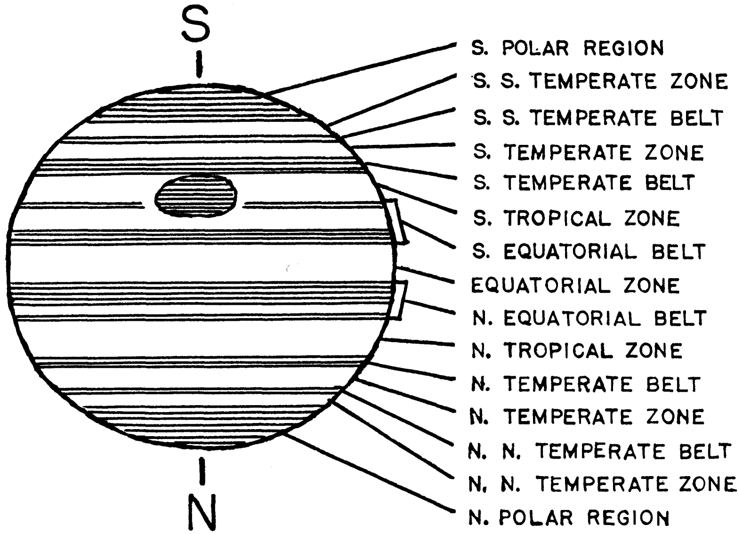
Hyperion

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
									Jan.	4	12.2
Jan.	10	19.4	Jan.	16	11.4	Jan.	20	20.9		25	18.3
Feb.	1	2.2	Feb.	6	17.4	Feb.	11	2.7	Feb.	16	1.4
	22	10.2		28	0.3		..	....		..	....
	..	....		..	....		..	....	May	11	14.0
May	18	1.2	May	23	9.7	May	27	18.2	June	2	0.3
June	8	11.6	June	13	18.8	June	18	3.2		23	10.4
	29	21.7	July	5	3.7	July	9	12.1	July	14	20.2
July	21	7.4		26	12.4		30	20.7	Aug.	5	5.4
Aug.	11	16.3	Aug.	16	20.7	Aug.	21	4.9		26	13.7
Sept.	2	0.4	Sept.	7	4.5	Sept.	11	12.5	Sept.	16	21.3
	23	7.8		28	11.8	Oct.	2	19.9	Oct.	8	4.4
Oct.	14	14.7	Oct.	19	19.0		24	3.1		29	11.4
Nov.	4	21.7	Nov.	10	2.3	Nov.	14	10.6	Nov.	19	18.8
	26	5.2	Dec.	1	10.1	Dec.	5	18.6	Dec.	11	3.1
Dec.	17	13.6		22	18.5		27	3.3			

Iapetus

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
			Jan.	20	22.7	Feb.	10	21.0	Mar.	1	9.5
	..	....		..	....		..	....		..	....
	..	....		..	....	May	2	8.0	May	21	18.9
June	10	12.9	July	1	15.2	July	22	2.7	Aug.	10	2.2
Aug.	29	9.1	Sept.	18	21.0	Oct.	8	20.2	Oct.	27	11.7
Nov.	15	12.2	Dec.	5	23.8	Dec.	26	7.7			

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.

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

During 1968 Saturn's rings open to half their maximum tilt, with the southern face visible. The major and minor axes of the outer edge of the outer ring have the following values during the year: Jan. 1, 39.81″, 3.99″; Apr. 2, 36.13″, 6.18″; Sept. 1, 43.53″, 10.20″; Oct. 15, 45.02″, 9.60″; Dec. 30, 41.32″, 7.99″.

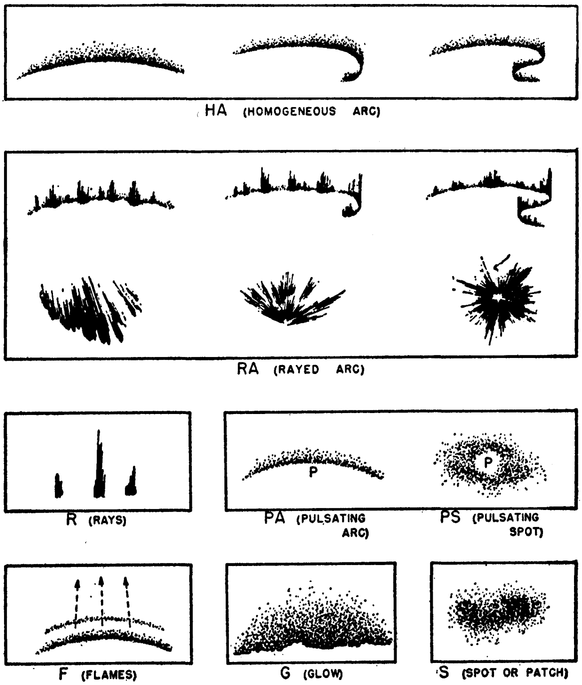
JUPITER—LONGITUDE OF CENTRAL MERIDIAN

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.

Month U.T.	SYSTEM I						SYSTEM II					
	Jan. 8^h	Feb. 6^h	Mar. 4^h	Apr. 2^h	May 2^h	Dec. 9^h	Jan. 8^h	Feb. 6^h	Mar. 4^h	Apr. 2^h	May 2^h	Dec. 9^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	104.4	249.7	79.5	223.0	278.3	85.8	341.5	251.0	220.2	127.7	314.1	286.7
2	262.4	47.8	237.5	20.9	76.0	243.7	131.8	41.4	10.5	277.9	104.2	76.9
3	60.4	205.8	35.5	178.8	233.8	41.5	282.2	191.8	160.9	68.2	254.4	227.2
4	218.4	3.8	193.5	336.7	31.6	199.4	72.6	342.2	311.3	218.5	44.5	17.4
5	16.4	161.9	351.5	134.6	189.4	357.2	222.9	132.6	101.6	8.7	194.7	167.6
6	174.4	319.9	149.5	292.4	347.2	155.1	13.3	283.0	252.0	159.0	344.8	317.8
7	332.4	118.0	307.5	90.3	144.9	312.9	163.7	73.5	42.4	309.2	135.0	108.0
8	130.4	276.0	105.4	248.2	302.7	110.8	314.1	223.9	192.7	99.5	285.1	258.3
9	288.4	74.0	263.4	46.1	100.5	268.6	104.4	14.3	343.1	249.7	75.2	48.5
10	86.4	232.1	61.4	203.9	225.2	66.5	254.8	164.7	133.4	39.9	225.4	198.7
11	244.4	30.1	219.4	1.8	56.0	224.4	45.2	315.1	283.8	190.2	15.5	349.0
12	42.4	188.2	17.4	159.6	213.8	22.2	195.6	105.5	74.1	340.4	165.6	139.2
13	200.4	346.2	175.3	317.5	11.5	180.1	345.9	255.9	224.5	130.6	315.8	289.4
14	358.4	144.2	333.3	115.3	169.3	338.0	136.3	46.3	14.8	280.8	105.9	79.7
15	156.4	302.3	131.3	273.2	327.0	135.8	286.7	196.7	165.2	71.1	256.0	229.9
16	314.5	100.3	289.2	71.0	124.8	293.7	77.1	347.1	315.5	221.3	46.1	20.2
17	112.5	258.3	87.2	228.9	282.5	91.6	227.5	137.5	105.8	11.5	196.3	170.4
18	270.5	56.4	245.1	26.7	80.3	249.5	17.9	287.9	256.1	161.7	346.4	320.7
19	68.5	214.4	43.1	184.5	238.0	47.4	168.3	78.3	46.5	311.9	136.5	110.9
20	226.5	12.4	201.0	342.4	35.8	205.3	318.7	228.7	196.8	102.1	286.6	261.2
21	24.6	170.5	359.0	140.2	193.5	3.1	109.1	19.1	347.1	252.3	76.7	51.4
22	182.6	328.5	156.9	298.0	351.2	161.0	259.5	169.5	137.4	42.5	226.8	201.7
23	340.6	126.5	314.9	95.8	149.0	318.9	49.9	319.9	287.7	192.7	16.9	352.0
24	138.7	284.6	112.8	253.6	306.7	116.8	200.3	110.3	78.0	342.8	167.0	142.2
25	296.7	82.6	270.7	51.5	104.4	274.7	350.7	260.7	228.3	133.0	317.1	292.5
26	94.7	240.6	68.6	209.3	262.2	72.6	141.1	51.1	18.6	283.2	107.2	82.8
27	252.8	38.6	226.6	7.1	59.9	230.5	291.5	201.5	168.9	73.4	257.3	233.0
28	50.8	196.6	24.5	164.9	217.6	28.4	81.9	351.9	319.2	223.6	47.4	23.3
29	208.8	354.6	182.4	322.7	15.3	186.4	232.3	142.3	109.5	13.7	197.5	173.6
30	6.9		340.3	120.5	173.0	344.3	22.7		259.7	163.9	347.6	323.9
31	164.9		138.2		330.8	142.2	173.1		50.0		137.7	114.2

THE POLAR AURORA

The polar aurora is a self-luminous phenomenon of the upper atmosphere, which is seen most frequently in high latitudes, but is visible to at least a latitude of 14° in both hemispheres. Standard auroral forms and accepted abbreviations are shown in the figure. Regular observations, at the same times on successive nights are useful. Observations can be sent in Canada to Dr. Peter M. Millman, National Research Council, Ottawa, Ontario.



THE OBSERVATION OF THE MOON

During 1968 the ascending node of the moon's orbit moves in the constellation Pisces (☊ from 24° to 5°). Thus the range of the moon's declination is approaching its greatest value. 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.

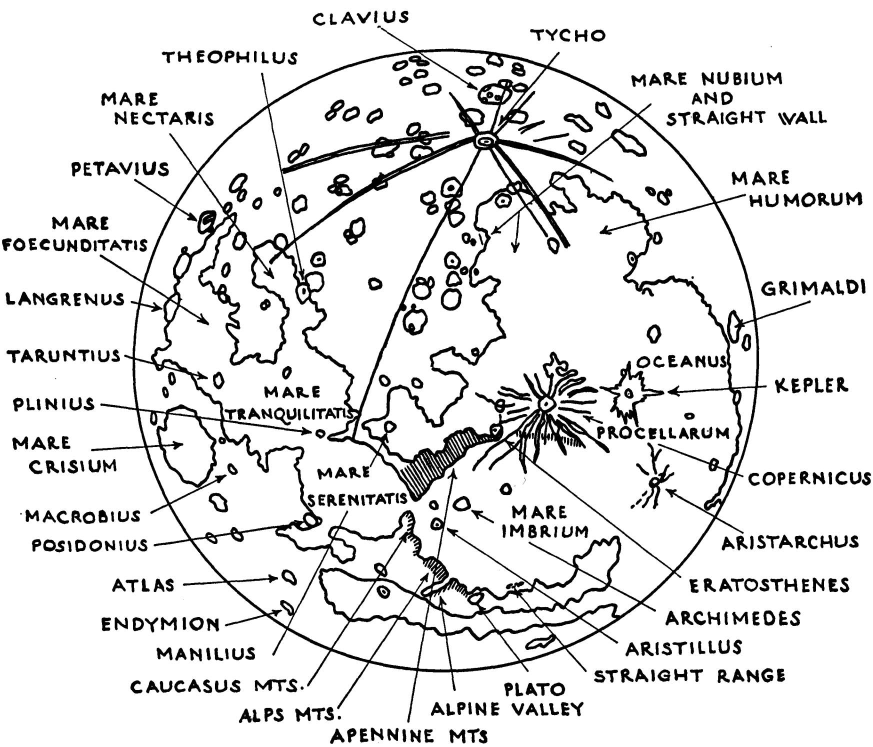
The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

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.

MAP OF THE MOON



South appears at the top.

