THE OBSERVER'S HANDBOOK 1966

Fifty-eighth Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

T   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.

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THE OBSERVER'S HANDBOOK 1966

EDITOR
RUTH J. NORTHCOTT

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252 COLLEGE STREET, TORONTO 2B, ONTARIO

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THE OBSERVER'S HANDBOOK for 1966 is the 58th edition. Some changes in the data include the epoch for star positions from 1960 to 1970, the times of sunrise and sunset, and of twilight, for the current year instead of average values, and the table of the Central Meridian of Mercury has been replaced by an illustration of the standard Auroral forms.

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 John Booker, Peter Broughton, Barbara Gaizauskas, Helen Sawyer Hogg, Joan Reick Hube, John Scherk, Bill Sherwood, Maude Towne, Isabel Williamson and Dorothy Yane. 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, 1966

New Year's Day	Sat.	Jan.	1
Epiphany	Thu.	Jan.	6
Accession of Queen Elizabeth (1952)	Sun.	Feb.	6
Septuagesima Sunday		Feb.	6
Quinquagesima (Shrove Sunday)		Feb.	20
Ash Wednesday		Feb.	23
St. David	Tue.	Mar.	1
St. Patrick	Thu.	Mar.	17
Palm Sunday		Apr.	3
Good Friday		Apr.	8
Easter Sunday		Apr.	10
Birthday of Queen Elizabeth (1926)	Thu.	Apr.	21
St. George	Sat.	Apr.	23
Rogation Sunday		May	15
Ascension Day	Thu.	May	19
Victoria Day	Mon.	May	23
Pentecost (Whit Sunday)		May	29
Trinity Sunday		June	5
Corpus Christi	Thu.	June	9
St. John Baptist (Midsummer Day)	Fri.	June	24
Dominion Day	Fri.	July	1
Birthday of Queen Mother Elizabeth (1900)	Thu.	Aug.	4
Labour Day	Mon.	Sept.	5
Hebrew New Year (Rosh Hashanah)	Thu.	Sept.	15
St. Michael (Michaelmas Day)	Thu.	Sept.	29
Thanksgiving	Mon.	Oct.	10
All Saints' Day	Tue.	Nov.	1
Remembrance Day	Fri.	Nov.	11
First Sunday in Advent		Nov.	27
St. Andrew	Wed.	Nov.	30
Christmas Day	Sun.	Dec.	25

JULIAN DAY CALENDAR, 1966

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

Jan. 1	9,127	May 1	9,247	Sept. 1	9,370
Feb. 1	9,158	June 1	9,278	Oct. 1	9,400
Mar. 1	9,186	July 1	9,308	Nov. 1	9,431
Apr. 1	9,217	Aug. 1	9,339	Dec. 1	9,461

The Julian Day commences at noon. Thus J.D. 2,439,127.0 = 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 8.80″ for the sun's parallax, and the astronomical unit of 92.9 million miles.

THE CONSTELLATIONS

Latin and French Names with Abbreviations

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

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

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

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

1 astronomical unit $= 1.495\times10^{13}$ cm. $= 1.495\times10^{8}$ km. $= 9.29\times10^{7}$ mi.
1 light-year $= 9.460\times10^{17}$ cm. $= 5.88\ \times10^{12}$ mi. = 0.3068 parsecs
1 parsec $= 3.084\times10^{18}$ cm. $= 1.916\times10^{13}$ mi. = 3.260 l.y.
1 megaparsec $= 10^{6}$ parsecs

Units of Time

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

The Earth

Equatorial radius, a = 6378.39 km. = 3963.35 mi.; flattening, $c = (a-b)/a = 1/297$
Polar radius, b = 6356.91 km. = 3950.01 mi.
1° of latitude $= 111.137-0.562 \cos 2\phi$ km. $= 69.057-0.349 \cos 2\phi$ mi. (at lat. ϕ)
1° of longitude $= 111.418 \cos\phi-0.094 \cos 3\phi$ km. $= 69.232 \cos\phi-0.0584 \cos 3\phi$ mi.
Mass of earth $= 5.98\times10^{24}$ kgm. $= 13.2\times10^{24}$ lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

Earth's Orbital Motion

Solar parallax = 8″.80 (adopted); recent determination = 8″.794 (radar, ♀, 1962)
Constant of aberration = 20″.47 (adopted)
Annual general precession = 50″.26; obliquity of ecliptic = 23° 26′ 40″ (1960)
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 = 299,860 km./sec. = 186,324 mi./sec. (adopted);
recent value, 299,792.50 ± 0.10 km./sec. (Froome, *Nature*, 1958)
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant $= 5.6694\times10^{-5}$ c.g.s. units

Miscellaneous

Constant of gravitation, $G = 6.670\times10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083\times10^{-28}$ gm.; mass of the proton $= 1.6724\times10^{-24}$ gm
Planck's constant, $h = 6.625\times10^{-27}$ erg. sec.
Loschmidt's number $= 2.6872\times10^{19}$ 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.

1966 EPHEMERIS OF THE SUN AND CORRECTION TO SUN-DIAL

Date	Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
	h m s	m s	° ′
Jan. 1	18 44 02	+ 3 30	−23 03.5
4	18 57 16	+ 4 53	−22 47.5
7	19 10 26	+ 6 13	−22 27.5
10	19 23 32	+ 7 28	−22 03.4
13	19 36 33	+ 8 39	−21 35.5
16	19 49 28	+ 9 44	−21 03.8
19	20 02 18	+10 42	−20 28.5
22	20 15 01	+11 35	−19 49.7
25	20 27 37	+12 20	−19 07.5
28	20 40 06	+12 58	−18 22.3
31	20 52 28	+13 29	−17 34.0
Feb. 3	21 04 42	+13 52	−16 42.9
6	21 16 48	+14 07	−15 49.2
9	21 28 47	+14 16	−14 53.1
12	21 40 40	+14 17	−13 54.8
15	21 52 25	+14 12	−12 54.3
18	22 04 05	+14 01	−11 52.0
21	22 15 38	+13 43	−10 48.0
24	22 27 05	+13 19	− 9 42.4
27	22 38 26	+12 50	− 8 35.6
Mar. 2	22 49 43	+12 16	− 7 27.6
5	23 00 54	+11 38	− 6 18.6
8	23 12 02	+10 55	− 5 08.9
11	23 23 06	+10 09	− 3 58.6
14	23 34 07	+ 9 20	− 2 47.8
17	23 45 07	+ 8 29	− 1 36.8
20	23 56 04	+ 7 37	− 0 25.6
23	0 07 00	+ 6 43	+ 0 45.5
26	0 17 55	+ 5 49	+ 1 56.4
29	0 28 50	+ 4 54	+ 3 06.9
Apr. 1	0 39 46	+ 4 00	+ 4 16.9
4	0 50 41	+ 3 06	+ 5 26.1
7	1 01 39	+ 2 14	+ 6 34.4
10	1 12 38	+ 1 24	+ 7 41.8
13	1 23 39	+ 0 36	+ 8 48.0
16	1 34 44	− 0 08	+ 9 52.9
19	1 45 52	− 0 50	+10 56.3
22	1 57 03	− 1 27	+11 58.1
25	2 08 19	− 2 01	+12 58.2
28	2 19 38	− 2 30	+13 56.3
May 1	2 31 02	− 2 55	+14 52.4
4	2 42 31	− 3 15	+15 46.2
7	2 54 05	− 3 30	+16 37.6
10	3 05 44	− 3 40	+17 26.6
13	3 17 28	− 3 45	+18 13.0
16	3 29 17	− 3 44	+18 56.6
19	3 41 11	− 3 39	+19 37.4
22	3 53 11	− 3 28	+20 15.1
25	4 05 15	− 3 12	+20 49.8
28	4 17 24	− 2 53	+21 21.2
31	4 29 37	− 2 29	+21 49.2
June 3	4 41 53	− 2 02	+22 13.9
6	4 54 13	− 1 31	+22 35.0
9	5 06 36	− 0 58	+22 52.6
12	5 19 01	− 0 22	+23 06.6
15	5 31 28	+ 0 16	+23 17.0
18	5 43 57	+ 0 55	+23 23.6
21	5 56 26	+ 1 35	+23 26.6
24	6 08 55	+ 2 14	+23 25.8
27	6 21 23	+ 2 52	+23 21.2
30	6 33 49	+ 3 29	+23 13.0

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 3	6 46 14	+ 4 03	+23 01.2
6	6 58 36	+ 4 35	+22 45.7
9	7 10 55	+ 5 03	+22 26.7
12	7 23 10	+ 5 29	+22 04.1
15	7 35 22	+ 5 50	+21 38.2
18	7 47 29	+ 6 07	+21 08.9
21	7 59 31	+ 6 18	+20 36.5
24	8 11 29	+ 6 25	+20 00.8
27	8 23 21	+ 6 27	+19 22.2
30	8 35 07	+ 6 22	+18 40.8
Aug. 2	8 46 48	+ 6 13	+17 56.5
5	8 58 23	+ 5 57	+17 09.6
8	9 09 53	+ 5 37	+16 20.3
11	9 21 18	+ 5 11	+15 28.5
14	9 32 38	+ 4 41	+14 34.5
17	9 43 53	+ 4 06	+13 38.5
20	9 55 04	+ 3 26	+12 40.4
23	10 06 10	+ 2 41	+11 40.6
26	10 17 12	+ 1 53	+10 39.1
29	10 28 10	+ 1 01	+ 9 36.1
Sept. 1	10 39 04	+ 0 05	+ 8 31.7
4	10 49 56	− 0 53	+ 7 26.2
7	11 00 46	− 1 53	+ 6 19.5
10	11 11 34	− 2 55	+ 5 11.8
13	11 22 21	− 3 58	+ 4 03.4
16	11 33 07	− 5 01	+ 2 54.3
19	11 43 53	− 6 05	+ 1 44.7
22	11 54 39	− 7 09	+ 0 34.8
25	12 05 26	− 8 12	− 0 35.3
28	12 16 14	− 9 13	− 1 45.5
Oct. 1	12 27 03	−10 13	− 2 55.5
4	12 37 56	−11 10	− 4 05.2
7	12 48 51	−12 03	− 5 14.5
10	12 59 50	−12 53	− 6 23.2
13	13 10 53	−13 39	− 7 31.2
16	13 22 01	−14 20	− 8 38.3
19	13 33 14	−14 56	− 9 44.3
22	13 44 33	−15 26	−10 48.9
25	13 55 57	−15 51	−11 52.1
28	14 07 27	−16 09	−12 53.7
31	14 19 04	−16 20	−13 53.5
Nov. 3	14 30 49	−16 24	−14 51.2
6	14 42 40	−16 21	−15 46.9
9	14 54 40	−16 10	−16 40.2
12	15 06 47	−15 52	−17 30.9
15	15 19 01	−15 25	−18 19.0
18	15 31 23	−14 52	−19 04.1
21	15 43 53	−14 11	−19 46.2
24	15 56 30	−13 22	−20 25.0
27	16 09 13	−12 27	−21 00.4
30	16 22 03	−11 26	−21 32.3
Dec. 3	16 35 00	−10 18	−22 00.5
6	16 48 02	− 9 05	−22 24.9
9	17 01 09	− 7 47	−22 45.4
12	17 14 20	− 6 25	−23 01.8
15	17 27 35	− 4 59	−23 14.2
18	17 40 52	− 3 31	−23 22.4
21	17 54 11	− 2 02	−23 26.3
24	18 07 30	− 0 33	−23 26.0
27	18 20 49	+ 0 56	−23 21.5
30	18 34 06	+ 2 24	−23 12.8

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

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

PHYSICAL ELEMENTS

Object	Equatorial Diameter miles	Oblateness	Mass ⊕ = 1	Mean Density water = 1	Surface Gravity ⊕ = 1	Rotation Period	Inclination of Equator to Orbit °	Albedo*
☉ Sun	864,000	0	333,000	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	59^d §	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	225^d‡	32	0.76
⊕ Earth	7,927	1/297	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	8,700?	?	0.9?	4?	?	6.39^d ?	?	0.14

Source of data is "Explanatory Supplement to the Ephemeris", 1961, except those marked * which are from D. C. Harris in "Planets and Satellites", *The Solar System,* vol. 3, 1961.

†Depending on latitude. For the physical observations of the sun, p. 60, the sidereal period of rotation is 25.38 m.s.d.

‡Mariner II, Dec. 14, 1962. § Radar, 1965.

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									
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.

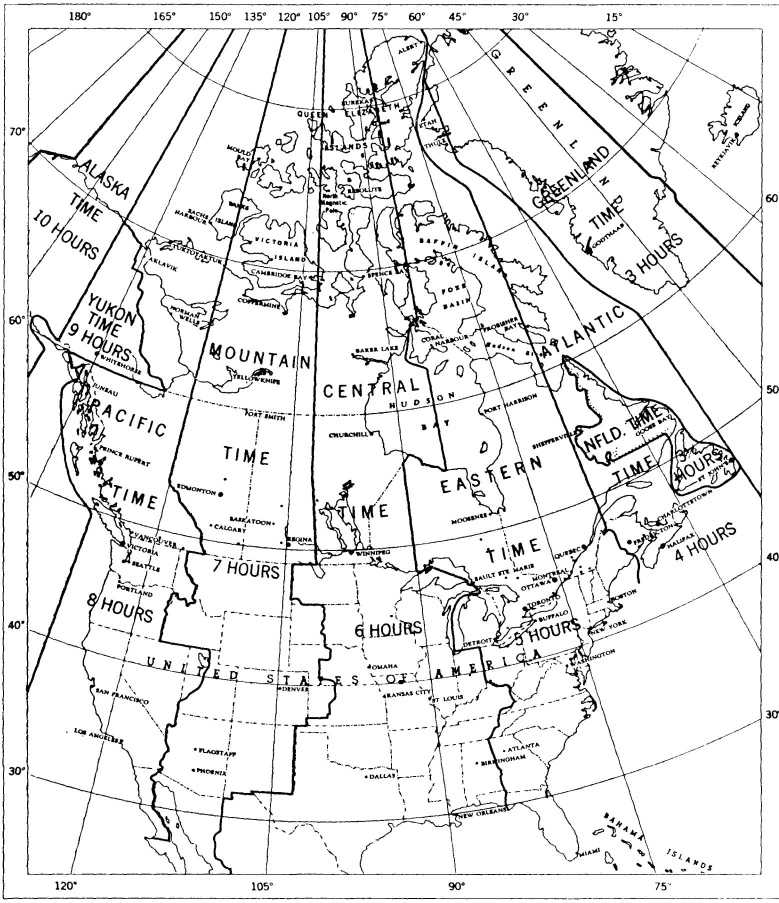
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

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 1966 will be about 36 seconds.

**Note:* The situation in Saskatchewan is confused, with the cities (except Lloydminster) on C.S.T. and many of the towns retaining M.S.T. The time zone boundary between C.S.T. and M.S.T. lies somewhere within the province of Saskatchewan.

MAP OF STANDARD TIME ZONES



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 32° 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.
Athabaska	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	+03M	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	60	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	−02M	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	+07M	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	+02M	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).

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

The above table gives the local mean time of the beginning of morning twilight, and of the ending of evening twilight, for various latitudes. To obtain the corresponding standard time, the method used is the same as for correcting the sunrise and sunset tables, as described on page 12. The entry —— in the above table indicates that at such dates and latitudes, twilight lasts all night. This table, taken from the American Ephemeris, is computed for ***astronomical*** twilight, i.e. for the time at which the sun is 108° from the zenith (or 18° below the horizon).

TIME OF MOONRISE AND MOONSET, 1966 (Local Mean Time)

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

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

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

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

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

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

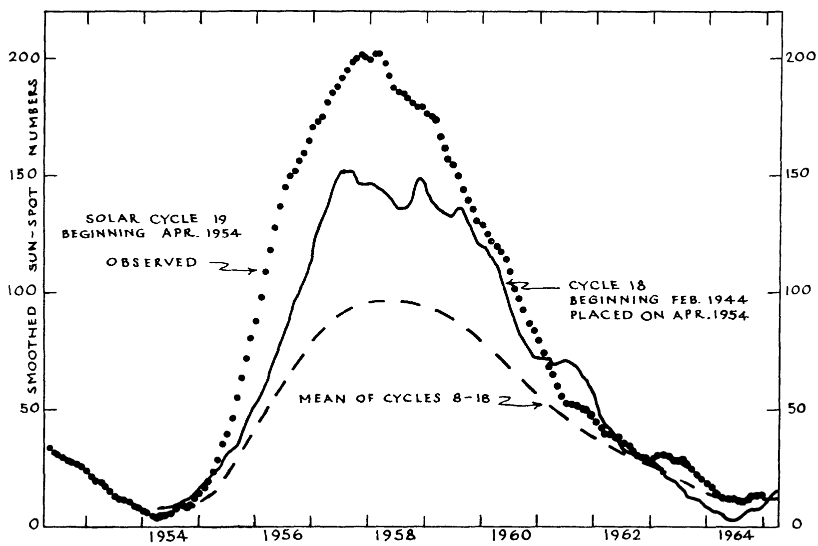
THE SUN AND PLANETS FOR 1966

THE SUN

The diagram represents the sun-spot activity of the current 19th cycle, as far as the final numbers are available. The present cycle began at the minimum in April 1954. For comparison, cycle 18 which began February 1944 (solid curve), and the mean of cycles 8 to 18 (dashed curve), are placed with their minima on April 1954.

The present cycle reached its maximum in January 1958 and since then has been declining slowly with the minimum in 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 1966

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Mar. 4	18°	−0.1	Apr. 18	28°	+0.6
June 30	26°	+0.7	Aug. 16	19°	+0.2
Oct. 26	24°	+0.1	Dec. 4	21°	−0.2

The most favourable elongations are: in the evening, Mar. 4; in the morning. Dec. 4.

The apparent diameter of the planet ranges from about 5″ to 11″.

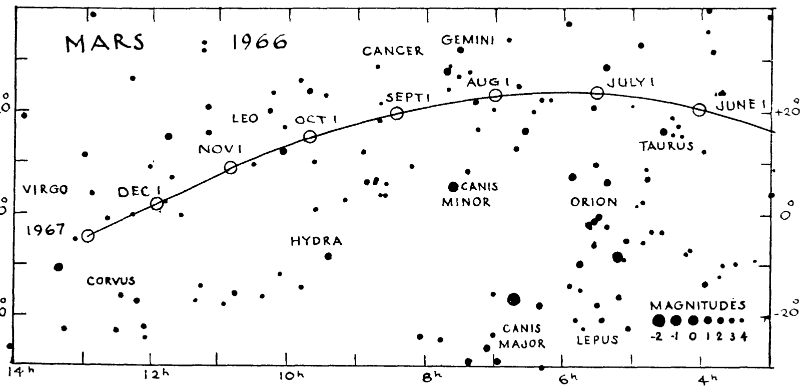
VENUS

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, 1966, Venus is brilliant (mag. −4.3) low in the south-western sky at sunset; its declination is −16°. It reaches inferior conjunction on Jan. 26 and moves into the morning sky. Greatest brilliancy, mag. −4.3, occurs on Mar. 1, and greatest western elongation, 46°, on April 6, when it crosses the meridian almost 3 hours before the sun at declination −11°. Superior conjunction occurs on Nov. 8. At the end of the year it is still close to the sun in the evening sky.

Its brilliance is largely due to 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; and a rotation period of 225 days (equal to its period of revolution).

The apparent diameter of the planet ranges from 63″ on Jan. 25 to 10″ in Oct. and Nov.



MARS

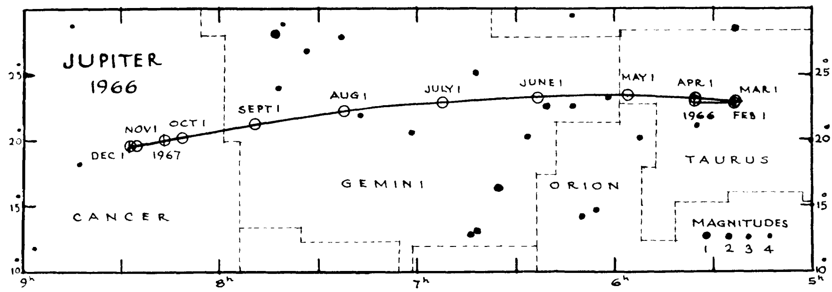
The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance 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, is almost a maximum.

On Jan. 1, 1966, Mars is in the evening sky, but is too close to the sun for observation, conjunction occurring on Apr. 29. It gradually emerges into the morning sky and by the end of the year it is in Virgo, crossing the meridian almost 6 hours before the sun. Its stellar magnitude is +1.1. See the map. The apparent diameter of the planet ranges from 3.8″ at mid-year to 6.6″ at year end.

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



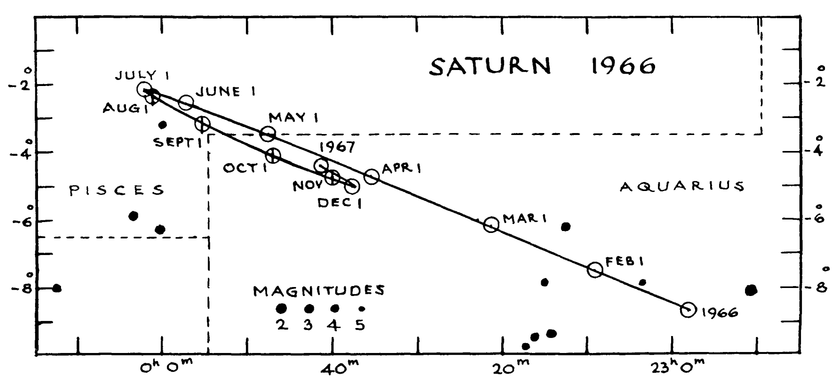
at a temperature of about −200°F. Intense radiation belts (like terrestrial Van Allen belts) have been disclosed by observations at radio wave-lengths.

