THE OBSERVER'S HANDBOOK 1964

Fifty-sixth Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 — Royal Charter 1903

The National Office of the Royal Astronomical Society of Canada is located at 252 College Street, Toronto 2B, Ontario. The business office of the Society, reading rooms and astronomical library, are housed here, as well as a large room for the accommodation of telescope making groups.

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

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

Requests for additional information regarding the Society or its publications may be sent to 252 College Street, Toronto 2B, Ontario. Communications to the Editor should be sent to Miss Ruth J. Northcott, David Dunlap Observatory, Richmond Hill, Ontario.

THE OBSERVER'S HANDBOOK 1964

EDITOR
RUTH J. NORTHCOTT

Fifty-sixth Year of Publication
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA
252 COLLEGE STREET, TORONTO 2B, ONTARIO

CONTENTS

PRINTED IN CANADA
BY THE UNIVERSITY OF TORONTO PRESS

THE OBSERVER'S HANDBOOK for 1964 is the 56th issue. The constellation names are given in French in addition to Latin and the official three-letter abbreviations; on the same page is listed the approximate position of the centre of each constellation. The table of miscellaneous astronomical data has been revised in accordance with the "Supplement to the Astronomical Ephemeris and Nautical Almanac", 1961. Distances are given in kilometres as well as miles and recent observed values of solar parallax and velocity of light are included. Further information concerning the data in this table is given on page 94 along with a drawing showing the nomenclature of the belts and zones of Jupiter. Tables of the lunar occultations visible in Halifax and Winnipeg are given, increasing the number of stations to six. H.M. Nautical Almanac Office would appreciate receiving reports of the observed timing of occultations.

Cordial thanks are offered to those who assisted in the preparation of this volume, to those who are named and to A. R. Constable, David Crampton, Barbara Gaizauskas, Art Griffin, Ian Halliday, Sandra Holm, Pierre Lemieux, Inge Sackmann, Maude Towne, Isabel Williamson and Dorothy Yane. Special thanks are due to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of the variable stars and to Gordon E. Taylor and the British Astronomical Association concerning the prediction of planetary appulses and occultations.

Our deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is thankfully acknowledged.

RUTH J. NORTHCOTT

ANNIVERSARIES AND FESTIVALS, 1964

New Year's Day	Wed.	Jan.	1
Epiphany	Mon.	Jan.	6
Septuagesima Sunday		Jan.	26
Accession of Queen Elizabeth (1952)	Thu.	Feb.	6
Quinquagesima (Shrove Sunday)		Feb.	9
Ash Wednesday		Feb.	12
St. David	Sun.	Mar.	1
St. Patrick	Tue.	Mar.	17
Palm Sunday		Mar.	22
Good Friday		Mar.	27
Easter Sunday		Mar.	29
Birthday of Queen Elizabeth (1926)	Tue.	Apr.	21
St. George	Thu.	Apr.	23
Rogation Sunday		May	3
Ascension Day	Thu.	May	7
Pentecost (Whit Sunday)		May	17
Victoria Day	Mon.	May	18
Trinity Sunday		May	24
Corpus Christi	Thu.	May	28
St. John Baptist (Midsummer Day)	Wed.	June	24
Dominion Day	Wed.	July	1
Birthday of Queen Mother Elizabeth (1900)	Tue.	Aug.	4
Labour Day	Mon.	Sept.	7
Hebrew New Year (Rosh Hashanah)	Mon.	Sept.	7
St. Michael (Michaelmas Day)	Tue.	Sept.	29
Thanksgiving	Mon.	Oct.	12
All Saints' Day	Sun.	Nov.	1
Remembrance Day	Wed.	Nov.	11
First Sunday in Advent		Nov.	29
St. Andrew	Mon.	Nov.	30
Christmas Day	Fri.	Dec.	25

JULIAN DAY CALENDAR, 1964

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

Jan. 1	8,396	May 1	8,517	Sept. 1	8,640
Feb. 1	8,427	June 1	8,548	Oct. 1	8,670
Mar. 1	8,456	July 1	8,578	Nov. 1	8,701
Apr. 1	8,487	Aug. 1	8,609	Dec. 1	8,731

The Julian Day commences at noon. Thus J.D. 2,438,396.0 = 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.

Latin	French	Abbr.	R.A.	Dec.
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... yd.
1 mile	= exactly 1.609344 kilometres	1 km. $= 10^5$ cm. = 0.61237... mi.
1 astronomical unit	$= 1.495 \times 10^{13}$ cm. $= 1.495 \times 10^8$ km. $= 9.29 \times 10^7$ mi.	
1 light-year	$= 9.460 \times 10^{17}$ cm. $= 5.88 \times 10^{12}$ mi. = 0.3068 parsecs	
1 parsec	$= 3.084 \times 10^{18}$ cm. $= 1.916 \times 10^{13}$ mi. = 3.260 l.y.	
1 megaparsec	$= 10^6$ parsecs	

UNITS OF TIME

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

THE EARTH

Equatorial radius, a = 6378.39 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 $= 5.98 \times 10^{24}$ kgm. $= 13.2 \times 10^{24}$ 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. 18*h* 04*m*, Dec. + 30°; solar velocity = 19.4 km./sec. = 12.1 mi./sec.

THE GALACTIC SYSTEM

North pole of galactic plane R.A. 12*h* 49*m*, Dec. + 27.°4 (1950)

Centre of galaxy R.A. 17*h* 42.4*m*, Dec. − 28° 55′ (1950) (zero pt. for new gal. coord.)

Distance to centre ~ 10,000 parsecs; diameter ~ 30,000 parsecs

Rotational velocity (at sun) ~ 262 km./sec.

Rotational period (at sun) $\sim 2.2 \times 10^8$ years

Mass $\sim 2 \times 10^{11}$ 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 $= 5.6694 \times 10^{-5}$ c.g.s. units

MISCELLANEOUS

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units

Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.; mass of the proton $= 1.6724 \times 10^{-24}$ gm.

Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.

Loschmidt's number $= 2.6872 \times 10^{19}$ molecules/cu. cm. of gas at S.T.P.

Absolute temperature = $T°$ K = $T°$ C+273° = 5/9 ($T°$ F+459°)

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

1964 EPHEMERIS OF THE SUN AT 0h E.T.

Date 1964	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′
Jan. 1	18 41 45	+ 3 00	−23 05.8
4	18 54 59	+ 4 24	−22 50.5
7	19 08 10	+ 5 46	−22 31.1
10	19 21 16	+ 7 03	−22 07.8
13	19 34 19	+ 8 15	−21 40.5
16	19 47 15	+ 9 22	−21 09.4
19	20 00 06	+10 23	−20 34.7
22	20 12 50	+11 18	−19 56.5
25	20 25 27	+12 05	−19 14.9
28	20 37 57	+12 45	−18 30.2
31	20 50 20	+13 18	−17 42.5
Feb. 3	21 02 35	+13 44	−16 51.9
6	21 14 43	+14 02	−15 58.6
9	21 26 44	+14 14	−15 02.9
12	21 38 38	+14 18	−14 04.9
15	21 50 25	+14 15	−13 04.8
18	22 02 05	+14 06	−12 02.7
21	22 13 39	+13 50	−10 59.0
24	22 25 07	+13 28	− 9 53.7
27	22 36 29	+13 01	− 8 47.1
Mar. 1	22 47 46	+12 28	− 7 39.3
4	22 58 59	+11 51	− 6 30.6
7	23 10 07	+11 10	− 5 21.0
10	23 21 12	+10 25	− 4 10.7
13	23 32 15	+ 9 38	− 3 00.0
16	23 43 14	+ 8 48	− 1 48.9
19	23 54 12	+ 7 56	− 0 37.7
22	0 05 08	+ 7 02	+ 0 33.4
25	0 16 03	+ 6 08	+ 1 44.3
28	0 26 58	+ 5 13	+ 2 54.9
31	0 37 53	+ 4 18	+ 4 04.9
Apr. 3	0 48 49	+ 3 24	+ 5 14.2
6	0 59 46	+ 2 32	+ 6 22.8
9	1 10 45	+ 1 41	+ 7 30.3
12	1 21 46	+ 0 53	+ 8 36.8
15	1 32 51	+ 0 08	+ 9 41.9
18	1 43 58	− 0 35	+10 45.6
21	1 55 09	− 1 14	+11 47.7
24	2 06 23	− 1 49	+12 48.0
27	2 17 42	− 2 20	+13 46.4
30	2 29 05	− 2 47	+14 42.8
May 3	2 40 33	− 3 08	+15 37.0
6	2 52 06	− 3 25	+16 28.9
9	3 03 44	− 3 36	+17 18.4
12	3 15 27	− 3 43	+18 05.2
15	3 27 16	− 3 44	+18 49.3
18	3 39 09	− 3 40	+19 30.6
21	3 51 08	− 3 31	+20 08.8
24	4 03 11	− 3 18	+20 44.0
27	4 15 19	− 3 00	+21 15.9
30	4 27 30	− 2 38	+21 44.5
June 2	4 39 46	− 2 11	+22 09.8
5	4 52 06	− 1 42	+22 31.6
8	5 04 28	− 1 09	+22 49.8
11	5 16 54	− 0 33	+23 04.4
14	5 29 21	+ 0 04	+23 15.4
17	5 41 49	+ 0 43	+23 22.7
20	5 54 17	+ 1 22	+23 26.2
23	6 06 46	+ 2 01	+23 26.1
26	6 19 14	+ 2 39	+23 22.2
29	6 31 40	+ 3 16	+23 14.6

Date 1964	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′
July 2	6 44 05	+ 3 51	+23 03.4
5	6 56 28	+ 4 24	+22 48.5
8	7 08 48	+ 4 54	+22 30.1
11	7 21 04	+ 5 21	+22 08.2
14	7 33 16	+ 5 43	+21 42.8
17	7 45 24	+ 6 01	+21 14.2
20	7 57 27	+ 6 14	+20 42.2
23	8 09 25	+ 6 23	+20 07.2
26	8 21 17	+ 6 25	+19 29.1
29	8 33 04	+ 6 23	+18 48.1
Aug. 1	8 44 46	+ 6 15	+18 04.3
4	8 56 23	+ 6 02	+17 17.9
7	9 07 54	+ 5 44	+16 29.0
10	9 19 20	+ 5 20	+15 37.6
13	9 30 41	+ 4 51	+14 44.0
16	9 41 57	+ 4 18	+13 48.3
19	9 53 08	+ 3 39	+12 50.6
22	10 04 14	+ 2 55	+11 51.1
25	10 15 16	+ 2 08	+10 49.9
28	10 26 15	+ 1 17	+ 9 47.2
31	10 37 10	+ 0 23	+ 8 43.0
Sept. 3	10 48 03	− 0 34	+ 7 37.6
6	10 58 54	− 1 33	+ 6 31.1
9	11 09 42	− 2 34	+ 5 23.6
12	11 20 29	− 3 37	+ 4 15.3
15	11 31 15	− 4 40	+ 3 06.3
18	11 42 01	− 5 45	+ 1 56.8
21	11 52 47	− 6 49	+ 0 47.0
24	12 03 33	− 7 52	− 0 23.1
27	12 14 21	− 8 54	− 1 33.2
30	12 25 10	− 9 54	− 2 43.3
Oct. 3	12 36 02	−10 51	− 3 53.1
6	12 46 58	−11 46	− 5 02.5
9	12 57 56	−12 37	− 6 11.4
12	13 08 59	−13 24	− 7 19.6
15	13 20 06	−14 07	− 8 26.8
18	13 31 18	−14 45	− 9 32.9
21	13 42 35	−15 17	−10 37.8
24	13 53 58	−15 44	−11 41.2
27	14 05 27	−16 04	−12 43.1
30	14 17 04	−16 17	−13 43.2
Nov. 2	14 28 47	−16 24	−14 41.4
5	14 40 38	−16 22	−15 37.4
8	14 52 36	−16 14	−16 31.2
11	15 04 42	−15 58	−17 22.4
14	15 16 55	−15 34	−18 10.9
17	15 29 15	−15 03	−18 56.5
20	15 41 43	−14 25	−19 39.1
23	15 54 19	−13 39	−20 18.4
26	16 07 01	−12 46	−20 54.5
29	16 19 51	−11 47	−21 27.0
Dec. 2	16 32 47	−10 41	−21 55.8
5	16 45 48	− 9 29	−22 20.9
8	16 58 54	− 8 12	−22 42.1
11	17 12 05	− 6 51	−22 59.2
14	17 25 19	− 5 27	−23 12.3
17	17 38 35	− 4 00	−23 21.2
20	17 51 54	− 2 32	−23 25.8
23	18 05 13	− 1 02	−23 26.3
26	18 18 32	+ 0 27	−23 22.5
29	18 31 50	+ 1 56	−23 14.5

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

Planet	Mean Distance from Sun (a)		Period of Revolution		Eccen-tri-city (e)	In-clina-tion (i)	Long. of Node (☊)	Long. of Peri-helion (π)	Mean Long. at Epoch (L)
	A. U.	millions of miles	Sidereal (P)	Syn-odic					
				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	Equa-torial Di-ameter	Ob-late-ness	Mass	Mean Den-sity	Sur-face Grav-ity	Rotation Period	Inclina-tion of Equator to Orbit	Albedo*
	miles		⊕ = 1	water = 1	⊕ = 1		°	
☉ 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	88^d	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	?	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 L. 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.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet: miles	Mean Distance from Planet: ″ *	Revolution Period: d	h	m	Orbit Incl. ° ‡	Discovery
SATELLITE OF THE EARTH									
Moon	−12.7	2160	238,900	...	27	07	43	Var.§	
SATELLITES OF MARS									
Phobos	11.6	(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 longtitude (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.