SUN—EPHEMERIS FOR PHYSICAL OBSERVATIONS, 1968

For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.46	−2.98	195.49	July 4	− 1.30	+3.26	273.80
6	+ 0.03	−3.55	129.64	9	+ 0.97	+3.78	207.62
11	− 2.38	−4.10	63.79	14	+ 3.22	+4.28	141.45
16	− 4.76	−4.61	357.95	19	+ 5.42	+4.75	75.29
21	− 7.07	−5.09	292.11	24	+ 7.58	+5.19	9.14
26	− 9.30	−5.53	226.28	29	+ 9.66	+5.60	303.00
31	−11.44	−5.92	160.45	Aug. 3	+11.66	+5.96	236.87
Feb. 5	−13.47	−6.27	94.62	8	+13.57	+6.29	170.75
10	−15.38	−6.57	28.79	13	+15.37	+6.57	104.65
15	−17.15	−6.81	322.95	18	+17.06	+6.80	38.56
20	−18.79	−7.01	257.11	23	+18.63	+6.99	332.49
25	−20.28	−7.14	191.26	28	+20.08	+7.13	266.42
Mar. 1	−21.62	−7.22	125.40	Sept. 2	+21.39	+7.21	200.38
6	−22.80	−7.25	59.53	7	+22.56	+7.25	134.34
11	−23.81	−7.22	353.65	12	+23.58	+7.23	68.31
16	−24.67	−7.14	287.75	17	+24.46	+7.16	2.30
21	−25.35	−7.00	221.83	22	+25.17	+7.04	296.30
26	−25.85	−6.81	155.90	27	+25.72	+6.87	230.32
31	−26.19	−6.57	89.95	Oct. 2	+26.10	+6.64	164.34
Apr. 5	−26.34	−6.28	23.98	7	+26.31	+6.37	98.36
10	−26.31	−5.94	317.99	12	+26.34	+6.05	32.40
15	−26.10	−5.57	251.98	17	+26.18	+5.68	326.45
20	−25.70	−5.15	185.94	22	+25.83	+5.27	260.50
25	−25.12	−4.70	119.89	27	+25.28	+4.81	194.56
30	−24.36	−4.21	53.82	Nov. 1	+24.54	+4.32	128.63
May 5	−23.41	−3.70	347.74	6	+23.60	+3.80	62.70
10	−22.29	−3.16	281.63	11	+22.47	+3.25	356.78
15	−21.00	−2.60	215.50	16	+21.15	+2.67	290.86
20	−19.54	−2.03	149.37	21	+19.63	+2.06	224.96
25	−17.93	−1.44	83.22	26	+17.94	+1.44	159.06
30	−16.18	−0.84	17.06	Dec. 1	+16.09	+0.81	93.16
June 4	−14.30	−0.24	310.89	6	+14.09	+0.18	27.27
9	−12.30	+0.37	244.71	11	+11.96	−0.47	321.38
14	−10.22	+0.97	178.53	16	+ 9.72	−1.10	255.51
19	− 8.05	+1.56	112.34	21	+ 7.39	−1.73	189.64
24	− 5.83	+2.14	46.16	26	+ 5.00	−2.35	123.78
29	− 3.57	+2.71	339.98	31	+ 2.58	−2.95	57.92

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, 1968

No.	Commences	No.	Commences	No.	Commences
1530	Jan. 15.84	1535	May 31.29	1540	Oct. 14.46
1531	Feb. 12.19	1536	June 27.49	1541	Nov. 10.76
1532	Mar. 10.52	1537	July 24.69	1542	Dec. 8.07
1533	Apr. 6.82	1538	Aug. 20.92		
1534	May 4.07	1539	Sept. 17.17		

ECLIPSES DURING 1968

In 1968 there will be four eclipses, two of the sun and two of the moon. Of these, the total eclipse of the sun of September 22nd will be barely visible as a partial eclipse in extreme north-eastern Canada, and both eclipses of the moon (on the nights of April 12–13 and October 5–6) will be visible throughout North America.

1. A partial eclipse of the sun on March 28, visible in the South Pacific and Antarctica.

2. A total eclipse of the moon on the night of April 12–13, visible in North America.

Moon enters penumbra	April 12, 21h 11m E.S.T.
Moon enters umbra	22h 10m E.S.T.
Total eclipse begins	23h 22m E.S.T.
Middle of eclipse	23h 47m E.S.T.
Total eclipse ends	April 13, 0h 12m E.S.T.
Moon leaves umbra	1h 25m E.S.T.
Moon leaves penumbra	2h 24m E.S.T.

3. A total eclipse of the sun on September 22, visible as a partial eclipse just at sunrise along the coast of Labrador and the eastern half of Baffin Island. The path of totality is in Siberia.

4. A total eclipse of the moon on the night of October 5–6, the beginning visible in all of North America, the end only in the north-western part.

Moon enters penumbra	October 6, 3h 44m E.S.T.
Moon enters umbra	4h 55m E.S.T.
Total eclipse begins	6h 10m E.S.T.
Middle of the eclipse	6h 42m E.S.T.
Total eclipse ends	7h 14m E.S.T.
Moon leaves umbra	8h 29m E.S.T.
Moon leaves penumbra	9h 40m E.S.T.

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.

Note that Jupiter, Saturn and stars of the Pleiades, are occulted in 1968.

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, 1968

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Jan. 6	Saturn	1.1	I	06.6	13 16.5	−0.6	+1.9	068	12 13.8	−0.3	+1.9	063
Jan. 6	Saturn	1.1	E	06.6	14 25.3	−0.8	+2.1	223	13 20.1	−0.6	+2.0	233
Jan. 9	π Ari	5.4	I	09.9	No Occ.	...	...	...	18 35.8	—	—	120
Jan. 9/10	45 Ari	5.9	I	10.0	0 31.5	−0.5	−2.1	102	23 22.4	−0.9	−2.1	102
Jan. 11	+22° 572	6.9	I	11.1	Low	...	...	...	2 22.2	+0.2	−2.0	109
Jan. 11	+24° 663	7.3	I	12.0	22 25.2	−2.1	−1.3	104	21 03.3	−2.1	−0.2	094
Jan. 17	107B. Leo	6.3	E	18.0	22 49.4	−1.0	+1.0	280	21 42.3	−0.6	+0.9	284
Jan. 22	76 Vir	5.4	E	22.2	2 26.4	+0.2	−2.0	357	1 26.0	0.0	−1.1	344
Jan. 25	α Sco	1.2	I	25.3	5 43.2	−0.6	+0.1	134	4 40.0	−0.1	−0.2	148
Jan. 25	α Sco	1.2	E	25.3	6 48.8	−1.6	+0.7	270	5 33.8	−1.6	+1.4	256
Jan. 25	116B. Sco	6.2	E	25.3	Sun	...	...	...	6 37.2	−1.6	+0.7	271
Feb. 6	τ Ari	5.2	I	08.4	21 40.8	−1.4	+1.5	031	20 28.4	−1.4	+2.2	025
Feb. 8	+26° 775*m*	6.9	I	10.3	19 41.5	−2.1	+0.3	088	18 23.4	−1.7	+1.2	076
Feb. 11	+27° 1296	7.2	I	12.5	0 05.8	—	—	170	No Occ.	...	...	...
Feb. 11	47 Gem	5.6	I	12.6	4 37.7	+0.2	−1.2	088	3 37.7	+0.1	−1.4	097
Feb. 11/12	ω Cnc	5.9	I	13.5	0 56.2	−1.9	−0.3	072	23 36.8	−1.9	−0.4	085
Feb. 12	4 Cnc	6.2	I	13.5	1 28.2	−0.8	−2.0	122	0 17.4	−0.9	−2.3	134
Feb. 15	53 Leo	5.3	E	16.6	4 36.7	+0.3	−2.8	359	3 34.5	−0.3	−2.4	341
Mar. 5	104B. Tau	5.5	I	06.6	18 55.8	−1.5	+3.4	019	Sun	...	...	...
Mar. 6	+25° 731	7.5	I	07.8	22 37.9	+0.3	−3.7	141	21 37.7	—	—	156
Mar. 7	107B. (Aur)	6.5	I	08.7	19 57.1	−1.8	−2.2	121	18 35.6	−2.1	−1.6	117
Mar. 8	228B. Aur	6.8	I	09.7	18 53.1	−1.9	+1.6	064	Sun	...	...	...
Mar. 8	49 Aur	5.0	I	09.8	21 50.0	−1.6	−0.8	086	20 32.1	−1.8	−0.7	092
Mar. 9	+27° 1219	6.8	I	10.0	Low	...	...	...	1 53.7	−0.2	−0.8	062
Mar. 10	76 Gem	5.4	I	11.0	Low	...	...	...	2 49.2	+0.3	−1.5	110
Mar. 10	28 Cnc	6.1	I	11.8	21 56.3	—	—	052	20 31.6	−2.3	+2.0	063
Mar. 16	86 Vir	5.8	E	17.8	22 17.5	−0.7	+1.0	280	Low	...	...	...
Mar. 19	31B. Sco	5.4	E	20.1	No Occ.	...	...	...	3 17.2	−0.1	−1.6	354
Mar. 21	*W* Sgr	Var.*	I	22.2	Sun	...	...	...	5 09.3	−1.3	−0.4	142
Mar. 31	40 Ari	6.0	I	03.0	Low	...	...	...	19 47.4	−0.2	−1.1	078
Apr. 1	+22° 523	6.6	I	04.1	No Occ.	...	...	...	21 19.8	−0.8	+1.2	020
Apr. 5	+27° 1337*m*	6.4	I	08.1	22 44.1	−0.7	−1.4	092	21 35.3	−0.8	−1.7	103
Apr. 6	134 B. Gem	6.5	I	08.2	0 58.6	+0.9	−2.3	154	0 06.8	+1.4	−3.3	172
Apr. 6	+27° 1362	6.9	I	08.3	Low	...	...	...	0 44.9	+0.2	−1.3	096
Apr. 7	+22° 2029	7.0	I	10.0	19 36.1	−1.2	−2.6	153	Sun	...	...	...
Apr. 8/9	+17° 2156	7.4	I	11.2	0 02.3	−1.8	−0.7	071	22 44.3	−1.7	−1.0	090
Apr. 9	53 Leo	5.3	I	12.2	23 53.3	−1.7	−1.1	092	22 36.3	−1.5	−1.1	108
May 1	415 B. Tau	6.1	I	04.4	22 24.9	+1.1	−2.5	152	Graze	...	...	...
May 2	+27° 1270	7.0	I	05.4	22 28.6	+0.4	−1.9	127	21 30.9	+0.4	−2.3	139
May 8	σ Leo	4.1	I	10.6	1 28.1	−0.2	−1.8	126	0 23.5	−0.4	−1.9	132
June 4	β Vir	3.8	I	08.8	Low	...	...	...	23 17.7	−0.2	−2.2	160
June 5	71 G. Vir	7.0	I	09.8	23 17.8	−1.1	−1.5	095	22 04.5	−1.3	−1.4	105
June 17	−7° 6036	6.4	E	21.0	2 26.6	−1.3	+1.3	281	1 17.4	−0.8	+1.3	289
July 6/7	48B. Sco	5.1	I	11.2	0 01.9	—	—	175	22 43.9	—	—	170
July 22	107B. (Aur)	6.5	E	26.4	Sun	...	...	...	3 03.9	−1.0	−0.2	324
Aug. 3	−27° 11076	6.5	I	09.6	21 22.8	−1.7	−1.2	134	20 06.2	−1.5	−0.8	136
Aug. 21	4 Cnc	6.2	E	26.9	3 52.0	0.0	+0.9	286	Low	...	...	...
Aug. 27	α Vir	1.2	I	03.8	15 27.3	−1.2	−1.1	139	14 16.9	−0.7	−1.2	155
Aug. 27	α Vir	1.2	E	03.8	16 40.5	−1.5	−1.2	294	15 23.0	−1.8	−0.5	281
Aug. 30	−26° 11327	7.3	I	07.0	Low	...	...	...	19 42.3	−1.5	−1.2	116
Sept. 1	−29° 15058	6.9	I	09.0	20 29.2	−1.5	+0.5	042	19 13.4	−1.8	+1.0	038
Sept. 3	56B. Cap	6.3	I	11.1	22 55.6	—	—	350	No Occ.	...	...	...
Sept. 4	ε Cap	4.7	I	12.1	22 24.5	−2.2	+0.1	098	21 05.2	−1.8	+0.8	085
Sept. 12	ζ Ari	5.0	E	19.3	2 52.4	−0.4	+3.4	195	1 48.9	−0.7	+2.5	216
Sept. 15	406B. Tau	5.6	E	22.3	2 49.1	0.0	+3.3	213	1 50.5	−0.1	+2.4	232
Sept. 26	48B. Sco	5.1	I	04.5	18 17.8	−1.3	−0.5	059	Sun	...	...	...
Sept. 28	−29° 14714	6.8	I	06.5	No Occ.	...	...	...	18 46.6	—	—	155
Oct. 2/3	−15° 6180	7.1	I	10.7	0 59.5	−0.5	+0.1	042	23 55.9	−0.3	+0.8	024
Oct. 10	27 Tau *m*	3.8	I	17.9	3 33.3	−1.6	+1.8	044	2 20.8	−1.2	+2.8	030
Oct. 10	+23° 563	6.1	E	17.9	No Occ.	...	...	...	3 16.3	—	—	188
Oct. 10	28 Tau	5.2	E	17.9	4 46.6	−1.8	−3.0	300	3 21.0	—	—	312
Oct. 10	27 Tau *m*	3.8	E	17.9	4 51.1	−1.7	−1.4	278	3 30.4	−2.2	−1.5	285
Oct. 13	+27° 1337*m*	6.4	E	21.7	23 03.2	−0.1	+0.6	301	Low	...	...	...

*4.3–5.1.