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, 1966, Jupiter is retrograding in Taurus and is low in the east at sunset; its stellar magnitude is −2.3. Direct motion resumes Feb. 15. On July 5 it is in conjunction with the sun and moves into the morning sky. Retrograde motion commences on Nov. 21 and continues for the rest of the year. (See map; circles with vertical lines denote retrograde motion.) At the end of the year it is in Cancer, rising about 3 hours after sunset and visible the rest of the night; its stellar magnitude is −2.1. The apparent diameter of the planet is 44″ on Jan. 1, decreases to 30″ in early July, and is 42″ on Dec. 31.

SATURN

Saturn was the outermost planet known until modern times. In size it is a good second to Jupiter. In addition to its family of nine satellites, this planet has a unique system of rings, and it is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway

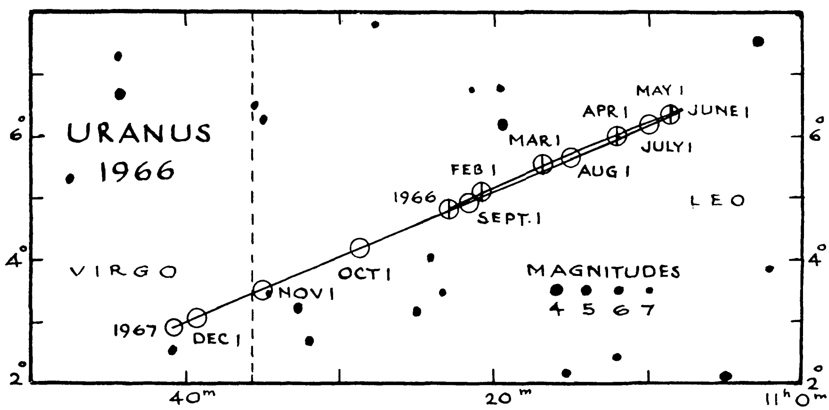


between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, and will be again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. See p. 59.

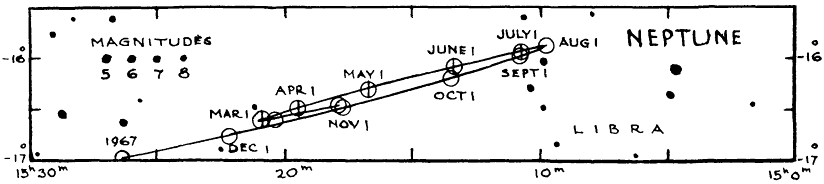
During 1966 Saturn crosses from Aquarius into Pisces, and on Jan. 1 it is just past the meridian at sunset; its stellar magnitude is +1.3 and its declination is −9°. On Mar. 10 it is in conjunction with the sun and moves into the morning sky. It reaches opposition by Sept. 19, when its stellar magnitude brightens to +0.8 and it is visible all night. It retrogrades from July 12 to Nov. 27 (see map; circles with vertical lines denote retrograde motion). At the end of the year it has stellar magnitude +1.4 and is nearing the meridian at sunset. The apparent diameter of the ball of the planet ranges from 14″ in early Mar. to 17″ in late Sept.

URANUS

Uranus was discovered in 1781 by Sir William Herschel by means of a $6\frac{1}{4}$-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 1966 Uranus is in Leo and Virgo (see map). At the beginning of the year it rises before midnight and is retrograding (direct motion resumes on May 23). It is in opposition on Mar. 8 and is above the horizon all night; its apparent diameter is 4.0″; its stellar magnitude is +5.7. When conjunction occurs on Sept. 13 its magnitude has faded to +5.9. It is in the morning sky the rest of the year; retrograde motion commences on Dec. 30. It is overtaken by Venus on Sept. 25, while Mars is close to it during November with conjunction occurring on Nov. 21.



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 1966 Neptune is in Libra (see map). It is in opposition on May 11, when it is above the horizon all night. Its stellar magnitude is then +7.7 and during the year 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 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 14 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 22 to Aug. 1.

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. 8, at which time its astrometric position is R.A. 11h 36m, Dec. +18° 56′.

THE SKY MONTH BY MONTH

BY JOHN F. HEARD

THE SKY FOR JANUARY 1966

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

The Sun—During January, the sun's R.A. increases from 18h 44m to 20h 57m and its Decl. changes from 23° 04′ S. to 17° 17′ S. The equation of time changes from −3m 36s to −13m 30s. These values of the equation of time are for noon E.S.T. on the first and last days of the month in this and in following months. The earth is at perihelion or nearest the sun on the 3rd, at a distance of 91,346,000 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. 17h 19m, Decl. 22° 20′ S. and on the 15th is in R.A. 18h 47m, Decl. 23° 57′ S., when it transits at 11h 12m. It is too close to the sun for observation.

Venus on the 1st is in R.A. 21h 02m, Decl. 15° 48′ S. and on the 15th is in R.A. 20h 53m, Decl. 12° 55′ S., when it has mag. −3.8, and transits at 13h 12m. For the first half of the month it is visible as an evening star very low in the south-west after sunset, but later it is too close to the sun for observation, being in inferior conjunction on the 26th.

Mars on the 15th is in R.A. 21h 23m, Decl. 16° 31′ S., and transits at 13h 46m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 5h 29m, Decl. 22° 56′ N., mag. −2.2, and transits at 21h 47m. In Taurus, it is well up in the east by sunset and is visible most of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 03m, Decl. 8° 12′ S., mag. +1.3, and transits at 15h 23m. In Aquarius, is past the meridian at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 11h 22m, Decl. 4° 55′ N., and transits at 3h 44m.

Neptune on the 15th is in R.A. 15h 19m, Decl. 18° 33′ S., and transits at 7h 41m.

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

			JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h 10m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sat. 1				6 10	3241O	17.28
Sun. 2					d324O	29.43
Mon. 3			Earth at perihelion............		O1324	41.57[l]
			Quadrantid meteors............			
	19		Venus stationary..............			
Tue. 4				3 00	12O34	53.71
Wed. 5	12		Jupiter 2° S. of moon..........		2O134	65.83
Thu. 6			Mercury at descending node....	23 40	1O324	77.96
Fri. 7	0	17	Full Moon.................		3O124	90.08
Sat. 8	0		Venus 4° N. of Mars...........		321O4	102.21
	5		Moon at perigee, 223,100 mi....			
Sun. 9				20 30	32O14	114.33
Mon. 10					O432*	126.46[b]
Tue. 11	2		Uranus 5° S. of moon..........		d41O3	138.59
Wed. 12				17 20	42O13	150.73
Thu. 13	15	00	Last Quarter...............		41O32	162.88
Fri. 14					43O12	175.03
Sat. 15	20		Neptune 0.7° N. of moon.......	14 10	4321O	187.19[l]
Sun. 16			Mars at perihelion.............		432O1	199.36
Mon. 17			Mercury at aphelion...........		4O32*	211.53
Tue. 18				11 00	41O23	223.71
Wed. 19					2O143	235.89
Thu. 20					1O34*	248.08
Fri. 21	10	47	New Moon.................	7 50	3O124	260.27
Sat. 22					312O4	272.46
Sun. 23	7		Mars 4° N. of moon...........		32O14	284.64
	14		Moon at apogee, 252,600 mi.....			
Mon. 24				4 40	1O324	296.83[b]
Tue. 25	0		Saturn 3° N. of moon..........		dO234	309.02
Wed. 26	4		Venus in inferior conjunction...		2O143	321.20
Thu. 27				1 30	14O3*	333.38
Fri. 28					43O12	345.55
Sat. 29			Venus at perihelion............	22 30	4312O	357.72
	14	49	First Quarter...............			
Sun. 30					432O1	9.88
Mon. 31			....		413O2	22.03[l]

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

[l]Jan. 3, −7.13°; Jan. 15, +7.10°; Jan. 31, −7.89°.

[b]Jan. 10, −6.61°; Jan. 24, +6.61°.

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

The Sun—During February the sun's R.A. increases from 20h 57m to 22h 46m and its Decl. changes from 17° 17′ S. to 7° 50′ S. The equation of time changes from −13m 39s to a maximum of −14m 18s on the 11th and then to −12m 37s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 1st is in R.A. 20h 44m, Decl. 20° 15′ S. and on the 15th is in R.A. 22h 22m, Decl. 11° 56′ S., when it transits at 12h 45m. It is too close to the sun for observation until month-end; superior conjunction is on the 5th.

Venus on the 1st is in R.A. 20h 12m, Decl. 12° 10′ S., and on the 15th is in R.A. 19h 55m, Decl. 13° 13′ S., when it has mag. −4.1, and transits at 10h 14m. Towards mid-month it begins to be observable as a morning star very low in the south-east just before sunrise.

Mars on the 15th is in R.A. 22h 56m, Decl. 7° 46′ S., and transits at 13h 17m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 5h 22m, Decl. 22° 56′ N., mag. −2.0, and transits at 19h 39m. In Taurus, it is high in the eastern sky at sunset and is visible most of the night. On the 15th 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. 23h 15m, Decl. 6° 53′ S., and transits at 13h 33m. In Aquarius, it is well down in the west at sunset.

Uranus on the 15th is in R.A. 11h 19m, Decl. 5° 18′ N., and transits at 1h 39m.

Neptune on the 15th is in R.A. 15h 21m, Decl. 16° 37′ S., and transits at 5h 40m.

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

d	h	m	FEBRUARY E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 22h 30m	Sun's Selen. Colong. 0h U.T. °
Tue. 1	19		Jupiter 2° S. of moon..........	19 10	40123	34.18
Wed. 2			....		4203*	46.32
Thu. 3			....		41203	58.46
Fri. 4			....	16 00	34012	70.59
Sat. 5	10	58	○ Full Moon.................		31204	82.72
	17		Moon at perigee, 221,500 mi....			
	22		Mercury in superior conjunction.			
Sun. 6			Mercury greatest hel. lat. S.....		32014	94.85
Mon. 7	11		Uranus 4° S. of moon..........	12 50	13024	106.97[b]
Tue. 8			....		01234	119.11
Wed. 9			....		2034*	131.24
Thu. 10			....	9 40	21034	143.39
Fri. 11			Neptune in quadrature W.......		30124	155.53
Sat. 12	2		Neptune 1° N. of moon........		d3104	167.69[l]
	3	53	☾ Last Quarter...............			
Sun. 13			....	6 30	32401	179.85
Mon. 14	20		Vesta stationary...............		43102	192.02
Tue. 15	3		Jupiter stationary.............		40123	204.20
	4		Venus stationary..............			
Wed. 16			....	3 20	42103	216.39
Thu. 17	7		Venus 12° N. of moon..........		d4203	228.57
Fri. 18			....		d4012	240.77
Sat. 19	16		Moon at apogee, 252,700 mi.....	0 00	43102	252.96
Sun. 20			Venus greatest hel. lat. N.......		32401	265.16[b]
	5	50	● New Moon.................			
Mon. 21	11		Mars 4° N. of moon...........	20 50	3104*	277.36
	12		Saturn 3° N. of moon..........			
Tue. 22	8		Mars 1.1° N. of Saturn.........		01324	289.56
	17		Neptune stationary............			
Wed. 23	11		Mercury 1.7° N. of Saturn......		21034	301.75
Thu. 24	8		Mercury 0.7° N. of Mars.......	17 40	20134	313.95
Fri. 25			Mercury at ascending node.....		0324*	326.14
Sat. 26			....		31024	338.33
Sun. 27			....	14 30	32014	350.51
Mon. 28	5	16	☽ First Quarter...............		3104*	2.68[l]

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

[l]Feb. 12, +7.74°; Feb. 28, −7.73°. [b]Feb. 7, −6.48°; Feb. 20, +6.54°.

THE SKY FOR MARCH 1966

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

The Sun—During March the sun's R.A. increases from 22h 46m to 0h 40m and its Decl. changes from 7° 50′ S. to 4° 17′ N. The equation of time changes from −12m 26s to −4m 14s. On the 20th at 20h 53m 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.

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. 23h 48m, Decl. 0° 24′ S., and on the 15th is in R.A. 0h 13m, Decl. 5° 14′ N., when it transits at 12h 40m. On the 4th it is at greatest eastern elongation and stands about 16 degrees above the western horizon at sunset. For about a week at this time it may be seen low in the west just after sunset. On the 21st it is in inferior conjunction.

Venus on the 1st is in R.A. 20h 09m, Decl. 14° 11′ S., and on the 15th is in R.A. 20h 46m, Decl. 14° 01′ S., when it has mag. −4.2, and transits at 9h 16m. It is a morning star visible low in the south-east for about an hour before sunrise. Greatest brilliancy is on the 1st.

Mars on the 15th is in R.A. 10h 17m, Decl. 1° 04′ N., and transits at 12h 47m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 5h 27m, Decl. 23° 05′ N., mag. −1.8, and transits at 17h 55m. In Taurus, it is about on the meridian at sunset and sets about an hour after midnight. 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. 23h 28m, Decl. 5° 33′ S., and transits at 11h 56m. Conjunction is on the 10th and Saturn is too close to the sun all month for easy observation.

Uranus on the 15th is in R.A. 11h 15m, Decl. 5° 46′ N., mag. 5.7 and transits at 23h 41m. Opposition is on the 8th, at which time its distance from the earth is 1,606,000,000 mi.

Neptune on the 15th is in R.A. 15h 21m, Decl. 16° 34′ S., and transits at 3h 50m.

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

			MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 50m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1	3		Jupiter 2° S. of moon..........		0412*	14.85
	4		Pallas in conjunction with sun..			
	18		Venus at greatest brilliancy.....			
Wed. 2			Mercury at perihelion..........	11 20	41203	27.01
Thu. 3			....		42013	39.17
Fri. 4	23		Mercury greatest elong. E., 18° .		41032	51.32
Sat. 5			....	8 10	43102	63.47
Sun. 6	6		Moon at perigee, 222,000 mi.....		43201	75.61[b]
	20	46	Full Moon.................			
	21		Uranus 4° S. of moon..........			
Mon. 7			....		43120	87.75
Tue. 8	0		Pluto at opposition............	5 00	40312	99.89
	10		Uranus at opposition...........			
Wed. 9			....		41203	112.03
Thu. 10	17		Saturn in conjunction with sun..		20413	124.18
Fri. 11	10		Mercury stationary............	1 50	10234	136.34
	11		Neptune 1° N. of moon........			
Sat. 12			Mercury greatest hel. lat. N.....		d3024	148.50[l]
Sun. 13			Jupiter in quadrature E........	22 40	3204*	160.66
	19	19	Last Quarter..............			
Mon. 14	1		Mercury 4° N. of Mars.........		31204	172.84
Tue. 15			....		30124	185.02
Wed. 16			....	19 30	d1034	197.20
Thu. 17	17		Venus 9° N. of moon...........		20143	209.40
Fri. 18	22		Moon at apogee, 252,400 mi.....		10423	221.60
Sat. 19			....	16 20	43012	233.80[b]
Sun. 20	20	53	Equinox. Spring begins.........		4320*	246.01
Mon. 21	9		Mercury in inferior conjunction.		43210	258.22
	23	47	New Moon.................			
Tue. 22			....	13 10	43012	270.44
Wed. 23			....		41023	282.65
Thu. 24			....		42013	294.87
Fri. 25			....	10 00	4103*	307.08
Sat. 26			....		43012	319.29
Sun. 27			....		32104	331.49
Mon. 28	14		Jupiter 3° S. of moon..........	6 50	d3204	343.69[l]
Tue. 29	15	44	First Quarter...............		30124	355.89
Wed. 30	13		Mercury 3° N. of Saturn.......		10234	8.07
Thu. 31			....	3 30	20134	20.25

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

[l]Mar. 12, +7.48°; Mar. 28, −6.78°. [b]Mar. 6, −6.52°; Mar. 19, +6.61°.

THE SKY FOR APRIL 1966

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

The Sun—During April the sun's R.A. increases from 0h 40m to 2h 31m and its Decl. changes from 4° 17′ N. to 14° 52′ N. The equation of time changes from −3m 56s to +2m 49s, being zero on the 15th. For changes in the length of the day, see p. 14.

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

Mercury on the 1st is in R.A. 23h 34m, Decl. 1° 49′ S., and on the 15th is in R.A. 23h 54m, Decl. 2° 48′ S., when it transits at 10h 22m. On the 18th it is at greatest western elongation, but this is an unfavourable elongation, Mercury being only about 10 degrees above the eastern horizon at sunrise.

Venus on the 1st is in R.A. 21h 45m, Decl. 11° 45′ S., and on the 15th is in R.A. 22h 40m, Decl. 8° 14′ S., when it has mag. −3.9, and transits at 9h 08m. Greatest western elongation is on the 6th, but even so it is only about 18 degrees above the south-eastern horizon at sunrise.

Mars on the 15th is in R.A. 1h 44m, Decl. 10° 23′ N., and transits at 12h 12m. It is too close to the sun for observation and on the 29th it is in conjunction.

Jupiter on the 15th is in R.A. 5h 44m, Decl. 23° 19′ N., mag. −1.6, and transits at 16h 10m. Moving from Taurus into Gemini, it is past the meridian at sunset and sets before midnight. 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. 23h 41m, Decl. 4° 08′ S., mag. +1.4, and transits at 10h 08m. It is a morning star rising about an hour before the sun. The earth is in the plane of the rings on the 2nd.

Uranus on the 15th is in R.A. 11h 10m, Decl. 6° 13′ N., and transits at 21h 34m.

Neptune on the 15th is in R.A. 15h 18m, Decl. 16° 24′ S., and transits at 1h 46m.

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

			APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 20m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1			....		1034*	32.43
Sat. 2	19		Mercury stationary............		d0124	44.60[b]
Sun. 3	5		Uranus 4° S. of moon..........	0 20	32104	56.76
	14		Moon at perigee, 224,300 mi....			
Mon. 4			Mercury at descending node....		32401	68.92
Tue. 5	6	14	Full Moon.................	21 10	4302*	81.08
Wed. 6	8		Venus greatest elong. W., 46°...		41023	93.24
Thu. 7	1		Juno in conjunction with sun...		42013	105.40
	20		Neptune 2° N. of moon........			
Fri 8	22		Mercury 1.0° N. of Saturn	18 00	41203	117.56
Sat. 9			....		40312	129.73[l]
Sun. 10			....		43120	141.91
Mon. 11			....	14 50	34201	154.09
Tue. 12	12	29	Last Quarter...............		3402*	166.27
Wed. 13			....		1024*	178.47
Thu. 14			....	11 40	20134	190.67
Fri. 15			Mercury at aphelion...........		21034	202.88
	13		Moon at apogee, 251,800 mi....			
Sat. 16	8		Venus 6° N. of moon...........		03124	215.09[b]
Sun. 17			Venus at descending node......	8 30	d3104	227.31
	15		Saturn 3° N. of moon..........			
Mon. 18	4		Mercury 2° N. of moon........		32014	239.53
	6		Mercury greatest elong. W., 28°.			
Tue. 19			....		31024	251.76
Wed. 20	15	36	New Moon.................	5 20	d042*	263.99
Thu. 21			....		24013	276.22
Fri. 22			Lyrid meteors.................		42103	288.45
Sat. 23			....	2 10	40132	300.68
Sun. 24			....		43102	312.90[l]
Mon. 25	3		Jupiter 3° S. of moon..........	23 00	43201	325.13
Tue. 26			....		4310*	337.35
Wed. 27	22	50	First Quarter...............		43012	349.56
Thu. 28			....	19 50	4203*	1.77
Fri. 29	0		Mars in conjunction with sun...		21403	13.97[b]
	19		Ceres in conjunction with sun...			
Sat. 30	12		Uranus 5° S. of moon..........		01234	26.16

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

[l]Apr. 9, +6.54°; Apr. 24, −5.57°. [b]Apr. 2, −6.63°; Apr. 16, +6.75°; Apr. 29, −6.71°.

THE SKY FOR MAY 1966

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

The Sun—During May the sun's R.A. increases from 2h 31m to 4h 34m and its Decl. changes from 14° 52′ N. to 21° 58′ N. The equation of time changes from +2m 56s to a maximum of +3m 45s on the 14th and then to +2m 27s at the end of the month. For changes in the length of the day, see p. 15. There is an annular eclipse, not visible in North America, on the 20th.

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. There is a penumbral eclipse on the 4th, not visible in North America.

Mercury on the 1st is in R.A. 1h 04m, Decl. 3° 46′ N., and on the 15th is in R.A. 2h 32m, Decl. 13° 18′ N., when it transits at 11h 05m. It is too close to the sun for observation; superior conjunction is on the 27th.

Venus on the 1st is in R.A. 23h 45m, Decl. 2° 47′ S., and on the 15th is in R.A. 0h 43m, Decl. 2° 43′ N., when it has mag. −3.6, and transits at 9h 13m. It is visible as a morning star low in the east for about two hours before sunrise.