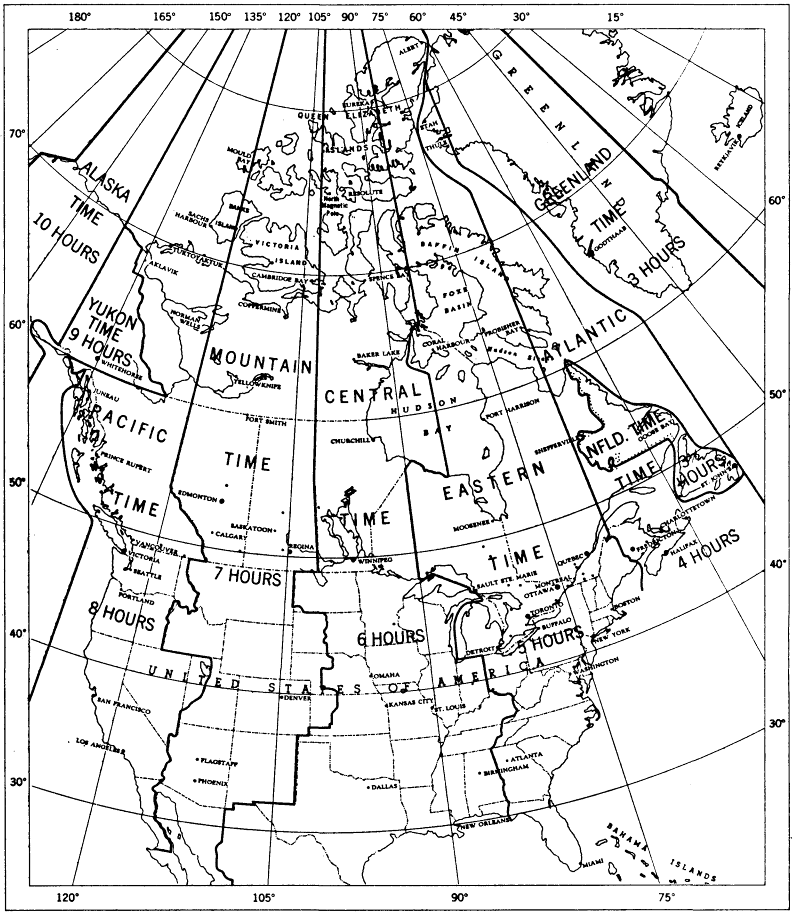
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

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 ΔT = ET − UT. The moon's position is tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1964 will be about 35 seconds.

**Note:* Some Canadian communities near the zone boundaries of south-east Saskatchewan and of eastern Quebec along the St. Lawrence River adopt the time of the adjacent zone.

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 sun's declination, apparent diameter and the equation of time do not have precisely the same values on corresponding days from year to year. As the times of sunrise and sunset depend upon these factors, these tables for the solar phenomena can give only average values which may be in error by one or two minutes.

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

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

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

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

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

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, 1964 (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		19 35	09 06	19 23	09 18	19 09	09 34	18 52	09 52	18 35	10 10
2		20 40	09 50	20 31	10 01	20 21	10 13	20 07	10 27	19 54	10 41
3		21 44	10 29	21 37	10 36	21 30	10 45	21 21	10 56	21 12	11 06
4		22 44	11 02	22 41	11 07	22 36	11 12	22 31	11 19	22 27	11 26
5		23 42	11 32	23 41	11 34	23 40	11 37	23 40	11 39	23 39	11 42
6	☾	.. ..	12 01	.. ..	12 00	.. ..	12 00	.. ..	11 58	.. ..	11 57
7		00 38	12 29	00 40	12 25	00 43	12 22	00 46	12 17	00 49	12 12
8		01 33	12 58	01 38	12 52	01 44	12 45	01 52	12 36	01 58	12 29
9		02 29	13 29	02 36	13 20	02 46	13 11	02 57	12 58	03 07	12 46
10		03 25	14 03	03 34	13 52	03 47	13 39	04 01	13 23	04 15	13 08
11		04 20	14 41	04 32	14 28	04 47	14 13	05 05	13 54	05 23	13 36
12		05 15	15 24	05 29	15 10	05 46	14 52	06 06	14 32	06 27	14 11
13		06 10	16 12	06 24	15 57	06 41	15 39	07 03	15 18	07 25	14 56
14	●	07 00	17 05	07 15	16 51	07 33	16 34	07 53	16 13	08 15	15 51
15		07 47	18 03	08 01	17 50	08 17	17 34	08 37	17 15	08 57	16 56
16		08 30	19 03	08 42	18 52	08 56	18 39	09 12	18 23	09 30	18 08
17		09 09	20 05	09 19	19 57	09 29	19 46	09 43	19 35	09 56	19 23
18		09 45	21 08	09 51	21 03	10 00	20 56	10 09	20 48	10 17	20 40
19		10 18	22 11	10 22	22 09	10 26	22 06	10 31	22 03	10 36	22 00
20		10 51	23 15	10 51	23 16	10 52	23 17	10 53	23 18	10 54	23 20
21		11 23	.. ..	11 20	.. ..	11 18	.. ..	11 15	.. ..	11 11	.. ..
22	☽	11 58	00 20	11 52	00 25	11 45	00 29	11 38	00 35	11 31	00 41
23		12 36	01 27	12 27	01 35	12 16	01 44	12 04	01 54	11 53	02 05
24		13 18	02 36	13 07	02 46	12 54	02 59	12 37	03 13	12 21	03 29
25		14 07	03 45	13 54	03 58	13 38	04 13	13 18	04 32	12 59	04 51
26		15 04	04 52	14 49	05 07	14 32	05 24	14 11	05 45	13 49	06 07
27		16 07	05 55	15 52	06 10	15 34	06 28	15 14	06 49	14 52	07 11
28	○	17 12	06 51	16 59	07 05	16 44	07 22	16 25	07 41	16 05	08 00
29		18 19	07 40	18 08	07 52	17 56	08 06	17 41	08 22	17 25	08 38
30		19 24	08 22	19 17	08 31	19 08	08 41	18 56	08 54	18 45	09 06
31		20 28	08 58	20 22	09 04	20 17	09 11	20 10	09 20	20 04	09 28
Feb.											
1		21 28	09 30	21 26	09 34	21 24	09 37	21 21	09 41	21 19	09 46
2		22 26	10 00	22 27	10 00	22 28	10 01	22 30	10 02	22 32	10 02
3		23 23	10 29	23 26	10 26	23 31	10 24	23 37	10 20	23 42	10 17
4		.. ..	10 58	.. ..	10 53	.. ..	10 47	.. ..	10 40	.. ..	10 33
5	☾	00 19	11 28	00 25	11 20	00 33	11 12	00 43	11 01	00 52	10 50
6		01 15	12 01	01 24	11 51	01 35	11 39	01 48	11 25	02 01	11 11
7		02 10	12 37	02 22	12 25	02 36	12 10	02 52	11 53	03 09	11 35
8		03 05	13 17	03 19	13 04	03 35	12 48	03 55	12 28	04 14	12 07
9		04 00	14 03	04 15	13 49	04 32	13 31	04 53	13 10	05 15	12 48
10		04 52	14 55	05 07	14 41	05 25	14 23	05 46	14 01	06 09	13 39
11		05 42	15 52	05 55	15 38	06 12	15 21	06 33	15 02	06 54	14 41
12		06 27	16 52	06 39	16 40	06 54	16 26	07 12	16 09	07 29	15 52
13	●	07 07	17 54	07 17	17 45	07 30	17 34	07 44	17 20	07 58	17 07
14		07 44	18 58	07 52	18 52	08 01	18 44	08 12	18 35	08 22	18 27
15		08 19	20 03	08 24	19 59	08 29	19 56	08 36	19 51	08 42	19 47
16		08 53	21 08	08 54	21 07	08 55	21 08	08 58	21 08	09 00	21 08
17		09 25	22 14	09 23	22 17	09 22	22 20	09 20	22 25	09 18	22 29
18		09 59	23 20	09 55	23 27	09 49	23 34	09 42	23 43	09 36	23 53
19		10 35	.. ..	10 28	.. ..	10 19	.. ..	10 08	.. ..	09 57	.. ..
20	☽	11 16	00 27	11 06	00 37	10 53	00 48	10 38	01 02	10 23	01 16
21		12 02	01 35	11 49	01 47	11 34	02 02	11 15	02 20	10 57	02 37
22		12 54	02 42	12 40	02 56	12 23	03 13	12 01	03 33	11 40	03 54
23		13 53	03 44	13 38	03 59	13 20	04 17	12 59	04 39	12 37	05 01
24		14 56	04 42	14 42	04 56	14 25	05 13	14 05	05 34	13 45	05 54
25		16 02	05 32	15 49	05 45	15 35	05 59	15 19	06 17	15 01	06 35
26		17 07	06 15	16 57	06 25	16 47	06 38	16 34	06 52	16 20	07 06
27	○	18 11	06 53	18 05	07 01	17 57	07 10	17 48	07 20	17 39	07 29
28		19 13	07 27	19 09	07 32	19 06	07 37	19 01	07 43	18 57	07 49
29		20 12	07 58	20 12	08 00	20 12	08 02	20 11	08 04	20 11	08 06

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

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

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

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

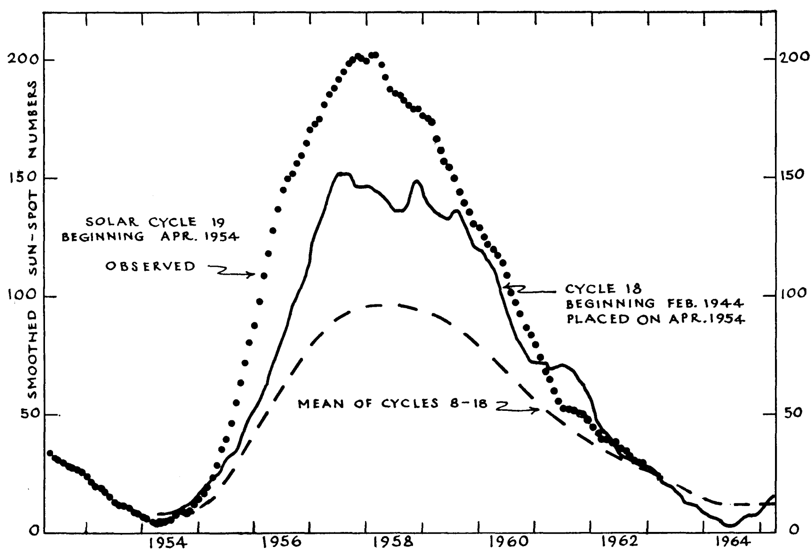
THE SUN AND PLANETS FOR 1964

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.

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. Its period of rotation on its axis is believed to be the same as its period of revolution about the sun, which is 88 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:

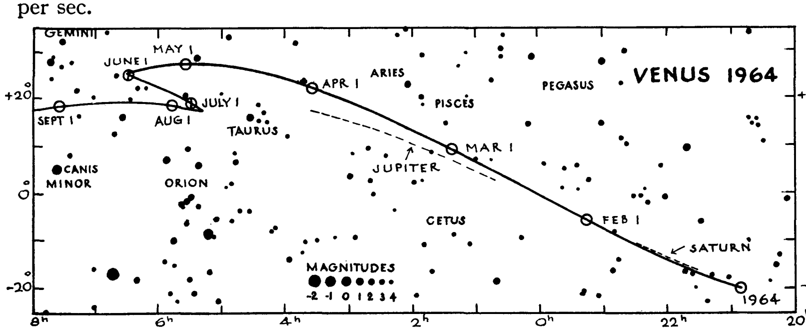
MAXIMUM ELONGATIONS OF MERCURY DURING 1964

Elong. East—Evening Star			Elong. West—Morning Star		
Date	Dist.	Mag.	Date	Dist.	Mag.
Apr. 7	19°	+0.2	Jan. 26	25°	+0.1
Aug. 5	27	+0.6	May 24	25	+0.8
Nov. 30	21	−0.2	Sept. 18	18	−0.0

The most favourable elongations to observe are: in the evening, Apr. 7; in the morning, Sept. 18.

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, 1964, Venus is in the evening sky and crosses the meridian about 2 hours after the sun; its declination is −19° and its stellar magnitude is −3.4. Greatest elongation east, 46°, occurs on Apr. 10, when it transits the meridian about 3 hours after the sun at a declination of +25°. Greatest brilliancy, mag.

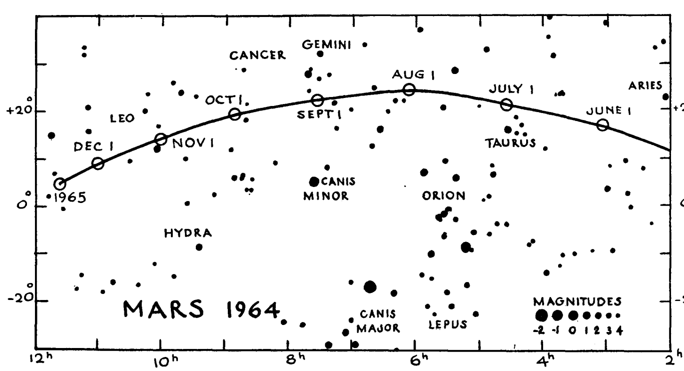
−4.2, is attained on May 13 and again on July 26. On June 19 it is in inferior conjunction with the sun and becomes a morning star. It attains greatest elongation west, 46°, on Aug. 29 when it crosses the meridian about 3 hours before the sun at declination +19°. At the end of the year it is low in the south-east at dawn. For its positions near elongations, see the map.

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

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. has been accurately determined.

The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days.