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Oct. 19	Jupiter	−1.3	I	27.1	7 52.8	−1.7	+1.0	093	6 39.7	−1.1	+0.8	103
Oct. 19	Jupiter	−1.3	E	27.1	8 53.0	−0.6	−1.9	344	7 44.6	−0.8	−1.2	331
Oct. 31	243 B. Aqr	6.8	I	09.3	Low	...	...	...	0 05.4	—	—	349
Nov. 2	44 Psc	6.0	I	11.3	1 40.9	−1.1	−1.9	096	0 27.4	−1.3	−1.0	082
Nov. 7	χ Tau	5.5	E	16.4	3 24.4	−1.8	+1.5	223	2 07.9	−1.8	+1.5	228
Nov. 8	354B. Tau	6.3	E	17.5	Sun	...	...	...	5 20.2	−0.1	−4.4	328
Nov. 11	ω Cnc	5.9	E	20.5	5 45.0	−1.1	−2.9	327	4 29.7	−1.5	−2.2	318
Nov. 11	4 Cnc	6.2	E	20.5	Sun	...	...	...	5 18.6	−2.1	−0.3	267
Nov. 27	−7° 5975	6.7	I	07.6	17 52.4	—	—	338	No Occ.	...	...	...
Nov. 30	169B. Psc	6.9	I	09.9	1 54.1	−0.3	+0.8	028	0 51.0	−0.5	+1.1	024
Dec. 2	27 Ari	6.4	I	11.9	No Occ.	...	...	...	2 29.2	—	—	356
Dec. 8	76 Gem	5.4	E	18.0	4 56.2	−1.5	−1.4	280	3 38.1	−1.9	−0.6	269
Dec. 15	α Vir	1.2	I	25.1	4 36.0	−0.4	−0.5	146	3 33.6	−0.1	−0.7	156
Dec. 15	α Vir	1.2	E	25.1	5 38.5	−1.2	+0.5	287	4 27.4	−1.1	+1.2	274
Dec. 22	φ Cap	5.4	I	03.1	17 26.8	−1.0	−0.2	062	Sun	...	...	...
Dec. 22	−20° 6178	6.7	I	03.2	Low	...	...	...	17 47.6	−0.8	−0.3	059
Dec. 24	85 Aqr	6.8	I	05.2	20 56.7	0.0	+1.4	013	20 01.4	—	—	349
Dec. 24	87 Aqr	7.4	I	05.3	Low	...	...	...	20 55.2	—	—	342
Dec. 27	254B. Psc	7.2	I	08.3	22 35.8	−1.1	−0.6	069	21 23.5	−1.3	+0.1	059
Dec. 30	23 Tau	4.2	I	11.3	21 35.4	−1.3	+2.8	030	20 28.9	−0.4	+4.4	011
Dec. 30	−23° 537	6.8	I	11.3	21 56.8	−2.1	0.0	084	20 37.5	−1.8	+1.0	071
Dec. 30	+23° 538	7.1	I	11.3	22 04.9	−1.8	+0.9	061	20 49.1	−1.5	+1.9	049
Dec. 30	η Tau	3.0	I	11.3	22 39.2	—	—	013	Graze	...	...	...
Dec. 30	26 Tau	6.6	I	11.4	23 06.3	−1.9	−1.6	102	21 44.8	−2.1	−0.6	093
Dec. 30	27 Tau *m*	3.8	I	11.4	23 19.7	−1.7	+0.4	061	22 02.9	−1.7	+1.2	054
Dec. 30	η Tau	3.0	E	11.3	23 23.5	—	—	312	Graze	...	...	...
Dec. 30	28 Tau	5.2	I	11.4	23 30.3	−1.7	+1.4	041	22 15.4	−1.6	+2.2	034
Dec. 30	+23° 569	6.8	I	11.4	23 54.4	−1.5	−3.4	124	22 33.6	−2.1	−2.6	117
Dec. 30/31	+23° 570	6.8	1	11.4	0 23.9	−1.3	−2.1	106	23 07.1	−1.7	−1.8	104
Dec. 31	+24° 599	6.4	I	11.5	4 05.4	−0.4	+0.1	038	3 00.6	−0.5	−0.3	049

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1968

Date	Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
					E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Jan. 3	−15° 6208	7.1	I	03.9	Low	...	...	...	18 27.8	−0.8	−0.3	055
Jan. 6	Saturn	1.1	I	06.6	12 09.1	−0.1	+1.8	064	Low	...	...	...
Jan. 6	Saturn	1.1	E	06.6	13 13.2	−0.5	+2.0	235	12 19.9	−0.1	+1.9	246
Jan. 8/9	+13° 351	7.4	I	09.1	0 56.5	0.0	−2.5	111	23 35.9	−0.8	−1.7	091
Jan. 9	π Ari	5.4	I	09.9	18 18.2	−2.9	−0.2	110	16 57.9	−0.8	+1.9	066
Jan. 9	45 Ari	5.9	I	10.0	23 20.5	−1.2	−2.7	110	21 43.8	−1.6	−0.4	078
Jan. 11	+22° 572	6.9	I	11.1	2 27.7	+0.3	−2.6	123	1 09.2	−0.5	−2.7	116
Jan. 11	+24° 663	7.3	I	12.0	20 50.8	−2.2	+0.1	095	19 31.0	−0.9	+2.1	055
Jan. 17	107 B. Leo	6.3	E	18.0	21 37.2	−0.5	+1.1	280	20 36.4	−0.2	+0.4	310
Jan. 22	76 Vir	5.4	E	22.2	1 27.0	−0.1	−0.6	330	Low	...	...	...
Jan. 25	α Sco	1.2	I	25.3	4 42.4	+0.6	−1.1	166	Low	...	...	...
Jan. 25	α Sco	1.2	E	25.3	5 20.4	−1.9	+2.4	239	Low	...	...	...
Jan. 25	116B. Sco	6.2	E	25.3	6 25.8	−1.7	+1.2	259	Low	...	...	...
Feb. 6	τ Ari	5.2	I	08.4	20 16.1	−1.5	+2.1	031	No Occ.	...	..	...
Feb. 6	63 Ari	5.2	I	08.4	No Occ.	...	...	...	19 33.4	—	—	131
Feb. 8	+26° 775*m*	6.9	I	10.3	18 11.6	−1.5	+1.5	075	Sun	...	...	...
Feb. 9	415 B. Tau	6.1	I	11.4	No Occ.	...	...	...	19 25.3	—	—	154
Feb. 11	47 Gem	5.6	I	12.6	3 40.7	0.0	−1.6	107	2 27.2	−0.3	−2.0	118
Feb. 11	134B. Gem	6.5	I	12.7	Low	...	...	...	4 53.8	+0.1	−1.2	081
Feb. 11	ω Cnc	5.9	I	13.5	23 26.6	−1.9	−0.6	097	21 54.5	−1.6	+0.7	088
Feb. 11/12	4 Cnc	6.2	I	13.5	0 17.0	−0.8	−2.9	149	22 40.9	−1.3	−2.3	145
Feb. 15	53 Leo	5.3	E	16.6	3 36.0	−0.6	−2.1	328	2 09.0	−1.1	−1.4	312
Mar. 6	+25° 731	7.5	I	07.8	No Occ.	...	...	...	19 59.6	—	—	150
Mar. 8	136 Tau	4.5	I	09.0	Low	...	...	...	2 13.7	+0.3	−1.4	095
Mar. 8	49 Aur	5.0	I	09.8	20 22.5	−2.0	−0.9	101	18 49.8	−1.6	+1.0	081
Mar. 9	+27° 1219	6.8	I	10.0	1 54.3	−0.2	−1.0	074	0 40.1	−0.5	−1.4	085
Mar. 9	+27° 1236	6.6	I	10.0	Low	...	...	...	2 39.3	+1.4	−3.0	169
Mar. 10	76 Gem	5.4	I	11.0	2 53.9	+0.3	−1.6	119	1 45.2	0.0	−2.1	130
Mar. 10	28 Cnc	6.1	I	11.8	20 16.0	−2.0	+1.4	076	19 02.7	−1.1	+3.8	049
Mar. 19	31 B. Sco	5.4	E	20.1	3 17.0	−0.6	−0.9	337	Low	...	...	...

Date	Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
					E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Mar. 21	*W* Sgr	Var.*	I	22.2	5 03.4	−1.0	−0.7	151	Low	...	...	...
Mar. 21	*W* Sgr	Var.*	E	22.2	5 48.5	−2.2	+1.3	220	Low	...	...	...
Mar. 30	12 H¹ Ari	6.3	I	02.0	19 36.8	−0.1	−1.2	082	Sun	...	...	...
Mar. 31	40 Ari	6.0	I	03.0	19 48.4	−0.3	−1.4	088	Sun	...	...	...
Apr. 1	+22° 523	6.6	I	04.1	21 14.8	−0.6	+0.3	038	20 03.3	−1.0	+0.6	033
Apr. 5	+27° 1337*m*	6.4	I	08.1	21 33.8	−0.8	−2.0	116	20 02.4	−1.3	−1.8	119
Apr. 5/6	+27° 1362	6.9	I	08.3	0 48.8	+0.2	−1.5	105	23 39.1	−0.1	−1.9	116
Apr. 7	λ Cnc	5.9	I	09.4	Low	...	...	...	2 22.5	+0.2	−1.4	097
Apr. 8	+17° 2156	7.4	I	11.2	22 36.9	−1.6	−1.2	104	21 03.4	−1.4	−0.8	116
Apr. 9	+15° 2167	7.2	I	11.4	Low	...	...	...	2 58.0	−0.3	−1.3	071
Apr. 9	53 Leo	5.3	I	12.2	22 29.8	−1.4	−1.3	122	21 00.2	−1.1	−0.9	133
Apr. 16	α Sco	1.2	I	18.3	0 08.9	—	—	038	Low	...	...	...
Apr. 16	α Sco	1.2	E	18.3	0 26.8	—	—	007	Low	...	...	...
May 2	+27° 1270	7.0	I	05.4	21 38.5	+0.7	−2.8	153	20 30.3	—	—	172
May 2	+27° 1296	7.2	I	05.5	Low	...	...	...	22 33.5	+0.3	−1.9	125
May 7/8	σ Leo	4.1	I	10.6	0 24.8	−0.4	−2.0	139	23 03.6	−0.5	−2.0	154
May 18	33 Cap	5.5	E	20.7	3 14.0	−1.5	+0.9	286	Low	...	...	...
June 2	37 Leo	5.7	I	06.9	Low	...	...	...	23 11.7	−0.1	−1.8	117
June 4	β Vir	3.8	I	08.8	23 20.9	−0.2	−2.4	167	22 04.7	+0.2	−2.6	185
June 5	71 G. Vir	7.0	I	09.8	21 59.3	−1.4	−1.4	114	Sun	...	...	...
June 9	α Sco	1.2	E	13.8	No Occ.	...	...	...	20 39.5	+0.2	−0.6	343
July 6	48B. Sco	5.1	I	11.2	22 41.3	—	—	178	No Occ.	...	...	...
July 12	ε Cap	4.7	E	16.4	Sun	...	...	...	3 20.4	−1.0	+0.5	221
July 14	χ Aqr	5.1	E	18.4	3 48.7	−2.2	+0.3	264	No Occ.	...	...	...
Aug. 13	ζ Psc	5.6	E	18.8	No Occ.	...	...	...	0 48.1	0.0	+2.5	190
Aug. 13	+6° 175	6.5	E	18.8	No Occ.	...	...	...	0 48.8	0.0	+2.5	190
Aug. 15	36 Ari	6.5	E	20.8	No Occ.	...	...	...	0 16.7	+0.7	+2.6	182
Aug. 20	47 Gem	5.6	E	25.9	No Occ.	...	...	...	3 44.4	+0.5	+2.4	228
Aug. 27	α Vir	1.2	I	03.8	14 16.6	−0.2	−1.8	171	13 08.7	—	—	195
Aug. 27	α Vir	1.2	E	03.8	15 11.3	−2.4	+0.2	266	13 34.1	—	—	238
Aug. 30	−26° 11327	7.3	I	07.0	19 34.9	−1.7	−1.0	117	Sun	...	...	...
Sept. 4	ε Cap	4.7	I	12.1	20 53.5	−1.6	+1.1	083	Low	...	...	...
Sept. 4	κ Cap	4.8	I	12.2	No Occ.	...	...	...	23 00.7	−1.7	+0.2	084
Sept. 9	171 B. Psc	6.3	E	16.4	Sun	...	...	...	4 08.5	−1.1	+0.3	233
Sept. 12	ζ Ari	5.0	E	19.3	1 40.2	−0.7	+2.4	222	0 39.0	−0.8	+1.7	258
Sept. 15	406B. Tau	5.6	E	22.3	1 45.7	0.0	+2.2	236	0 55.3	−0.1	+1.5	270
Sept. 17	76 Gem	5.4	E	24.4	No Occ.	...	...	...	2 40.1	+0.5	+2.9	225
Sept. 28	−29° 14714	6.8	I	06.5	18 35.8	—	—	153	Sun	...	...	...
Sept. 29	234B. Sgr	5.9	I	07.6	21 31.6	−0.2	+0.6	023	No Occ.	...	...	...
Oct. 2	−15° 6180	7.1	I	10.7	23 52.3	−0.3	+1.1	019	No Occ.	...	...	...
Oct. 10	104B. Tau	5.5	E	17.8	No Occ.	...	...	...	0 45.9	−0.2	+3.1	201
Oct. 10	27 Tau *m*	3.8	I	17.9	2 09.0	−1.0	+3.0	029	No Occ.	...	...	...
Oct. 10	+23° 563	6.1	E	17.9	3 02.4	—	—	186	2 00.9	−1.2	+1.8	234
Oct. 10	28 Tau	5.2	E	17.9	3 10.9	—	—	309	No Occ.	...	...	...
Oct. 10	27 Tau *m*	3.8	E	17.9	3 19.3	−2.4	−1.0	283	No Occ.	...	...	...
Oct. 13	49 Aur	5.0	E	21.0	Sun	...	...	...	5 37.4	−1.9	+1.2	244
Oct. 15	λ Cnc	5.9	E	23.0	No Occ.	...	...	...	4 10.1	−1.0	+2.9	240
Oct. 19	Jupiter	−1.3	I	27.1	6 32.6	−0.9	+0.4	114	5 26.8	−0.4	+1.2	101
Oct. 19	Jupiter	−1.3	E	27.1	7 41.0	−1.0	−0.6	317	6 25.6	−0.5	−0.3	322
Oct. 31	243B. Aqr	6.8	I	09.3	0 03.9	—	—	346	No Occ.	...	...	...
Nov. 1/2	44 Psc	6.0	I	11.3	0 20.5	−1.6	−0.8	081	22 58.7	−1.0	+1.1	038
Nov. 7	χ Tau	5.5	E	16.4	1 54.4	−1.7	+2.1	224	0 33.9	−1.6	+1.0	261
Nov. 8	354B. Tau	6.3	E	17.5	5 24.2	−0.8	−3.1	311	3 39.7	—	—	330
Nov. 10	+27° 1337*m*	6.4	E	19.6	Sun	...	...	...	6 10.3	−1.2	−1.9	297
Nov. 11	ω Cnc	5.9	E	20.5	4 23.3	−1.8	−1.5	307	2 44.2	−1.6	−1.8	328
Nov. 11	4 Cnc	6.2	E	20.5	5 04.6	−2.5	+0.9	253	3 34.4	−1.7	+1.0	265
Nov. 15	σ Leo	4.1	I	24.6	5 01.0	−1.8	+2.8	070	4 00.1	—	—	047
Nov. 15	σ Leo	4.1	E	24.6	5 43.1	−0.2	−3.2	000	4 18.6	—	—	015
Nov. 24	−24° 16262	7.2	I	04.6	No Occ.	...	...	...	17 18.5	−2.4	−0.9	122
Nov. 30	169B. Psc	6.9	I	09.9	0 46.1	−0.6	+0.9	029	No Occ.	...	...	...
Dec. 2	27 Ari	6.4	I	11.9	2 15.9	−1.1	+2.3	015	No Occ.	...	...	...
Dec. 2	ζ Ari	5.0	I	12.8	No Occ.	...	...	...	21 19.4	−1.8	+0.6	096
Dec. 8	76 Gem	5.4	E	18.0	3 25.6	−2.4	+0.5	255	1 53.2	−1.7	+0.8	267
Dec. 12	χ Leo	4.7	E	22.1	Sun	...	...	...	5 40.3	−1.6	−0.4	288
Dec. 15	α Vir	1.2	I	25.1	3 36.1	+0.2	−1.6	171	Low	...	...	...
Dec. 15	α Vir	1.2	E	25.1	4 17.5	−1.2	+2.1	257	Low	...	...	...
Dec. 22	−20° 6178	6.7	I	03.2	17 43.1	−0.9	−0.1	054	Sun	...	...	...
Dec. 23	−15° 6180	7.1	I	04.2	No Occ.	...	...	...	18 19.0	−2.2	−1.8	109
Dec. 24	85 Aqr	6.8	I	05.2	19 59.9	—	—	344	No Occ.	...	...	...
Dec. 24	87 Aqr	7.4	I	05.3	20 52.6	—	—	342	No Occ.	...	...	...
Dec. 27	254B. Psc	7.2	I	08.3	21 15.1	−1.5	+0.3	059	20 02.8	−0.6	+2.2	016
Dec. 30	151B. Ari	6.7	I	10.6	Low	...	...	...	2 31.3	+0.3	−3.4	130