Mars on the 15th is in R.A. 3h 10m, Decl. 17° 43′ N., and transits at 11h 40m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 6h 08m, Decl. 23° 24′ N., mag. −1.5, and transits at 14h 36m. In Gemini, 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. 56.

Saturn on the 15th is in R.A. 23h 52m, Decl. 3° 01′ S., mag. +1.4, and transits at 8h 21m. In Pisces, it rises about two hours before the sun.

Uranus on the 15th is in R.A. 11h 08m, Decl. 6° 26′ N., and transits at 19h 34m.

Neptune on the 15th is in R.A. 15h 15m, Decl. 16° 12′ S., mag. 7.7, and transits at 23h 41m. Opposition is on the 11th, at which time its distance from the earth is 2,723,000,000 mi.

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

			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20h 50m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Sun. 1	9		Moon at perigee, 227,600 mi....	16 40	13024	38.35
	13		Venus 1.0° N. of Saturn.......			
Mon. 2			....		32014	50.53
Tue. 3			....		3104*	62.71
Wed. 4	16	01	◯ Full Moon................	13 20	30124	74.89
			Penumbral eclipse of ☾, p. 64			
Thu. 5			η Aquarid meteors............			
			Mercury greatest hel. lat. S.....		21034	87.06
	5		Neptune 2° N. of moon........			
Fri. 6			....		d2043	99.24
Sat. 7			....	10 10	01423	111.42[l]
Sun. 8			....		d1402	123.60
Mon. 9			....		43201	135.79
Tue. 10			....	7 00	43120	147.98
Wed. 11	19		Neptune at opposition.........		43012	160.18
Thu. 12	6	19	☾ Last Quarter...............		d4103	172.38
Fri. 13	8		Moon at apogee, 251,300 mi....	3 50	d4203	184.59[b]
Sat. 14			....		4023*	196.81
Sun. 15	4		Saturn 3° N. of moon..........		41032	209.04
Mon. 16	12		Venus 2° N. of moon...........	0 40	32041	221.27
Tue. 17			....		31204	233.50
Wed. 18			Mars at ascending node........	21 30	30124	245.74
Thu. 19			....		10234	257.98
Fri. 20			Uranus at perihelion...........		20134	270.22[l]
	4	43	● New Moon................			
			Annular eclipse of ☉, p. 64..			
Sat. 21			Venus at aphelion.............	18 20	0234*	282.47[l]
Sun. 22	18		Jupiter 3° S. of moon..........		10324	294.71
Mon. 23	20		Uranus stationary.............		32014	306.95
Tue. 24			Mercury at ascending node.....	15 10	31204	319.19
Wed. 25			....		34012	331.43
Thu. 26			....		4102*	343.66
Fri. 27	2		Mercury in superior conjunction.	12 00	42013	355.88[b]
	3	51	☽ First Quarter...............			
	9		Moon at perigee, 229,800 mi....			
	17		Uranus 5° S. of moon..........			
Sat. 28			....		4103*	8.09
Sun. 29			Mercury at perihelion..........		d4032	20.30
Mon. 30			Jupiter at ascending node......	8 40	43201	32.50
Tue. 31			....		43210	44.70

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]May 7, +5.47°; May 20, 21, −5.15°. [b]May 13, +6.85°; May 27, −6.74°.

THE SKY FOR JUNE 1966

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

The Sun—During June the sun's R.A. increases from 4h 34m to 6h 38m and its Decl. changes from 21° 58′ N. to 23° 09′ N. The equation of time changes from +2m 18s to −3m 31s, being zero on the 14th. The solstice is on the 21st at 15h 33m 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. 4h 58m, Decl. 23° 55′ N., and on the 15th is in R.A. 6h 58m, Decl. 24° 48′ N., when it transits at 13h 29m. For about a week at the end of the month it may be seen as an evening star low in the west just after sunset. Greatest eastern elongation is on the 30th at which time the planet stands about 15 degrees above the western horizon at sunset.

Venus on the 1st is in R.A. 1h 56m, Decl. 9° 36′ N., and on the 15th is in R.A. 2h 59m, Decl. 14° 49′ N., when it has mag. −3.5, and transits at 9h 27m. It is visible as a morning star low in the east for about two hours before sunrise.

Mars on the 15th is in R.A. 4h 42m, Decl. 22° 32′ N., and transits at 11h 09m. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 6h 37m, Decl. 23° 12′ N., mag. −1.4, and transits at 13h 03m. In Gemini, at mid-month, it is low in the west at sunset and sets about two hours later; by month's end it is too close to the sun for observation.

Saturn on the 15th is in R.A. 0h 00m, Decl. 2° 19′ S., mag. +1.3, and transits at 6h 26m. In Pisces, it rises about four hours before the sun.

Uranus on the 15th is in R.A. 11h 09m, Decl. 6° 21′ N., and transits at 17h 33m.

Neptune on the 15th is in R.A. 15h 12m, Decl. 16° 00′ S., and transits at 21h 36m.

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

			JUNE E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	12		Neptune 1° N. of moon........			56.89
Thu. 2	3		Pluto stationary...............	5 30		69.08
Fri. 3	2	41	○ Full Moon.................			81.27
Sat. 4			....			93.46[l]
Sun. 5			....	2 20		105.65
Mon. 6			Uranus in quadrature E........			117.84
Tue. 7			....	23 10		130.04
Wed. 8			Mercury greatest hel. lat. N.....			142.24
Thu. 9			....			154.44[b]
Fri. 10	3		Moon at apogee, 251,200 mi....	20 00		166.65
	23	59	☾ Last Quarter...............			
Sat. 11	15		Mercury 2° N. of Jupiter.......			178.87
	16		Saturn 2° N. of moon..........			
Sun. 12			....			191.09
Mon. 13			Venus greatest hel. lat. S.......	16 50		203.32
Tue. 14			....			215.56
Wed. 15	18		Venus 1° S. of moon...........			227.80
Thu. 16			....	13 40		240.04
Fri. 17			....			252.29[l]
Sat. 18	15	09	● New Moon.................			264.54
Sun. 19			....	10 30		276.80
Mon. 20			Saturn in quadrature W........			289.05
	8		Mercury 3° S. of moon.........			
Tue. 21	15	33	Solstice. Summer begins........			301.30
Wed. 22	3		Moon at perigee, 227,900 mi....	7 20		313.55
Thu. 23			....			325.79[b]
Fri. 24	0		Uranus 4° S. of moon..........			338.03
Sat. 25	8	23	☽ First Quarter...............	4 00		350.26
Sun. 26			....			2.48
Mon. 27			....			14.69
Tue. 28	18		Neptune 1° N. of moon........	0 50		26.90
Wed. 29			....			39.11
Thu. 30	15		Mercury greatest elong. E., 26°..	21 40		51.31[l]

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

[l]June 4, +4.77°; June 17, −5.74°; June 30, +5.11°.

[b]June 9, +6.81°; June 23, −6.67°.

Jupiter being near the sun, configurations of the satellites are not given between June 1 and August 1.

THE SKY FOR JULY 1966

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

The Sun—During July the sun's R.A. increases from 6h 38m to 8h 43m and its Decl. changes from 23° 09′ N. to 18° 12′ N. The equation of time changes from −3m 43s to −6m 19s. On the 5th the earth is in aphelion or farthest from the sun, 94,448,000 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. 8h 27m, Decl. 19° 18′ N., and on the 15th is in R.A. 8h 52m, Decl. 14° 24′ N., when it transits at 13h 18m. For about a week following greatest elongation on June 30th it may be seen as an evening star low in the west just after sunset.

Venus on the 1st is in R.A. 4h 15m, Decl. 19° 34′ N., and on the 15th is in R.A. 5h 25m, Decl. 22° 05′ N., when it has mag. −3.3, and transits at 9h 56m. It is a morning star to be seen low in the east for about two hours before sunrise.

Mars on the 15th is in R.A. 6h 11m, Decl. 24° 01′ N., and transits at 10h 41m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 7h 06m, Decl. 22° 39′ N., mag. −1.4, and transits at 11h 34m. Conjunction is on the 5th, but towards the end of the month it can be seen as a morning star rising about an hour before the sun.

Saturn on the 15th is in R.A. 0h 02m, Decl. 2° 13′ S., mag. +1.1, and transits at 4h 31m. In Pisces, it rises before midnight and is visible the rest of the night. On the 12th it is stationary in right ascension and begins to retrograde, i.e. move westward among the stars.

Uranus on the 15th is in R.A. 11h 12m, Decl. 5° 58′ N., and transits at 15h 39m.

Neptune on the 15th is in R.A. 15h 10m, Decl. 15° 54′ S., and transits at 19h 36m.

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

				JULY E.S.T.	Mins. Algol		Sun' Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1			Mercury at descending node....			63.51
Sat.	2	14	37	⊛ Full Moon................			75.70
Sun.	3			....	18 30		87.89
Mon.	4			....			100.09
Tue.	5			Earth at aphelion............			
		9		Jupiter in conjunction with sun			112.28
Wed.	6			....	15 20		124.48[b]
Thu.	7	20		Moon at apogee, 251,600 mi....			136.68
Fri.	8			....			148.89
Sat.	9	2		Saturn 2° N. of moon..........	12 10		161.10
Sun.	10	16	43	☾ Last Quarter..............			173.31
Mon.	11			....			185.53
Tue.	12			Mercury at aphelion...........	9 00		197.76
		12		Saturn stationary..............			
Wed.	13	19		Mercury stationary............			210.00
Thu.	14			....			222.23[l]
Fri.	15	18		Venus 4° S. of moon...........	5 40		234.48
Sat.	16	12		Mars 3° S. of moon............			246.73
Sun.	17	23	31	● New Moon................			258.98
Mon.	18			....	2 30		271.23
Tue.	19	20		Moon at perigee, 224,800 mi....			283.48
Wed.	20			....	23 20		295.74[b]
Thu.	21	8		Uranus 4° S. of moon..........			307.98
Fri.	22			....			320.23
Sat.	23			....	20 10		332.47
Sun.	24	14	00	☽ First Quarter...............			344.70
Mon.	25	23		Neptune 2° N. of moon........			356.92
Tue.	26			....	17 00		9.14
Wed.	27			....			21.35[l]
Thu.	28	9		Mercury in inferior conjunction.			33.55
Fri.	29			δ Aquarid meteors.............	13 50		45.75
Sat.	30			....			57.95
Sun.	31			....			70.14

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

[l]July 14, −6.66°; July 27, +6.29°. [b]July 6, +6.67°; July 20, −6.55°.

Jupiter being near the sun, configurations of the satellites are not given between June 1 and August 1.

THE SKY FOR AUGUST 1966

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

The Sun—During August the sun's R.A. increases from 8h 43m to 10h 39m and its Decl. changes from 18° 12′ N. to 8° 32′ N. The equation of time changes from −6m 16s to −0m 20s. 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 15m, Decl. 14° 58′ N., and on the 15th is inR.A. 8h 20m, Decl. 18° 07′ N., when it transits at 10h 48m. For about a week at mid-month it may be seen as a morning star low on the eastern horizon just before sunrise. Greatest western elongation is on the 16th at which time it stands about 16 degrees above the eastern horizon at sunrise.

Venus on the 1st is in R.A. 6h 54m, Decl. 22° 32′ N., and on the 15th is in R.A. 8h 06m, Decl. 20° 35′ N., when it has mag. −3.3, and transits at 10h 35m. It is a morning star to be seen low in the east for about two hours before sunrise.

Mars on the 15th is in R.A. 7h 40m, Decl. 22° 20′ N., and transits at 10h 07m. It is a morning star in Gemini rising about two hours before the sun. On the 12th it passes 0.7° N. of Jupiter, and on the 15th is 6° S. of Pollux.

Jupiter on the 15th is in R.A. 7h 35m, Decl. 21° 46′ N., mag. −1.4, and transits at 10h 01m. In Gemini, it is a morning star rising about two hours before the sun. On the 24th it is 7° S. of Pollux (see Mars.) 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. 23h 59m, Decl. 2° 42′ S., mag. +1.0, and transits at 2h 25m. In Pisces it rises about two hours after sunset and is visible the rest of the night.

Uranus on the 15th is in R.A. 11h 18m, Decl. 5° 20′ N., and transits at 13h 43m.

Neptune on the 15th is in R.A. 15h 10m, Decl. 15° 55′ S., and transits at 17h 34m.

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, 12, −7.40°; Aug. 23, +7.35°. [b]Aug. 2, +6.55°; Aug. 16, −6.48°; Aug. 30, +6.55°.

d	h	m	AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 18h 45m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1			Mercury greatest hel. lat. S.....	10 40	41O23	82.33
	4	06	Full Moon................			
	12		Neptune stationary............			
Tue. 2			....		42O31	94.52b
Wed. 3	21		Venus 1.0° S. of Mars..........		4321O	106.71
Thu. 4	11		Moon at apogee, 252,200 mi....	7 20	43O12	118.91
Fri 5	8		Saturn 2° N. of moon..........		431O2	131.10
Sat. 6			....		42O13	143.30
Sun. 7	7		Mercury stationary............	4 10	42O3*	155.50
	12		Venus 0.1° S. of Jupiter........			
Mon. 8			Venus at ascending node.......		14O23	167.71
Tue. 9	7	56	Last Quarter..............		dO134	179.92
Wed. 10			....	1 00	231O4	192.14
Thu. 11			....		3O214	204.37l
Fri. 12			Perseid meteors...............	21 50	31O24	216.60l
			Neptune in quadrature E.......			
	0		Mars 0.7° N. of Jupiter........			
Sat. 13			....		2O14*	228.83
Sun. 14	3		Jupiter 4° S. of moon..........		21O34	241.07
	5		Mars 4° S. of moon...........			
	15		Venus 4° S. of moon..........			
	21		Mercury 6° S. of moon.........			
Mon. 15			....	18 40	dO234	253.32
Tue. 16	2		Mercury greatest elong. W., 19°.		O2134	265.56b
	6	48	New Moon................			
Wed. 17	2		Moon at perigee, 222,600 mi....		2314O	277.81
	20		Uranus 4° S. of moon..........			
Thu. 18			....	15 30	34O21	290.06
Fri. 19			....		431O2	302.30
Sat. 20			Mercury at ascending node.....		423O1	314.54
Sun. 21			....	12 20	421O3	326.77
Mon. 22	5		Neptune 2° N. of moon........		4O123	338.99
	22	02	First Quarter..............			
Tue. 23			....		4O23*	351.21l
Wed. 24	19		Pallas stationary.............	9 10	4213O	3.42
Thu. 25			Mercury at perihelion..........		34O1*	15.63
Fri. 26			....		31O42	27.83
Sat. 27			....	5 50	23O14	40.02
Sun. 28			....		21O34	52.21
Mon. 29			....		O1234	64.39
Tue. 30	11		Vesta in conjunction with sun...	2 40	O234*	76.57b
	19	14	Full Moon.................			
Wed. 31	18		Moon at apogee, 252,500 mi....		d21O4	88.76

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

The Sun—During September the sun's R.A. increases from 10h 39m to 12h 27m and its Decl. changes from 8° 32′ N. to 2° 55′ S. The equation of time changes from −0m 01s to +9m 57s. On the 23rd at 6h 43m 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.

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. 10h 07m, Decl. 13° 21′ N., and on the 15th is in R.A. 11h 47m, Decl. 2° 53′ N., when it transits at 12h 14m. It is too close to the sun for observation, superior conjunction being on the 10th.

Venus on the 1st is in R.A. 9h 31m, Decl. 15° 39′ N., and on the 15th is in R.A. 10h 38m, Decl. 9° 59′ N., when it has mag. −3.4, and transits at 11h 04m. It is a morning star to be seen low in the north-east for about an hour before sunrise.

Mars on the 15th is in R.A. 9h 03m, Decl. 18° 03′ N., and transits at 9h 27m. Moving through Cancer into Leo, it is a morning star rising about three hours before the sun.

Jupiter on the 15th is in R.A. 8h 00m, Decl. 20° 45′ N., mag. −1.6, and transits at 8h 24m. Moving into Cancer, it rises about four hours before the sun and is well up in the eastern sky by sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 52m, Decl. 3° 37′ S., mag. +0.8, and transits at 0h 16m. In Pisces, it rises about at sunset and sets about at sunrise; opposition is on the 19th, the distance from the earth then being 795,200,000 mi.

Uranus on the 15th is in R.A. 11h 25m, Decl. 4° 35′ N., and transits at 11h 48m.

Neptune on the 15th is in R.A. 15h 12m, Decl. 16° 04′ S., and transits at 15h 34m.

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

SEPTEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 17h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1	11		Saturn 2° N. of moon..........	23 30	32O14	100.94
Fri. 2			....		31O42	113.12
Sat. 3			....		d34O1	125.30
Sun. 4			Mercury greatest hel. lat. N.....	20 20	421O3	137.49
Mon. 5			....		4O123	149.68
Tue. 6			....		41O23	161.87
Wed. 7	21	08	☾ Last Quarter...............	17 10	42O13	174.07
Thu. 8			....		432O*	186.27
Fri. 9			....		431O2	198.48[l]
Sat. 10			Venus at perihelion............	14 00	43O21	210.70
	2		Mercury in superior conjunction.			
	22		Jupiter 5° S. of moon..........			
Sun. 11	5		Pluto in conjunction with sun...		214O3	222.92
	20		Mars 4° S. of moon............			
Mon. 12			....		O2143	235.14
Tue. 13	2		Uranus in conjunction with sun.	10 50	1O234	247.37[b]
	11		Venus 4° S. of moon...........			
Wed. 14	12		Moon at perigee, 221,800 mi....		2O134	259.61
	14	14	● New Moon.................			
Thu. 15			....		32O4*	271.84
Fri. 16			....	7 30	31O24	284.08
Sat. 17			....		3O214	296.31
Sun. 18	14		Neptune 2° N. of moon........		21O4*	308.53
Mon. 19	11		Saturn at opposition...........	4 20	O413*	320.75
Tue. 20			....		41O23	332.97
Wed. 21	9	25	☽ First Quarter...............		42O13	345.18[l]
Thu. 22			....	1 10	4231O	357.38
Fri. 23	6	43	Equinox. Autumn begins.......		d43O2	9.57
Sat. 24			....	22 00	43O21	21.76
Sun. 25	8		Venus 0.8° N. of Uranus.......		421O*	33.94
Mon. 26			....		4O13*	46.12[b]
Tue. 27			Mercury at descending node....	18 50	41O23	58.29
	20		Moon at apogee, 252,400 mi....			
Wed. 28	13		Saturn 2° N. of moon..........		2O413	70.46
Thu. 29	11	48	○ Full Moon, Harvest Moon...		231O4	82.63
Fri. 30			....	15 40	3O124	94.79

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Sept. 9, −7.62°; Sept. 21, +7.71°. [b]Sept. 13, −6.55°; Sept. 26, +6.68°.

THE SKY FOR OCTOBER 1966

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

The Sun—During October the sun's R.A. increases from 12h 27m to 14h 23m and its Decl. changes from 2° 55′ S. to 14° 13′ S. The equation of time changes from +10m 17s to +16m 21s. 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 penumbral eclipse on the night of the 28th–29th, "visible" in North America.

Mercury on the 1st is in R.A. 13h 23m, Decl. 9° 09′ S., and on the 15th is in R.A. 14h 39m, Decl. 17° 36′ S., when it transits at 13h 07m. Greatest eastern elongation is on the 26th, so that the planet might be seen as an evening star, but this is a very unfavourable elongation, Mercury being only about 10 degrees above the south-western horizon at sunset.

Venus on the 1st is in R.A. 11h 52m, Decl. 2° 24′ N., and on the 15th is in R.A. 12h 57m, Decl. 4° 35′ S., when it has mag. −3.5, and transits at 11h 24m. Early in the month it may be seen as a morning star very low in the east just before sunrise, but by month's end it is too close to the sun for easy observation.

Mars on the 15th is in R.A. 10h 16m, Decl. 12° 18′ N., mag. +1.8, and transits at 8h 42m. In Leo, it rises about four hours before the sun. On the 10th it is only one degree north of Regulus.

Jupiter on the 15th is in R.A. 8h 18m, Decl. 19° 54′ N., mag. −1.7, and transits at 6h 44m. In Cancer, it rises at about midnight and is near the meridian at sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 43m, Decl. 4° 29′ S., mag. +1.0, and transits at 22h 06m. In Pisces, it is risen by sunset and is visible until nearly sunrise. The earth is in the plane of the rings on the 29th.

Uranus on the 15th is in R.A. 11h 32m, Decl. 3° 52′ N., and transits at 9h 56m.