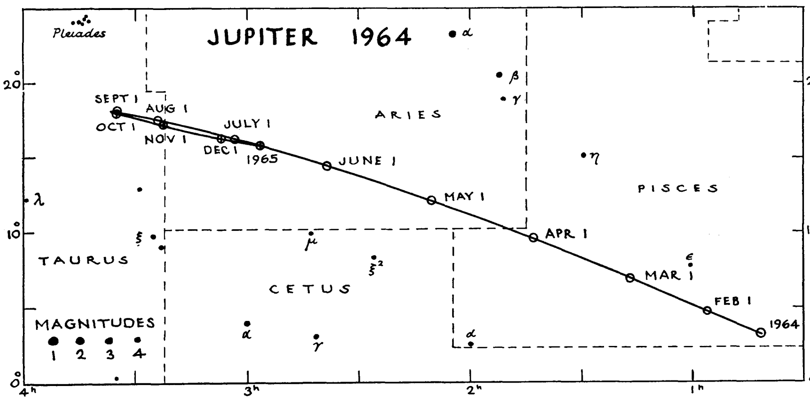


At the opposition on Sept. 10, 1956, the planet was closer to the earth than it will be for some years. The last opposition was on Feb. 4, 1963.

During the first half of 1964 Mars is poorly placed for observation, conjunction with the sun occurring on Feb. 16. For the rest of the year it is in the morning sky. On Dec. 31 it is in Virgo with declination +5°, and transits about 7 hours before the sun.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). Not so long ago it was generally believed that the planet was still cooling down from its original high temperature, but from actual measurements of the radiation from it to the earth it has been deduced that the surface is at about −200°F. The spectroscope shows that its atmosphere contains ammonia and methane.

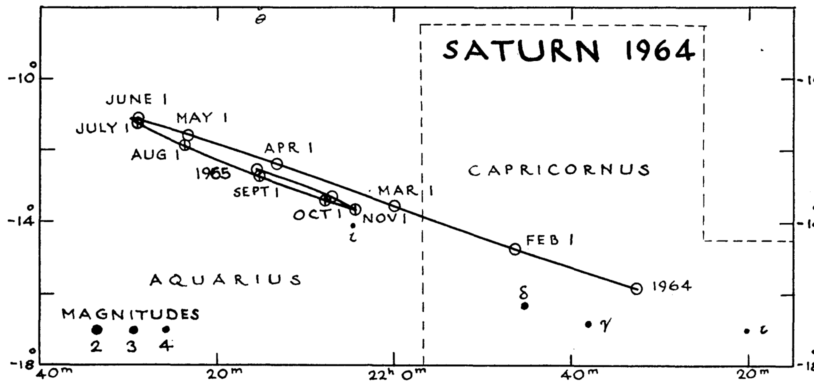


Jupiter is a fine object for the telescope. Many details of the cloud belts as well as the flattening of the planet, due to its short rotation period, are visible, and the phenomena of its satellites provide a continual interest.

On Jan. 1, 1964, Jupiter is in Pisces, just east of the meridian at sunset; its stellar magnitude is −2.0. On Apr. 22 it reaches conjunction with the sun and moves into the morning sky. It comes into opposition with the sun on Nov. 13, when it is visible all night. It is then in Aries (near Taurus) with stellar magnitude −2.4. It retrogrades from Sept. 14 to the end of the year (see map; circles with vertical lines denote retrograde motion). On Dec. 31 it is in Aries, high in the eastern sky at sunset in declination +16°; its stellar magnitude has faded to −2.2.

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. Thus during 1964 the northern face of the rings is



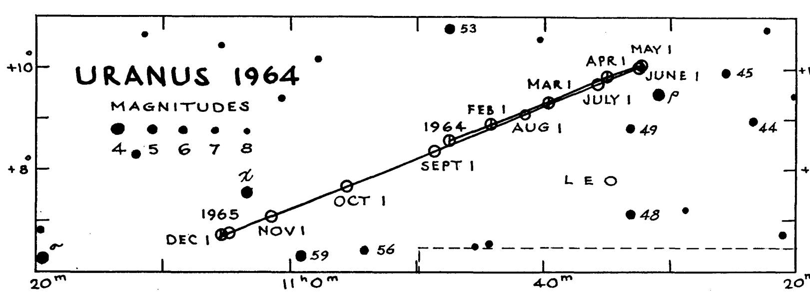
visible, with a tilt fluctuating between 14° and 8°; the ellipse of the outer edge of the rings has an apparent major axis of about 39″ and a minor axis of about 7″.

On Jan. 1, 1964, Saturn is in Capricornus, low in the south-western sky at sunset; stellar magnitude is +1.0. On Feb. 15 it is in conjunction with the sun, and moves into the morning sky. It reaches opposition with the sun on Aug. 24, when its stellar magnitude is +0.6 and it is visible all night. It retrogrades from June 15 to Nov. 2 (see map; circles with vertical lines denote retrograde motion). On Dec. 31 it is in Aquarius and is west of the meridian at sunset; stellar magnitude is +1.1.

URANUS

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

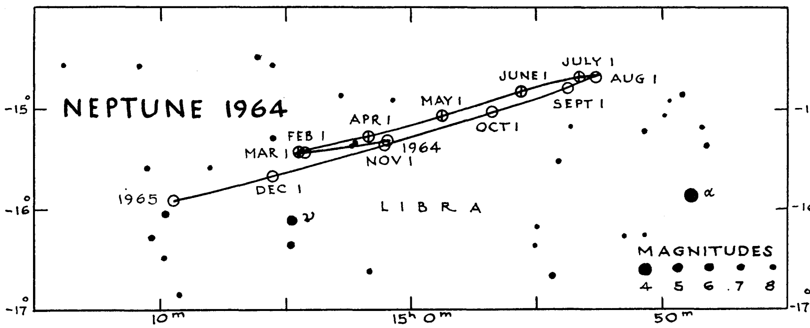
During 1964 Uranus is in Leo (see map). At the beginning of the year it rises before midnight and is retrograding (direct motion is resumed on May 13). It is in opposition with the sun on Feb. 27 and is above the horizon all night; its apparent diameter is 4.0″ and its stellar magnitude is +5.7. When conjunction



occurs on Sept. 2, its magnitude has faded to +5.8. It is in the morning sky the rest of the year; retrograde motion commences on Dec. 20. It is overtaken by Venus on Oct. 16 and by Mars on Dec. 5.

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 1964 Neptune is in Libra (see map). It is in opposition to the sun on May 6, 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. 9 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 18 to July 27.

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. 3, at which time its astrometric position is R.A. 11h 19m, Dec. +19° 56′.

THE SKY MONTH BY MONTH

BY F. J. HEARD

THE SKY FOR JANUARY 1964

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

The Sun—During January the sun's R.A. increases from 18h 42m to 20h 54m and its Decl. changes from 23° 06′ S. to 17° 26′ S. The equation of time changes from −3m 00s to −13m 28s. There is a partial eclipse of the sun on the 14th, visible in the south polar regions.

For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 18h 19m, Decl. 20° 21′ S, and transits at 10h 43m. Inferior conjunction is on the 4th so that for most of the month it is too close to the sun for observation. However, greatest western elongation is on the 26th, and Mercury might be seen with difficulty for a few mornings at this time just above the south-eastern horizon before sunrise. Its greatest altitude at sunrise during this time is 11 degrees.

Venus on the 15th is in R.A. 22h 01m, Decl. 13° 55′ S., mag. −3.4, and transits at 14h 27m. It is an evening star visible in the south-west for about two hours after sunset.

Mars on the 15th is in R.A. 20h 15m, Decl. 20° 54′ S., and transits at 12h 41m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 0h 47m, Decl. 3° 42′ N., mag. −1.9, and transits at 17h 10m. In Pisces, it is approaching the meridian at sunset and sets about at 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. 21h 39m, Decl. 15° 20′ S., and transits at 14h 02m. In Capricornus, it is well down in the south-west at sunset and sets within about two hours.

Uranus on the 15th is in R.A. 10h 46m, Decl. 8° 41′ N., and transits at 3h 11m. It rises about three hours after sunset.

Neptune on the 15th is in R.A. 15h 02m, Decl. 15° 23′ S., and transits at 7h 26m. It rises about two hours after midnight.

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

	d	h	m	JANUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 50m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1			....	2 00	3104*	105.64
Thu.	2			⊕ at perihelion		30124	117.77
				Dist. from ☉, 91,345,000 mi.			
				□♃☉ east..................			
Fri.	3	13		☌♅☾ ♅ 4° S..................	22 50	2043*	129.90
Sat.	4			Quadrantid meteors, see p. 68..........		21403	142.04[l]
		9		☌☿☉ inferior..................			
Sun.	5					40123	154.18
Mon.	6	10	58	☾ Last Quarter..................	19 40	d4102	166.33[b]
Tue.	7			....		43201	178.49
Wed.	8			....		43120	190.65
Thu.	9	2		☌♆☾ ♆ 3° S..................	16 30	43012	202.82
		17		☌♀♄ ♀ 0.6° S................			
		19		☾ at apogee. Dist. from ⊕, 251,900 mi. .			
Fri.	10			☿ greatest hel. lat. N.............		41203	214.99
Sat.	11			....		d4203	227.17
Sun.	12			....	13 20	40123	239.35
Mon.	13	3		☌☿☾ ☿ 3° N..................		10342	251.53
Tue.	14	15	44	● New Moon. Eclipse of ☉, see p. 61		32014	263.72
Wed.	15	6		☿ stationary in R.A.............	10 10	31204	275.91
Thu.	16	20		☌♄☾ ♄ 2° N..................		30124	288.10
Fri.	17	12		☌♀☾ ♀ 3° N..................		d104*	300.29
Sat.	18			....	7 00	d2034	312.47[l]
Sun.	19			....		0234*	324.65
Mon.	20	14		☌♃☾ ♃ 4° N..................		10342	336.83
Tue.	21			....	3 50	32401	349.00[b]
Wed.	22	0	29	☽ First Quarter.................		34120	1.16
Thu.	23			....		43012	13.32
Fri.	24			....	0 40	4102*	25.46
Sat.	25	20		☾ at perigee. Dist. from ⊕, 227,200 mi.		42013	37.61
Sun.	26	19		☿ greatest elongation W., 25°.....	21 30	403**	49.74
Mon.	27			....		41032	61.88
Tue.	28	18	23	○ Full Moon....................		43201	74.01
Wed.	29				18 20	32104	86.13
Thu.	30	22		☌♅☾ ♅ 4° S..................		30124	98.26
Fri.	31			....		13024	110.39

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Jan. 4, +6.86°; Jan. 18, −5.59°. [b]Jan. 6, −6.84°; Jan. 21, +6.76°.

THE SKY FOR FEBRUARY 1964

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 54m to 22h 48m and its Decl. changes from 17° 26′ S. to 7° 39′ S. The equation of time changes from −13m 28s to a maximum of −14m 18s on the 12th and then to −12m 28s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 20h 35m, Decl. 20° 10′ S., and transits at 11h 00m. It is too close to the sun all month for observation.

Venus on the 15th is in R.A. 0h 19m, Decl. 1° 35′ N., mag. −3.6, and transits at 14h 43m. It is an evening star, dominating the western sky for about three hours after sunset.

Mars on the 15th is in R.A. 21h 54m, Decl. 13° 56′ S., and transits at 12h 17m. It is too close to the sun for observation, conjunction being on the 16th.

Jupiter on the 15th is in R.A. 1h 05m, Decl. 5° 44′ N., mag. −1.8, and transits at 15h 27m. In Pisces, it is well past the meridian at sunset and sets about four 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. 21h 53m, Decl. 14° 08′ S., and transits at 12h 14m. It is too close to the sun for observation, being in conjunction on the 15th.

Uranus on the 15th is in R.A. 10h 42m, Decl. 9° 07′ N., mag. 5.7, and transits at 1h 05m. It rises about at sunset. Opposition is on the 27th.

Neptune on the 15th is in R.A. 15h 04m, Decl. 15° 27′ S., and transits at 5h 26m. It rises about at midnight.

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

	d	h	m	FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 30m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1			....	15 10	20134	122.53[l]
Sun.	2			....		1034*	134.67
Mon.	3			☿ at ☋		d0324	146.81[b]
Tue.	4			♂ greatest hel. lat. S.	12 00	32014	158.96
Wed.	5	7	43	☾ Last Quarter		32104	171.12
		10		☌ ♆ ☾ ♆ 3° S.			
Thu.	6	15		☾ at apogee. Dist. from ⊕, 251,300 mi.		30412	183.28
Fri.	7			□ ♆ ☉ west	8 40	41302	195.45
Sat.	8			....		42013	207.62
Sun.	9			....		41203	219.80
Mon.	10			....	5 30	40123	231.99
Tue.	11	14		☌ ☿ ☾ ☿ 0.7° N.		4320*	244.18
Wed.	12			....		43210	256.37
Thu.	13			☿ at aphelion	2 20	43012	268.57
		8	02	● New Moon			
Fri.	14			....		43102	280.77[l]
Sat.	15	1		☌ ♄ ☉	23 10	20413	292.96
Sun.	16	8		☌ ♀ ☾ ♀ 5° N.		12043	305.16
		22		☌ ♂ ☉			
Mon.	17	4		☌ ♃ ☾ ♃ 4° N.		01234	317.35[b]
Tue.	18	22		♆ stationary in R.A.	20 00	10324	329.53
Wed.	19			....		32104	341.72
Thu.	20	8	25	☽ First Quarter		30214	353.89
Fri.	21			♀ at ☊	16 50	31024	6.06
		3		☾ at perigee. Dist. from ⊕, 230,000 mi.			
Sat.	22			....		20314	18.22
Sun.	23			....		12043	30.38
Mon.	24			....	13 40	40123	42.53
Tue.	25			....		41032	54.67
Wed.	26			....		d4320	66.81
Thu.	27	5		☌ ♅ ☾ ♅ 4° S.	10 30	4301*	78.95
		7	40	○ Full Moon			
		9		☍ ♅ ☉ Dist. from ⊕, 1,608,000,000 mi.			
		21		☌ ☿ ♄ ☿ 1.0° S.			
Fri.	28	3		☌ ♀ ♃ ♀ 1.7° N.		43102	91.09
Sat.	29			♂ at perihelion		4201*	103.23[l]

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Feb. 1, +5.67°; Feb. 14, −5.23°; Feb. 29, +4.69°. [b]Feb. 3, −6.75°; Feb. 17, +6.64°.