*4.3–5.1.

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	Toronto *a*	Toronto *b*	Toronto *P*	Winnipeg C.S.T.	Winnipeg *a*	Winnipeg *b*	Winnipeg *P*
				d	h m	m	m	°	h m	m	m	°
Dec. 30	23 Tau	4.2	I	11.3	20 19.2	—	—	007	No Occ.	...	...	...
Dec. 30	+23° 537	6.8	I	11.3	20 24.9	−1.7	+1.4	069	19 20.2	−0.4	+2.9	027
Dec. 30	+23° 538	7.1	I	11.3	20 36.9	−1.4	+2.1	047	Graze	...	...	...
Dec. 30	26 Tau	6.6	I	11.4	21 32.6	−2.3	−0.3	094	20 08.3	−1.1	+1.9	054
Dec. 30	+23° 563	6.1	I	11.4	No Occ.	...	...	...	20 33.4	−2.1	−0.1	105
Dec. 30	27 Tau *m*	3.8	I	11.4	21 50.3	−1.8	+1.4	056	20 46.0	−0.2	+4.3	010
Dec. 30	28 Tau	5.2	I	11.4	22 02.1	−1.6	+2.3	037	No Occ.	...	...	...
Dec. 30	+23° 569	6.8	I	11.4	22 25.2	−2.6	−3.1	123	20 42.7	−1.6	+1.0	079
Dec. 30	+23° 570	6.8	I	11.4	22 59.5	−2.1	−2.0	110	21 21.3	−1.7	+0.8	074
Dec. 31	+24° 599	6.4	I	11.5	2 58.4	−0.5	−0.6	062	1 41.2	−1.0	−0.4	057

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1968

Date	Star	Mag.	I or E	Age of Moon	Edmonton M.S.T.	Edmonton *a*	Edmonton *b*	Edmonton *P*	Vancouver P.S.T.	Vancouver *a*	Vancouver *b*	Vancouver *P*
				d	h m	m	m	°	h m	m	m	°
Jan. 2	37 Cap	5.8	I	02.9	Low	...	...	...	17 28.9	−1.7	−1.8	107
Jan. 3	−15° 6208	7.1	I	03.9	17 17.4	−0.5	+0.6	025	Sun	...	...	...
Jan. 5	74B. Psc	6.8	I	06.0	21 40.2	−0.8	−2.3	100	20 39.2	−1.4	−2.7	107
Jan. 8	+13° 351	7.4	I	09.1	22 15.5	−1.1	−0.8	074	21 04.6	−1.6	−0.6	080
Jan. 9	45 Ari	5.9	I	10.0	20 21.8	−1.3	+1.2	053	19 03.2	−1.2	+1.7	051
Jan. 10	+22° 572	6.9	I	11.1	23 47.0	−1.1	−2.2	108	22 44.6	−1.7	−3.7	126
Jan. 11	33 Tau	6.0	I	11.3	3 52.0	−0.3	−0.3	038	2 51.7	−0.2	−0.8	060
Jan. 11	+24° 663	7.3	I	12.0	18 32.4	0.0	+3.0	024	17 22.3	+0.5	+3.2	016
Jan. 22	86 Vir	5.8	E	22.4	7 11.2	−1.1	−0.9	303	6 00.6	−1.6	−0.4	286
Jan. 24	169B. Lib	5.8	E	24.4	7 25.4	−0.8	−0.4	326	6 17.0	−1.0	0.0	308
Jan. 24	177B. Lib	6.2	E	24.5	No Occ.	...	...	...	6 48.8	−0.4	−0.9	345
Feb. 5	36 Ari	6.5	I	07.6	No Occ.	...	...	...	23 06.1	−0.7	+0.8	027
Feb. 6	63 Ari	5.2	I	08.4	17 52.9	−1.7	+0.5	091	Sun	...	...	...
Feb. 6	65 Ari	5.9	I	08.4	19 17.1	—	—	135	Graze	...	...	...
Feb. 8	332B. Tau	6.6	I	10.4	18 13.6	—	—	136	Sun	...	...	...
Feb. 10	+27° 1296	7.2	I	12.5	19 28.2	−1.5	−0.7	136	18 15.9	−1.6	−0.9	142
Feb. 11	47 Gem	5.6	I	12.6	1 12.6	−0.6	−2.3	129	0 19.4	−0.3	−3.7	156
Feb. 11	+27° 1337*m*	6.4	I	12.7	No Occ.	...	...	...	0 58.1	—	—	038
Feb. 11	134B. Gem	6.5	I	12.7	3 48.2	−0.2	−1.6	093	2 53.2	−0.2	−1.8	110
Feb. 11	ω Cnc	5.9	I	13.5	20 37.1	−1.1	+1.8	075	19 20.4	−0.9	+1.6	084
Feb. 11	4 Cnc	6.2	I	13.5	21 13.4	−1.3	−0.9	135	20 04.7	−1.5	−9.9	151
Feb. 14/15	53 Leo	5.3	E	16.6	0 47.2	−1.2	−0.5	300	23 33.6	−1.5	+0.6	277
Mar. 5	36 Tau	5.7	I	07.0	23 57.2	−0.4	−0.4	042	22 56.3	−0.4	−0.9	064
Mar. 7	406B. Tau	5.6	I	09.0	No Occ.	...	...	...	23 14.2	−1.2	−0.2	051
Mar. 8	136 Tau	4.5	I	09.0	1 11.5	+0.1	−1.8	106	0 21.0	+0.2	−2.2	126
Mar. 8	+27° 1219	6.8	I	10.0	23 23.6	−0.8	−1.5	095	22 21.7	−0.9	−2.0	116
Mar. 9	+27° 1270	7.0	I	10.1	Low	...	...	...	3 07.0	+0.3	−1.3	091
Mar. 9/10	76 Gem	5.4	I	11.0	0 36.2	−0.1	−2.6	145	23 52.0	—	—	178
Mar. 17	621B. Vir	6.4	E	18.2	4 56.4	−0.9	−1.3	319	3 50.8	−1.2	−1.1	308
Apr. 5	+27° 1362	6.9	I	08.3	22 28.0	−0.3	−2.3	128	21 36.5	0.0	−3.3	153
Apr. 6	+26° 1564	7.2	I	08.4	Low	...	...	...	1 43.1	+1.2	−2.4	168
Apr. 7	λ Cnc	5.9	I	09.4	1 18.7	0.0	−1.7	108	0 25.9	0.0	−1.9	123
Apr. 9	+15° 2167	7.2	I	11.4	1 44.7	−0.6	−1.6	085	0 44.1	−0.8	−1.6	101
Apr. 9	53 Leo	5.3	I	12.2	19 41.9	−0.9	−0.5	137	Sun	...	...	...
May 2	+27° 1296	7.2	I	05.5	21 29.1	+0.2	−2.5	138	20 45.2	+0.9	−4.0	167
May 3/4	4 Cnc	6.2	I	06.6	0 20.4	0.0	−1.3	073	23 26.0	0.0	−1.4	087
May 7	σ Leo	4.1	I	10.6	21 50.4	−0.1	−2.3	175	No Occ.	...	...	...
May 29	+27° 1236	6.6	I	02.9	22 03.1	+0.5	−1.5	115	21 15.0	+0.6	−1.8	130
May 30	76 Gem	5.4	I	03.9	22 26.6	0.0	−1.2	065	21 31.5	0.0	−1.3	080
June 2	37 Leo	5.7	I	06.9	22 01.5	−0.3	−2.0	127	21 06.2	−0.3	−2.1	142
July 4	40 H. Vir	5.1	I	09.3	22 30.7	−0.9	−1.5	143	21 27.7	−0.9	−1.5	153
July 12	ε Cap	4.7	E	16.4	2 03.8	−1.2	+0.6	242	0 47.2	−1.4	+1.0	248
Aug. 5	183B. Sgr	6.2	I	11.8	Low	...	...	...	22 32.3	−1.6	−0.1	089
Aug. 12	ζ Psc	5.6	E	18.8	23 54.2	−0.1	+2.1	210	22 44.9	0.0	+2.1	215
Aug. 12	+6° 175	6.5	E	18.8	23 54.9	−0.1	+2.1	210	22 45.6	0.0	+2.1	214
Aug. 14	12 H.[1] Ari	6.3	E	19.9	1 50.8	—	—	171	0 44.4	+0.3	+2.7	185
Aug. 14	36 Ari	6.5	E	20.8	23 32.9	+0.4	+2.0	203	Low	...	...	...
Aug. 15	40 Ari	6.0	E	20.9	1 51.6	+0.1	+2.5	201	0 43.1	+0.1	+2.3	209
Aug. 20	47 Gem	5.6	E	25.9	2 57.6	+0.4	+1.6	255	Low	...	...	...
Sept. 4	κ Cap	4.8	I	12.2	21 39.9	−1.2	+1.0	066	20 22.7	−1.2	+1.4	063