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

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

d	h	m	OCTOBER E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 16h 50m	Sun's Selen. Colong. 0h U.T. °
Sat. 1			....		3O24*	106.96
Sun. 2			Venus greatest hel. lat. N.......		231O4	119.13
Mon. 3			....	12 30	2O134	131.30
Tue. 4			....		1O234	143.47
Wed. 5	1		Pallas at opposition............		dO134	155.64
Thu. 6			....	9 10	d21O4	167.82
Fri. 7	8	09	☾ Last Quarter...............		34O21	180.01[l]
Sat. 8			Mercury at aphelion...........		43O2*	192.20
	13		Jupiter 5° S. of moon..........			
Sun. 9			....	6 00	d432O	204.40
Mon. 10	10		Mars 4° S. of moon............		42O13	216.60[b]
Tue. 11	23		Uranus 4° S. of moon..........		41O23	228.81
Wed. 12	22		Moon at perigee, 223,000 mi....	2 50	4O213	241.02
Thu. 13	22	52	● New Moon.................		421O3	253.24
Fri. 14			....	23 40	34O21	265.46
Sat. 15	11		Mercury 2° S. of moon.........		31O42	277.68
Sun. 16	2		Neptune 2° N. of moon........		d32O4	289.89
Mon. 17			....	20 30	2O134	302.10
Tue. 18			....		1O234	314.31
Wed. 19			....		O2134	326.51[l]
Thu. 20			Orionid meteors...............	17 20	21O34	338.71
Fri. 21	0	35	☽ First Quarter..............		3O14*	350.90
Sat. 22	7		Mercury 5° N. of Neptune......		31O24	3.08
Sun. 23			....	14 10	32O41	15.26[b]
Mon. 24			....		42O3*	27.43
Tue. 25	5		Moon at apogee, 252,000 mi....		41O23	39.59
	16		Saturn 2° N. of moon..........			
Wed. 26	11		Mercury greatest elong. E., 24°..	11 00	4O213	51.75
Thu. 27			Jupiter in quadrature W........		421O3	63.91
Fri. 28			Mercury greatest hel. lat. S.....		43O1*	76.06
Sat. 29	5	01	○ Full Moon, Hunter's Moon .. Penumbral eclipse of ☾, p. 64.	7 40	431O2	88.21
Sun. 30			....		432O1	100.36
Mon. 31			....		2O***	112.51

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Oct. 7, −7.04°; Oct. 19, +7.32°. [b]Oct. 10, −6.72°; Oct. 23, +6.82°.

THE SKY FOR NOVEMBER 1966

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

The Sun—During November the sun's R.A. increases from 14h 23m to 16h 26m and its Decl. changes from 14° 13′ S. to 21° 42′ S. The equation of time changes from +16m 23s to +11m 21s. There is a total eclipse on the 12th, not visible generally in North America. 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. 15h 54m, Decl. 23° 16′ S., and on the 15th is in R.A 15h 42m, Decl. 20° 09′ S., when it transits at 12h 01m. It is mostly too close to the sun for observation, inferior conjunction being on the 17th. However, by month's end it is approaching greatest western elongation and may be seen as a morning star low in the south-east just before sunrise.

Venus on the 1st is in R.A. 14h 16m, Decl. 12° 38′ S., and on the 15th is in R.A. 15h 26m, Decl. 18° 12′ S., when it has mag. −3.5, and transits at 11h 51m. It is in superior conjunction on the 8th, so that it is not easily observed during this month.

Mars on the 15th is in R.A. 11h 24m, Decl. 5° 41′ N., mag. +1.6, and transits at 7h 48m. In Leo, it rises about an hour after midnight and is approaching the meridian by sunrise.

Jupiter on the 15th is in R.A. 8h 27m, Decl. 19° 30′ N., mag. −1.9, and transits at 4h 51m. In Cancer, it rises about two hours before midnight and is past the meridian by sunrise. On the 21st it is stationary in right ascension and begins to retrograde, i.e. move westward, among the stars. 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. 23h 38m, Decl. 4° 57′ S., mag. +1.2, and transits at 19h 59m. In Pisces, it is well up at sunset and sets about two hours after midnight. On the 27th it is stationary in right ascension and resumes direct, or eastward, motion among the stars.

Uranus on the 15th is in R.A. 11h 37m, Decl. 3° 16′ N., and transits at 8h 00m.

Neptune on the 15th is in R.A. 15h 20m, Decl. 16° 37′ S., and transits at 11h 42m.

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]Nov. 3, −5.85°; Nov. 16, +6.31°; Nov. 30, −4.96°.

[b]Nov. 6, −6.79°; Nov. 19, +6.85°.

			NOVEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 15h 15m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1			....	4 30	d0243	124.66
Wed. 2			....		01243	136.81
Thu. 3			....		21034	148.96^{l}
Fri. 4			....	1 20	23014	161.12
Sat. 5			Taurid meteors................		31024	173.29
	0		Jupiter 5° S. of moon..........			
	5		Ceres stationary...............			
	17	19	☾ Last Quarter...............			
Sun. 6	17		Mercury stationary...........	22 10	d3014	185.46^{b}
Mon. 7	22		Mars 3° S. of moon...........		2104*	197.64
Tue. 8	10		Uranus 4° S. of moon..........		01243	209.83
	20		Venus in superior conjunction...			
Wed. 9			....	19 00	d023*	222.02
Thu. 10	4		Moon at perigee, 225,800 mi....		42103	234.21
Fri. 11			....		42301	246.41
Sat. 12	9	27	● New Moon................ Eclipse of ☉, p. 64	15 50	43102	258.62
Sun. 13			....		43021	270.82
Mon. 14	13		Neptune in conjunction with sun		42130	283.02
Tue. 15			....	12 40	4013*	295.22
Wed. 16			Leonid meteors................		4023*	307.42^{l}
			Mercury at ascending node.....			
Thu. 17	6		Mercury in inferior conjunction.		d2403	319.61
Fri. 18			....	9 30	d2014	331.79
Sat. 19			Mars greatest hel. lat. N........			
	19	21	☽ First Quarter...............		31024	343.97^{b}
Sun. 20			Mercury at perihelion..........		30214	356.14
Mon. 21	11		Jupiter stationary.............	6 20	23104	8.31
	15		Mars 1.0° N. of Uranus........			
	21		Saturn 2° N. of moon..........			
	22		Moon at apogee, 251,500 mi....			
Tue. 22			....		0134*	20.47
Wed. 23			....		10234	32.62
Thu. 24			....	3 00	d2034	44.77
Fri. 25			....		20134	56.92
Sat. 26	10		Mercury stationary............	23 50	31402	69.05
Sun. 27			Venus at descending node......		34021	81.19
	7		Saturn stationary.............			
	21	41	○ Full Moon................			
Mon. 28			....		43210	93.33
Tue. 29	3		Pallas stationary..............	20 40	42031	105.46
Wed. 30			....		41023	117.59^{l}

THE SKY FOR DECEMBER 1966

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 26m to 18h 43m and its Decl. changes from 21° 42′ S. to 23° 05′ S. The equation of time changes from +10m 59s to −2m 59s, being zero on the 25th.The solstice is on the 22nd at 2h 29m 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. 15h 07m, Decl. 14° 54′ S., and on the 15th is in R.A. 16h 12m, Decl. 19° 52′ S., when it transits at 10h 39m. For a week or more at the beginning of the month it may be seen as a morning star low on the south-eastern horizon just before sunrise; greatest western elongation is on the 4th at which time it stands about 19 degrees above the south-eastern horizon at sunrise.

Venus on the 1st is in R.A. 16h 49m, Decl. 22° 35′ S., and on the 15th is in R.A. 18h 06m, Decl. 24° 06′ S., when it has mag. −3.4, and transits at 12h 34m. It is an evening star but too close to the sun for easy observation.

Mars on the 15th is in R.A. 12h 24m, Decl. 0° 32′ S., mag. +1.3, and transits at 6h 50m. In Virgo, it rises soon after midnight and is past the meridian at sunrise.

Jupiter on the 15th is in R.A. 8h 24m, Decl. 19° 47′ N., mag. −2.1, and transits at 2h 49m. In Cancer, it rises about three hours after sunset and is visible the rest of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 23h 39m, Decl. 4° 48′ S., mag. +1.3, and transits at 18h 02m. In Pisces, it is nearing the meridian at sunset and sets at about midnight. The earth is in the plane of the rings on the 17–18th.

Uranus on the 15th is in R.A. 11h 40m, Decl. 2° 58′ N., and transits at 6h 05m.

Neptune on the 15th is in R.A. 15h 24m, Decl. 16° 53′ S., and transits at 9h 48m.

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

			DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 14h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1			Mercury greatest hel. lat. N....		d4013	129.73
Fri. 2	5		Jupiter 5° S. of moon..........	17 30	4203*	141.87
Sat. 3			....		34102	154.02[b]
Sun. 4	12		Mercury greatest elong. W., 21°.		3012*	166.16
Mon. 5	1	23	☾ Last Quarter...............	14 20	32104	178.32
	7		Mercury 0.6° N. of Neptune....			
	18		Uranus 4° S. of moon..........			
Tue. 6	8		Mars 2° S. of moon............		2014*	190.48
Wed. 7	13		Moon at perigee, 229,200 mi....		10234	202.65
Thu. 8			....	11 10	d0134	214.83
Fri. 9			....		21034	227.01
Sat. 10	1		Neptune 2° N. of moon........		d3024	239.20
	11		Mercury 3° N. of moon........			
Sun. 11	22	14	● New Moon.................	8 00	30124	251.39
Mon. 12	1		Juno stationary...............		32104	263.58
Tue. 13			Geminid meteors.............		4201*	275.77
Wed. 14			....	4 50	41023	287.96[l]
Thu. 15			Saturn in quadrature E.........		40213	300.15
Fri. 16			Uranus in quadrature W........		42103	312.34[b]
Sat. 17			....	1 40	43012	324.52
Sun. 18			....		43012	336.69
Mon. 19	7		Saturn 2° N. of moon..........	22 30	43210	348.86
	16	41	☽ First Quarter..............			
	19		Moon at apogee, 251,200 mi....			
Tue. 20			....		24301	1.02
Wed. 21			....		10423	13.17
Thu. 22			Ursid meteors.................	19 20	02143	25.32
	2	29	Solstice. Winter commences.....			
	4		Ceres at opposition...........			
Fri. 23			....		21034	37.47
Sat. 24			Mercury at descending node....		3014*	49.61
Sun. 25			....	16 10	3024*	61.74
Mon. 26			Mars at aphelion.............		32104	73.87[l]
Tue. 27	12	44	○ Full Moon................		23014	86.00
Wed. 28			....	12 50	10243	98.12
Thu. 29	9		Jupiter 5° S. of moon..........		d0213	110.25
Fri. 30	10		Uranus stationary.............		42103	122.38[b]
	18		Pluto stationary..............			
Sat. 31			....	9 40	d4201	134.51[b]

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

[l]Dec. 14, +5.20°; Dec. 26, −5.37°.

[b]Dec. 3, −6.72°; Dec. 16, +6.71°; Dec. 30, 31, —6.55°.

PHENOMENA OF JUPITER'S SATELLITES, E.S.T. 1956

JANUARY

d	h	m	Sat.	Phen.
1	3	13	I	TI
	3	35	I	SI
	5	26	I	Te
	5	47	I	Se
2	0	30	I	OD
	3	07	I	ER
	21	39	I	TI
	22	03	I	SI
	23	52	I	Te
3	0	16	I	Se
	1	30	II	OD
	4	59	II	ER
	18	56	I	OD
	21	35	I	ER
4	18	18	I	Te
	18	45	I	Se
	20	21	II	TI
	21	15	II	SI
	23	02	II	Te
	23	58	II	Se
6	18	17	II	ER
	23	35	III	TI
7	1	34	III	SI
	2	23	III	Te
	4	28	III	Se
8	4	58	I	TI
9	2	15	I	OD
	5	02	I	ER
	23	24	I	TI
	23	58	I	SI
10	1	36	I	Te
	2	11	I	Se
	3	45	II	OD
	18	37	III	ER
	20	41	I	OD
	23	30	I	ER
11	17	50	I	TI
	18	26	I	SI
	20	03	I	Te
	20	39	I	Se
	22	38	II	TI
	23	52	II	SI
12	1	20	II	Te
	2	36	II	Se
	17	59	I	ER
13	20	53	II	ER
14	2	55	III	TI
16	4	00	I	OD
17	1	10	I	TI
	1	53	I	SI
	3	22	I	Te
	4	05	I	Se
	19	34	III	OR
	19	41	III	ED
	22	27	I	OD
	22	38	III	ER
18	1	26	I	ER
	19	36	I	TI
	20	21	I	SI
	21	48	I	Te
	22	34	I	Se
19	0	57	II	TI
	2	30	II	SI
	3	39	II	Te
	19	54	I	ER
20	19	11	II	OD
	23	28	II	ER
22	18	32	II	Se
24	2	56	I	TI
	3	47	I	SI
	20	10	III	OD
	23	02	III	OR
	23	41	III	ED
25	0	14	I	OD
	2	39	III	ER
25	3	21	I	ER
	21	23	I	TI
25	22	16	I	SI
	23	35	I	Te
26	0	29	I	Se
	3	19	II	TI
	18	40	I	OD
	21	50	I	ER
27	18	02	I	Te
	18	57	I	Se
	21	31	II	OD
28	2	04	II	ER
29	18	25	II	SI
	19	11	II	Te
	21	09	II	Se
31	23	42	III	OD

FEBRUARY

d	h	m	Sat.	Phen.
1	2	02	I	OD
	2	34	III	OR
	23	11	I	TI
2	0	11	I	SI
	1	23	I	Te
	2	24	I	Se
	20	29	I	OD
	23	45	I	ER
3	18	40	I	SI
	19	50	I	Te
	20	52	I	Se
	23	53	II	OD
4	18	14	I	ER
	20	31	III	Se
5	18	54	II	TI
	21	03	II	SI
	21	36	II	Te
	23	46	II	Se
9	1	01	I	TI
	2	06	I	SI
	22	18	I	OD
10	1	41	I	ER
	19	28	I	TI
	20	35	I	SI
	21	40	I	Te
	22	48	I	Se
11	2	18	II	OD
	19	52	III	Te
	20	10	I	ER
	21	34	III	SI
12	0	32	III	Se
	21	21	II	TI
	23	40	II	SI
13	0	03	II	Te
	2	24	II	Se
14	20	35	II	ER
17	0	10	I	OD
	21	19	I	TI
	22	30	I	SI
	23	31	I	Te
18	0	43	I	Se
	18	38	I	OD
	20	42	III	TI
	22	05	I	ER
	23	35	III	Te
19	1	35	III	SI
	19	12	I	Se
	23	51	II	TI
21	23	12	II	ER
22	18	45	III	ER
24	23	11	I	TI
25	0	25	I	SI
	1	23	I	Te
	20	30	I	OD
26	0	00	I	ER
	0	31	III	TI
	18	54	I	SI
	19	51	I	Te
	21	07	I	Se
28	20	31	II	OD

MARCH

d	h	m	Sat.	Phen.
1	19	44	III	ED
	22	46	III	ER
2	20	56	II	Se
4	1	04	I	TI
	22	24	I	OD
5	19	33	I	TI
	20	50	I	SI
	21	45	I	Te
	23	02	I	Se
6	20	25	I	ER
7	23	04	II	OD
8	21	26	III	OR
	23	44	III	ED
9	20	50	II	SI
	20	56	II	Te
	23	33	II	Se
12	0	19	I	OD
	21	28	I	TI
	22	45	I	SI
	23	40	I	Te
13	0	58	I	Se
	22	20	I	ER
14	19	27	I	Se
15	22	28	III	OD
16	20	51	II	TI
	23	26	II	SI
	23	33	II	Te
18	20	22	II	ER
19	20	39	III	Se
	23	23	I	TI
20	20	43	I	OD
21	0	16	I	ER
	20	05	I	Te
	21	22	I	Se
23	23	29	II	TI
25	22	59	II	ER
26	19	26	III	Te
	21	37	III	SI
27	20	24	IV	ED
	20	27	IV	ER
	22	40	I	OD
28	19	49	I	TI
	21	05	I	SI
	22	02	I	Te
	23	17	I	Se
29	20	40	I	ER

APRIL

d	h	m	Sat.	Phen.
1	20	19	II	OD
2	20	37	III	TI
	23	36	III	Te
3	20	41	II	Se
4	21	47	I	TI
	23	00	I	SI
5	22	35	I	ER
6	19	43	I	Se
8	23	01	II	OD
10	20	33	II	SI
	20	55	II	Te
	23	18	II	Se
12	21	06	I	OD
13	19	46	III	ED
	20	28	I	Te
	21	38	I	Se
	22	54	III	ER
17	20	55	II	TI
19	20	11	II	ER
20	20	14	I	TI
	21	20	I	SI
	22	23	III	OR
	22	28	I	Te
21	20	54	I	ER
27	22	14	I	TI

MAY

d	h	m	Sat.	Phen.
1	20	48	III	Se
3	20	42	II	OD
5	20	23	II	Se
	21	34	I	OD
6	20	59	I	Te
	21	54	I	Se
8	21	09	III	Te
	21	40	III	SI
12	21	19	II	Te
13	20	46	I	TI
	21	35	I	SI
14	21	08	I	ER

Jupiter being near the sun, phenomena of the satellites are not given between June 1 and Aug. 6.

AUGUST

d	h	m	Sat.	Phen.
12	3	59	I	SI
20	3	02	I	ED
21	3	22	I	Te
22	3	15	II	ED
28	2	56	III	ER
	2	56	III	OD
	3	06	I	TI
31	2	55	II	Se

SEPTEMBER

d	h	m	Sat.	Phen.
3	3	30	IV	Se
4	3	32	III	ED
	4	10	I	SI
7	2	40	II	SI
9	2	38	II	OR
12	3	11	I	ED
13	2	48	I	Se
	3	49	I	Te
15	1	45	III	TI
20	2	26	I	SI
	3	32	I	TI
	4	17	IV	TI
	4	41	I	Se
21	2	56	I	OR
22	1	29	III	SI
23	2	56	II	ED
25	2	14	II	Te
27	4	20	I	SI
28	1	26	I	ED
	1	52	IV	ED
	4	54	I	OR
29	1	03	I	Se
	2	14	I	Te

OCTOBER

d	h	m	Sat.	Phen.
2	2	04	II	TI
	2	31	II	Se
	4	55	II	Te
3	3	47	III	OR
5	3	20	I	ED
6	0	42	I	SI
	1	54	I	TI
	2	57	I	Se
	4	10	I	Te
7	1	19	I	OR
	3	29	IV	Te
9	2	16	II	SI
	4	44	II	TI
	5	05	II	Se
10	2	49	III	ER
	4	25	III	OD
11	2	47	II	OR
13	2	35	I	SI
	3	50	I	TI
	4	50	I	Se

d	h	m	Sat.	Phen.
14	3	15	I	OR
15	0	34	I	Te
16	4	50	II	SI
17	3	22	III	ED
20	4	29	I	SI
21	1	35	I	ED
	2	01	III	Te
	5	10	I	OR
22	0	13	I	TI
	1	12	I	Se
	2	28	I	Te
25	2	33	II	ED
26	23	33	II	Se
27	2	09	II	Te
28	0	46	III	Se
	2	30	III	TI
	3	28	I	ED
29	0	50	I	SI
	2	06	I	TI
	3	06	I	Se
	4	22	I	Te
30	1	32	I	OR

NOVEMBER

d	h	m	Sat.	Phen.
1	1	56	IV	OD
	5	07	II	ED
2	23	18	II	SI
3	1	51	II	TI
	2	09	II	Se
	4	43	II	Te
4	1	19	III	SI
	4	45	III	Se
	5	22	I	ED
	23	49	II	OR
5	2	44	I	SI
	3	58	I	TI
	4	59	I	Se
	23	50	I	ED
6	3	25	I	OR
	23	27	I	Se
7	0	42	I	Te
	23	53	III	OR
9	0	01	IV	SI
	3	51	IV	Se
10	1	53	II	SI
10	4	23	II	TI
	4	44	II	Se
11	5	17	III	SI
12	2	19	II	OR
	4	37	I	SI
	5	50	I	TI
13	1	44	I	ED
	5	16	I	OR
	23	05	I	SI
14	0	17	I	TI
	1	21	I	Se
	2	33	I	Te
	22	42	III	ER
	23	43	I	OR
15	0	08	III	OD
	3	41	III	OR
17	4	28	II	SI
	23	31	IV	OR
18	23	33	II	ED
19	4	46	II	OR
20	3	37	I	ED
	22	59	II	Te
21	0	58	I	SI
	2	07	I	TI
	3	14	I	Se
	4	23	I	Te
	22	06	I	ED
	23	12	III	ED
22	1	33	I	OR
	2	41	III	ER
	3	51	III	OD
	22	50	I	Te
25	21	55	IV	Se
26	2	07	II	ED
	4	10	IV	TI
27	5	31	I	ED
	22	33	II	TI
	23	13	II	Se
28	1	26	II	Te
	2	52	I	SI
	3	56	I	TI
	5	07	I	Se
	6	12	I	Te
	23	59	I	ED
29	3	11	III	ED
	3	22	I	OR
	22	23	I	TI
29	23	36	I	Se
30	0	39	I	Te
	21	49	I	OR

DECEMBER

d	h	m	Sat.	Phen.
2	21	17	III	TI
3	0	50	III	Te
	4	41	II	ED
4	1	49	IV	ED
	5	54	IV	ER
	22	57	II	SI
5	0	57	II	TI
	1	49	II	Se
	3	51	II	Te
	4	45	I	SI
	5	43	I	TI
6	1	53	I	ED
	5	10	I	OR
	22	44	II	OR
	23	13	I	SI
7	0	10	I	TI
	1	29	I	Se
	2	26	I	Te
	23	37	I	OR
8	20	53	I	Te
9	21	09	III	SI
10	0	38	III	Se
	0	49	III	TI
	4	21	III	Te
12	1	33	II	SI
	3	19	II	TI
	4	26	II	Se
	6	13	II	Te
13	0	13	IV	Te
	3	47	I	ED
	20	31	II	ED
14	1	04	II	OR
	1	06	I	SI
	1	56	I	TI
	3	22	I	Se
	4	12	I	Te
	22	15	I	ED
15	1	23	I	OR
	20	22	I	TI
15	21	51	I	Se
	22	39	I	Te
17	1	07	III	SI
	4	16	III	TI
	4	36	III	Se
19	4	09	II	SI
	5	39	II	TI
20	5	41	I	ED
	21	33	III	OR
	23	05	II	ED
21	0	00	IV	ER
	2	29	IV	OD
	3	00	I	SI
	3	21	II	OR
	3	41	I	TI
	5	16	I	Se
	5	58	I	Te
22	0	10	I	ED
	3	09	I	OR
	20	21	II	Se
	21	28	I	SI
	21	43	II	Te
	22	08	I	TI
	23	44	I	Se
23	0	24	I	Te
	21	35	I	OR
24	5	05	III	SI
28	0	54	III	OR
	1	39	II	ED
	4	53	I	SI
	5	26	I	TI
	5	37	II	OR
29	2	04	I	ED
	4	54	I	OR
	5	52	IV	SI
	20	04	II	SI
	21	07	II	TI
	22	57	II	Se
	23	21	I	SI
	23	52	I	TI
30	0	01	II	Te
	1	38	I	Se
	2	08	I	Te
	20	32	I	ED
	23	20	I	OR
31	20	06	I	Se
	20	34	I	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 January to May, and on the west side from August to December.