THE SKY FOR MARCH 1964

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 for an observer in latitude 45° N.

The Sun—During March the sun's R.A. increases from 22h 48m to 0h 42m and its Decl. changes from 7° 39′ S. to 4° 28′ N. The equation of time changes from −12m 28s to −4m 00s. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 23h 48m, Decl. 2° 49′ S., and transits at 12h 19m. Until late in the month it is too close to the sun for observation, superior conjunction being on the 13th. (See April.)

Venus on the 15th is in R.A. 2h 22m, Decl. 15° 49′ N., mag. −3.8, and transits at 14h 52m. It is a brilliant evening star dominating the western sky for three hours or more after sunset.

Mars on the 15th is in R.A. 23h 20m, Decl. 5° 23′ S., and transits at 11h 49m. It is a morning star but as yet too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 1h 28m, Decl. 8° 06′ N., mag. −1.6, and transits at 13h 55m. In Pisces, it is well down in the west at sunset and sets about two hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 06m, Decl. 13° 00′ S., and transits at 10h 34m. It is a morning star but it is too close to the sun for easy observation.

Uranus on the 15th is in R.A. 10h 37m, Decl. 9° 35′ N., and transits at 23h 02m. It is well up in the east at sunset.

Neptune on the 15th is in R.A. 15h 03m, Decl. 15° 22′ S., and transits at 3h 31m. It rises in the late evening.

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

	d	h	m	MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 15m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1			....	7 20	42103	115.38[b]
Mon.	2			....		40123	127.53
Tue.	3	7		☍ ♇ ☉ Dist. from ⊕, 2,964,000,000 mi.		10423	139.68
		19		☌ ♆ ☾ ♆ 2° S..................			
Wed.	4			☿ greatest hel. lat. S.............	4 10	23014	151.84
Thu.	5	12		☾ at apogee. Dist. from ⊕, 251,200 mi.		3204*	164.00
Fri.	6	5	00	☾ Last Quarter..................		31024	176.17
Sat.	7			....	1 00	32014	188.35
Sun.	8			....		21034	200.53
Mon.	9			....	21 50	02134	212.72
Tue.	10			....		10234	224.92
Wed.	11			....		23041	237.12
Thu.	12	0		☌ ♄ ☾ ♄ 3° N..................	18 40	34210	249.32[l]
Fri.	13	3		☌ ☿ ☉ superior.................		d4302	261.53
		21	14	● New Moon..................			
Sat.	14			....		d4301	273.74
Sun.	15	21		☌ ♃ ☾ ♃ 4° N..................	15 30	42103	285.96[b]
Mon.	16			....		40213	298.16
Tue.	17	1		☌ ♀ ☾ ♀ 6° N..................		41023	310.37
		11		☾ at perigee. Dist. from ⊕, 228,200 mi.			
Wed.	18			....	12 10	42301	322.58
Thu.	19			....		32410	334.77
Fri.	20	9	10	☉ enters ♈. Spring commences....		30142	346.97
		15	40	☽ First Quarter................			
Sat.	21			....	9 00	3024*	359.15
Sun.	22			....		21034	11.33
Mon.	23			☿ at ☊......................		02134	23.50
Tue.	24			....	5 50	10234	35.67
Wed.	25	11		☌ ♅ ☾ ♅ 4° S..................		d2014	47.83
		17		Juno stationary in R.A...............			
Thu.	26			♀ at perihelion................		32104	59.99[l]
Fri.	27	21	49	○ Full Moon....................	2 40	30124	72.15
Sat.	28			☿ at perihelion................		3402*	84.31[b]
Sun.	29			....	23 30	42103	96.47
Mon.	30			....		4013*	108.63
Tue.	31	2		☌ ♆ ☾ ♆ 2° S..................		41023	120.79
		18		☌ ☿ ♃ ☿ 3° N..................			

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Mar. 12, −5.97°; Mar. 26, +4.72°. [b]Mar. 1, −6.62°; Mar. 15, +6.53°, Mar. 28, −6.55°.

THE SKY FOR APRIL 1964

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

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

The Sun—During April the sun's R.A. increases from 0h 42m to 2h 33m and its Decl. changes from 4° 28′ N. to 15° 01′ N. The equation of time changes from −4m 00s to +2m 54s, 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 15th is in R.A. 2h 32m, Decl. 18° 07′ N., and transits at 12h 56m. On the 7th it is in greatest eastern elongation. This is a favourable elongation, Mercury being about 19 degrees above the western horizon at sunset. For about a week before and after this date it should be possible to see Mercury low in the western sky just after sunset. By the 27th it is in inferior conjunction.

Venus on the 15th is in R.A. 4h 34m, Decl. 25° 37′ N., mag. −4.0, and transits at 15h 02m. It is at greatest eastern elongation on the 10th and so is well up in the western sky at sunset and does not set until about four hours later. It is approaching greatest brilliancy (see May).

Mars on the 15th is in R.A. 0h 48m, Decl. 4° 20′ N., and transits at 11h 15m. It is a morning star but as yet too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 1h 56m, Decl. 10° 45′ N., mag. −1.6, and transits at 12h 21m. It is too close to the sun for easy observation, being in conjunction on the 22nd.

Saturn on the 15th is in R.A. 22h 18m, Decl. 11° 57′ S., mag. +1.2, and transits at 8h 44m. In Aquarius, it rises in the south-east within about two hours of sunrise.

Uranus on the 15th is in R.A. 10h 33m, Decl. 9° 57′ N., and transits at 20h 56m. It is approaching the meridian at sunset.

Neptune on the 15th is in R.A. 15h 00m, Decl. 15° 11′ S., and transits at 1h 27m. It rises soon after sunset.

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

	d	h	m	APRIL E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h00m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1			....	20 20	42O31	132.95
Thu.	2	7		☾ at apogee. Dist. from ⊕, 251,500 mi.		4321O	145.13
Fri.	3	22		Pallas stationary in R.A...............		43O12	157.30
Sat.	4			....	17 10	431O2	169.48
Sun.	5	0	46	☾ Last Quarter..................			181.67
Mon.	6			....			193.87
Tue.	7			☿ greatest hel. lat. N.............	14 00		206.07
		13		☿ greatest elongation E., 19°......			
Wed.	8	15		☌ ♄ ☾ ♄ 3° N................			218.28
Thu.	9			....			230.49[l]
Fri.	10	4		♀ greatest elongation E., 46°......	10 50		242.71
Sat.	11			....			254.94[b]
Sun.	12	7	38	● New Moon..................			267.16
Mon.	13	9		☌ ☿ ☾ ☿ 8° N................	7 40		279.39
Tue.	14	5		☾ at perigee. Dist. from ⊕, 224,900 mi.			291.62
Wed.	15	13		☌ ♀ ☾ ♀ 6° N................			303.84
Thu.	16	23		☿ stationary in R.A.............	4 30		316.07
Fri.	17			♀ greatest hel. lat. N.............			328.28
Sat.	18	23	10	☽ First Quarter.................			340.49
Sun.	19			....	1 20		352.70
Mon.	20			....			4.90
Tue.	21			Lyrid meteors, see p. 68...............	22 10		17.09[l]
		15		☌ ♅ ☾ ♅ 4° S................			
Wed.	22	9		☌ ♃ ☉............................			29.28
Thu.	23			....			41.46
Fri.	24			....	18 50		53.64[b]
Sat.	25			....			65.81
Sun.	26	12	50	○ Full Moon....................			77.99
Mon.	27	5		☌ ☿ ☉ inferior.................	15 40		90.16
		8		☌ ♆ ☾ ♆ 2° S................			
Tue.	28			....			102.34
Wed.	29	21		☾ at apogee. Dist. from ⊕, 252,100 mi.			114.52
Thu.	30			....	12 30		126.70

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57. Jupiter being near the sun, configurations of the satellites are not given between April 5 and June 1.

[l]Apr. 9, −6.95°; Apr. 21, +5.83°. [b]Apr. 11, +6.53°; Apr. 24, −6.62°.

THE SKY FOR MAY 1964

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

The Sun—During May the sun's R.A. increases from 2h 33m to 4h 36m and its Decl. changes from 15° 01′ N. to 22° 02′ N. The equation of time changes from +2m 54s to a maximum of +3m 44s on the 14th and then to +2m 20s at the end of the month. For changes in the length of the day, see p. 15.

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

Mercury on the 15th is in R.A. 2h 04m, Decl. 9° 23′ N., and transits at 10h 32m. Though poorly placed for observation early in the month, it is at greatest western elongation on the 24th. However, even then it will be less than 10 degrees above the eastern horizon at sunrise, and therefore difficult to observe.

Venus on the 15th is in R.A. 6h 14m, Decl. 27° 18′ N., mag. −4.2, and transits at 14h 42m. It is a spectacular object in the western sky for about three hours after sunset (at mid-month). Greatest brilliancy is on the 13th. However, it is rapidly approaching the sun and by month's end it is quite low in the west at sunset.

Mars on the 15th is in R.A. 2h 14m, Decl. 12° 53′ N., and transits at 10h 42m. It is a morning star but rises less than an hour before sunrise and so is difficult to observe.

Jupiter on the 15th is in R.A. 2h 23m, Decl. 13° 10′ N., mag. −1.6, and transits at 10h 50m. It is a morning star but barely risen at sunrise.

Saturn on the 15th is in R.A. 22h 27m, Decl. 11° 16′ S., mag. +1.2, and transits at 6h 54m. In Aquarius, it rises about three hours before the sun.

Uranus on the 15th is in R.A. 10h 32m, Decl. 10° 04′ N., and transits at 18h 57m. It is about on the meridian at sunset.

Neptune on the 15th is in R.A. 14h 57m, Decl. 14° 57′ S., mag. 7.7, and transits at 23h 22m. It is low in the south-east at sunset. Opposition is on the 6th.

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

---

[l]May 7, −7.68°; May 19, +6.96°. [b]May 9, +6.64°; May 21, −6.74°.

	d	h	m	MAY E.S.T.	Min. of Algol h m	Sun's Selen. Colong. 0h U.T. °
Fri.	1			☿ at ☋		138.88
		11		Ceres stationary in R.A.		
Sat.	2			....		151.07
Sun.	3			....	9 20	163.27
Mon.	4			η Aquarid meteors, see p. 68		175.47
		17	20	☾ Last Quarter		
Tue.	5			....		187.67
Wed.	6	3		☌ ♄ ☾ ♄ 3° N.	6 10	199.89
		19		☍ ♆ ☉ Dist. from ⊕, 2,723,000,000 mi.		
Thu.	7			....		212.11[l]
Fri.	8			....		224.33
Sat.	9	12		☿ stationary in R.A.	3 00	236.57[b]
Sun.	10	7		☌ ♂ ☾ ♂ 4° N.		248.80
		7		☌ ☿ ☾ ☿ 2° N.		
		8		☌ ☿ ♂ ☿ 1.9° S.		
		15		☌ ♃ ☾ ♃ 4° N.		
Mon.	11	16	02	● New Moon; ☿ at aphelion	23 50	261.05
Tue.	12	11		☾ at perigee. Dist. from ⊕, 222,700 mi.		273.29
Wed.	13	14		♀ at greatest brilliancy		285.53
		14		♅ stationary in R.A.		
Thu.	14	11		☌ ♀ ☾ ♀ 4° N.	20 40	297.77
Fri.	15			....		310.01
Sat.	16			....		322.24
Sun.	17			....	17 30	334.47
Mon.	18	2		☍ Juno ☉. See p. 67		346.69
		7	43	☽ First Quarter		
		12		☍ Pallas ☉. See p. 67		
		20		☌ ♅ ☾ ♅ 4° S.		
Tue.	19	14		☌ ♂ ♃ ♂ 0.6° N.		358.91[l]
Wed.	20			....	14 20	11.12
Thu.	21			....		23.32[b]
Fri.	22			....		35.52
Sat.	23			....	11 00	47.71
Sun.	24	13		☌ ♆ ☾ ♆ 2° S.		59.91
		15		☿ greatest elongation W., 25°		
Mon.	25			□ ♄ ☉ west		72.09
		9		☌ ☿ ♃ ☿ 3° S.		
Tue.	26	4	29	○ Full Moon	7 50	84.28
Wed.	27			□ ♅ ☉ east		96.47
		4		☾ at apogee. Dist. from ⊕, 252,400 mi.		
Thu.	28	1		♇ stationary in R.A.		108.66
Fri.	29	1		♀ stationary in R.A.	4 40	120.85
Sat.	30			....		133.05
Sun.	31			☿ greatest hel. lat. S.		145.25

THE SKY FOR JUNE 1964

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

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

The Sun—During June the sun's R.A. increases from 4h 36m to 6h 40m and its Decl. changes from 22° 02′ N. to 23° 08′ N. The equation of time changes from +2m 20s to −3m 39s, being zero on the 13th. There is a partial eclipse of the sun on the 9th, visible in Australia. 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. There is a total eclipse of the moon on the night of the 24th, its end being visible in North America.

Mercury on the 15th is in R.A. 4h 33m, Decl. 21° 03′ N., and transits at 11h 02m. It is too close to the sun for observation, superior conjunction is on the 27th.