Date	Star	Mag.	I or E	Age of Moon	Edmonton				Vancouver			
					M.S.T.	*a*	*b*	*P*	P.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Sept. 9	171B. Psc	6.3	E	16.4	2 46.6	−1.7	−0.1	264	1 27.5	−2.1	+0.3	271
Sept. 11	ζ Ari	5.0	E	19.3	23 34.1	−0.6	+1.5	283	22 23.2	−0.4	+1.3	291
Sept. 12	36 Tau	5.7	E	20.3	23 05.4	+0.7	+2.2	200	22 03.6	+0.7	+2.0	206
Sept. 14	406B. Tau	5.6	E	22.3	23 59.4	0.0	+1.2	293	Low	...	...	...
Sept. 17	76 Gem	5.4	E	24.4	1 53.8	+0.3	+1.7	254	Low	...	...	...
Sept. 28	δ Sgr	2.8	E	06.6	Low	...	...	...	18 00.4	—	—	203
Oct. 1	33 Cap	5.5	I	09.7	19 51.8	−1.7	+0.6	108	18 32.8	−1.5	+1.0	104
Oct. 2	143B. Aqr	6.6	I	10.7	19 04.2	—	—	137	Sun	...	...	...
Oct. 6	*147B. Psc	5.8	I	14.0	4 56.2	−0.3	+1.5	010	3 47.6	−0.5	+1.0	023
Oct. 6	*147B. Psc	5.8	E	14.0	5.35.5	−0.3	−2.9	292	4 41.3	−0.5	−1.9	275
Oct. 9	104B. Tau	5.5	E	17.8	23 48.6	−0.5	+2.2	232	22 36.2	−0.3	+2.0	238
Oct. 9/10	+23° 563	6.1	E	17.9	0 47.1	−1.2	+1.4	262	23 30.0	−1.1	+1.5	268
Oct. 10	+24° 599	6.4	E	18.0	Sun	...	...	...	4 38.9	−1.6	−1.0	270
Oct. 11/12	107B. (Aur)	6.5	E	19.9	1 01.8	+0.5	+4.1	198	23 52.3	+0.6	+3.3	204
Oct. 13	49 Aur	5.0	E	21.0	4 15.6	−1.4	+1.2	259	2 56.1	−1.2	+1.9	251
Oct. 15	λ Cnc	5.9	E	23.0	3 06.2	−0.6	+1.9	262	1 54.3	−0.2	+1.9	257
Oct. 19	Jupiter	−1.3	I	27.1	4 28.8	0.0	+1.7	089	Low	...	...	...
Oct. 19	Jupiter	−1.3	E	27.1	5 19.1	−0.2	−0.3	329	4 17.4	−0.1	+0.2	313
Oct. 29	29 Aqr *m*	6.5	I	08.2	19 13.0	−2.2	0.0	114	17 51.2	−1.8	+0.8	105
Nov. 1	44 Psc	6.0	I	11.3	21 55.0	−0.1	+2.3	003	20 46.3	—	—	348
Nov. 6	χ Tau	5.5	E	16.4	23 11.7	−1.6	+0.5	292	21 53.5	−1.6	+0.6	299
Nov. 10	+27° 1337*m*	6.4	E	19.6	4 43.2	−1.4	−1.2	296	3 29.4	−1.8	−0.1	278
Nov. 11	4 Cnc	6.2	E	20.5	2 16.4	−1.1	+1.0	279	1 01.4	−0.8	+1.4	272
Nov. 29	171B. Psc	6.3	I	09.9	22 30.4	−1.6	−0.9	089	21 14.9	−2.0	−0.2	086
Dec. 2	ζ Ari	5.0	I	12.8	20 04.4	−0.8	+1.8	067	18 50.3	−0.5	+2.0	060
Dec. 7/8	76 Gem	5.4	E	18.0	0 33.0	−1.2	+0.9	280	23 17.2	−1.0	+1.4	272
Dec. 11	37 Leo	5.7	E	21.1	No Occ.	...	...	...	1 08.8	−0.7	−2.6	353
Dec. 12	χ Leo	4.7	E	22.1	4 16.7	−1.4	+0.8	277	2 55.0	−1.6	+2.9	250
Dec. 13	β Vir	3.8	E	23.1	No Occ.	...	...	...	1 57.1	−0.2	−1.6	350
Dec. 26	147B. Psc	5.8	I	07.5	23 17.6	−0.7	−2.7	107	22 22.0	—	—	124
Dec. 28	19 Ari	6.0	I	09.4	19 11.8	—	—	121	17 47.0	−2.2	+0.5	108
Dec. 29	+16° 281	6.8	I	09.6	1 55.1	−0.6	+1.0	018	0 47.0	−0.7	+0.1	041
Dec. 30	151 B. Ari	6.7	I	10.6	1 17.7	−0.4	−3.6	126	No Occ.	...	...	...
Dec. 30	104B. Tau	5.5	I	11.4	18 23.6	−1.3	+1.0	109	17 07.7	−0.9	+1.4	101
Dec. 30	26 Tau	6.6	I	11.4	19 06.9	−0.1	+3.0	023	17 55.4	+0.3	+3.2	015
Dec. 30	+23° 563	6.1	I	11.4	19 12.8	−1.0	+1.6	074	17 57.1	−0.7	+1.9	069
Dec. 30	+23° 569	6.8	I	11.4	19 29.7	−0.8	+2.1	051	18 14.6	−0.4	+2.3	045
Dec. 30	+23° 570	6.8	I	11.4	20 06.6	−0.9	+2.2	046	18 50.0	−0.6	+2.4	042
Dec. 30/31	+24° 599	6.4	I	11.5	0 22.2	−1.3	+0.3	052	23 07.0	−1.6	+0.2	065

*During Total Lunar Eclipse.

PLANETARY APPULSES AND OCCULTATIONS

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

ASTEROIDS—EPHEMERIDES AT OPPOSITION, 1968

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 brighest 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.

Ephemerides for the four brightest asteroids are given when the asteroids are near opposition, along with maps for Ceres and Vesta. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.

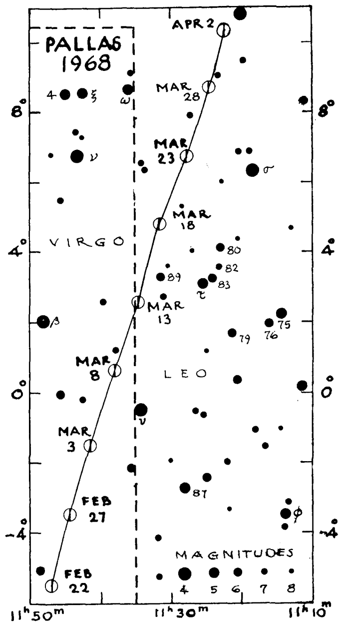
During 1968 the very faint asteroid, Icarus, comes within about four million miles of the earth on June 15. The orbit of Icarus is the smallest among the asteroids: it passes inside the orbit of Mercury; its eccentricity is 0.83 (highest) and its inclination 23°. This year Icarus also passes close to Mercury and the perturbations caused by this planet may lead to an improved value of the mass of Mercury.

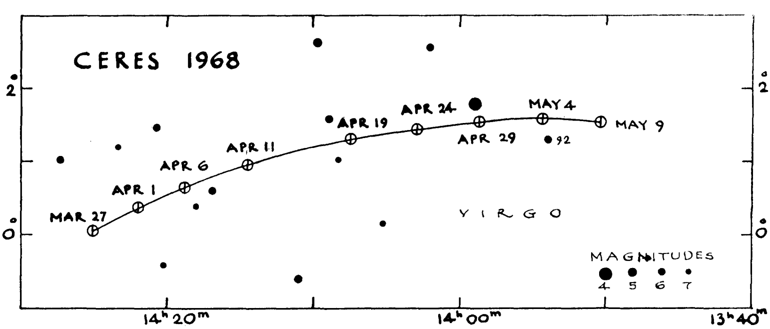
PALLAS (No. 2)
Opp. Mar. 13 in Vir   Mag. 6.9

	h m	
Feb. 22	11 47.0	−5°24′
27	11 44.4	−3 31
Mar. 3	11 41.4	−1 31
8	11 38.0	+0 33
13	11 34.5	+2 39
18	11 31.1	+4 43
23	11 27.8	+6 44
28	11 24.8	+8 37
Apr. 2	11 22.2	+10 23

CERES (No. 1)
Opp. Apr. 19 in Vir   Mag. 6.6

	h m	° ′
Mar. 30	14 23.4	+0 15
Apr. 4	14 19.9	+0 34
9	14 16.1	+0 51
14	14 11.9	+1 06
19	14 07.5	+1 19
24	14 03.1	+1 28
29	13 58.7	+1 35
May 4	13 54.4	+1 37
9	13 50.5	+1 34





JUNO (No. 3)
Opp. Apr. 25 in Vir   Mag. 10.0

	h m	
Apr. 5	14 44.4	−2°59′
10	14 41.1	−2 23
15	14 37.5	−1 48
20	14 33.7	−1 14
25	14 29.8	−0 41
30	14 25.7	−0 11
May 5	14 21.8	+0 16
10	14 17.9	+0 40
15	14 14.3	+1 00

VESTA (No. 4)
Opp. Oct. 20 in Cet   Mag. 6.4

	h m	° ′
Sept. 30	2 15.3	+1 32
Oct. 5	2 11.5	+1 04
10	2 07.2	+0 36
15	2 02.6	+0 10
20	1 57.8	−0 15
25	1 52.9	−0 36
30	1 48.1	−0 54
Nov. 4	1 43.6	−1 08
9	1 39.4	−1 16

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 kilometers 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 1968. Although in 1968 we have passed the current Leonid peak, the shower should still be above average strength. This year the full moon will handicap observations of the Perseids, the best summer show for amateur observation.

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 1968

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Velocity	Normal Duration to ¼ strength of Max.
				Position at Max.		Daily Motion				
	Date	E.S.T.	Moon	R.A.	Dec.	R.A.	Dec.			
				h m	°	m	°		km/sec	days
Quadrantids	Jan. 3	17^h	F.Q.	15 28	+50	—	—	40	41	1.1
Lyrids	Apr. 21	18	L.Q.	18 16	+34	+4.4	0.0	15	48	2
η Aquarids	May 4	20	F.Q.	22 24	00	+3.6	+0.4	20	64	3
δ Aquarids	July 29	—	F.Q.	22 36	−17	+3.4	+0.17	20	40	—
Perseids	Aug. 11	21	F.M.	03 04	+58	+5.4	+0.12	50	60	4.6
Orionids	Oct. 20	23	N.M.	06 20	+15	+4.9	+0.13	25	66	2
Taurids	Nov. 5	—	F.M.	03 32	+14	+2.7	+0.13	15	28	—
Leonids	Nov. 16	19	L.Q.	10 08	+22	+2.8	−0.42	25	72	—
Geminids	Dec. 13	13	L.Q.	07 32	+32	+4.2	−0.07	50	35	2.6
Ursids	Dec. 22	07	N.M.	14 28	+76	—	—	15	34	2

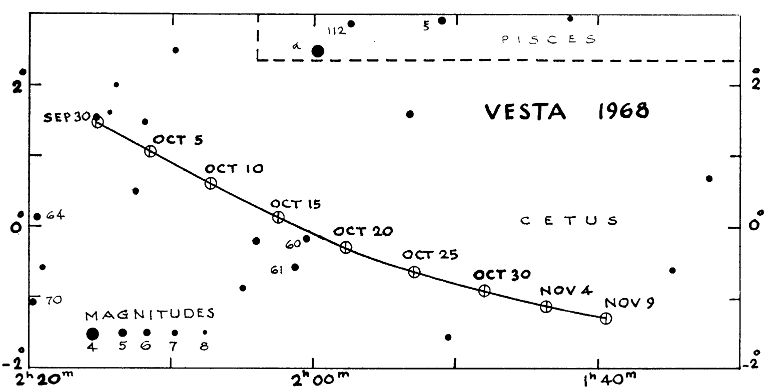


TABLE OF PRECESSION FOR 50 YEARS

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

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		
	h m	° ′				″		l.y.	″	km./sec.		
α Tri	01 51.4	+29 26	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	*−12.6*		
ε Cas	52.2	+63 31	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1		
β Ari	53.0	+20 40	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	*−01.9*		
α Hyi	57.8	−61 43	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07		
γ And *A*	02 02.1	+42 11	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″	γ And = *Almach*
α UMi *A*	02.5	+89 08	1.99v	+0.60v	F8 Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11^m 4.0^d, *B* 8.9^m 18″	*Polaris*
α Ari	05.5	+23 19	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3		*Hamal*
β Tri	07.8	+34 51	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+09.9*		
o Cet *A*	17.8	−03 07	2.0v		(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332^d, *B* 10^m 1″	*Mira*
γ Cet *AB*	41.7	+03 07	3.48	+0.11	A2 V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″	
θ Eri *AB*	57.1	−40 25	2.92	+0.13	*A3 V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″	*Acamar*
α Cet	03 00.7	+03 58	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9		*Menkar*
γ Per	02.6	+53 23	2.91:	+0.72:	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 01.7m; Dec. +89° 07′ (1968).**