SATURN'S SATELLITES, 1966

Name	Greatest E. Elongation E.S.T.*		Mean Synodic Period	
	d	h	d	h
Mimas	Sept. 19	13.8	0	22.6
Enceladus	Sept. 18	21.8	1	8.9
Tethys	Sept. 19	13.5	1	21.3
Dione	Sept. 20	0.7	2	17.7
Rhea	Sept. 18	13.3	4	12.5
Titan	Sept. 23	13.6†	15	23.3
Hyperion	Sept. 28	8.5†	21	07.6
Iapetus	Sept. 9	4.9†	79	22.1
Phoebe			523	15.6

*Near opposition of Saturn, 1966 Sept. 19.

†See p. 58 for more information.

SATURN'S SATELLITES, TITAN, HYPERION AND IAPETUS

Elongations and Conjunctions, E.S.T. 1966

Titan

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
						Jan.	3	4.3	Jan.	6	23.6
Jan.	10	22.2	Jan.	15	3.1		19	4.4		22	23.7
	26	22.4		31	3.4		..	....		..	....
	..	....		..	....		..	....		..	....
Apr.	17	1.1	Apr.	21	6.2	Apr.	25	6.7	Apr.	29	1.8
May	3	1.4	May	7	6.5	May	11	6.8	May	15	1.9
	19	1.5		23	6.5		27	6.6		31	1.7
June	4	1.3	June	8	6.2	June	12	6.2	June	16	1.1
	20	0.7		24	5.5		28	5.4	July	2	0.2
July	5	23.7	July	10	4.5	July	14	4.2		17	22.9
	21	22.4		26	3.0		30	2.6	Aug.	2	21.3
Aug.	6	20.6	Aug.	11	1.1	Aug.	15	0.7		18	19.3
	22	18.4		26	22.9		30	22.5	Sept.	3	17.0
Sept.	7	16.1	Sept.	11	20.5	Sept.	15	20.1		19	14.7
	23	13.6		27	18.0	Oct.	1	17.7	Oct.	5	12.3
Oct.	9	11.1	Oct.	13	15.5		17	15.4		21	10.0
	25	8.8		29	13.3	Nov.	2	13.4	Nov.	6	8.1
Nov.	10	6.9	Nov.	14	11.5		18	11.7		22	6.5
	26	5.4		30	10.1	Dec.	4	10.4	Dec.	8	5.2
Dec.	12	4.3	Dec.	16	9.1		20	9.5		24	4.5
	28	3.6									

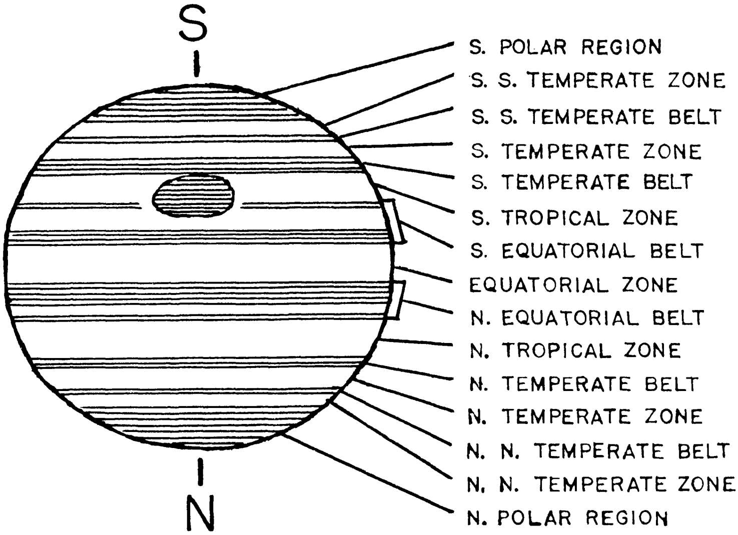
Hyperion

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
			Jan.	1	1.8	Jan.	6	1.8	Jan.	10	8.2
Jan.	15	21.0		22	9.0		27	7.9		31	14.7
	..	....		..	....		..	....		..	....
	..	....	Apr.	17	15.0	Apr.	22	8.9	Apr.	26	17.6
May	2	14.0	May	8	22.1	May	13	14.9	May	18	0.1
	23	21.7		30	4.9	June	3	20.8	June	8	6.4
June	14	4.9	June	20	11.4		25	2.4		29	12.3
July	5	11.4	July	11	17.3	July	16	7.8	July	20	17.8
	26	17.2	Aug.	1	22.8	Aug.	6	13.0	Aug.	10	22.9
Aug.	16	22.4		23	4.0		27	18.2	Sept.	1	3.9
Sept.	7	3.4	Sept.	13	9.2	Sept.	17	23.5		22	9.1
	28	8.5	Oct.	4	14.8	Oct.	9	5.3	Oct.	13	14.9
Oct.	19	14.4		25	21.2		30	12.0	Nov.	3	21.7
Nov.	9	21.5	Nov.	16	4.8	Nov.	20	19.7		25	5.7
Dec.	1	6.2	Dec.	7	13.7	Dec.	12	4.6	Dec.	16	15.1
	22	16.5		28	23.9						

Iapetus

Elong. E.			Inf. Conj.			Elong. W.			Sup. Conj.		
	d	h		d	h		d	h		d	h
Jan.	11	7.2	Jan.	31	23.4		..	....		..	....
	..	....		..	....		..	....		..	....
	..	....	Apr.	23	11.6	May	14	14.5	June	3	3.2
June	22	8.7	July	12	21.3	Aug.	2	10.3	Aug.	21	10.7
Sept.	9	4.9	Sept.	29	6.6	Oct.	19	15.4	Nov.	7	17.6
Nov.	26	15.6	Dec.	17	2.3						

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 1966 Saturn's rings are in an almost edge-on position. The earth is in the plane of the rings three times, on Apr. 2, Oct. 29 and Dec. 17–18, when the rings will be completely invisible. Three passages through this plane will next occur in 1980. The major and minor axes of the outer edge of the outer ring have the following values during the year: Jan. 3, 37.21″, 3.07″; Apr. 1, 35.55″, 0.05″ (northern face); July 14, 40.95″, 2.13″; Oct. 26, 42.88″, 0.05″ (southern face); Dec. 17, 39.48″, 0.01″ (northern face); Dec. 29, 38.68″, 0.19″ (southern face).

LONGITUDE OF JUPITER'S CENTRAL MERIDIAN

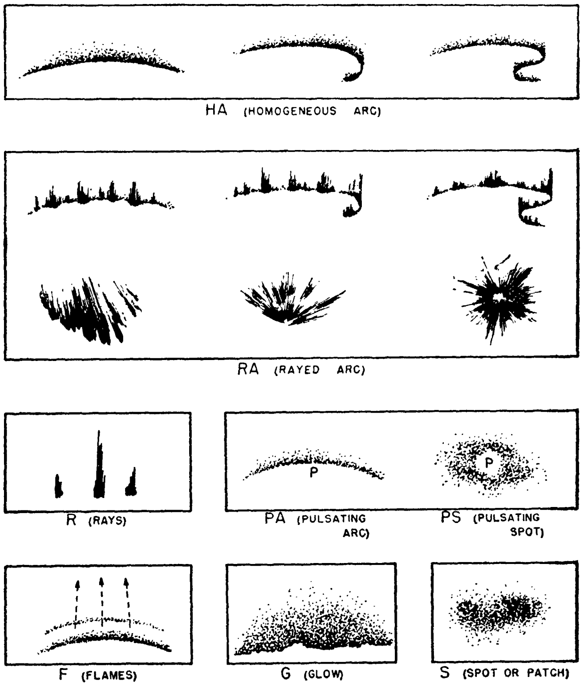
The table lists the longitude of the central meridian of the illuminated disk of Jupiter for given times daily during the period when the planet is favourably placed. System I applies to the regions between the middle of the North Equatorial Belt and the middle of the South Equatorial Belt; System II 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. 3^h	Feb. 2^h	Mar. 1^h	Oct. 8^h	Nov. 6^h	Dec. 4^h	Jan. 3^h	Feb. 2^h	Mar. 1^h	Oct. 8^h	Nov. 6^h	Dec. 4^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	288.2	107.7	170.1	335.4	116.2	101.6	336.8	280.1	129.3	99.4	4.4	121.5
2	86.2	265.6	327.9	133.2	274.1	259.5	127.2	70.3	279.4	249.6	154.7	271.9
3	244.1	63.5	125.6	291.1	72.1	57.5	277.6	220.6	69.5	39.9	305.0	62.3
4	42.1	221.3	283.4	88.9	230.0	215.5	67.9	10.8	219.7	190.1	95.3	212.6
5	200.1	19.2	81.2	246.7	27.9	13.5	218.3	161.1	9.8	340.3	245.6	3.0
6	358.1	177.1	238.9	44.6	185.8	171.5	8.6	311.3	159.9	130.5	35.9	153.4
7	156.1	334.9	36.7	202.4	343.8	329.5	159.0	101.5	310.0	280.7	186.2	303.7
8	314.1	132.8	194.4	00.3	141.7	127.5	309.3	251.7	100.2	70.9	336.5	94.1
9	112.0	290.6	352.2	158.1	299.6	285.5	99.7	41.9	250.3	221.1	126.8	244.5
10	270.0	88.4	149.9	316.0	97.5	83.5	250.0	192.1	40.4	11.4	277.1	34.8
11	68.0	246.3	307.7	113.8	255.5	241.5	40.3	342.4	190.5	161.6	67.4	185.2
12	225.9	44.1	105.4	271.7	53.4	39.6	190.7	132.6	340.6	311.8	217.7	335.6
13	23.9	201.9	263.1	69.6	211.4	197.6	341.0	282.8	130.7	102.1	8.0	126.0
14	181.8	359.8	60.9	227.4	9.3	355.6	131.3	73.0	280.8	252.3	158.3	276.4
15	339.8	157.6	218.6	25.3	167.3	153.6	281.6	223.1	70.9	42.5	308.6	66.8
16	137.7	315.4	16.3	183.2	325.2	311.6	71.9	13.3	221.0	192.8	99.0	217.1
17	295.6	113.2	174.1	341.0	123.2	109.6	222.3	163.5	11.1	343.0	249.3	7.5
18	93.6	271.0	331.8	138.9	281.1	267.7	12.6	313.7	161.2	133.3	39.6	157.9
19	251.5	68.8	129.5	296.8	79.1	65.7	162.9	103.9	311.3	283.5	189.9	308.3
20	49.4	226.6	287.2	94.7	237.0	223.7	313.2	254.0	101.4	73.7	340.3	98.7
21	207.4	24.4	85.0	252.6	35.0	21.7	103.5	44.2	251.5	224.0	130.6	249.1
22	5.3	182.2	242.7	50.4	193.0	179.8	253.7	194.4	41.6	14.3	280.9	39.5
23	163.2	340.0	40.4	208.3	350.9	337.8	44.0	344.5	191.7	164.5	71.3	189.9
24	321.1	137.8	198.1	6.2	148.9	135.8	194.3	134.7	341.8	314.8	221.6	340.3
25	119.0	295.6	355.8	164.1	306.9	293.8	344.6	284.9	131.8	105.0	11.9	130.7
26	276.9	93.4	153.5	322.0	104.8	91.9	134.9	75.0	281.9	255.3	162.3	281.1
27	74.8	251.2	311.2	119.9	262.8	249.9	285.1	225.2	72.0	45.6	312.6	71.5
28	232.7	48.9	108.9	277.8	60.8	47.9	75.4	15.3	222.1	195.8	103.0	221.9
29	30.6		266.6	75.7	218.8	206.0	225.6		12.2	346.1	253.3	12.3
30	188.5		64.3	233.6	16.8	4.0	15.9		162.2	136.4	43.7	162.7
31	346.4		222.0	31.5		162.1	166.2		312.3	286.7		313.1

Dec. 1, 0_h U.T.: System I: 315.3°; System II: 336.4°

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 1966 the ascending node of the moon's orbit moves from the constellation Taurus into Aries (☊ from 63° to 43°). 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 $\frac{1}{2}$° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 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.

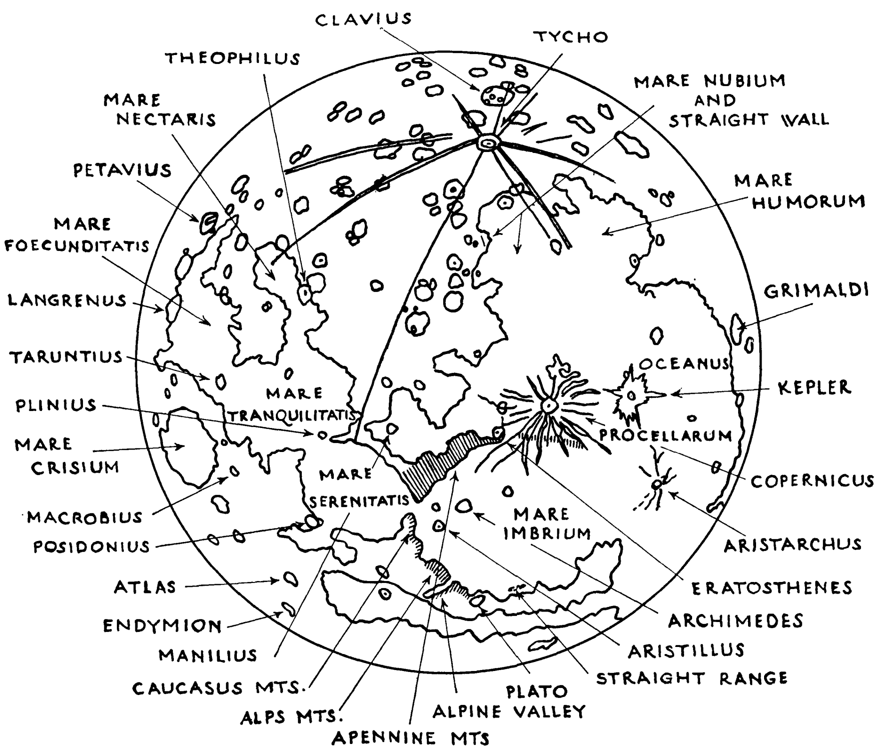
The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

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.

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1966
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.23	−3.04	110.62	July 5	− 1.08	+3.31	188.89
6	− 0.20	−3.61	44.76	10	+ 1.19	+3.84	122.72
11	− 2.61	−4.15	338.92	15	+ 3.44	+4.33	56.55
16	− 4.98	−4.66	273.08	20	+ 5.64	+4.80	350.39
21	− 7.29	−5.14	207.25	25	+ 7.79	+5.24	284.25
26	− 9.52	−5.57	141.41	30	+ 9.86	+5.64	218.11
31	−11.64	−5.96	75.58	Aug. 4	+11.85	+6.00	151.98
Feb. 5	−13.66	−6.30	9.75	9	+13.75	+6.32	85.86
10	−15.56	−6.59	303.91	14	+15.54	+6.59	19.76
15	−17.32	−6.83	238.08	19	+17.23	+6.82	313.68
20	−18.94	−7.02	172.23	24	+18.78	+7.00	247.60
25	−20.42	−7.15	106.39	29	+20.22	+7.14	181.54
Mar. 2	−21.74	−7.23	40.52	Sept. 3	+21.51	+7.22	115.49
7	−22.90	−7.25	334.65	8	+22.67	+7.25	49.45
12	−23.91	−7.21	268.76	13	+23.68	+7.23	343.43
17	−24.74	−7.12	202.86	18	+24.54	+7.15	277.42
22	−25.41	−6.98	136.95	23	+25.24	+7.03	211.43
27	−25.90	−6.78	71.02	28	+25.77	+6.85	145.44
Apr. 1	−26.21	−6.54	5.06	Oct. 3	+26.13	+6.62	79.45
6	−26.35	−6.25	299.09	8	+26.32	+6.34	13.48
11	−26.30	−5.91	233.10	13	+26.33	+6.01	307.52
16	−26.07	−5.53	167.08	18	+26.15	+5.64	241.57
21	−25.65	−5.11	101.05	23	+25.78	+5.22	175.63
26	−25.06	−4.65	35.00	28	+25.22	+4.77	109.68
May 1	−24.27	−4.16	328.93	Nov. 2	+24.46	+4.27	43.75
6	−23.31	−3.65	262.84	7	+23.50	+3.75	337.82
11	−22.18	−3.11	196.73	12	+22.35	+3.19	271.90
16	−20.87	−2.55	130.60	17	+21.01	+2.60	205.99
21	−19.39	−1.97	64.47	22	+19.48	+2.00	140.08
26	−17.77	−1.38	358.32	27	+17.77	+1.38	74.18
31	−16.00	−0.78	292.16	Dec. 2	+15.91	+0.75	8.28
June 5	−14.11	−0.18	225.98	7	+13.89	+0.11	302.39
10	−12.11	+0.43	159.81	12	+11.75	−0.53	236.51
15	−10.01	+1.03	93.63	17	+ 9.50	−1.17	170.64
20	− 7.84	+1.62	27.44	22	+ 7.16	−1.80	104.77
25	− 5.61	+2.20	321.26	27	+ 4.77	−2.41	38.90
30	− 3.35	+2.77	255.08				

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, 1966

No.	Commences	No.	Commences	No.	Commence
1503	Jan. 9.40	1508	May 25.87	1513	Oct. 9.02
1504	Feb. 5.74	1509	June 22.07	1514	Nov. 5.32
1505	Mar. 5.08	1510	July 19.27	1515	Dec. 2.63
1506	Apr. 1.38	1511	Aug. 15.50	1516	Dec. 29.95
1507	Apr. 28.65	1512	Sept. 11.75		

ECLIPSES DURING 1966

In 1966 there will be four eclipses, two of the sun and two of the moon. Of these only the penumbral eclipse of the moon of the night of October 28–29 will be visible generally in North America.

1. A penumbral eclipse of the moon on May 4, not visible at all in North America.

2. An annular eclipse of the sun on May 20, visible in the South Atlantic, Africa and Asia but not at all in North America.

3. A penumbral eclipse of the moon on the night of October 28–29 "visible" (though penumbral eclipses are barely detectable) generally in North America.

Moon enters penumbra...	October 29, 2h 53m E.S.T.
Middle of eclipse....................	5h 12m E.S.T.
Moon leaves penumbra..............	7h 31m E.S.T.

4. A total eclipse of the sun on November 12, visible in South America and across the South Atlantic, visible as a partial eclipse in Central America, Mexico and in the American States near the Gulf of Mexico.

LUNAR OCCULTATIONS

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.

The co-ordinates of the standard stations are: Halifax, λ_0 63° 36.0′, ϕ_0+44° 38.0′; Montreal, λ_0 73° 34.7′, ϕ_0+45° 30.3′; Toronto, λ_0 79° 23.9′, ϕ_0+43° 39.8′; Winnipeg, λ_0 97° 06.0′, ϕ_0+49° 55.0; Edmonton, λ_0 113° 05′, ϕ_0+53° 32′; Vancouver, λ_0 123° 06′, ϕ_0+49° 30′.