Venus on the 15th is in R.A. 6h 07m, Decl. 22° 47′ N., mag. −3.1, and transits at 12h 29m. It is still visible as an evening star low in the west after sunset at the beginning of the month, but by the 19th it is in inferior conjunction and no longer visible. By month's end it begins to be seen as a morning star, very low in the east just before sunrise.

Mars on the 15th is in R.A. 3h 44m, Decl. 19° 36′ N., and transits at 10h 10m. It is a morning star rising about an hour before the sun but still difficult to observe.

Jupiter on the 15th is in R.A. 2h 50m, Decl. 15° 18′ N., mag. −1.7, and transits at 9h 15m. In Aries, it rises about two hours before the sun.

Saturn on the 15th is in R.A. 22h 30m, Decl. 11° 05′ S., mag. +1.0, and transits at 4h 55m. In Aquarius, it rises before midnight and is visible for the rest of the night. On the 15th it is stationary in right ascension and begins to move westward among the stars.

Uranus on the 15th is in R.A. 10h 34m, Decl. 9° 53′ N., and transits at 16h 57m. It is well past the meridian at sunset.

Neptune on the 15th is in R.A. 14h 54m, Decl. 14° 45′ S., and transits at 21h 17m. It is approaching the meridian at sunset.

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

	d	h	m	JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 15m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Mon.	1			□ ♇ ☉ east....................	1 30	d3014	157.45
		12		☌ ☿ ♂ ☿ 3° S.................			
Tue.	2	13		☌ ♄ ☾ ♄ 3° N.................		2104*	169.66
Wed.	3	6	08	☾ Last Quarter.................	22 20	01243	181.87
Thu.	4			....		0423*	194.09[l]
Fri.	5			....		42103	206.32[b]
Sat.	6			....	19 10	43201	218.56
Sun.	7	12		☌ ♃ ☾ ♃ 3° N.................		43102	230.80
Mon.	8	5		☌ ♂ ☾ ♂ 3° N.................		43021	243.04
		14		☌ ☿ ☾ ☿ 1° N.................			
Tue.	9	21		☾ at perigee. Dist. from ⊕, 222,100 mi.	16 00	42130	255.29
		23	23	● New Moon. Eclipse of ☉, see p. 61			
Wed.	10			....		40213	267.55
Thu.	11			....		4023*	279.80
Fri.	12			♀ at ☋.......................	12 50	d4203	292.05
Sat.	13			....		23014	304.30
Sun.	14			....		31024	316.54
Mon.	15	4		☌ ♅ ☾ ♅ 4° S.................	9 30	30124	328.78
		19		♄ stationary in R.A.............			
Tue.	16	18	02	☽ First Quarter.................		21304	341.01[l]
Wed.	17			....		0134*	353.24[b]
Thu.	18			....	6 20	10234	5.46
Fri.	19			☿ at ☊.......................		20134	17.68
		18		☌ ♀ ☉ inferior.................			
Sat.	20	17		☌ ♆ ☾ ♆ 2° S.................		23014	29.89
Sun.	21	3	57	☉ enters ♋. Summer commences.......	3 10	31042	42.09
		5		☍ Ceres ☉. See p. 67................ Dist. from ⊕, 171,000,000 mi.			
Mon.	22			....		34012	54.29
Tue.	23	7		☾ at apogee. Dist. from ⊕, 252,400 mi.		42310	66.49
Wed.	24			☿ at perihelion..................	0 00	4031*	78.69
		20	09	○ Full Moon. Eclipse of ☾, see p. 61			
Thu.	25			....		41023	90.88
Fri.	26			....	20 50	42013	103.08
Sat.	27	2		☌ ☿ ☉ superior.................		4203*	115.27
Sun.	28			....		43102	127.47
Mon.	29	19		☌ ♄ ☾ ♄ 3° N.................	17 40	34012	139.67
Tue.	30			♂ at ☊.......................		32104	151.88

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]June 4, −7.76°; June 16, +7.43°. [b]June 5, +6.79°; June 17, −6.80°.

THE SKY FOR JULY 1964

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

The Sun—During July the sun's R.A. increases from 6h 40m to 8h 45m and its Decl. changes from 23° 08′ N. to 18° 04′ N. The equation of time changes from −3m 39s to a maximum of −6m 25s on the 26th and then to −6m 15s at the end of the month. There is a partial eclipse of the sun on the 9th, visible in North Central Canada. For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 8h 55m, Decl. 19° 01′N., and transits at 13h 26m. During the last few evenings of the month it might be seen with difficulty very low on the western horizon, close to Regulus, just after sunset.

Venus on the 15th is in R.A. 5h 21m, Decl. 17° 55′ N., mag. −4.1, and transits at 9h 47m. It is a morning star, rising in the east about an hour before sunrise. Greatest brilliancy is on the 26th.

Mars on the 15th is in R.A. 5h 13m, Decl. 23° 11′ N., mag. +1.6, and transits at 9h 41m. In Taurus, it rises about two hours before the sun.

Jupiter on the 15th is in R.A. 3h 13m, Decl. 16° 52′ N., mag. −1.8, and transits at 7h 40m. In Aries, it rises at about 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. 22h 27m, Decl. 11° 26′ S., mag. +0.9, and transits at 22h 54m. In Aquarius, it rises about two hours after sunset and is past the meridian by dawn.

Uranus on the 15th is in R.A. 10h 38m, Decl. 9° 26′ N., and transits at 15h 03m. It is low in the west at sunset.

Neptune on the 15th is in R.A. 14h 53m, Decl. 14° 39′ S., and transits at 19h 17m. It is past the meridian at sunset.

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

	d	h	m	JULY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 00m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Wed.	1			....		20314	164.09
Thu.	2	15	31	☾ Last Quarter..................	14 30	10234	176.30[lb]
Fri.	3			....		d0134	188.53
Sat.	4			☿ greatest hel. lat. N.		21034	200.76
Sun.	5			⊕ at aphelion..................	11 20	d3024	212.99
				Dist. from ☉, 94,456,000 mi.			
		7		☌ ♃ ☾ ♃ 3° N.................			
Mon.	6			....		30124	225.23
Tue.	7	1		☌ ♂ ☾ ♂ 2° N.................		32104	237.48
		12		☌ ♀ ☾ ♀ 4° S.................			
Wed.	8	6		☾ at perigee. Dist. from ⊕, 223,100 mi.	8 00	24031	249.73
Thu.	9	6	31	● New Moon. Eclipse of ☉, see p. 61		41023	261.98
Fri.	10	7		☌ ☿ ☾ ☿ 0.9° S................		40213	274.24
Sat.	11	6		♀ stationary in R.A.............	4 50	42103	286.49
Sun.	12	15		☌ ♅ ☾ ♅ 4° S.................		43021	298.75
Mon.	13			....		4302*	310.99
Tue.	14			....	1 40	43210	323.24
Wed.	15			....		42301	335.47[lb]
Thu.	16			♀ at aphelion..................	22 30	14023	347.70
		6	48	☽ First Quarter................			
Fri.	17	17		Juno stationary in R.A...............		02143	359.93
		23		☌ ♆ ☾ ♆ 2° S.................			
Sat.	18	0		Pallas stationary in R.A..............		21034	12.15
		2		☌ ♀ ♂ ♀ 5° S.................			
Sun.	19			....	19 20	3014*	24.36
Mon.	20	16		☾ at apogee. Dist. from ⊕, 251,900 mi.		3024*	36.57
Tue.	21	19		Vesta stationary in R.A..............		32104	48.77
Wed.	22			....	16 10	23014	60.97
Thu.	23			....		10234	73.17
Fri.	24	10	58	○ Full Moon....................		01423	85.36
Sat.	25			....	13 00	21403	97.55
Sun.	26	11		♀ at greatest brilliancy...........		4301*	109.74
		22		☌ ♄ ☾ ♄ 3° N.................			
Mon.	27			☿ at ☋........................		43102	121.94
		16		♆ stationary in R.A.............			
Tue.	28			....	9 50	d4320	134.13
Wed.	29			δ Aquarid meteors, see p. 68...........		42301	146.33[lb]
Thu.	30			....		41023	158.54
Fri.	31	22	30	☾ Last Quarter..................	6 30	40123	170.75

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]July 2, −7.06°; July 15, +7.22°; July 29, −5.86°.

[b]July 2, +6.81°; July 15, −6.79°; July 29, +6.70°.

THE SKY FOR AUGUST 1964

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

The Sun—During August the sun's R.A. increases from 8h 45m to 10h 41m and its Decl. changes from 18° 04′ N. to 8° 21′ N. The equation of time changes from −6m 15s to −0m 14s. For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 11h 07m, Decl. 2° 06′ N., and transits at 13h 31m. On the 5th it is at greatest eastern elongation. This is not a favourable elongation, however, the planet being less than 10 degrees above the western horizon at sunset.

Venus on the 15th is in R.A. 6h 31m, Decl. 19° 10′ N., mag. −4.1, and transits at 8h 57m. It is a brilliant morning star and by the 29th it has reached greatest western elongation, at which time it rises more than three hours before the sun.

Mars on the 15th is in R.A. 6h 44m, Decl. 23° 37′ N., mag. +1.7, and transits at 9h 10m. In Gemini, it rises about three hours before the sun.

Jupiter on the 15th is in R.A. 3h 30m, Decl. 17° 51′ N., mag. −2.0, and transits at 5h 55m. Moving into Taurus, it is well up by midnight and is nearly to the meridian by dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 20m, Decl. 12° 13′ S., mag. +0.7, and transits at 0h 45m. In Aquarius, it rises at about sunset and sets at about dawn. Opposition is on the 24th.

Uranus on the 15th is in R.A. 10h 45m, Decl. 8° 46′ N., and transits at 13h 08m. It is too close to the sun for observation.

Neptune on the 15th is in R.A. 14h 53m, Decl. 14° 42′ S., and transits at 17h 16m. It is well down in the south-west at sunset.

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

	d	h	m	AUGUST E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 2h 45m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sat.	1	22		☌♃☾ ♃ 2° N.		42103	182.96
Sun.	2			. . . .		24031	195.19
Mon.	3			. . . .	3 20	31042	207.42
Tue.	4	9		☌☿♅ ☿ 2° S.		d3014	219.65
		11		☌♀☾ ♀ 5° S.			
		18		☌♂☾ ♂ 0.2° N.			
Wed.	5	10		☾ at perigee. Dist. from ⊕, 225,600 mi.		2304*	231.89
		14		☿ greatest elongation E., 27°.			
Thu.	6			. . . .	0 10	10234	244.14
Fri.	7			□♆☉ east.		01234	256.39
				☿ at aphelion.			
		14	17	🌑 New Moon.			
Sat.	8			♀ greatest hel. lat. S.	21 00	21034	268.63
Sun.	9	3		☌♅☾ ♅ 4° S.		20314	280.88
		9		☌☿☾ ☿ 8° S.			
Mon.	10			. . . .		31042	293.13
Tue.	11			Perseid meteors, see p. 68.	17 50	34021	305.37[b]
		8		Ceres stationary in R.A.			
Wed.	12			. . . .		4320*	317.61[l]
Thu.	13			. . . .		41032	329.85
Fri.	14	7		☌♆☾ ♆ 2° S.	14 40	40123	342.07
		22	20	🌓 First Quarter.			
Sat.	15			. . . .		42103	354.29
Sun.	16			. . . .		42031	6.51
Mon.	17			□♃☉ west.	11 30	43102	18.72
		7		☾ at apogee. Dist. from ⊕, 251,400 mi.			
Tue.	18	17		☿ stationary in R.A.		34012	30.92
Wed.	19			. . . .		32104	43.12
Thu.	20			. . . .	8 10	d04**	55.31
Fri.	21			. . . .		01234	67.50
Sat.	22			. . . .		12034	79.68
Sun.	23	0	26	🌕 Full Moon.	5 00	20134	91.87
		2		☌♄☾ ♄ 3° N.			
Mon.	24	15		☍♄☉ Dist. from ⊕, 815,000,000 mi.		13024	104.05
Tue.	25			. . . .		30124	116.23[lb]
Wed.	26			. . . .	1 50	32104	128.41[b]
Thu.	27			☿ greatest hel. lat. S.		3041*	140.60
Fri.	28	6		☌♀♂ ♀ 4° S.	22 40	4032*	152.79
Sat.	29	5		♀ greatest elongation W., 46°.		41203	164.99
		8		☌♃☾ ♃ 2° N.			
Sun.	30	4	16	🌗 Last Quarter.		42013	177.19
Mon.	31			. . . .	19 30	41302	189.40

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Aug. 12, +6.53°; Aug. 25, −4.89°. [b]Aug. 11, −6.68°; Aug. 25, 26, +6.55°.

THE SKY FOR SEPTEMBER 1964

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

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

The Sun—During September the sun's R.A. increases from 10h 41m to 12h 29m and its Decl. changes from 8° 21′ N. to 3° 07′ S. The equation of time changes from −0m 04s to +10m 13s. 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 15th is in R.A. 10h 28m, Decl. 9° 29′ N., and transits at 10h 51m. On the 2nd it is in inferior conjunction, but by the 18th it has reached greatest western elongation. This is a favourable elongation, Mercury being about 18 degrees above the eastern horizon at sunrise. For about a week before and after this time it should be possible to identify Mercury below Regulus just before sunrise.

Venus on the 15th is in R.A. 8h 36m, Decl. 17° 06′ N., mag. −3.8, and transits at 9h 01m. Though declining in brightness, it is still a prominent morning star rising about three hours before the sun.

Mars on the 15th is in R.A. 8h 09m, Decl. 21° 07′ N., mag. +1.6, and transits at 8h 32m. Moving into Cancer, it now rises about four hours before the sun.