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* 14ᵐ 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. 3.4ᵐ min. 4.8ᵐ, 35.52ᵈ	
υ Car *AB*	46.4	−64 56	2.95	+0.26	*A7 II*	0.020	−2.1	340	0.012	+13.6	*A* 3.02ᵐ *B* 6.03ᵐ 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* 8.1ᵐ 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* 2.29ᵐ *B* 3.54ᵐ 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* 2.7ᵐ *B* 7.2ᵐ 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* 1.88ᵐ *B* 4.82ᵐ 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* 4.90^m 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* 8.26^m 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* 2.9^m *B* 2.9^m 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0	V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3*	*V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 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* 5.61^m 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* 3.94^m 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, 4.0^d	**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 (h m)	Dec. (° ′)	V	$B-V$	Type	π (″)	M_V	D (l.y.)	μ (″)	R (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* 2.78^m *B* 5.04^m 1″, *C* 4.93^m 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, 0.25^d, *B* 8.49^m 20″
η Dra *A*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 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* 0.86^m–1.02^m *B* 5.07^m 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* 2.91^m *B* 5.46^m 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, 1.4^d
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* 3.0^m *B* 3.4^m 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* 3.2^m ± 0.3 *B* 5.4^m 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* 10^m 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* 11.49^m 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 1968. 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		Dec. 1970		Magnitudes			Sep. 1968.0	P.A. 1968.0	P (app.)
			h	m	°	′	comb.	A	B	″	°	years
λ	Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	178	640
α	Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.9	290	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	253	1,100
Σ	1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	235	220
35	Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.9	154	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	2.8	358	1,200
ϵ^2	Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.2	97	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	11.3	300	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	10.9	72	50
α	Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	139	420
ζ	Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.1	337	60
ζ	Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.6	82	1,150
+42° 1956		KUI	08	58.7	+41	53	3.9	4.1	6.2	0.5	252	22
γ	Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.4	122	620
ξ	U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	2.8	127	60
γ	Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.7	304	170
Σ	1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.2	150	155
ζ	Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.2	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	0.6	277	35
α	Her AB	10418	17	13.3	+14	26	3.1*	3.2	5.4	4.6	108	—
Σ	2173	10598	17	28.8	−01	02	5.3	6.0	6.1	0.8	147	45
70	Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	2.8	66	88
β	648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.6	190	60
4	Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	6	150
τ	Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	0.9	194	50
Σ	3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.5	292	800

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

THE NEAREST STARS

By R. M. Petrie* and Jean K. McDonald

Perhaps the most difficult problem in observational astronomy is the determination of the distances to the stars. The reason, of course, is that the distances are so enormous as to require the measurement of vanishingly small angular displacements. As the earth goes in its orbit around the sun the stars show a small change in their positions and it is this small apparent movement which is called the annual parallax. If we can measure the parallax we can at once calculate the distance to the star concerned.

Astronomers speak of stellar distances in terms of light-years or, alternatively, parsecs. A light-year is the distance light travels in one year with its speed of 186,000 miles per second. If we know the parallax in seconds of arc we obtain the distance in light-years by dividing 3.26 by the parallax. Thus the star Sirius, which has an annual parallax of 0.″375, is 8.7 light-years distant. The reciprocal of the parallax gives the distance in parsecs; Sirius is 2.7 parsecs from the sun.

The apparent motion, per year, of a star across the sky, called proper motion, is a good indication of a star's distance. Obviously, the nearer stars will appear to move more rapidly than their more distant fellows and this fact has many times been instrumental in the discovery of nearby stars.

The table accompanying this note lists, in order of distance, all known stars within sixteen light-years. Including the sun it contains fifty-five stars, but it does not contain the unseen companions of double and multiple stars entered in the table. The table is taken from a paper by Professor van de Kamp, published in 1953. In addition to the name and position for each star, the table gives spectral type, Sp.; parallax, π; distance in light-years, D; proper motion in second of arc per year, μ; total velocity with respect to the sun in km./sec., W; apparent visual magnitude, m; and finally, luminosity in terms of the sun, L. In column four, *wd* indicates a white dwarf, and *e* indicates an emission-line star.

The stars within sixteen light-years form an important astronomical table because the annual parallaxes are large enough to be well determined. This means that we have accurate knowledge of the distances, speeds, and luminosities of these stars. Furthermore this sample is probably quite representative of the stellar population in our part of the galaxy, and as such is well worth our study.

It is interesting to note that most of the stars are cool red dwarfs, of type M. This must be the most populous of all the stellar varieties. Only ten of these nearby stars are bright enough to be seen with the unaided eye (magnitude less than five). Only three stars, Sirius, Altair, and Procyon, are brighter than the sun while the great majority are exceedingly faint. Not one giant star is contained in the list nor is there a B-type star. This is a consequence of the extreme rarity of very hot and very bright stars. One may conclude that stars brighter than the sun are very scarce.

Another striking fact is the prevalence of double and multiple stars, there being sixteen such systems if we count unseen components. Obviously double and multiple stars are quite common in the stellar population, and must be explained by any acceptable theory of stellar formation and evolution.

*Deceased

THE NEAREST STARS

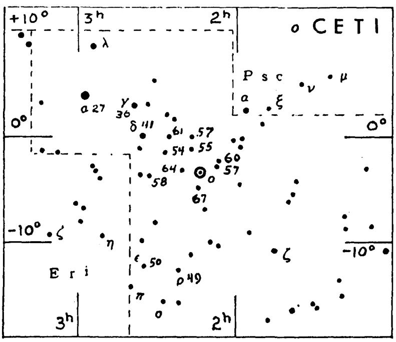
Star	1970 α		δ		Sp.	π	D	μ	W	m	L
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G2					−26.9	1.0
α Cen A	14	37	−60	43	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	27	−62	33	M5*e*					11	0.000052
Barnard's *	17	56	+4	36	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	55	+7	13	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726–8A	1	37	−18	07	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B					M6*e*					13.0	0.00003
Lal. 21185*	11	02	+36	10	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6	44	−16	41	A1	.375	8.7	1.32	18	−1.4	23.
B					*wd*					7.1	0.008
Ross 154	18	48	−23	51	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23	40	+44	01	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ϵ Eri	3	32	−9	34	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11	46	+1	01	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21	06	+38	36	K6	.293	11.1	5.22	106	5.6	0.052
B					M0					6.3	0.028
Luy. 789–6	22	37	−15	31	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7	38	+5	18	F5	.288	11.3	1.25	20	0.4	5.8
B					*wd*					10.8	0.00044
ϵ Ind	22	02	−56	55	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18	42	+59	35	M4	.280	11.6	2.29	38	8.9	0.0028
B					M4					9.7	0.0013
Groom. 34 A	0	17	+43	51	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B					M4*e*					10.9	0.00044
τ Ceti	1	43	−16	06	G8	.275	11.8	1.92	37	3.5	0.36
Lac. 9352	23	04	−36	02	M2	.273	11.9	6.87	118	7.2	0.013
BD +5°1668	7	26	+5	28	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21	15	−39	00	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5	11	−45	00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22	27	+57	33	M4	.249	13.1	0.87	29	9.9	0.0013
B					M5*e*					11.4	0.00033
Ross 614 A	6	28	−2	48	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B					?					14.8	0.000016
BD−12°4523	16	29	−12	35	M5	.244	13.4	1.24	27	10.0	0.0013
van Maanen's	0	47	+5	16	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12	32	+9	12	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B					M6*e*					12.6	0.00014
Groom. 1618	10	09	+49	36	K5	.222	14.7	1.45	41	6.8	0.030
CD−37°15492	0	03	−37	30	M3	.219	14.9	6.09	134	8.6	0.0058
CD−46°11540	17	27	−46	53	M4	.213	15.3	1.15		9.7	0.0023
BD+20°2465*	10	18	+20	01	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD−44°11909	17	36	−44	17	M5	.209	15.6	1.14		11.2	0.00058
CD−49°13515	21	31	−49	08	M3	.209	15.6	0.78		9	0.0044
AOe 17415–6	17	37	+68	22	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22	51	−14	25	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13	44	+15	04	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11	44	−64	39	*wd*	.203	16.0	2.69		11	0.0008
o^2 Eri A	4	14	−7	42	K0	.200	16.3	4.08	105	4.5	0.30
B					*wd*A					9.2	0.0040
C					M5*e*					11.0	0.0008
70 Oph A	18	04	+2	31	K1	.199	16.4	1.13	28	4.2	0.40
B					K5					5.9	0.083
Altair	19	49	+8	47	A7	.198	16.5	0.66	31	0.8	8.3
BD+43°4305	22	46	+44	11	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11	45	+78	50	M4	0.196	16.6	0.87	121	11.0	0.0008

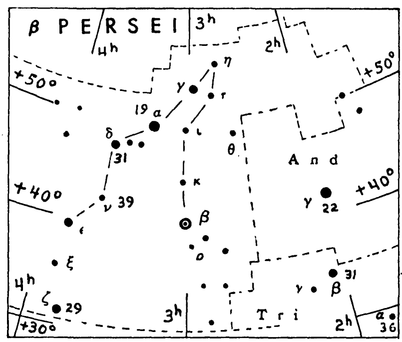
*Star has an unseen component.

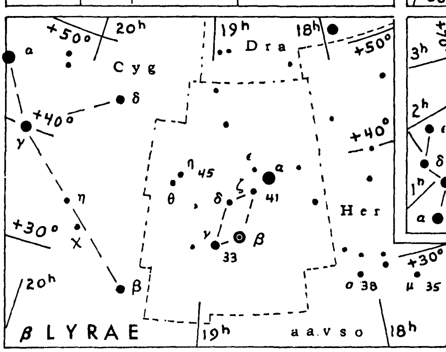
VARIABLE STARS

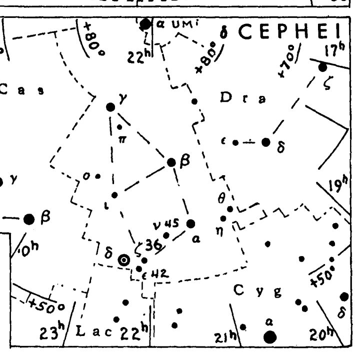
Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 36 is of mag. 3.6. Use two comparison stars, one brighter and one fainter than the variable, and estimate the 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*, 1967, International Supplement.









LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1968	Variable	Max. m	Per d	Epoch 1968
001755 T Cas	7.8	445	Sept. 19	143227 R Boo	7.2	223	July 16
001838 R And	7.0	409	Dec. 30	151731 S CrB	7.3	361	Mar. 4
021143 W And	7.4	397	Apr. 15	154639 V CrB	7.5	358	Dec. 17
0214*03* o Cet	3.4	332	Sept. 20	154615 R Ser	6.9	357	Dec. 5
0228*13* U Cet	7.5	235	June 19	160625 RU Her	8.0	484	Aug. 13
023133 R Tri	6.2	266	Sept. 26	162119 U Her	7.5	406	Aug. 4
043065 T Cam	8.0	374	Nov. 13	1621*12* V Oph	7.5	298	June 20
0455*14* R Lep	6.8	432	Mar. 24	163266 R Dra	7.6	245	Aug. 30
050953 R Aur	7.7	459	Mar. 12	164715 S Her	7.6	307	Oct. 17
054920 U Ori	6.3	372	July 2	1702*15* R Oph	7.9	302	June 28
0617*02* V Mon	7.0	335	Feb. 7	171723 RS Her	7.9	219	Jan. 29
065355 R Lyn	7.9	379	Jan. 8	180531 T Her	8.0	165	Jan. 15
070122aR Gem	7.1	370	May 2	181136 W Lyr	7.9	196	Mar. 17
070310 R CMi	8.0	338	May 4	183308 X Oph	6.8	334	Oct. 15
072708 S CMi	7.5	332	Jan. 26	190108 R Aql	6.1	300	July 24
081112 R Cnc	6.8	362	Jan. 30	1910*17* T Sgr	8.0	392	Oct. 23
081617 V Cnc	7.9	272	Mar. 31	1910*19* R Sgr	7.3	269	Jan. 4
084803 S Hya	7.8	257	Jan. 24	193449 R Cyg	7.5	426	Feb. 3
0850*08* T Hya	7.8	288	Jan. 2	194048 RT Cyg	7.3	190	May 29
093934 R LMi	7.1	372	Jan. 13	194632 χ Cyg	5.2	407	July 19
094211 R Leo	5.8	313	Sept. 24	200938 RS Cyg	7.2	418	Dec. 22
103769 R UMa	7.5	302	Jan. 27	201647 U Cyg	7.2	465	Apr. 18
1214*18* R Crv	7.5	317	Mar. 9	2044*05* T Aqr	7.7	202	Feb. 27
122001 SS Vir	6.8	355	Feb. 21	210868 T Cep	6.0	390	Feb. 10
123160 T UMa	7.7	257	Apr. 30	213753 RU Cyg	8.0	234	July 10
123307 R Vir	6.9	146	May 23	230110 R Peg	7.8	378	Nov. 12
123961 S UMa	7.8	226	Jan. 31	230759 V Cas	7.9	228	Apr. 19
131546 V CVn	6.8	192	Jan. 24	231508 S Peg	8.0	319	Jan. 12
1327*06* S Vir	7.0	378	Oct. 31	2338*15* R Aqr	6.5	387	July 31
134440 R CVn	7.7	328	Apr. 23	235350 R Cas	7.0	431	Dec. 2
142584 R Cam	7.9	270	Mar. 4	2357*15* W Cet	7.6	351	May 3
142539 V Boo	7.9	258	Feb. 1				