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1966

					Halifax				Montreal			
Date	Star	Mag.	I or E	Age of Moon	A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Jan. 2	+14° 502	7.3	I	11.1	[illegible]0 03.5	−1.6	+1.2	061	18 51.7	−1.1	+1.9	045
Jan. 3	164B. Tau	6.8	I	12.3	[illegible]3 38.2	−1.4	+0.6	052	22 24.6	−1.4	+1.2	045
Jan. 10	46 Leo	5.7	E	18.5	5 41.7	−0.8	−1.9	311	4 29.9	−1.2	−1.4	299
Jan. 16	κ Lib	5.0	E	24.5	5 54.0	−1.0	+0.1	305	4 45.2	−0.9	+0.7	292
Jan. 25	−8° 1666	7.1	I	04.3	No Occ.	...	...	...	18 29.0	−1.8	−2.9	110
Jan. 26	54B. (Cet)	6.3	I	05.3	20 14.7	−0.4	+0.9	027	19 12.6	−0.2	+1.8	012
Jan. 30	+17° 564	7.2	I	09.3	19 28.8	−1.9	+0.2	080	18 11.8	−1.6	+1.2	065
Feb. 1	+24° 854	6.9	I	11.5	23 06.8	−1.2	−3.1	132	21 49.8	−1.7	−2.8	130
Feb. 23	167B. (Psc)	7.3	I	03.5	Low	...	...	...	19 35.6	−0.5	−2.2	102
Feb. 25	+11° 335	7.5	I	05.5	19 16.6	−1.6	−2.8	112	Sun	...	...	...
Feb. 28	51 Tau	5.6	I	07.7	Low	...	...	...	0 03.1	0.0	−0.9	071
Feb. 28	103 Tau	5.5	I	08.6	21 41.5	−1.3	−0.4	071	20 26.6	−1.6	−0.1	071
Mar. 2	+25° 1594	7.0	I	10.6	19 49.5	−1.8	−0.7	116	18 32.0	−1.6	0.0	109
Mar. 2	49 Gem	6.9	I	10.6	21 29.7	−1.7	−0.7	099	20 12.0	−1.7	−0.3	099
Mar. 3	57 Gem	5.1	I	10.8	2 36.9	+0.5	−2.2	143	1 40.2	+0.7	−2.9	158
Mar. 27	99 Tau	6.0	I	05.9	Low	...	...	...	22 55.5	−0.2	−0.5	055
Mar. 28	+25° 978	6.6	I	06.8	19 48.2	−1.3	−1.9	113	Sun	...	...	...
Mar. 28	+25° 1058	6.6	I	07.0	Low	...	...	...	23 54.9	−0.2	−0.5	054
Mar. 28/29	39 Gem	6.1	I	08.0	0 32.9	−0.9	+0.2	040	23 24.4	−0.8	−0.5	057
Mar. 29/30	40 Gem	6.3	I	08.0	0 39.3	−0.1	−1.1	079	23 36.2	−0.3	−1.3	090
Mar. 31	+22° 2029	7.0	I	09.9	21 39.7	−1.3	−1.5	121	20 25.0	−1.4	−1.6	130
Apr. 4	7 Vir	5.2	I	13.1	3 40.4	−0.3	−2.0	141	2 34.8	−0.4	−2.0	149
Apr. 8	11H. Lib	5.5	E	17.1	2 01.2	−0.6	−1.3	342	0 53.3	−0.8	−0.6	326
Apr. 9	ρ Oph m.	4.8	E	18.0	0 31.1	−1.0	+0.8	286	Low	...	...	...
Apr. 23	+22° 712	6.8	I	03.1	19.49.6	—	—	149	No Occ.	...	....	...
Apr. 30	398B. Leo	6.7	I	10.2	21 51.4	−0.3	−2.7	172	20 51.8	—	—	199
May 10	ω Sgr	4.8	E	19.5	Sun	...	...	...	3 05.5	−1.8	+0.8	270
May 25	9B. Leo	6.7	I	05.6	21 32.8	0.0	−2.2	144	20 30.5	0.0	−2.6	158
May 26	42 Leo	6.1	I	06.6	21 43.4	−0.5	−1.9	129	20 36.2	−0.6	−2.1	142
May 26	167B. Leo	7.1	I	06.8	Low	...	...	...	23 56.8	−0.1	−1.3	082
May 29	76B. Vir	7.0	I	08.8	Low	...	...	...	0 12.5	−0.6	−1.5	089
May 29	44 Vir	5.9	I	09.7	23 01.4	0.0	−2.8	183	No Occ.	...	...	...
May 29	46 Vir	6.1	I	09.7	Graze	...	...	...	21 36.1	−2.5	−0.1	074
June 6	248B. Sgr	5.6	E	16.8	1 19.3	−1.8	+0.6	275	0 03.9	−1.5	+1.0	271
June 25	γ Vir m.	2.9	E	07.1	20 16.0	−1.9	−0.8	271	Sun	...	...	...
July 21	424B. Leo	7.0	I	03.8	20 27.5	+0.5	−3.1	187	No Occ.	...	...	...
July 28	11B. Sgr	6.8	I	10.9	22 06.7	−1.9	−0.4	104	20 47.8	−1.8	0.0	106
Aug. 6	14 Cet	5.9	E	19.1	Sun	...	...	...	3 23.8	−2.2	+0.4	262
Aug. 12	118 Tau f.	5.9	E	25.1	2 59.4	+0.1	+1.7	243	2 01.6	+0.1	+1.5	256
Aug. 24	−26° 12213	7.4	I	08.6	22 12.2	−1.1	−0.4	053	20 59.8	−1.4	+0.1	045
Aug. 26	248B. Sgr	5.6	I	10.6	21 03.5	−1.9	+0.7	054	19 45.2	−1.9	+1.2	053
Sept. 19	19 Sco	4.8	I	05.2	Low	...	...	...	18 37.3	−1.5	−1.2	106
Sept. 20	38 Oph	7.0	I	06.2	19 26.6	−1.5	−0.5	066	Sun	...	...	...
Sept. 21	−27° 12658	6.7	I	07.2	20 30.5	−0.8	+0.5	032	19 23.2	—	—	017
Sept. 30	μPsc	5.1	E	16.3	21 51.2	+0.2	+3.0	181	20 53.3	−0.1	+2.5	197
Oct. 4	37 Tau	4.5	I	19.6	Sun	...	...	...	4 40.0	−1.6	+0.8	055
Oct. 5	315B. Tau	6.3	E	20.6	4 48.8	—	—	184	3 43.1	−1.1	+3.6	203
Oct. 5	125 Tau	5.0	E	21.3	22 15.0	+0.3	+1.3	266	Low	...	...	...
Oct. 23	−17° 6491	7.4	I	09.8	18 11.4	−1.4	+1.8	046	Sun	...	...	...
Oct. 25	376B. Aqr	6.3	I	11.8	19 16.8	−0.3	+2.8	002	Graze	...	...	...
Oct. 26	14 Cet	5.9	I	13.0	22 05.7	−2.3	+0.4	084	20 47.5	−1.6	+1.4	065
Oct. 31	ν Tau	4.4	E	17.9	20 05.1	+0.4	+1.9	225	19 10.4	+0.4	+1.6	236
Oct. 31	72 Tau	5.4	E	17.9	20 38.4	0.0	+1.7	245	19 40.4	+0.1	+1.5	257
Nov. 1	95 Tau	6.2	E	18.2	5 41.8	−1.7	+2.3	204	4 26.8	−1.7	+3.0	202
Nov. 2	+26° 884	6.5	E	19.2	4 59.9	—	—	332	3 40.2	—	—	335
Nov. 2/3	+27°1122	6.5	E	20.0	0 02.8	−1.1	+0.8	287	22 53.1	−1.0	+0.4	304
Nov. 4	28 Cnc	6.1	E	22.0	23 53.7	−1.2	−1.5	339	No Occ.	...	...	...
Nov. 5	υ^1 Cnc	5.7	E	22.1	1 08.0	—	—	342	No Occ.	...	...	...
Nov. 7	46 Leo	5.7	E	24.2	5 18.0	−1.6	+1.4	264	4 05.6	−1.2	+1.7	262
Nov. 18	113B. Cap	6.9	I	06.3	17 48.5	−1.2	+1.1	031	Sun	...	...	...

Date	Star	Mag.	I or E	Age of Moon	Halifax A.S.T.	a	b	P	Montreal E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Nov. 20	τ Aqr	4.2	I	08.4	17 58.6	−1.8	+1.1	065	16 43.9	−1.4	+1.6	053
Nov. 24	+7° 275	6.6	I	12.5	20 32.1	−1.1	+1.9	042	19 25.5	−0.6	+2.4	024
Dec. 1	134B. Gem	6.5	E	18.6	1 43.9	−1.8	−0.8	300	0 25.2	−1.8	−0.8	308
Dec. 2/3	90H.[1] Cnc	6.1	E	20.6	0 19.3	−0.9	+0.2	304	23 11.8	−0.7	0.0	315
Dec. 6	7 Vir	5.2	E	23.7	3 22.5	−1.2	+3.2	244	2 15.8	−0.7	+3.3	242
Dec. 8	575B. Vir	6.2	E	25.8	5 53.1	−0.6	−0.4	321	4 47.8	−0.5	+0.1	312
Dec. 14	60 Sgr	5.0	I	02.7	Low	...	...	...	16 39.0	−0.5	+0.2	034
Dec. 15	86B. Cap m.	6.2	I	03.7	17 15.0	−2.5	−1.7	113	Sun	...	...	...
Dec. 16	143B. Cap	6.2	I	04.7	17 30.7	—	—	350	No Occ.	...	...	...
Dec. 18	ψ^3 Aqr	5.2	I	06.8	19 48.5	−0.5	+1.1	024	18 47.1	+0.1	+2.4	001
Dec. 22	122G. Psc m.	6.9	I	10.1	Low	...	...	...	0 25.7	−0.4	−1.3	083
Dec. 22	278B. Psc	6.7	I	10.1	Low	...	...	...	0 54.1	−0.3	−0.5	061
Dec. 23	+15° 414	6.9	I	11.8	17 48.0	−0.8	+1.9	063	Sun	...	...	...
Dec. 25	37 Tau	4.5	I	13.2	3 50.9	−0.4	−0.4	055	2 45.5	−0.6	−0.6	062
Dec. 25	39 Tau	6.0	I	13.2	4 03.6	−0.1	−1.0	077	3 00.4	−0.3	−1.2	084

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1966

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	a	b	P	Winnipeg C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 2	+14° 502	7.3	I	11.1	18 42.2	−0.9	+2.2	040	17 58.3	—	—	347
Jan. 3	164B. Tau	6.8	I	12.3	22 13.7	−1.5	+1.4	047	21 16.0	—	—	353
Jan. 9	42 Leo	6.1	E	18.3	No Occ.	...	...	...	21 33.6	+0.3	+2.8	235
Jan. 10	46 Leo	5.7	E	18.5	4 23.9	−1.6	−0.9	286	2 52.4	−1.5	+0.1	280
Jan. 25	−8° 6166	7.1	I	04.3	18 22.4	−2.1	−2.5	107	Sun	...	...	...
Jan. 26	54B. (Cet)	6.3	I	05.3	19 07.6	−0.3	+2.0	011	No Occ.	...	...	...
Jan. 30	+17° 564	7.2	I	09.3	18 00.4	−1.5	+1.5	062	Sun	...	...	...
Jan. 30	26B. Tau	6.4	I	09.4	No Occ.	...	...	...	18 22.8	−2.6	−1.3	122
Feb. 1	+24° 854	6.9	I	11.5	21 45.2	—	—	140	20 02.1	−1.6	+0.2	100
Feb. 2	399B. Tau	7.2	I	11.7	Low	...	...	...	3 11.5	+0.8	−3.2	151
Feb. 3	37 Gem	5.8	I	12.7	Low	...	...	...	3 56.7	−0.1	−1.5	102
Feb. 12	11H. Lib	5.5	E	21.8	Sun	...	...	...	6 26.1	−2.4	+0.7	245
Feb. 23	167B. (Psc)	7.3	I	03.5	19 36.5	−0.8	−2.6	108	Sun	...	...	...
Feb. 27/28	51 Tau	5.6	I	07.7	0 04.6	−0.1	−1.1	082	22 51.9	−0.6	−1.2	078
Feb. 27	56 Tau	5.3	I	07.7	Low	...	...	...	23 35.6	−0.6	−0.2	045
Feb. 28	103 Tau	5.5	I	08.6	20 17.1	−1.8	−0.2	078	18 52.9	−1.4	+1.7	050
Mar. 2	49 Gem	6.9	I	10.6	20 02.2	−1.8	−0.3	106	Sun	...	...	...
Mar. 3	λ Cnc	5.9	I	11.7	21 45.1	—	—	042	No Occ.	...	...	...
Mar. 13	26 Oph	5.8	E	21.0	Sun	...	...	...	4 43.7	−0.8	−0.3	326
Mar. 13	88B. Oph	5.9	E	21.0	Sun	...	...	...	4 49.8	−1.3	+0.2	298
Mar. 27	99 Tau	6.0	I	05.9	22 55.5	−0.2	−0.7	067	21 42.7	−0.6	−0.9	068
Mar. 28	139 Tau	4.9	I	07.0	No Occ.	...	...	...	22 40.1	—	—	014
Mar. 28	+25° 1058	6.6	I	07.0	23 54.8	−0.2	−0.8	067	22 41.8	−0.6	−1.0	072
Mar. 29	7B. Gem	7.0	I	07.1	Low	...	...	...	0 58.1	+0.7	−2.0	135
Mar. 29	39 Gem	6.1	I	08.0	23 21.0	−0.8	−0.8	071	21 58.2	−1.2	−0.8	076
Mar. 29	40 Gem	6.3	I	08.0	23 37.1	−0.3	−1.5	101	22 17.8	−0.7	−1.7	106
Mar. 31	+22° 2029	7.0	I	09.9	20 20.3	−1.3	−2.0	142	Sun	...	...	...
Apr. 4	7 Vir	5.2	I	13.1	2 36.3	−0.4	−2.2	158	1 17.0	−0.1	−2.5	176
Apr. 8	11H. Lib	5.5	E	17.1	0 49.0	−0.9	−0.2	313	Low	...	...	...
Apr. 22	13 Tau	5.5	I	02.1	19 46.3	−0.7	+1.1	025	Sun	...	...	...
Apr. 22	14 Tau	6.3	I	02.2	20 14.4	−0.2	−0.4	055	Sun	...	...	...
Apr. 23	τ Tau	4.3	I	03.2	Low	...	...	...	20 58.1	—	—	154
Apr. 24	+25° 941	6.9	I	04.3	Low	...	...	...	22 02.3	0.0	−1.3	089
May 6	88B. Oph	5.9	E	16.4	23 34.3	+0.1	−1.0	342	Low	...	...	...
May 9	τ Sgr	3.4	I	18.6	No Occ.	...	...	...	4 14.8	−1.8	−0.5	135
May 10	ω Sgr	4.8	E	19.5	2 53.7	−1.7	+1.0	266	Low	...	...	...
May 10	60 Sgr	5.0	E	19.5	Sun	...	...	...	3 27.9	−1.5	+0.9	272
May 25	9B. Leo	6.7	I	05.6	20 37.4	+0.6	−3.6	176	No Occ.	...	...	...
May 26	42 Leo	6.1	I	06.6	20 37.5	−0.4	−2.5	155	Sun	...	...	...
May 26	167B. Leo	7.1	I	06.8	23 58.4	−0.2	−1.3	089	22 42.0	−0.6	−1.6	099
May 28/29	76B. Vir	7.0	I	08.8	0 11.3	−0.8	−1.5	096	22 44.7	−1.1	−1.4	107
May 29	46 Vir	6.1	I	09.7	21 23.1	−2.2	−0.3	090	Sun	...	...	...

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	a	b	P	Winnipeg C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
June 23	291B. Leo	7.3	I	05.3	22 49.1	−0.3	−1.0	070	21 30.8	−0.8	−1.4	079
June 24	7 Vir	5.2	I	06.3	23 17.6	−0.1	−1.9	131	22 00.1	−0.5	−1.9	136
June 26	82 Vir	5.2	I	08.3	23 38.1	−0.9	−1.3	081	22 08.6	−1.5	−1.1	087
July 24	λ Vir	4.6	I	06.9	Low	...	...	...	21 41.0	−1.0	−1.6	114
July 28	11B. Sgr	6.8	I	10.9	20 37.5	−1.7	+0.1	113	Sun	...	...	...
July 31	ω Sgr	4.8	I	13.1	No Occ.	...	...	...	1 21.8	−1.9	−1.2	113
Aug. 6	14 Cet	5.9	E	19.1	3 09.5	−2.5	+0.5	270	No Occ.	...	...	...
Aug. 9	σ Ari	5.5	E	22.2	4 04.0	−0.7	+2.5	209	3 03.1	−0.8	+1.8	245
Aug. 10	13 Tau	5.5	E	23.2	Sun	...	...	...	3 30.3	−1.2	+1.1	284
Aug. 12	118 Tau f.	5.9	E	25.1	2 00.0	+0.2	+1.3	259	Low	...	...	...
Aug. 24	−26° 12213	7.4	I	08.6	20 49.9	−1.8	+0.4	046	Sun	...	...	...
Sept. 6	175B. (Ari)	6.4	E	20.9	Sun	...	...	...	4 08.1	−1.4	+1.3	243
Sept. 11	λ Cnc	5.9	E	26.0	Sun	...	...	...	4 27.0	−0.4	+1.1	281
Sept. 21	−27° 12658	6.7	I	07.2	19 12.5	—	—	017	No Occ.	...	...	...
Sept. 30	μ Psc	5.1	E	16.3	20 47.9	−0.1	+2.4	201	19 59.9	0.0	+2.1	220
Oct. 4	37 Tau	4.5	I	19.6	4 28.5	−1.8	+0.9	058	3 18.3	−0.6	+3.5	017
Oct. 4	37 Tau	4.5	E	19.6	Sun	...	...	...	4 09.8	−2.2	−2.0	298
Oct. 4	39 Tau	6.0	E	19.6	Sun	...	...	...	4 40.0	−1.7	−0.3	265
Oct. 5	315B. Tau	6.3	E	20.6	3 30.5	−0.9	+3.8	203	2 26.7	−1.1	+1.7	245
Oct. 5	98 Tau	5.6	E	20.6	5 10.2	−2.1	−1.0	281	No Occ.	...	...	...
Oct. 8	ω Cnc	5.9	E	23.7	Sun	...	...	...	5 14.2	—	—	339
Oct. 24	290B. Aqr	6.4	I	11.1	No Occ.	...	...	...	23 15.4	−2.2	−1.7	103
Oct. 26	14 Cet	5.9	I	13.0	20 35.9	−1.4	+1.7	059	19 31.3	−0.6	+2.1	032
Oct. 31	72 Tau	5.4	E	17.9	19 38.7	+0.2	+1.4	260	Low	...	...	...
Nov. 1	95 Tau	6.2	E	18.2	4 07.6	—	—	185	3 00.1	−1.4	+1.6	227
Nov. 2	+25° 879	6.3	E	19.1	No Occ.	...	...	...	0 45.4	−0.5	+2.8	218
Nov. 2	+26° 884	6.5	E	19.2	3 38.3	—	—	321	No Occ.	...	...	...
Nov. 2	+27° 1122	6.5	E	20.0	22 46.7	−0.9	+0.2	309	No Occ.	...	...	...
Nov. 4	76 Gem	5.4	E	21.3	Sun	...	...	...	5 24.2	−1.7	0.0	268
Nov. 7	46 Leo	5.7	E	24.2	3 55.8	−0.9	+2.2	252	2 55.1	−0.4	+1.2	279
Nov. 24	+7° 275	6.6	I	12.5	19 18.3	−0.3	+2.6	017	No Occ.	...	...	...
Nov. 30	+27° 1122	6.5	E	17.8	Sun	...	...	...	5 50.9	−0.5	−2.3	304
Dec. 1	134B. Gem	6.5	E	18.6	0 16.1	−1.7	−0.4	305	No Occ.	...	...	...
Dec. 2	28 Cnc	6.1	E	19.8	6 03.1	—	—	358	4 33.9	—	—	352
Dec. 2	90H.^{1} Cnc	6.1	E	20.6	23 08.3	−0.5	0.0	314	No Occ.	...	...	...
Dec. 4	42 Leo	6.1	E	21.8	6 25.0	−2.2	−0.1	265	4 51.1	−1.9	+1.2	258
Dec. 6	7 Vir	5.2	E	23.7	2 04.0	—	—	223	Low	...	...	...
Dec. 7	44 Vir	5.9	E	24.9	Sun	...	...	...	5 46.7	−0.5	−0.8	334
Dec. 8	575B. Vir	6.2	E	25.8	4 44.7	−0.5	+0.4	300	Low	...	...	...
Dec. 18	ψ^3 Aqr	5.2	I	06.8	18 44.2	—	—	351	No Occ.	...	...	...
Dec. 18	−10° 6098	7.5	I	06.9	No Occ.	...	...	...	18 30.2	−2.2	−0.4	093
Dec. 19	25B. (Cet)	6.8	I	08.1	No Occ.	...	...	...	23 23.6	−0.6	−2.3	100
Dec. 21/22	122G. Psc m.	6.9	I	10.1	0 25.2	−0.6	−1.5	089	23 03.9	−1.0	−0.2	059
Dec. 21/22	278B. Psc	6.7	I	10.1	0 53.3	−0.4	−0.7	067	23 40.6	−0.7	+0.3	041
Dec. 25	37 Tau	4.5	I	13.2	2 43.1	−0.7	−0.8	072	1 22.6	−1.2	−0.2	060
Dec. 25	39 Tau	6.0	I	13.2	3 00.9	−0.4	−1.5	094	1 39.3	−1.0	−1.2	084