Jupiter on the 15th is in R.A. 3h 36m, Decl. 18° 08′ N., mag. −2.2, and transits at 3h 59m. In Taurus, it rises in the late evening and is past the meridian before dawn. On the 14th it is stationary in right ascension and begins to move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 22h 11m, Decl. 13° 03′ S., mag. +0.7, and transits at 22h 30m. In Aquarius, it is risen at sunset and sets before sunrise.

Uranus on the 15th is in R.A. 10h 52m, Decl. 8° 03′ N., and transits at 11h 13m. It is too close to the sun for observation. Conjunction is on the 2nd.

Neptune on the 15th is in R.A. 14h 55m, Decl. 14° 53′ S., and transits at 15h 16m. It is low in the south-west at sunset.

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

SEPTEMBER E.S.T.					Min. of Algol	Config. of Jupiter's Sat. 2h 30m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Tue.	1	20		☍ Vesta ☉. See p. 67................		43012	201.62
				Dist. from ⊕, 123, 900, 000 mi.			
		21		☾ at perigee. Dist. from ⊕, 228,700 mi.			
Wed.	2	2		☌ ☿ ☉ inferior..................		43210	213.84
		8		☌ ♂ ☾ ♂ 1° S.................			
		11		☌ ♀ ☾ ♀ 5° S.................			
		17		☌ ♅ ☉............................			
Thu.	3			....	16 20	43201	226.07
Fri.	4			....		4032*	238.30
Sat.	5	23	35	● New Moon...................		dd043	250.54
Sun.	6	9		☌ ♇ ☉............................	13 10	20134	262.77
Mon.	7			....		13024	275.01[b]
Tue.	8			....		30124	287.25[l]
Wed.	9			....	9 50	32104	299.48
Thu.	10	16		☌ ♆ ☾ ♆ 2° S.................		32014	311.71
		17		☿ stationary in R.A.............			
Fri.	11			....		10324	323.93
Sat.	12			....	6 40	d0243	336.15
Sun.	13	16	24	☽ First Quarter................		24013	348.36
Mon.	14	2		☾ at apogee. Dist. from ⊕, 251, 100mi.		d4102	0.56
		18		♃ stationary in R.A.............			
Tue.	15			☿ at ☊.......................	3 30	43012	12.76
Wed.	16			....		43210	24.96
Thu.	17			....		43201	37 14
Fri.	18	7		☿ greatest elongation W., 18°.....	0 20	41032	49.32
Sat.	19	6		☌ ♄ ☾ ♄ 3° N..................		40123	61.50
Sun.	20			☿ at perihelion..................	21 10	4203*	73.67[l]
Mon.	21	10		☌ ☿ ♅ ☿ 0.6° N...............		4103*	85.84
		12	31	○ Full Moon, Harvest Moon......			
Tue.	22	19	17	☉ enters ♎. Autumn commences......		30142	98.01[b]
Wed.	23			....	18 00	31204	110.17
Thu.	24			....		32014	122.34
Fri.	25	14		☌ ♃ ☾ ♃ 1° N..................		10324	134.51
Sat.	26			....	14 50	01234	146.68
Sun.	27	0		☾ at perigee. Dist. from ⊕, 229,700 mi.		2034*	158.86
Mon.	28	10	02	☾ Last Quarter..................		d034*	171.05
Tue.	29			....	11 30	30142	183.24
Wed.	30			☿ greatest hel. lat. N............		31420	195.44
		19		☌ ♂ ☾ ♂ 2° S.................			

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Sept. 8, +5.67°; Sept. 20, −4.99°. [b]Sept. 7, −6.54°; Sept. 22, +6.52°.

THE SKY FOR OCTOBER 1964

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

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

The Sun—During October the sun's R.A. increases from 12h 29m to 14h 25m and its Decl. changes from 3° 07′ S. to 14° 22′ S. The equation of the time changes from +10m 13s to +16m 22s. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24.

Mercury on the 15th is in R.A. 13h 19m, Decl. 7° 20′ S., and transits at 11h 47m. It is not well placed for observation this month, being in superior conjunction on the 15th.

Venus on the 15th is in R.A. 10h 50m, Decl. 8° 16′ N., mag. −3.6, and transits at 9h 16m. It is a prominent morning star, rising about three hours before the sun.

Mars on the 15th is in R.A. 9h 23m, Decl. 16° 48′ N., mag. +1.5, and transits at 7h 48m. In Cancer, it rises about five hours before the sun and is approaching the meridian at sunrise.

Jupiter on the 15th is in R.A. 3h 30m, Decl. 17° 44′ N., mag. −2.4, and transits at 1h 55m. Moving from Taurus into Aries, it rises soon 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. 56.

Saturn on the 15th is in R.A. 22h 05m, Decl. 13° 34′ S., mag. +0.8, and transits at 20h 27m. In Aquarius, it is well up in the south-east at sunset and sets soon after midnight.

Uranus on the 15th is in R.A. 10h 58m, Decl. 7° 23′ N., and transits at 9h 22m. It is well up in the east at sunrise.

Neptune on the 15th is in R.A. 14h 59m, Decl. 15° 10′ S., and transits at 13h 22m. It is too close to the sun for easy observation.

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

OCTOBER E.S.T.					Min. of Algol	Config. of Jupiter's Sat. 1h 10m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thu.	1	22		☌ ♀ ☾ ♀ 5° S.		43201	207.64
Fri.	2				8 20	41032	219.85
Sat.	3			♀ at ☊		40123	232.07
		2		☌ ♅ ☾ ♅ 4° S.			
Sun.	4					42103	244.29[b]
Mon.	5	11	20	● New Moon	5 10	42013	256.51
Tue.	6					4302*	268.73[l]
Wed.	7					d3410	280.95
Thu.	8	2		☌ ♆ ☾ ♆ 2° S.	2 00	32041	293.17
Fri.	9					1024*	305.38
Sat.	10				22 50	01234	317.59
Sun.	11	22		☾ at apogee. Dist. from ⊕, 251,300 mi.		21034	329.80
Mon.	12					20134	342.00
Tue.	13	11	57	☽ First Quarter	19 40	3024*	354.19
Wed.	14					31024	6.38
Thu.	15	14		☌ ☿ ☉ superior		32014	18.56
Fri.	16	13		☌ ♄ ☾ ♄ 3° N.	16 30	13042	30.73
		19		☌ ♀ ♅ ♀ 0.1° N.			
Sat.	17					40132	42.90
Sun.	18	17		Vesta stationary in R.A.		41203	55.06[l]
Mon.	19				13 20	42013	67.21[b]
Tue.	20			Orionid meteors, see p. 68		41302	79.37
		23	46	○ Full Moon, Hunter's Moon			
Wed.	21					d4302	91.52
Thu.	22	18		☌ ♃ ☾ ♃ 1° N.	10 00	43201	103.66
Fri.	23			☿ at ☋		4310*	115.81
		17		☾ at perigee. Dist. from ⊕, 226, 800 mi.			
Sat.	24					40132	127.97
Sun.	25				6 50	12043	140.12
Mon.	26					20134	152.28
Tue.	27	16	59	☾ Last Quarter		13024	164.45
Wed.	28				3 40	30124	176.62
Thu.	29	4		☌ ♂ ☾ ♂ 3° S.		3204*	188.80
Fri.	30	11		☌ ♅ ☾ ♅ 5° S.		3104*	200.99
Sat.	31	18		☌ ♀ ☾ ♀ 4° S.	0 30	01324	213.18

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Oct. 6, +5.19°; Oct. 18, −5.90°. [b]Oct. 4, −6.52°; Oct. 19, +6.62°.

THE SKY FOR NOVEMBER 1964

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

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

The Sun—During November the sun's R.A. increases from 14h 25m to 16h 28m and its Decl. changes from 14° 22′ S. to 21° 47′ S. The equation of time changes from +16m 22s to a maximum of +16m 24s on the 3rd and then to +11m 03s at the end of the month. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25.

Mercury on the 15th is in R.A. 16h 30m, Decl. 24° 02′ S., and transits at 12h 56m. Greatest eastern elongation is on the 30th, but this elongation is very unfavourable, Mercury being only about 8 degrees above the south-western horizon at sunset.

Venus on the 15th is in R.A. 13h 08m, Decl. 5° 15′ S., mag. −3.5, and transits at 9h 32m. It is a morning star, declining in brightness, but still visible in the south-east for more than two hours before sunrise.

Mars on the 15th is in R.A. 10h 28m, Decl. 11° 34′ N., mag. +1.2, and transits at 6h 51m. In Leo, near Regulus, it rises at about midnight and is near the meridian at dawn.

Jupiter on the 15th is in R.A. 3h 15m, Decl. 16° 47′ N., mag. −2.4, and transits at 23h 33m. In Aries, it rises at about sunset and sets just before sunrise, opposition being on the 13th. 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. 22h 05m, Decl. 13° 33′ S., mag. +1.0, and transits at 18h 25m. In Aquarius, it is well up towards the meridian at sunset and sets about at midnight. On the 2nd it is stationary in right ascension and resumes eastward motion among the stars.

Uranus on the 15th is in R.A. 11h 03m, Decl. 6° 53′ N., and transits at 7h 25m. It rises soon after midnight.

Neptune on the 15th is in R.A. 15h 03m, Decl. 15° 29′ S., and transits at 11h 24m. It is too close to the sun for observation. Conjunction is on the 9th.

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

NOVEMBER 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		°
Sun. 1			....		24013	225.38[lb]
Mon. 2	1		♄ stationary in R.A.	21 20	41032	237.58
Tue. 3			☿ at aphelion		43012	249.78
Wed. 4	2	17	● New Moon		43210	261.98
Thu. 5			Taurid meteors, see p. 68	18 10	d4320	274.19
	2		☌ ☿ ☾ ☿ 4° S.			
Fri. 6			♀ at perihelion		40132	286.39
Sat. 7			....		d4103	298.59
Sun. 8	17		☾ at apogee. Dist. from ⊕, 251,900 mi.	15 00	42013	310.79
Mon. 9	18		☌ ♆ ☉		14023	322.98
Tue. 10			....		30142	335.17
Wed. 11			....	11 50	32104	347.35
Thu. 12	7	21	☽ First Quarter		32014	359.53
	21		☌ ♄ ☾ ♄ 3° N.			
Fri. 13	5		☍ ♃ ☉ Dist. from ⊕, 372,500,000 mi.		0324*	11.70
Sat. 14			....	8 40	10234	23.86
Sun. 15			....		20134	36.02[lb]
Mon. 16			Leonid meteors, see p. 68		10234	48.17
Tue. 17			....	5 20	30412	60.31
Wed. 18	23		☌ ♃ ☾ ♃ 2° N.		34210	72.45
Thu. 19	10	43	○ Full Moon		43201	84.58
Fri. 20			□ ♄ ☉ east	2 10	402**	96.72
	19		☾ at perigee. Dist. from ⊕, 223,500 mi.			
Sat. 21			....		41023	108.85
Sun. 22			....	23 00	42013	120.99
Mon. 23			☿ greatest hel. lat. S.		4103*	133.12
Tue. 24			....		43012	145.27
Wed. 25			....	19 50	34120	157.42
Thu. 26	2	11	☾ Last Quarter		32041	169.58
	11		☌ ♂ ☾ ♂ 3° S.			
	18		☌ ⛢ ☾ ⛢ 5° S.			
Fri. 27			♀ greatest hel. lat. N.		13024	181.74
Sat. 28			....	16 40	d0234	193.91[lb]
Sun. 29			....		20134	206.09
Mon. 30	5		☿ greatest elongation E., 21°		12034	218.27
	23		☌ ♀ ☾ ♀ 2° S.			

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Nov. 1, +5.72°; Nov. 15, −6.96°; Nov. 28, +6.96°.

[b]Nov. 1, −6.64°; Nov. 15, +6.76°; Nov. 28, −6.78°.

THE SKY FOR DECEMBER 1964

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 28m to 18h 45m and its Decl. changes from 21° 47′ S. to 23° 02′ S. The equation of time changes from +11m 03s to −3m 22s. There is a partial eclipse of the sun on the 3rd, invisible in North America except for the southern part of Alaska. 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. There is a total eclipse of the moon on the night of the 18th–19th, visible in North America.

Mercury on the 15th is in R.A. 18h 08m, Decl. 22° 39′ S., and transits at 12h 27m. It is an evening star early in the month, though difficult to observe (see Nov.). On the 18th it is in inferior conjunction, but by the end of the month it is a morning star standing about 12 degrees above the south-eastern horizon at sunrise—about the same altitude as Antares and some 10 degrees "to the left" of it.

Venus on the 15th is in R.A. 15h 31m, Decl. 17° 27′ S., mag. −3.4, and transits at 9h 57m. It is still a morning star, but approaching the sun so that it is visible low in the south-east for less than two hours before sunrise at year's end.

Mars on the 15th is in R.A. 11h 20m, Decl. 6° 57′ N., mag. +0.8, and transits at 5h 44m. Moving into Virgo, it rises before midnight and is past the meridian before dawn.

Jupiter on the 15th is in R.A. 3h 01m, Decl. 15° 55′ N., mag. −2.3, and transits at 21h 21m. In Aries, it is well up by sunset and sets about four hours after midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 22h 10m, Decl. 13° 00′ S., mag. +1.1, and transits at 16h 32m. In Aquarius, it is near the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 11h 05m, Decl. 6° 42′ N., and transits at 5h 29m. It rises before midnight.

Neptune on the 15th is in R.A. 15h 07m, Decl. 15° 46′ S., and transits at 9h 30m. It is too close to the sun for easy observation.