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1968 E.S.T.
005381 U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 1.41*
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. 2.42*
035512 λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 4.70*
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. 9.43
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 2.11
154428 R Cr B	5.8	14.8	R Cr B	cFpep		
171014 α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	
1842*05* R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633 β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 2.52*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.16
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 3.68
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 3.04

*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 h m	δ ° ′	P	D	m	r	Sp	Remarks
188	00 41.0	+85 11	9.3	14	14.6	1.55	f5	oldest known
752	01 56.0	+37 32	6.6	45	9.6	0.38	f0	
869	02 16.9	+57 01	4.3	30	9.5	2.26	b0	h Per
884	02 20.3	+56 59	4.4	30	9.5	2.41	b0	χ Per, M supergiants
Perseus	03 20	+48 30	2.3	240	5	0.17	b3	moving cl., α Per
Pleiades	03 45.3	+24 02	1.6	120	4.2	0.125	b7	M45, best known
Hyades	04 18	+15 34	0.8	400	*1.5*	0.040	a2	moving cl. in Tau*
1912	05 26.6	+35 49	7.0	18	9.7	1.37	b8	
1976/80	05 33.9	−05 24	2.5	50	*5.5*	0.42	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				P	D	m	r	Sp	Remarks
	h	m	°	′						
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	*0.29*	*b3*	
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	O supergiants, 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	*0.41*	*b9*	
6705	18	49.5	−06	19	6.8	12.5	12	1.72	b8	M11, very rich cl.
Me1227	20	06.7	−79	25	5.2	60	*9*	*0.24*	*b9*	
IC1396	21	38.0	+57	22	5.1	60	*8.6*	*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				B	D	Sp	m	N	r	V
		h	m	°	′							
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

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

NGC	M	Con	α 1970 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 40.3	+51 25	Pl	1.5	11	17	15,000	
1952	1	Tau	05 32.7	+22 00		6	11	16	4,100	Crab
1976	42	Ori	05 33.8	−05 25	Dif	30			1,800	Orion
B33		Ori	05 39.4	−02 29	Drk	4			300	Horsehead
2261		Mon	06 37.5	+08 45	Dif	2				Hubble's var.
2392		Gem	07 27.4	+20 59	Pl	0.3	8	10	2,800	
2440		Pup	07 40.5	−18 08	Pl	0.9	11	16	8,600	
3587	97	UMa	11 13.1	+55 11	Pl	3.3	11	14	12,000	Owl
		Cru	12 50	−63	Drk	300			300	Coalsack
6210		Her	16 43.2	+23 51	Pl	0.3	10	12	5,600	
B72		Oph	17 21.8	−23 36	Drk	20			400	S nebula
6514	20	Sgr	18 00.6	−23 02	Dif	24			3,200	Trifid
B86		Sgr	18 01.1	−27 53	Drk	5				
6523	8	Sgr	18 01.8	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 37	Pl	0.4	9	11	3,500	
6572		Oph	18 10.7	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 13.8	−18 15	Drk	15				
6618	17	Sgr	18 19.1	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.5	+33 00	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 44.0	+50 27	Pl	0.4	9	11	3,400	
6853	27	Vul	19 58.3	+22 38	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 44.4	+30 36	Dif	60				Network
7000		Cyg	20 57.8	+44 12	Dif	100				N. America
7009		Aqr	21 02.5	−11 30	Pl	0.5	8	12	3,000	
7662		And	23 24.5	+42 22	Pl	0.3	9	13	3,900	

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

This table lists most of the strongest sources of radio emission as well as a representative number of sources with interesting properties. Although most of these have been identified with optical objects, it should be remembered that many of the weaker sources remain unidentified. The flux, which is a measure of the intensity of the source, is given in units of 10^{-26} watts/metre^2/cycle per second at a frequency of 960 Mc./sec. or a wave-length of 31 cm. The relative intensities of these sources can be quite different at different frequencies. In particular Jupiter is a very strong emitter at lower frequencies. The distances are derived, in general, from measurements in the optical region. Many extra-galactic sources are double and this is indicated in the column "Approximate Radio Size" by noting the size of each individual emitting region followed by their separation, *s*.

Name	R.A. 1970 h m	Dec. ° ′	Flux	Distance thousands of l.y.	Approximate Radio Size
Tycho's S'nova	00 24.0	+63 57	57	1	6′.6
Andromeda Gal.	00 41.0	+41 06	65	2000	10°
Fornax A	03 21.2	−37 17	150	60000	18′ + 18′, *s*29′
Crab Neb., M1	05 32.6	+22 00	1030	4	5′
Orion Neb., M42	05 33.8	−05 25	360	2	4° × 3°
IC 443	06 15.5	+22 36	195	4	1.5°
Rosette Neb.	06 30.4	+04 53	24	5	1.2°
3C 273	12 27.7	+02 14	50	1500000	< 12″
Virgo A, M 87	12 29.3	+12 34	300	40000	4′.7
Centaurus A	13 23.6	−42 52	2010	10000	3°, complex
3C 295	14 10.4	+52 19	30	4500000	< 12″
3C 353	17 19.0	−00 57	84	800000	4′
Kepler's S'nova	17 29.0	−21 16	20	4	2′
Galactic Nucleus	17 44.1	−28 50	240	26	1° × 1.5°, complex
Omega Neb., M 17	18 18.6	−16 18	500	3	8′
3C 392	18 54.6	+01 17	211	?	15′
Cygnus A	19 58.4	+40 39	2160	500000	51″ + 51″, *s*1′.3
Cygnus X	20 21.5	+40 17	800	5	0°.6 × 1°.8
HB 21	20 45.6	+50 34	180	?6	1°.3
Cygnus loop	20 50.8	+29 34	252	2	2° × 2°.5
N. America Neb.	20 54.0	+43 57	350	3	1°.5 × 2°
Cassiopeia A	23 22.1	+58 38	3120	10	4′
Sun			300000		0°.6
Moon			500		0°.5
Jupiter			5		3.3 × eq. diam. 1 × polar diam.

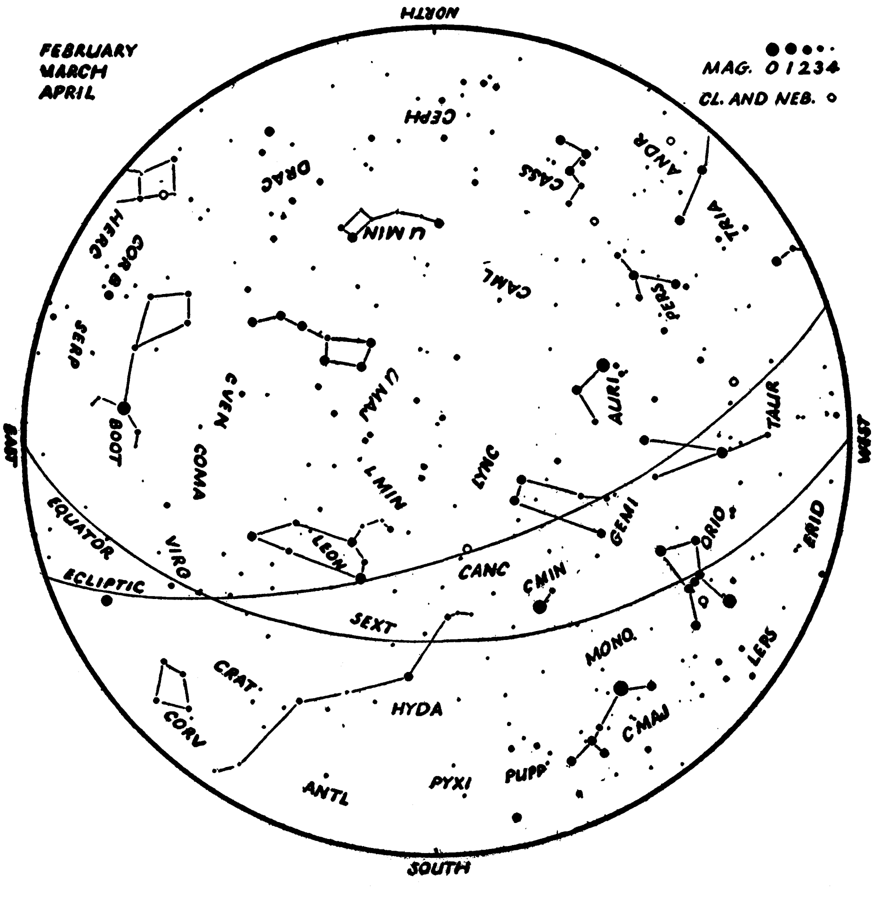
MESSIER'S CATALOGUE OF DIFFUSE OBJECTS

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	6.4	GC*
3	5272	CVn	13 40.8	+28 32	6.3	GC*
4	6121	Sco	16 21.8	−26 26	6.5	GC*
5	5904	Ser	15 17.0	+02 13	6.1	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	8.0	GC
10	6254	Oph	16 55.5	−04 04	6.7	GC*
11	6705	Sct	18 49.5	−06 19	6	OC*
12	6218	Oph	16 45.6	−01 54	7.1	GC*
13	6205	Her	16 40.6	+36 31	5.9	GC*
14	6402	Oph	17 36.0	−03 14	8.5	GC
15	7078	Peg	21 28.6	+12 02	6.4	GC*
16	6611	Ser	18 17.2	−13 48	7	OC*
17	6618	Sgr	18 19.1	−16 12		DN*
18	6613	Sgr	18 18.2	−17 09	7	OC
19	6273	Oph	17 00.7	−26 13	7.4	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	5.6	GC*
23	6494	Sgr	17 55.1	−19 00	7	OC*
24	6603	Sgr	18 16.7	−18 27	6	OC
25	4725†	Sgr	18 29.9	−19 16		OC*
26	6694	Sct	18 43.6	−09 26	8	OC
27	6853	Vul	19 58.4	+22 38	8.2	PN*
28	6626	Sgr	18 22.6	−24 52	7.6	GC
29	6913	Cyg	20 22.9	+38 25	7	OC
30	7099	Cap	21 38.6	−23 18	7.7	GC
31	224	And	0 41.1	+41 06	3.5	G-Sb*
32	221	And	0 41.1	+40 42	8.2	G-E*
33	598	Tri	1 32.2	+30 30	5.8	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	—	—		Star
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		OC*
45	—	Tau	3 45.7	+24 01		OC*
46	2437	Pup	7 40.4	−14 45	9	OC*
47	2478	Pup	7 53.3	−15 20		OC
48	—	Hya	8 12.6	−01 27		OC?
49	4472	Vir	12 28.3	+08 10	8.5	G-E*
50	2323	Mon	7 01.5	−08 18	6	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	7.8	GC
54	6715	Sgr	18 53.2	−30 31	7.8	GC
55	6809	Sgr	19 38.1	−31 01	6.2	GC*
56	6779	Lyr	19 15.4	+30 07	8.7	GC
57	6720	Lyr	18 52.5	+33 00	9.0	PN*
58	4579	Vir	12 36.2	+11 59	9.6	G-SBb
59	4621	Vir	12 40.5	+11 50	10.0	G-E
60	4649	Vir	12 42.1	+11 44	9.0	G-E
61	4303	Vir	12 20.3	+04 39	9.6	G-Sc
62	6266	Sco	16 59.3	−30 04	7.3	GC
63	5055	CVn	13 14.4	+42 11	8.6	G-Sb*
64	4826	Com	12 55.2	+21 51	8.5	G-Sb*
65	3623	Leo	11 17.3	+13 16	9.4	G-Sa
66	3627	Leo	11 18.6	+13 10	9.0	G-Sb
67	2682	Cnc	8 49.5	+11 56	7	OC*
68	4590	Hya	12 37.8	−26 35	8.2	GC
69	6637	Sgr	18 29.4	−32 23	8.0	GC
70	6681	Sgr	18 41.3	−32 19	8.1	GC
71	6838	Sge	19 52.4	+18 42	9	GC
72	6981	Aqr	20 51.8	−12 41	9.3	GC
73	6994	Aqr	20 57.3	−12 46		OC
74	628	Psc	1 35.1	+15 38	9.3	G-Sc
75	6864	Sgr	20 04.3	−22 01	8.6	GC
76	650	Per	1 40.3	+51 25	11.4	PN*
77	1068	Cet	2 41.1	−00 07	8.9	G-Sb
78	2068	Ori	5 45.3	+00 02		DN
79	1904	Lep	5 22.9	−24 33	7.5	GC
80	6093	Sco	16 15.2	−22 55	7.5	GC
81	3031	UMa	9 53.4	+69 12	7.0	G-Sb*
82	3034	UMa	9 53.6	+69 50	8.4	G-Irr*
83	5236	Hya	13 35.3	−29 43	8.3	G-Sc*
84	4374	Vir	12 23.6	+13 03	9.4	G-E
85	4382	Com	12 23.8	+18 21	9.3	G-SO
86	4406	Vir	12 24.6	+13 06	9.2	G-E
87	4486	Vir	12 29.2	+12 33	8.7	G-Ep
88	4501	Com	12 30.4	+14 35	9.5	G-Sb
89	4552	Vir	12 34.1	+12 43	10.3	G-E
90	4569	Vir	12 35.3	+13 19	9.6	G-Sb
91	—	—	—	—		comet?
92	6341	Her	17 16.2	+43 11	6.4	GC*
93	2447	Pup	7 43.2	−23 48	6	OC
94	4736	CVn	12 49.6	+41 17	8.3	G-Sb*
95	3351	Leo	10 42.3	+11 52	9.8	G-SBb
96	3368	Leo	10 45.1	+11 59	9.3	G-Sa
97	3587	UMa	11 13.1	+55 11	11.1	PN*
98	4192	Com	12 12.2	+15 04	10.2	G-Sb
99	4254	Com	12 17.3	+14 35	9.9	G-Sc
100	4321	Com	12 21.4	+15 59	9.4	G-Sc
101	5457	UMa	14 02.1	+54 30	7.9	G-Sc*
102	5866	Dra	15 05.7	+55 52		G-SO
103	581	Cas	1 31.2	+60 32	7	OC