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1966

Date	Star	Mag.	I or E	Age of Moon	Edmonton M.S.T.	a	b	P	Vancouver P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 4	53 Tau	5.4	I	12.6	4 37.0	−0.1	−0.5	047	3 38.3	−0.2	−0.8	067
Jan. 10	46 Leo	5.7	E	18.5	1 32.4	−1.1	+0.7	279	0 16.3	−1.1	+1.7	260
Jan. 26	−2° 69	6.8	I	05.5	20 45.2	−0.8	−2.2	099	19 44.3	−1.4	−2.6	106
Jan. 31	τ Tau	4.3	I	10.6	No Occ.	...	...	...	23 14.8	—	—	005
Feb. 1	+24° 854	6.9	I	11.5	18 45.5	−0.9	+1.5	075	Sun	...	...	...
Feb. 3	37 Gem	5.8	I	12.7	2 47.6	−0.3	−1.8	111	1 52.6	−0.3	−2.4	132
Feb. 9	46 Vir	6.1	E	18.9	6 37.0	−0.7	−1.7	322	5 34.5	−1.1	−1.4	308
Feb. 24	+6° 275	7.3	I	04.7	21 19.5	—	—	140	No Occ.	...	...	...
Feb. 27	51 Tau	5.6	I	07.7	21 36.0	−0.9	−0.9	075	20 28.9	−1.3	−1.1	089
Feb. 27	56 Tau	5.3	I	07.7	22 23.3	−0.9	0.0	044	21 14.2	−1.1	−0.3	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	°
Mar. 25	+15° 447	7.3	I	04.0	21 32.2	—	—	146	No Occ.	...	...	...
Mar. 27	99 Tau	6.0	I	05.9	20.26.8	−1.0	−0.6	068	19 18.8	−1.3	−0.9	085
Mar. 28	139 Tau	4.9	I	07.0	21 17.2	−1.7	+1.9	028	19 58.4	−1.5	+0.4	056
Mar. 28	+25° 1058	6.6	I	07.0	21 25.8	−0.9	−1.0	077	20 20.1	−1.1	−1.3	096
Mar. 28	7B. Gem	7.0	I	07.1	23 59.9	+0.7	−2.9	148	No Occ.	...	...	...
Mar. 29	39 Gem	6.1	I	08.0	20 35.6	−1.4	−0.4	079	19 23.0	−1.6	−0.6	097
Mar. 29	40 Gem	6.3	I	08.0	20 57.5	−1.0	−1.6	111	19 53.7	−1.2	−2.3	131
Mar. 30	+25° 1594	7.0	I	08.1	1 24.3	−0.1	−1.1	069	0 28.0	−0.2	−1.3	087
Mar. 30	49 Gem	6.9	I	08.2	No Occ.	...	...	...	1 48.6	−0.2	−0.5	048
Apr. 1	η Leo	3.6	I	11.1	No Occ.	...	...	...	21 58.5	—	—	044
Apr. 23	300B. Tau	6.2	I	03.3	No Occ.	...	...	...	20 26.7	−1.0	+1.0	024
Apr. 24	+25° 941	6.9	I	04.3	20 54.6	−0.3	−1.6	096	19 59.0	−0.3	−2.2	116
Apr. 24	+25° 978	6.6	I	04.3	22 34.0	−0.1	−1.0	066	21 37.7	−0.1	−1.3	084
Apr. 25	+25° 1460	6.9	I	05.4	23 44.7	+0.5	−1.9	133	23 00.1	+0.9	−2.7	156
Apr. 26	86B. Gem	6.6	I	05.4	0 14.6	+1.0	−2.3	156	No Occ.	...	...	...
Apr. 28	+22° 2029	7.0	I	07.5	1 44.1	—	—	035	0 42.5	−0.3	−0.9	059
Apr. 29	210B. Leo	6.8	I	09.4	23 34.2	−1.9	−0.3	057	22 20.0	−1.6	−0.8	086
Apr. 30	228B. Leo	6.8	I	09.5	2 21.8	+0.3	−2.1	168	1 35.4	+0.7	−2.8	185
May 26	46 Leo	5.7	I	06.8	23 16.8	—	—	051	22 09.9	−1.1	−1.2	075
May 28	398B. Leo	6.7	I	07.9	Low	...	...	...	0 24.5	−0.3	−1.6	097
May 31	8 Lib	5.3	I	11.8	22 38.1	—	—	058	21 13.8	−1.8	+0.7	086
May 31	α Lib	2.9	I	11.9	22 43.1	−2.2	+0.6	065	21 21.0	−1.7	+0.6	090
May 31	α Lib	2.9	E	11.9	23 25.0	−0.4	−1.5	354	22 23.9	−0.8	−1.0	333
June 10	257B. Aqr	6.3	E	21.1	Sun	...	...	...	2 16.6	−0.8	+2.5	194
June 26	575B. Vir	6.2	I	08.4	Low	...	...	...	23 21.6	−0.7	−2.0	146
June 28	150B. Lib	6.2	I	10.5	Low	...	...	...	23 22.6	−1.3	−1.4	129
July 27	28 Oph	6.7	I	10.0	22 01.2	−1.6	−0.3	070	20 43.9	−1.8	+0.2	079
July 27	31 Oph	6.8	I	10.0	Low	...	...	...	21 17.8	−2.0	+0.4	053
July 30	ω Sgr	4.8	I	13.1	23 51.6	−1.6	0.0	095	22 33.9	−1.7	+0.5	095
July 31	60 Sgr	5.0	I	13.2	Low	...	...	...	0 35.7	−2.0	−0.9	109
Aug. 4	290B. Aqr	6.4	E	17.2	Sun	...	...	...	2 53.4	−1.3	+0.7	228
Aug. 9	σ Ari	5.5	E	22.2	1 58.3	−0.6	+1.7	267	0 46.7	−0.4	+1.6	273
Aug. 10	14 Tau	6.3	E	23.3	3 12.1	−0.7	+1.6	264	1 59.8	−0.5	+1.5	270
Aug. 21	47B. Lib	6.8	I	05.7	Low	...	...	...	20 06.3	−1.3	−0.7	056
Aug. 25	−28° 14871	7.5	I	09.7	Low	...	...	...	19 49.6	−1.5	−0.1	127
Sept. 1/2	54B. (Cet)	6.3	E	16.8	0 36.8	−0.4	+2.1	193	23 23.0	−0.6	+2.2	202
Sept. 6	175B. (Ari)	6.4	E	20.9	2 50.0	−1.4	+1.1	272	1 31.7	−1.3	+1.2	280
Sept. 7	ν Tau	4.4	I	22.1	Sun	...	...	...	4 35.1	−2.2	−0.9	116
Sept. 11	λ Cnc	5.9	E	26.0	3 25.1	−0.3	+0.7	306	2 20.8	−0.1	+0.5	307
Sept. 23	−25° 14697	7.0	I	09.4	Low	...	...	...	22 09.7	−0.5	+0.3	028
Sept. 26	161B. (Cap)	6.4	I	11.5	Low	...	...	...	0 25.1	−0.2	+0.7	022
Oct. 4	39 Tau	6.0	E	19.6	3 09.0	−2.0	−0.8	293	1 49.8	−2.2	−0.3	295
Oct. 5	315B. Tau	6.3	E	20.6	1 16.0	−0.9	+1.3	272	0 02.1	−0.8	+1.3	277
Oct. 8	4 Cnc	6.2	E	23.7	4 46.0	−1.1	+0.6	286	3 32.3	−0.9	+1.0	279
Oct. 10	η Leo	3.6	I	25.8	Sun	...	...	...	5 45.3	−1.0	+1.5	085
Oct. 21	86B. Cap m	6.2	I	08.0	Low	...	...	...	19 47.4	−1.6	−0.2	074
Oct. 24	290B. Aqr	6.4	I	11.1	21 45.7	−1.4	+0.3	069	20 28.1	−1.5	+1.0	061
Oct. 25	ψ^3 Aqr	5.2	I	11.2	Low	...	...	...	0 44.4	—	—	349
Oct. 26	14 Cet	5.9	I	13.0	18 32.9	−0.2	+2.2	016	Sun	...	...	...
Oct. 30	13 Tau	5.5	E	17.0	20 51.9	+0.9	+3.0	180	19 48.3	+0.7	+2.5	190
Oct. 31	284B. Tau	6.0	E	18.1	21 45.8	+0.2	+2.4	210	20 39.5	+0.3	+2.1	216
Nov. 1	95 Tau	6.2	E	18.2	1 43.0	−1.3	+1.1	250	0 24.9	−1.2	+1.5	250
Nov. 1	+25° 879	6.3	E	19.1	23 45.1	−0.5	+1.9	246	22 33.5	−0.3	+1.8	250
Nov. 1	125 Tau	5.0	E	19.2	Graze	...	...	...	23 37.3	—	—	182
Nov. 4	76 Gem	5.4	E	21.3	4 00.7	−1.4	+0.4	277	2 43.9	−1.3	+1.2	266
Nov. 7	46 Leo	5.7	E	24.2	1 55.1	−0.1	+0.8	297	Low	...	...	...
Nov. 17	40B. Cap	6.2	I	05.5	Low	...	...	...	18 56.0	−1.3	−0.8	080
Nov. 22	376B. Aqr	6.3	I	09.7	Low	...	...	...	0 17.8	−0.9	−2.8	108
Nov. 22	54B. (Cet)	6.3	I	10.6	No Occ.	...	...	...	19 04.0	—	—	123
Nov. 22/23	11 Cet	7.5	I	10.7	0 32.4	−1.0	−2.0	096	23 28.3	−1.6	−2.1	101
Nov. 30	+27° 1122	6.5	E	17.8	4 31.4	−0.9	−2.1	301	3 25.8	−1.4	−1.1	281
Dec. 1	λ Cnc	5.9	E	19.7	23 32.3	−0.1	+2.6	237	22 22.4	+0.2	+2.5	234
Dec. 2	28 Cnc	6.1	E	19.8	Graze	...	...	...	2 07.2	−1.4	−2.0	329
Dec. 4	42 Leo	6.1	E	21.8	3 31.6	−1.2	+1.7	258	2 09.1	−1.0	+4.0	234
Dec. 7	44 Vir	5.9	E	24.9	4 38.3	−0.3	−0.3	329	3 35.0	−0.3	+0.3	308
Dec. 18	−10° 6098	7.5	I	06.9	17 04.1	−1.4	+1.0	065	Sun	...	...	...
Dec. 19	25B. (Cet)	6.8	I	08.1	22 05.3	−0.9	−1.0	074	20 58.2	−1.3	−0.7	075
Dec. 21	122G. Psc m.	6.9	I	10.1	21 49.5	−0.9	+1.0	034	20 35.1	−1.0	+1.5	033
Dec. 21	278B. Psc	6.7	I	10.1	22 32.5	−0.6	+1.7	016	21 18.9	−0.7	+1.9	019
Dec. 24/25	37 Tau	4.5	I	13.2	0 04.0	−1.2	+0.8	047	22 46.8	−1.5	+1.0	056
Dec. 24/25	39 Tau	6.0	I	13.2	0 17.7	−1.3	−0.3	073	23 04.1	−1.6	−0.2	082
Dec. 25	192B. Tau	6.2	I	13.3	4 12.3	−0.2	−1.1	071	3 14.8	−0.3	−1.5	090

PLANETARY APPULSES AND OCCULTATIONS

The close approach of a planet to a star is of interest to observers. Surprisingly few observable appulses of planets and stars of 9th magnitude or brighter occur during a year. An even rarer occurrence is the observable occultation of a star by a planet. No planetary appulses or occultations are observable from Canada during 1966, according to Mr. Gordon E. Taylor of the British Astronomical Association.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1966

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

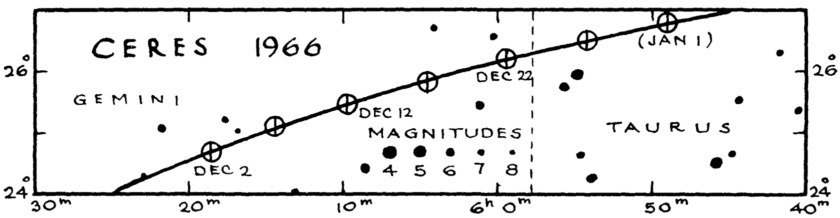
Ephemerides for the four brightest asteroids are given when the asteroids are near opposition, along with maps for Ceres and Vesta. Since Vesta was at opposition near the end of 1965, the map for this opposition is repeated. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.

PALLAS (No. 2)
Opp. Oct. 5 in Cet Mag 8.1

		h	m	
Sept.	10	1	26.6	− 6°12′
	15	1	24.6	− 7 33
	20	1	22.0	− 8 55
	25	1	19.0	−10 19
	30	1	15.7	−11 42
Oct.	5	1	12.0	−13 03
	10	1	08.2	−14 21
	15	1	04.2	−15 34
	20	1	00.3	−16 41
	25	0	56.6	−17 41

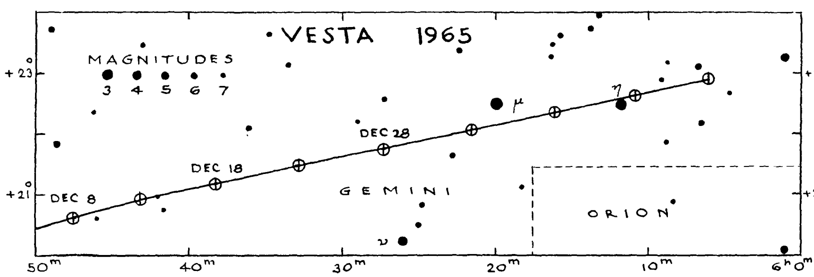
CERES (No. 1)
Opp. Dec. 22 in Gem Mag. 6.6

		h	m	
Dec.	2	6	18.5	+24°44′
	7	6	14.4	+25 06
	12	6	09.8	+25 29
	17	6	04.7	+25 51
	22	5	59.5	+26 12
	27	5	54.2	+26 31
Jan.	1	5	49.1	+26 49



VESTA (No. 4)
Opp. 1965 Dec. 28 Mag. 6.6

	1966	h	m	
Jan.	1	6	22.7	+22°00′
	6	6	17.2	+22 17
	11	6	11.9	+22 34
	16	6	07.0	+22 49



METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

Meteoroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 10 to 45 miles per second they become luminous and appear as meteors or fireballs and, if large enough to avoid complete vapourization, 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 1966. The Leonid shower is increasing in strength and will be of particular interest. The Perseid and the Geminid showers are the two best showers for the amateur.

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 2, 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.

The velocities of shower meteors in miles per second are: Quadrantids, 25; Lyrids, 30; η Aquarids, 40; δ Aquarids, 25; Perseids, 37; Orionids, 41; Taurids, 17; Leonids, 45; Geminids, 22; Ursids, 21.

Meteor Showers For 1966

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Vel.	Normal Duration to ¼ strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.	Position at Max. Dec.	Daily Motion R.A.	Daily Motion Dec.			
				h m	°	m	°		mi./sec.	days
Quadrantids	Jan. 3	13^h	F.M.	15 28	+50	—	—	40	25	0.6
Lyrids	Apr. 22	06	N.M.	18 16	+34	+4.4	0.0	15	30	2.3
η Aquarids	May 5	06	F.M.	22 24	00	+3.6	+0.4	20	40	1.8
δ Aquarids	July 29	—	F.M.	22 36	−17	+3.4	+0.17	20	25	20
Perseids	Aug. 12	09	L.Q.	03 04	+58	+5.4	+0.12	50	37	5.0
Orionids	Oct. 20	21	F.Q.	06 20	+15	+4.9	+0.13	25	41	8
Taurids	Nov. 5	—	L.Q.	03 32	+14	+2.7	+0.13	15	17	(30)
Leonids	Nov. 16	20	F.Q.	10 08	+22	+2.8	−0.42	25	45	4
Geminids	Dec. 13	14	N.M.	07 32	+32	+4.2	−0.07	50	22	6.0
Ursids	Dec. 22	19	F.Q.	14 28	+76	—	—	15	21	2.2

TABLE OF PRECESSION FOR 50 YEARS

R.A.	Prec. in Dec.	Precession in Right Ascension														Prec. in Dec.	R.A.
		$\delta = +85°$	+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	o 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.

We are indebted to Dr. Daniel L. Harris, Yerkes Observatory, particularly for his compilation of the photometric data from numerous sources.

Star	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification		Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
Star	R.A. 1970	Dec.	V	$B-V$	Type		π	M_V	D	μ	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″
α UMi *A*	02 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* γ And = *Almach*
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.** 2 h 00.2 m; **Dec.** +89° 06′ (1966).

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, $A3.59^m$ $B4.98^m$ 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″, $\theta = 90°$	***Sirius***
α Pic	48.1	−61 54	3.27	+0.21	*A5* *V*		+2.1	57	0.272	+20.6		
τ Pup	49.2	−50 35	2.97	+1.17	*K0* *III*		+0.1	124	0.079	*+36.4*		
ϵ CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
o^2 CMa	07 01.8	−23 47	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	07.2	−26 21	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.6	−44 36			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	16.1	−37 03	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.9	−29 14	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.7	+08 21	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.3	−43 14	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	32.7	+31 57	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	} 5″, *B−V*+0.02, *C* $9.08v^m$ 73″	*Castor*
α Gem *B*	32.7	+31 57	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.7	+05 18	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7^m 5″	***Procyon***
β Gem	43.5	+28 06	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	48.0	−24 48	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	56.0	−52 54	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.5	−39 55	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	06.3	−24 13	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.6	−47 16	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ϵ Car	21.9	−59 24	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		*Avior*
o UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0* *V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0^m *B* 5.1^m 3″ *CD* 10^m 69″	
ϵ Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A* 3.7^m*B* 5.2^m 0.2″ 15^y, *C* 6.8^m 3″ *D* 12^m 20″	
ζ Hya	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″	

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

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

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.7	−60 13	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7ᵐ *B* 3.9ᵐ 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* 3.19ᵐ *B* 8.61ᵐ 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* 2.47ᵐ *B* 5.04ᵐ 3″	
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15ᵐ 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* 7.8ᵐ 71″	
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84ᵐ 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* 3.5ᵐ *B* 3.7ᵐ 1″	
α CrB	33.4	+26 49	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11ᵐ, 17.4ᵈ	*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* 3.47ᵐ *B* 7.70ᵐ 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	
μ^1 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 1966. 0; and the period, if known.

Many of the components are themselves very close visual or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars, p. 74, and of The Nearest Stars, p. 86.)

Star	A.D.S.	R.A. 1970 h	m	Dec. 1970 °	′	Magnitudes comb.	A	B	Sep. 1966.0 ″	P.A. 1966.0 °	P (app.) years
λ Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	177	640
α Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.9	291	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	254	1,100
Σ 1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	232	220
35 Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.9	151	670
Σ 2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	353	—
ϵ^1 Lyr	11635	18	43.4	+39	39	5.1	5.4	6.5	2.8	359	1,200
ϵ^2 Lyr	11635	18	43.4	+39	36	4.4	5.1	5.3	2.2	98	600
π Aql	12962	19	47.4	+11	44	5.6	6.0	6.8	1.4	109	—
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	11.2	299	480
Σ 186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	50	160
γ And AB	1630	02	02.0	+42	12	2.1*	2.1	5.4	9.8	64	—
α C Ma	5423	06	43.9	−16	41	−1.4	−1.4	8.5	11.0	76	50
α Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	147	420
ζ Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.1	344	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	292	22
γ Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.3	122	620
ξ U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	2.7	132	60
γ Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.8	305	170
Σ 1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.1	149	155
ζ Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.1	307	125
ξ Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.0	343	150
ζ Her	10157	16	40.2	+31	39	2.8	2.9	5.5	0.6	0	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	0.9	151	45
70 Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	3.2	75	88
β 648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.8	206	61
4 Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	5	150
τ Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	0.9	203	50
Σ 3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.5	289	800

*There is a marked colour difference between the components.

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.