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

DECEMBER 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		°
Tue.	1	21		☌ ♆ ☾ ♆ 1° S.	13 30	30124	230.46
Wed.	2			. . . .	. .	31204	242.64
Thu.	3	20	19	● New Moon. Eclipse of ☉, see p. 61		32014	254.84
Fri.	4			. . . .	10 20	13042	267.03
Sat.	5			□ ♂ ☉ west.		40132	279.22
		3		☌ ♂ ♅ ♂ 1.6° N.			
		17		☌ ☿ ☾ ☿ 0.6° S.			
Sun.	6			□ ♅ ☉ west.		4203*	291.41
		7		☾ at apogee. Dist. from ⊕, 252,500 mi.			
Mon.	7			□ ♇ ☉ west.	7 10	42103	303.60
Tue.	8			. . . .		43012	315.78
Wed.	9	1		☿ stationary in R.A.		d4310	327.96
		23		☌ ♀ ♆ ♀ 0.1° S.			
Thu.	10	7		☌ ♄ ☾ ♄ 3° N.	4 00	43201	340.14
Fri.	11			. . . .		43102	352.31
Sat.	12			☿ at ☊.		40132	4.47[b]
		1	02	☽ First Quarter.			
Sun.	13			Geminid meteors, see p. 68.	0 50	21043	16.63[l]
Mon.	14			. . . .		d2034	28.78
Tue.	15			. . . .	21 30	03124	40.92
Wed.	16	4		☌ ♃ ☾ ♃ 2° N.		31024	53.06
Thu.	17			☿ at perihelion.		32014	65.19
Fri.	18	16		☌ ☿ ☉ inferior.	18 20	3104*	77.32
		21	42	○ Full Moon. Eclipse of ☾, see p. 61			
Sat.	19	6		☾ at perigee. Dist. from ⊕, 221,700 mi.		01324	89.44
Sun.	20	9		♅ stationary in R.A.		21043	101.57
		18		☌ Juno ☉.			
Mon.	21	14	50	☉ enters ♑. Winter commences.	15 10	24013	113.69
Tue.	22			Ursid meteors, see p. 68.		4032*	125.82
Wed.	23			. . . .		43102	137.95
Thu.	24	1		☌ ♅ ☾ ♅ 5° S.	12 00	43201	150.10
		14		☌ ♂ ☾ ♂ 3° S.			
Fri.	25	11		♇ stationary in R.A.		4310*	162.24[b]
		14	27	☾ Last Quarter.			
Sat.	26			. . . .		4012*	174.40[l]
Sun.	27			☿ greatest hel. lat. N.	8 50	41203	186.56
Mon.	28	22		☿ stationary in R.A.		42013	198.72
Tue.	29	4		☌ ♆ ☾ ♆ 1° S.		4032*	210.90
Wed.	30			. . . .	5 40	31024	223.07
Thu.	31	9		☌ ♀ ☾ ♀ 0.3° N.		32014	235.25
		17		☌ ☿ ☾ ☿ 2° N.			

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.

[l]Dec. 13, −7.59°; Dec. 26, +7.80°. [b]Dec. 12, +6.81°; Dec. 25, −6.82°.

JANUARY

d	h	m	Sat.	Phen.
1	19	14	II	OD
	21	45	II	OR
	22	02	II	ED
2	21	26	I	TI
	22	47	I	SI
3	18	43	I	OD
	19	19	II	Se
	22	16	I	ER
4	18	07	I	Te
	19	26	I	Se
6	18	52	III	TI
	21	36	III	Te
8	21	54	II	OD
10	19	20	II	Te
	19	32	II	SI
	20	40	I	OD
	21	55	II	Se
11	17	52	I	TI
	19	12	I	SI
	20	04	I	Te
	21	22	I	Se
12	18	40	I	ER
17	18	37	III	ED
	19	31	II	TI
	21	04	III	ER
	22	00	II	Te
	22	08	II	SI
18	19	49	I	TI
	21	08	I	SI
	22	02	I	Te
19	19	05	II	ER
	20	35	I	ER
24	20	08	III	OR
25	21	48	I	TI
26	19	04	I	OD
	19	14	II	OR
	19	18	II	ED
	21	44	II	ER
27	18	30	I	Te
	19	43	I	Se
31	21	37	III	OD

FEBRUARY

d	h	m	Sat.	Phen.
2	19	28	II	OD
	21	03	I	OD
3	18	18	I	TI
	19	29	I	SI
	20	30	I	Te
	21	40	I	Se
4	18	55	I	ER
	19	00	III	Se
	19	01	II	Se
10	20	18	I	TI
	21	25	I	SI
11	18	47	III	Te
	19	14	II	SI
	19	30	II	Te
	20	41	III	SI
	20	50	I	ER
18	19	33	I	OD
	19	48	II	TI
	20	27	III	TI
19	19	01	I	Te
	20	01	I	Se
20	19	01	II	ER
26	18	50	I	TI
	19	46	I	SI
27	19	09	I	ER
29	18	51	III	ED

MARCH

d	h	m	Sat.	Phen.
7	19	37	III	OD
13	19	37	I	Te
18	19	12	III	Se

Jupiter being near the sun, phenomena of the satellites are not given between Mar. 21 and June 14.

JULY

d	h	m	Sat.	Phen.
5	2	52	I	Se
8	2	09	III	OR
10	1	54	II	SI
12	1	43	II	OR
	2	37	I	SI
13	3	08	I	OR
15	1	28	III	ER
19	1	54	II	ER
	2	01	II	OD
20	1	39	I	ED
21	1	08	I	Se
	2	23	I	Te
22	3	17	III	ED
26	0	39	III	Te
	2	05	II	ED
27	3	33	I	ED
28	0	53	I	SI
	1	31	II	Te
	2	11	I	TI
	3	01	I	Se
29	1	33	I	OR

AUGUST

d	h	m	Sat.	Phen.
2	2	49	III	TI
4	1	27	II	Se
	1	49	II	TI
	2	47	I	SI
5	3	29	I	OR
6	0	43	I	Te
9	1	16	III	SI
	3	25	III	Se
11	1	41	II	SI
12	1	50	I	ED
13	0	30	I	TI
	1	17	I	Se
	1	38	II	OR
	2	37	I	Te
	23	53	I	OR
19	3	44	I	ED
20	1	02	I	SI
	1	04	III	OD
	1	29	II	ER
	1	50	II	OD
	2	24	I	TI
	2	59	III	OR
	3	11	I	Se
21	1	47	I	OR
26	23	20	III	ED
27	1	31	III	ER
	1	39	II	ED
	2	56	I	SI
	4	03	II	ER
	4	16	I	TI
28	0	07	I	ED
	3	40	I	OR
	22	44	I	TI
	23	01	II	TI
	23	32	I	Se
29	0	51	I	Te
	1	21	II	Te

SEPTEMBER

d	h	m	Sat.	Phen.
3	3	20	III	ED
	4	13	II	ED
4	2	01	I	ED
	22	51	II	SI
	23	18	I	SI
5	0	36	I	TI
	1	15	II	Se
	1	26	I	Se
	1	33	II	TI
5	2	43	I	Te
	3	53	II	Te
	23	59	I	OR
6	22	27	II	OR
	22	43	III	TI
7	0	31	III	Te
11	3	56	I	ED
12	1	11	I	SI
	1	28	II	SI
	2	26	I	TI
	3	20	I	Se
	3	52	II	Se
	4	03	II	TI
	4	33	I	Te
	22	24	I	ED
13	1	50	I	OR
	21	48	I	Se
	22	29	II	ER
	22	33	II	OD
	23	00	I	Te
	23	26	III	Se
14	0	54	II	OR
	2	28	III	TI
	4	14	III	Te
19	3	05	I	SI
	4	05	II	SI
	4	15	I	TI
20	0	19	I	ED
	3	39	I	OR
	21	33	I	SI
	22	39	II	ED
	22	42	I	TI
	23	42	I	Se
21	0	49	I	Te
	1	17	III	SI
	3	18	II	OR
	3	25	III	Se
	22	06	I	OR
22	22	03	II	Te
24	21	49	III	OR
27	2	13	I	ED
	23	27	I	SI
28	0	30	I	TI
	1	13	II	ED
	1	35	I	Se
	2	37	I	Te
	20	42	I	ED
	23	54	I	OR
29	21	03	I	Te
	22	07	II	TI
	22	25	II	Se
30	0	27	II	Te

OCTOBER

d	h	m	Sat.	Phen.
1	21	34	III	ER
	23	37	III	OD
2	1	21	III	OR
4	4	07	I	ED
5	1	20	I	SI
	2	16	I	TI
	3	29	I	Se
	3	47	II	ED
	4	23	I	Te
	22	36	I	ED
6	1	41	I	OR
	20	43	I	TI
	21	58	I	Se
	22	37	II	SI
	22	50	I	Te
7	0	29	II	TI
	1	02	II	Se
	2	49	II	Te
	20	08	I	OR
8	21	09	II	OR
	23	24	III	ED
9	1	34	III	ER
	3	05	III	OD
	4	48	III	OR
12	3	14	I	SI
	4	02	I	TI
13	0	31	I	ED
	3	27	I	OR
	21	42	I	SI
	22	28	I	TI
	23	52	I	Se
14	0	35	I	Te
	1	15	II	SI
	2	49	II	TI
	3	40	II	Se
	5	08	II	Te
	21	53	I	OR
15	19	39	II	ED
	23	26	II	OR
16	3	24	III	ED
19	5	08	I	SI
	19	26	III	Se
	20	02	III	TI
	21	43	III	Te
20	2	25	I	ED
	5	12	I	OR
	23	36	I	SI
21	0	12	I	TI
	1	46	I	Se
	2	20	I	Te
	3	52	II	SI
	5	06	II	TI
	20	54	I	ED
	23	38	I	OR
22	20	14	I	Se
	20	46	I	Te
	22	14	II	ED
23	1	41	II	OR
24	19	36	II	Se
	20	35	II	Te
26	21	18	III	SI
	23	21	III	TI
	23	28	III	Se
27	1	03	III	Te
	4	20	I	ED
28	1	30	I	SI
	1	56	I	TI
	3	40	I	Se
	4	04	I	Te
	22	49	I	ED
29	1	22	I	OR
	19	59	I	SI
	20	22	I	TI
	22	08	I	Se
	22	30	I	Te
30	0	48	II	ED
	3	55	II	OR
	19	48	I	OR
31	19	48	II	SI
	20	30	II	TI
	22	14	II	Se
	22	50	II	Te

NOVEMBER

d	h	m	Sat.	Phen.
3	1	18	III	SI
	2	36	III	TI
	3	28	III	Se
	4	20	III	Te
4	3	25	I	SI
	3	40	I	TI
	5	34	I	Se
5	0	43	I	ED
	3	06	I	OR
	21	53	I	SI
	22	05	I	TI
6	0	03	I	Se
	0	13	I	Te
	3	24	II	ED
	18	07	III	OR
	19	12	I	ED
	21	32	I	OR
7	18	31	I	Se
	18	39	I	Te
	22	25	II	SI
	22	45	II	TI
8	0	51	II	Se
	1	05	II	Te
9	19	15	II	OR
10	5	19	III	SI
	5	50	III	TI
11	5	19	I	SI
	5	23	I	TI
12	2	38	I	ED
	4	50	I	OR
	23	48	I	SI
	23	49	I	TI
13	1	57	I	Te
	1	57	I	Se
	5	59	II	ED
	19	28	III	ED
	21	07	I	OD
	21	39	III	ER
	23	17	I	ER
14	18	14	I	TI
	18	16	I	SI

d	h	m	Sat.	Phen.
14	20	23	I	Te
	20	26	I	Se
15	0	59	II	TI
	1	02	II	SI
	3	20	II	Te
	3	29	II	Se
	17	46	I	ER
16	19	08	II	OD
	21	42	II	ER
19	4	24	I	OD
20	1	32	I	TI
	1	42	I	SI
	3	40	I	Te
	3	52	I	Se
	22	49	III	OD
	22	50	I	OD
21	1	12	I	ER
	1	41	III	ER
	19	58	I	TI
	20	11	I	SI
	22	06	I	Te
	22	21	I	Se
22	3	13	II	TI
	3	40	II	SI
	19	41	I	ER
23	21	21	II	OD
24	0	18	II	ER
25	18	42	II	Te
	19	24	II	Se
27	3	16	I	TI
	3	37	I	SI
28	0	34	I	OD
	2	04	III	OD
	3	08	I	ER
	21	42	I	TI
	22	06	I	SI
	23	50	I	Te
29	0	15	I	Se
	19	01	I	OD
	21	36	I	ER
30	18	16	I	Te
	18	44	I	Se
	23	35	II	OD

DECEMBER

d	h	m	Sat.	Phen.
1	2	54	II	ER
	17	21	III	SI
	17	27	III	Te
	19	32	III	Se
2	18	36	II	TI
	19	35	II	SI
	20	58	II	Te
	22	02	II	Se
5	2	19	I	OD
	23	26	I	TI
6	0	01	I	SI
	1	35	I	Te
	2	10	I	Se
	20	45	I	OD
	23	32	I	ER
7	17	53	I	TI
	18	29	I	SI
	20	01	I	Te
	20	39	I	Se
8	1	51	II	OD
	18	00	I	ER
	18	52	III	TI
	20	49	III	Te
	21	23	III	SI
	23	34	III	Se
9	20	53	II	TI
	22	13	II	SI
	23	16	II	Te
10	0	39	II	Se
11	18	50	II	ER
13	1	12	I	TI
	1	56	I	SI
	3	21	I	Te
	22	31	I	OD
14	1	27	I	ER
	19	39	I	TI
	20	25	I	SI
	21	47	I	Te
	22	34	I	Se

d	h	m	Sat.	Phen.
15	19	56	I	ER
	22	15	III	TI
16	0	16	III	Te
	1	24	III	SI
	3	36	III	Se
	23	12	II	TI
17	0	50	II	SI
	1	35	II	Te
	3	16	II	Se
18	21	26	II	ER
19	17	46	III	ER
20	2	59	I	TI
21	0	18	I	OD
	21	26	I	TI
	22	20	I	SI
	23	34	I	Te
22	0	29	I	Se
	18	46	I	OD
	21	51	I	ER
23	1	41	III	TI
	18	01	I	Te
	18	58	I	Se
24	1	33	II	TI
25	19	39	II	OD
26	0	04	II	ER
	17	43	III	OR
	19	35	III	ED
	21	49	III	ER
27	19	12	II	Se
28	2	06	I	OD
	23	14	I	TI
29	0	15	I	SI
	1	23	I	Te
	2	25	I	Se
	20	33	I	OD
	23	46	I	ER
30	17	41	I	TI
	18	44	I	SI
	19	50	I	Te
	20	53	I	Se
31	18	15	I	ER

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 west side from June to October and disappearances of satellites II and III in November; all others are on the east side. No eclipses of satellite IV are visible this year.