†Index Catalogue Number.

STAR MAP I

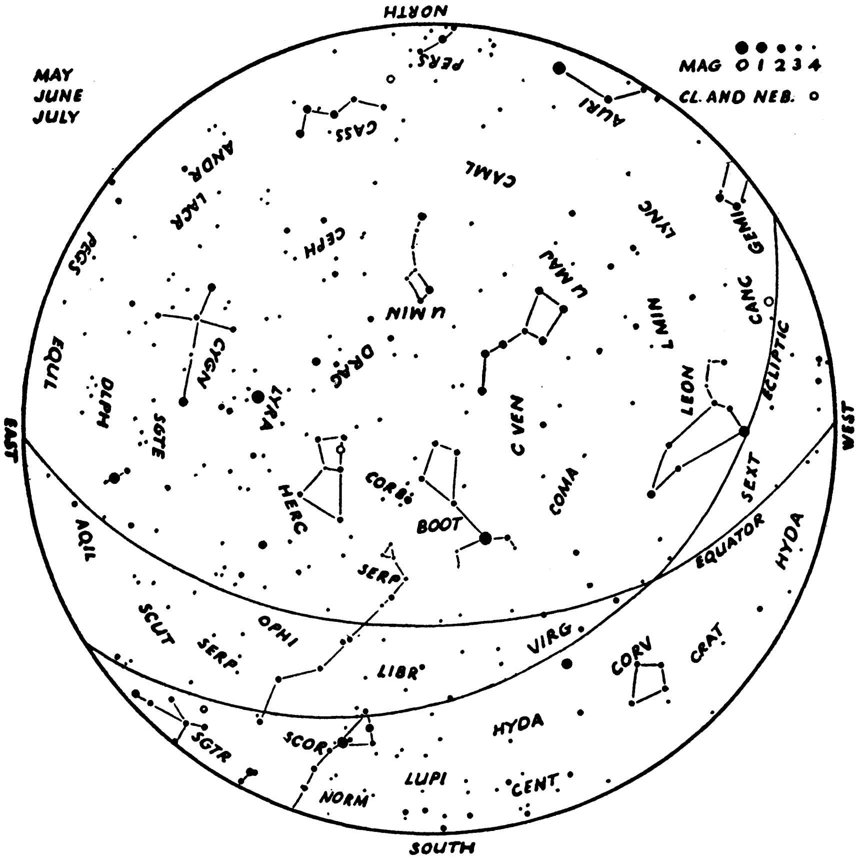


The above map represents the evening sky at

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

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

STAR MAP 2

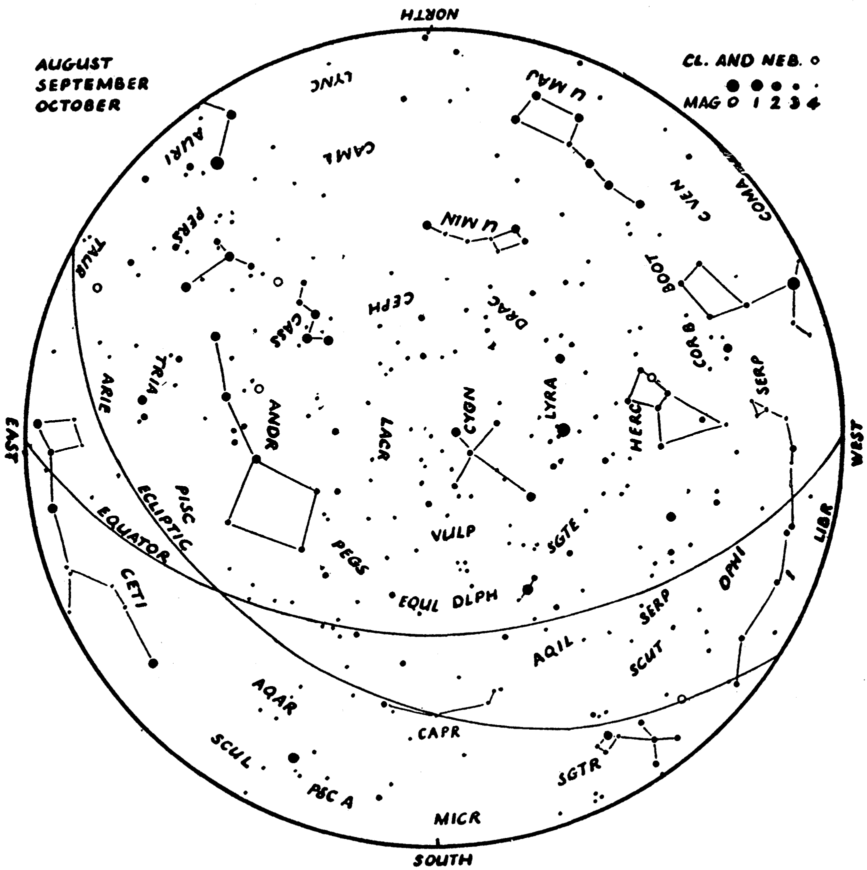


The above map represents the evening sky at

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

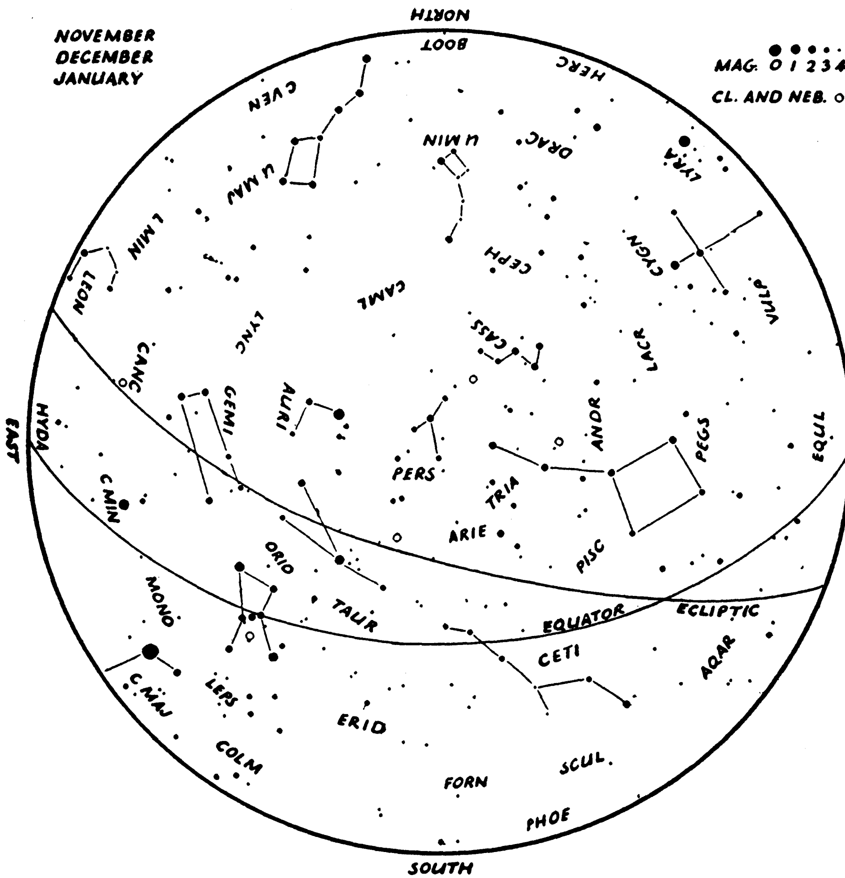


The above map represents the evening sky at

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.

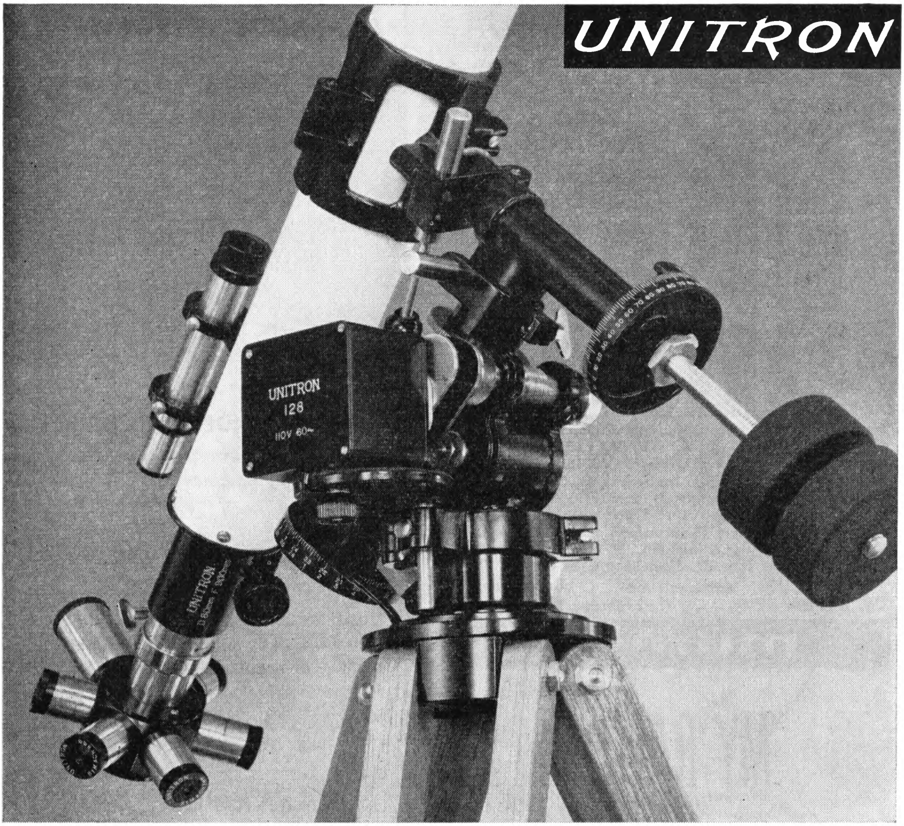
STAR MAP 4



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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4" PHOTO-EQUATORIAL — **$890**
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4" EQUATORIAL with weight-driven clock drive, metal pier, eyepieces as above — **$1075**

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

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CALENDAR 1968

Jan.

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	....	....	....
....	....	....	....	....	....	....

Feb.

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	....	....
....	....	....	....	....	....	....

Mar.

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	....	....	....
....	....	....	....	....	....	....

Aug.

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
....	....	....	....	....	....	....

Sept.

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	....	....	....	....	....
....	....	....	....	....	....	....

Oct.

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	....	....
....	....	....	....	....	....	....

Nov.

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
....	....	....	....	....	....	....

Dec.

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	....	....	....	....
....	....	....	....	....	....	....

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