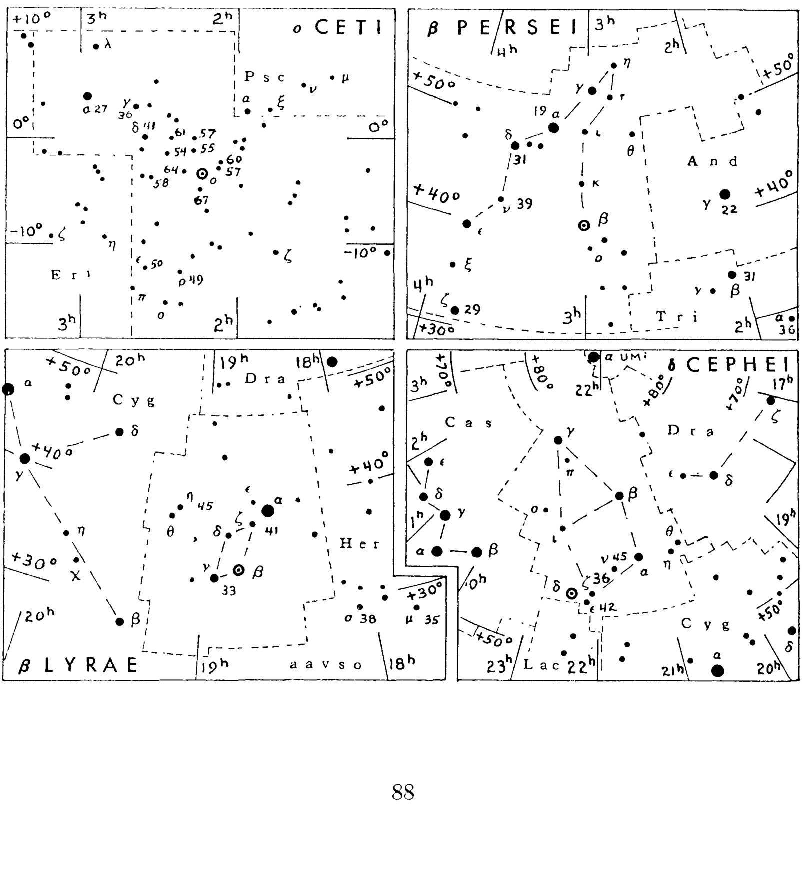
Star	1970				Sp.	π	D	μ	W	m	L
	α		δ								
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G2					-26.9	1.0
α Cen A	14	37	−60	43	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	27	−62	33	M5*e*					11	0.000052
Barnard's *	17	56	+ 4	36	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	55	+ 7	13	M6*e*	.421	7.7	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
o² 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,* 1965, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable		Max. m	Per d	Epoch 1966	Variable		Max. m	Per d	Epoch 1966
001755	T Cas	7.8	445	Apr. 14	143227	R Boo	7.2	223	Feb. 6
001838	R And	7.0	409	Oct. 20	151731	S CrB	7.3	361	Mar. 24
021143	W And	7.4	397	Feb. 18	154639	V CrB	7.5	358	Jan. 4
0214*03*	o Cet	3.4	332	Jan. 6	154615	R Ser	6.9	357	Jan. 11
0228*13*	U Cet	7.5	235	July 16	160625	RU Her	8.0	484	. .
023133	R Tri	6.2	266	July 22	162119	U Her	7.5	406	May 10
043065	T Cam	8.0	374	Oct. 29	1621*12*	V Oph	7.5	298	Jan. 1
0455*14*	R Lep	6.8	432	. .	163266	R Dra	7.6	245	Aug. 17
050953	R Aur	7.7	459	Dec. 12	164715	S Her	7.6	307	Apr. 22
054920	U Ori	6.3	372	June 24	1702*15*	R Oph	7.9	302	Jan. 9
0617*02*	V Mon	7.0	335	Apr. 17	171723	RS Her	7.9	219	Apr. 1
065355	R Lyn	7.9	379	Jan. 10	180531	T Her	8.0	165	Mar. 23
070122a	R Gem	7.1	370	Apr. 26	181136	W Lyr	7.9	196	Jan. 20
070310	R CMi	8.0	338	July 1	183308	X Oph	6.8	334	Feb. 7
072708	S CMi	7.5	332	Mar. 30	190108	R Aql	6.1	300	Feb. 28
081112	R Cnc	6.8	362	Feb. 10	1910*17*	T Sgr	8.0	392	Aug. 30
081617	V Cnc	7.9	272	Jan. 7	1910*19*	R Sgr	6.3	269	July 12
084803	S Hya	7.8	257	Sept. 7	193449	R Cyg	7.5	426	Dec. 6
0850*08*	T Hya	7.8	288	May 13	194048	RT Cyg	7.3	190	May 7
093934	R LMi	7.1	372	Jan. 5	194632	χ Cyg	5.2	407	May 3
094211	R Leo	5.8	313	Mar. 10	200938	RS Cyg	7.2	418	Sept. 7
103769	R UMa	7.5	302	June 5	201647	U Cyg	7.2	465	. .
1214*18*	R Crv	7.5	317	June 14	2044*05*	T Aqr	7.7	202	July 3
122001	SS Vir	6.8	355	Apr. 29	210868	T Cep	6.0	390	. .
123160	T UMa	7.7	257	Apr. 11	213753	RU Cyg	8.0	234	Aug. 18
123307	R Vir	6.9	146	Jan. 1	230110	R Peg	7.8	378	Oct. 30
123961	S UMa	7.8	226	Mar. 30	230759	V Cas	7.9	228	May 16
131546	V CVn	6.8	192	July 9	231508	S Peg	8.0	319	Apr. 14
1327*06*	S Vir	7.0	378	Oct. 23	2338*15*	R Aqr	6.5	387	June 7
134440	R CVn	7.7	328	July 4	235350	R Cas	7.0	431	Aug. 7
142584	R Cam	7.9	270	Sept. 10	2357*15*	W Cet	7.6	351	May 22
142539	V Boo	7.9	258	Jan. 4					

OTHER TYPES OF VARIABLE STARS

Variable		Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1966 E.S.T.
005381	U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 3.32*
025838	ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	
030140	β Per	2.1	3.3	Ecl	B8+G	2.86731	Jan. 1.25*
035512	λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 3.40*
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. 9.88
065820	ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 1.19
154428	R Cr B	5.8	14.8	R Cr B	cFpep		
171014	α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	
1842*05*	R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633	β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 8.26*
192242	RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.11
194700	η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 1.66
222557	δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 3.22

*Minimum

STAR CLUSTERS

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

N.G.C.	M	Con.	α 1970 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist l.y.
869		h Per	02 16.9	+57 01	Op	30	7			4,300
884		χPer	02 20.3	+56 59	Op	30	7			4,300
1039	34	Per	02 40.1	+42 39	Op	30	9	80		1,500
Pleiades	45	Tau	03 45.3	+24 02	Op	120	4.2	250		490
Hyades		Tau	04 18	+15 34	Op	400	4.0	100		120
1912	38	Aur	05 26.6	+35 49	Op	18	9.7	100		2,800
2099	37	Aur	05 50.4	+32 32	Op	24	9.7	150		2,700
2168	35	Gem	06 07.0	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 45.8	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 38.4	+20 06	Op	90	6.5	350		490
5139		ωCen	13 25.0	−47 09	Gl	23	12.9		3	22,000
5272	3	C Vn	13 40.8	+28 32	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 17.0	+02 12	Gl	13	14.0		3.6	35,000
6121	4	Sco	16 21.8	−26 27	Gl	14	13.9		5.2	24,000
6205	13	Her	16 40.6	+36 31	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 45.6	−01 54	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 55.5	−04 04	Gl	8	14.1		5.4	36,000
6341	92	Her	17 16.2	+43 11	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 55.1	−19 01	Op	27	10.2	120		2,200
6611	16	Ser	18 17.2	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 34.5	−23 57	Gl	17	12.9		3.6	22,000
7078	15	Peg	21 28.6	+12 02	Gl	7	14.3		5.2	43,000
7089	2	Aqr	21 31.9	−00 58	Gl	8	14.6		5.0	45,000
7092	39	Cyg	21 31.1	+48 16	Op	32	6.5	25		1,000
7654	52	Cas	23 22.9	+61 25	Op	13	11.0	120		4,400

GALACTIC NEBULAE

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

N.G.C.	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

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

N.G.C.	M	Con	α 1970 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance millions of l.y.	Vel. km / sec
221	32	And	00 41.0	+40 42	E	3×3	8.8	1.6	− 185
224	31	And	00 41.0	+41 06	Sb	160×40	5.0	1.6	− 220
SMC		Tuc	00 53	−72 32	I	220×220	1.5	0.17	+ 170
598	33	Tri	01 32.2	+30 31	Sc	60×40	7.0	1.4	− 70
LMC		Dor	05 21	−69 25	I	430×530	0.5	0.17	+ 280
3031	81	UMa	09 53.2	+69 13	Sb	16×10	8.3	4.8	− 30
3034	82	UMa	09 53.5	+69 50	I	7× 2	9.0	5.2	+ 290
3368	96	Leo	10 45.1	+11 59	Sa	7× 4	10.0	11.4	+ 940
3623	65	Leo	11 17.3	+13 16	Sb	8× 2	9.9	10.0	+ 800
3627	66	Leo	11 18.7	+13 10	Sb	8× 2	9.1	8.6	+ 650
4258		CVn	12 17.5	+47 29	Sb	20× 6	8.7	9.2	+ 500
4374	84	Vir	12 23.5	+13 03	E	3× 2	9.9	12.0	+1050
4382	85	Com	12 23.9	+18 22	E	4× 2	10.0	7.4	+ 500
4472	49	Vir	12 28.3	+08 10	E	5× 4	10.1	11.4	+ 850
4565		Com	12 34.9	+26 09	Sb	15× 1	11.0	15.2	+1100
4594		Vir	12 38.4	−11 27	Sa	7× 2	9.2	14.4	+1140
4649	60	Vir	12 42.2	+11 43	E	4× 3	9.5	15.0	+1090
4736	94	CVn	12 49.5	+41 17	Sb	5× 4	8.4	6.0	+ 290
4826	64	Com	12 55.3	+21 51	Sb	8× 4	9.2	2.6	+ 150
5005		CVn	13 09.5	+37 13	Sc	5× 2	11.1	13.2	+ 900
5055	63	CVn	13 14.4	+42 11	Sb	8× 3	9.6	7.2	+ 450
5194	51	CVn	13 28.6	+47 21	Sc	12× 6	7.4	6.0	+ 250
5236	83	Hya	13 35.4	−29 43	Sc	10× 8	8	5.8	+ 500
6822		Sgr	19 43.3	−14 51	I	20×10	11	2.0	− 150
7331		Peg	22 35.7	+34 15	Sb	9× 2	10.4	10.4	+ 500

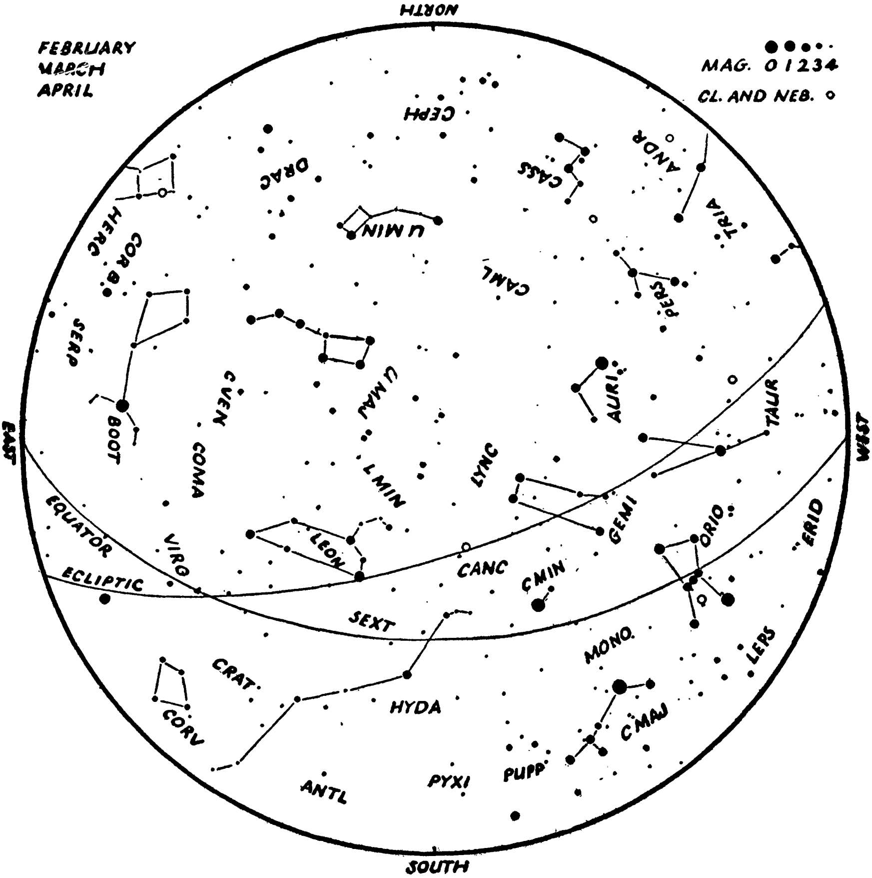
RADIO SOURCES

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.

STAR MAP I

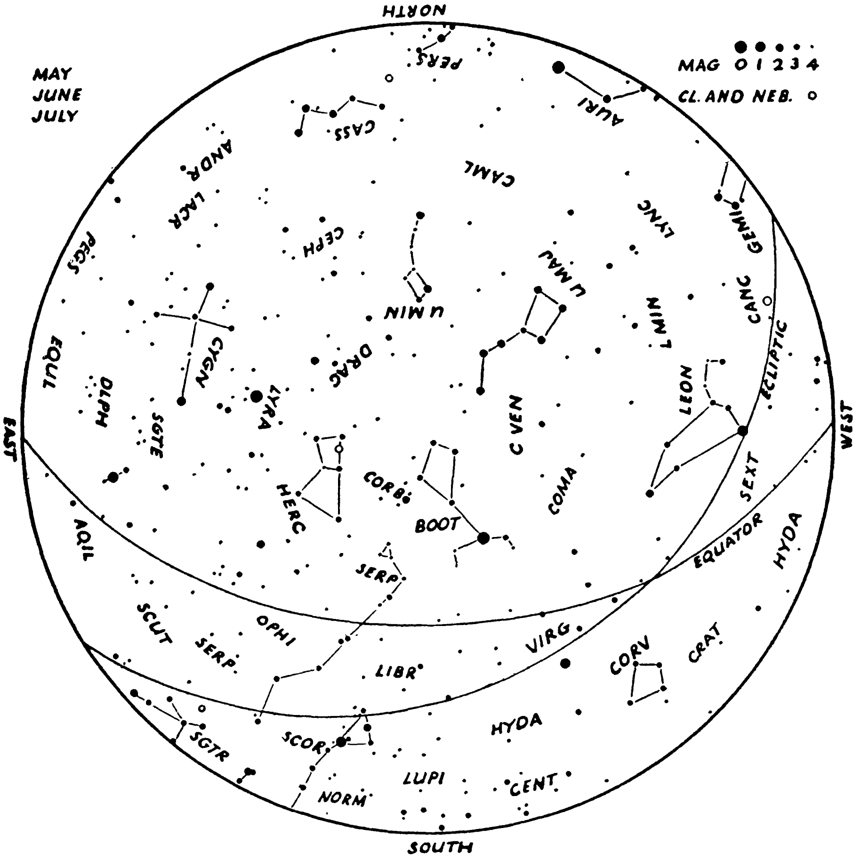


The above map represents the evening sky at

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

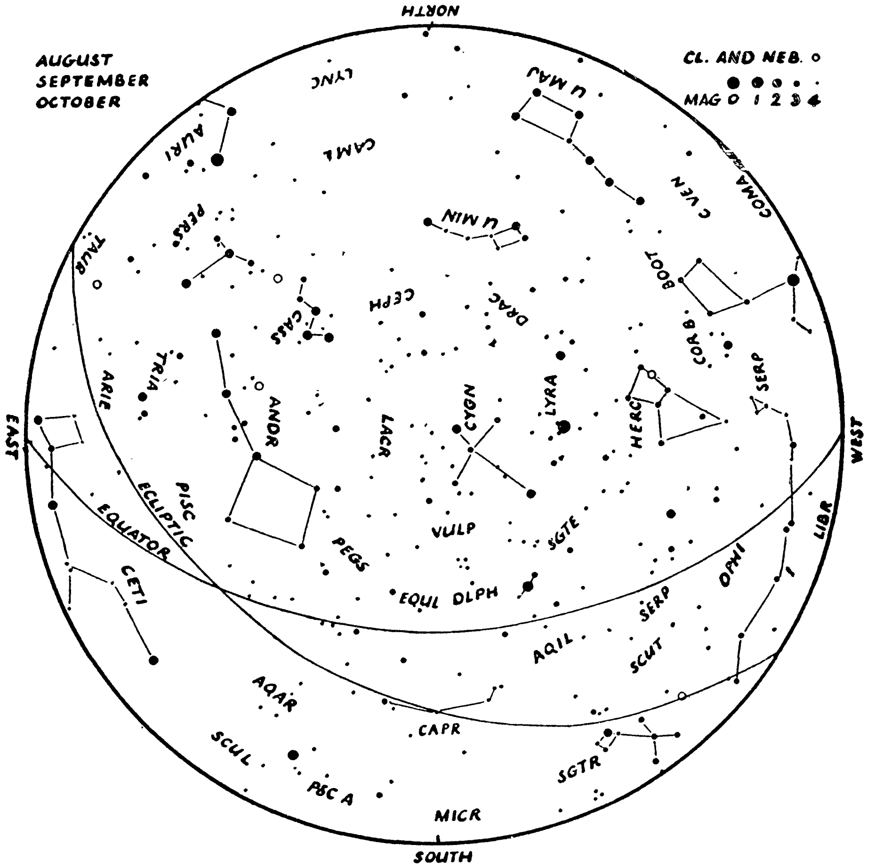


The above map represents the evening sky at

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

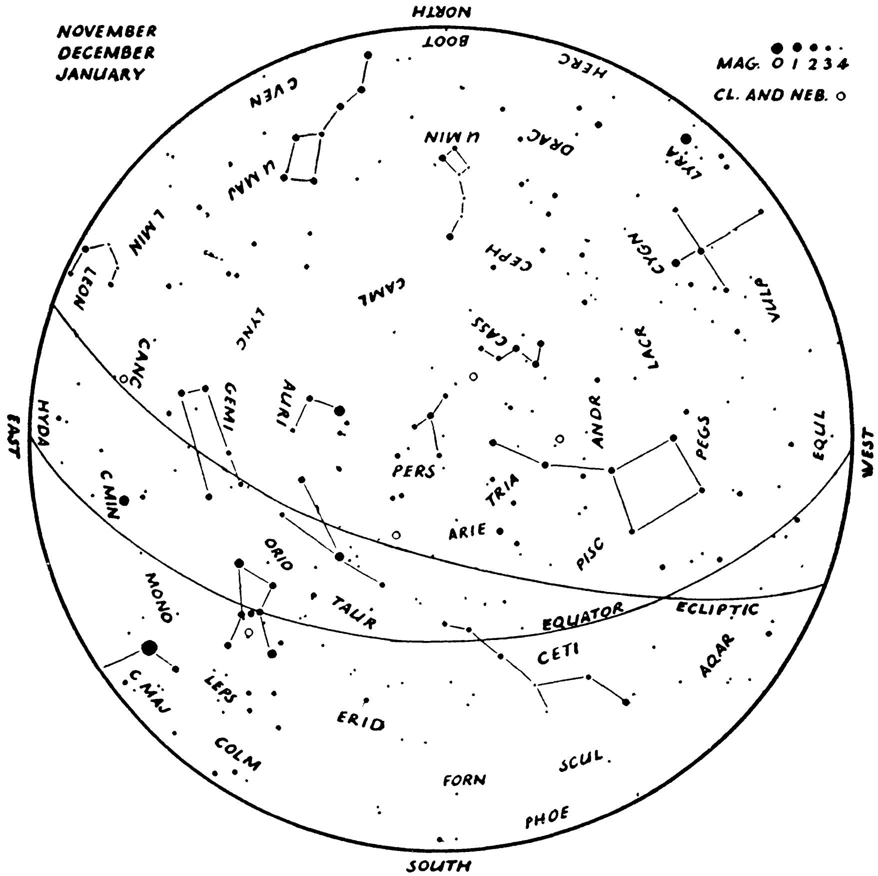


The above map represents the evening sky at

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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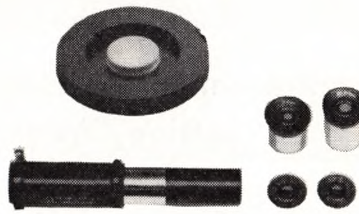

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with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x

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

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

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

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

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

6" PHOTO-EQUATORIAL as above but with 4" guide telescope, illuminated diagonal, UNIBALANCE, ASTRO-CAMERA Model 330 $5660

6" PHOTO-EQUATORIAL as above with addition of 3" Astrographic Camera Model 80 $6075

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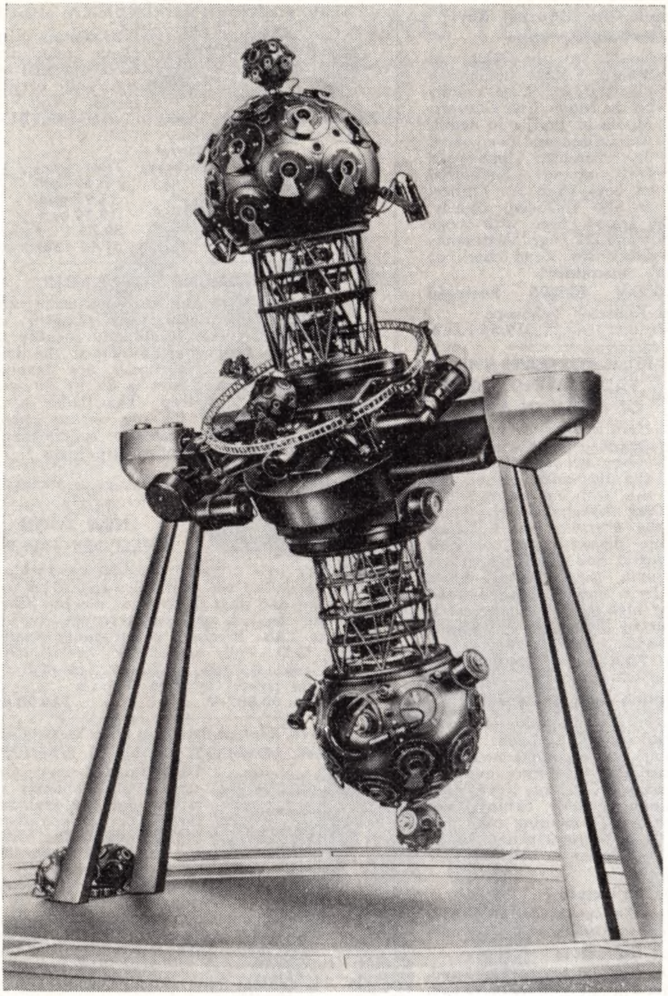


B of M

CALENDAR 1966

Jan.

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Feb.

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April

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May

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