THE OBSERVATION OF THE MOON

During 1964 the ascending node of the moon's orbit moves from the constellation Cancer into Gemini (☊ from 101° to 82°). See p. 62 for occultations of the planets and 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.)

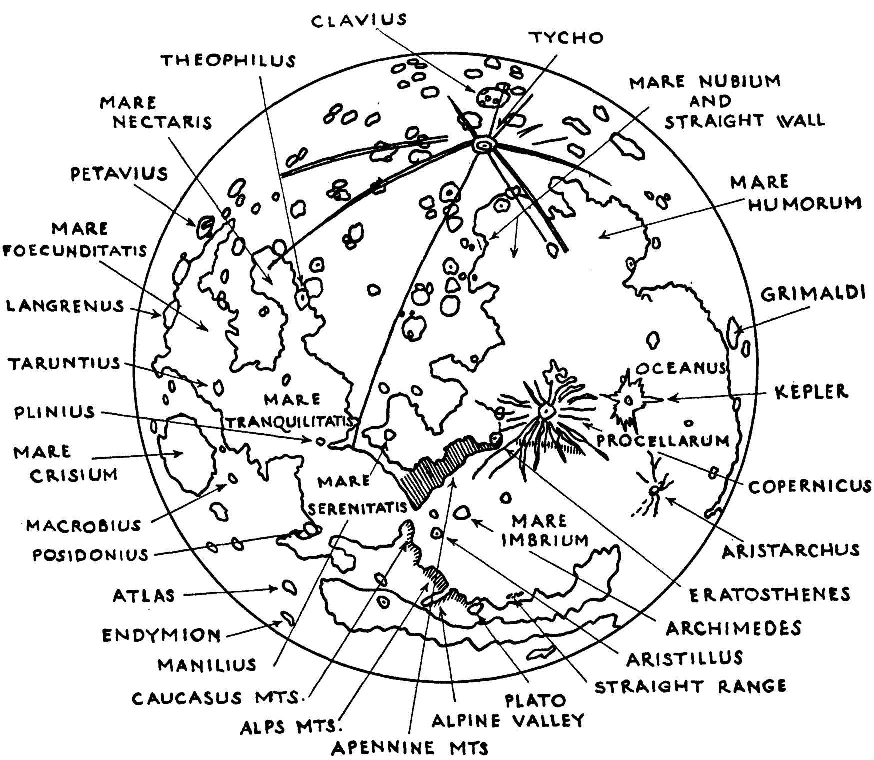
Sunrise will occur at a given point *east* of the central meridian of the moon when the sun's selenographic colongitude is equal to the eastern selenographic longitude of the point; at a point *west* of the central meridian when the sun's selenographic colongitude is equal to 360° minus the western selenographic 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].

MAP OF THE MOON



South appears at the top.

LONGITUDE OF JUPITER'S CENTRAL MERIDIAN

By Geoffrey Gaherty, Jr.

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. 22^h	Aug. 5^h	Sept. 3^h	Oct. 0^h	Nov. 22^h	Dec. 22^h	Jan. 22^h	Aug. 5^h	Sept. 3^h	Oct. 0^h	Nov. 22^h	Dec. 22^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	107.9	316.3	97.6	46.8	350.4	51.0	328.1	356.7	262.1	343.3	43.5	235.2
2	265.6	114.2	255.5	204.8	148.5	209.0	118.2	146.9	52.4	133.7	193.9	25.5
3	63.4	272.0	53.4	2.8	306.5	7.0	268.3	297.1	202.7	284.0	344.3	175.9
4	221.1	69.9	211.4	160.8	104.5	165.0	58.4	87.4	353.0	74.4	134.7	326.2
5	18.8	227.7	9.3	318.8	262.6	322.9	208.5	237.6	143.3	224.8	285.1	116.5
6	176.5	25.6	167.2	116.8	60.6	120.9	358.6	27.8	293.6	15.2	75.5	266.9
7	334.2	183.4	325.2	274.8	218.7	278.8	148.7	178.0	83.9	165.5	225.9	57.2
8	131.9	341.3	123.1	72.8	16.7	76.8	298.8	328.3	234.2	315.9	16.3	207.5
9	289.7	139.2	281.1	230.9	174.7	234.8	88.8	118.5	24.5	106.3	166.7	357.8
10	87.4	297.0	79.0	28.9	332.8	32.7	238.9	268.7	174.9	256.7	317.1	148.2
11	245.1	94.9	237.0	186.9	130.8	190.6	29.0	59.0	325.2	47.1	107.5	298.5
12	42.8	252.8	34.9	344.9	288.8	348.6	179.1	209.2	115.5	197.5	257.9	88.8
13	200.5	50.7	192.9	142.9	86.9	146.5	329.1	359.5	265.8	347.9	48.4	239.1
14	358.2	208.5	350.8	301.0	244.9	304.4	119.2	149.7	56.2	138.3	198.8	29.4
15	155.9	6.4	148.8	99.0	42.9	102.4	269.3	300.0	206.5	288.7	349.2	179.7
16	313.6	164.3	306.8	257.0	201.0	260.3	59.3	90.2	356.8	79.1	139.6	330.0
17	111.2	322.2	104.7	55.0	359.0	58.2	209.4	240.5	147.1	229.5	289.9	120.3
18	268.9	120.1	262.7	213.1	157.0	216.1	359.5	30.7	297.5	19.8	80.3	270.5
19	66.6	278.0	60.7	11.1	315.0	14.0	149.5	181.0	87.8	170.3	230.7	60.8
20	224.3	75.9	218.6	169.1	113.1	171.9	299.6	331.2	238.2	320.7	21.1	211.1
21	22.0	233.8	16.6	327.2	271.1	329.8	89.6	121.5	28.5	111.1	171.5	1.4
22	179.7	31.7	174.6	125.2	69.1	127.7	239.7	271.8	178.9	261.5	321.9	151.6
23	337.4	189.6	332.6	283.2	227.1	285.6	29.7	62.1	329.2	51.9	112.3	301.9
24	135.0	347.5	130.5	81.3	25.1	83.5	179.8	212.3	119.6	202.3	262.6	92.2
25	292.7	145.4	288.5	239.3	183.1	241.4	329.8	2.6	269.9	352.7	53.0	242.4
26	90.4	303.3	86.5	37.3	341.1	39.3	119.9	152.9	60.3	143.1	203.4	32.7
27	248.1	101.2	244.5	195.4	139.1	197.1	269.9	303.2	210.6	293.5	353.7	182.9
28	45.7	259.1	42.5	353.4	297.1	355.0	60.0	93.4	1.0	83.9	144.1	333.2
29	203.4	57.0	200.5	151.5	95.1	152.9	210.0	243.7	151.4	234.3	294.5	123.4
30	1.1	214.9	358.5	309.5	253.1	310.7	0.0	34.0	301.7	24.7	84.8	273.6
31	158.7	12.9		107.5		108.6	150.1	184.3		175.1		63.8

Nov. 1, 0^h U.T.: System I: 265.6°; System II: 325.5°.

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1964
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.97	−2.98	38.91	July 4	− 1.31	+3.26	117.23
6	+ 0.05	−3.56	333.06	9	+ 0.96	+3.79	51.05
11	− 2.37	−4.10	267.22	14	+ 3.21	+4.29	344.88
16	− 4.74	−4.62	201.38	19	+ 5.42	+4.76	278.72
21	− 7.06	−5.09	135.54	24	+ 7.57	+5.20	212.57
26	− 9.29	−5.53	69.71	29	+ 9.65	+5.60	146.43
31	−11.43	−5.92	3.88	Aug. 3	+11.65	+5.96	80.30
				8	+13.56	+6.29	14.19
Feb. 5	−13.46	−6.27	298.04	13	+15.37	+6.57	308.08
10	−15.37	−6.57	232.21	18	+17.06	+6.80	242.00
15	−17.15	−6.81	166.38	23	+18.63	+6.99	175.92
20	−18.78	−7.01	100.54	28	+20.07	+7.13	109.85
25	−20.28	−7.14	34.69	Sept. 2	+21.39	+7.21	43.80
Mar. 1	−21.61	−7.22	328.82	7	+22.56	+7.25	337.77
6	−22.79	−7.25	262.95	12	+23.58	+7.23	271.75
11	−23.81	−7.22	197.07	17	+24.46	+7.16	205.74
16	−24.67	−7.14	131.17	22	+25.17	+7.04	139.73
21	−25.35	−7.00	65.26	27	+25.72	+6.87	73.74
26	−25.86	−6.81	359.33	Oct. 2	+26.11	+6.64	7.76
31	−26.19	−6.57	293.38	7	+26.31	+6.37	301.79
Apr. 5	−26.34	−6.28	227.40	12	+26.34	+6.05	235.83
10	−26.31	−5.94	161.42	17	+26.18	+5.68	169.88
15	−26.10	−5.56	95.41	22	+25.83	+5.27	103.93
20	−25.71	−5.15	29.38	27	+25.29	+4.81	37.99
25	−25.13	−4.70	323.32	Nov. 1	+24.55	+4.32	332.06
30	−24.36	−4.21	257.25	6	+23.61	+3.80	266.13
May 5	−23.42	−3.70	191.16	11	+22.48	+3.24	200.21
10	−22.30	−3.16	125.06	16	+21.16	+2.66	134.30
15	−21.01	−2.60	58.94	21	+19.65	+2.06	68.39
20	−19.55	−2.02	352.80	26	+17.96	+1.44	2.48
25	−17.94	−1.44	286.65	Dec. 1	+16.11	+0.81	296.59
30	−16.19	−0.84	220.49	6	+14.10	+0.17	230.70
June 4	−14.31	−0.24	154.32	11	+11.97	−0.47	164.82
9	−12.32	+0.37	88.14	16	+ 9.73	−1.11	98.94
14	−10.23	+0.97	21.96	21	+ 7.41	−1.74	33.07
19	− 8.06	+1.56	315.78	26	+ 5.02	−2.35	327.21
24	− 5.84	+2.14	249.59	31	+ 2.60	−2.95	261.35
29	− 3.59	+2.71	183.41				

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, 1964

No.	Commences	No.	Commences	No.	Commences
1476	Jan. 3.95	1481	May 19.46	1486	Oct. 2.59
1477	Jan. 31.29	1482	June 15.66	1487	Oct. 29.88
1478	Feb. 27.63	1483	July 12.86	1488	Nov. 26.19
1479	Mar. 25.95	1484	Aug. 9.07	1489	Dec. 23.51
1480	Apr. 22.22	1485	Sept. 5.32		

ECLIPSES DURING 1964

In 1964 there will be six eclipses, four of the sun and two of the moon. Of these, three will be visible in parts of Canada: a total eclipse of the moon on the night of June 24 of which the end will be visible over most of Canada: a partial eclipse of the sun on July 9, visible in north central Canada; and a total eclipse of the moon on the night of December 19, visible over all of Canada.

1. *A Partial Eclipse of the Sun* on January 14, visible in Antarctica and in the southern tip of South America.

2. *A Partial Eclipse of the Sun* on June 9 (E.S.T.) visible in Australia.

3. *A Total Eclipse of the Moon* on June 24. The beginning is invisible in North America, but the end is visible generally in North America except for the north-western part where the moon will not yet have risen when the eclipse is ended.

Moon enters umbra	18h 10m E.S.T.
Total eclipse begins	19h 16m E.S.T.
Middle of Eclipse	20h 07m E.S.T.
Total eclipse ends	20h 58m E.S.T.
Moon leaves umbra	22h 04m E.S.T.

4. *A Partial Eclipse of the Sun* on July 9. It will be visible just about at sunrise over the northern parts of Alberta, Saskatchewan and Manitoba.

5. *A Partial Eclipse of the Sun* on December 3. It will be visible in north-eastern Asia and over much of the Pacific Ocean, but in North America only in south-western Alaska just before sunset.

6. *A Total Eclipse of the Moon* on December 18. The whole eclipse will be visible in both North and South America.

Moon enters umbra	20h 00m E.S.T.
Total eclipse begins	21h 08m E.S.T.
Middle of Eclipse	21h 38m E.S.T.
Total eclipse ends	22h 08m E.S.T.
Moon leaves umbra	23h 16m E.S.T.

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, 1964

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 1	η Cnc	5.5	E	16.2	4 14.3	−1.5	−0.7	264	2 57.0	−1.9	0.0	255
Jan. 19	24B. Cet	6.0	I	5.1	19 54.1	—	—	128	18 32.5	−1.8	−1.8	104
Jan. 25	312B. Tau	6.2	I	10.4	2 38.7	+0.3	−2.6	132	1 39.1	+0.3	−3.5	141
Jan. 25	ζ Tau	3.0	E	11.1	17 52.1	−0.5	+1.9	242	Sun	...	...	...
Feb. 1	ν Vir	4.2	I	17.4	2 35.3	−2.1	+0.4	89	1 16.6	−1.7	+0.5	99
Feb. 1	ν Vir	4.2	E	17.4	3 43.3	−0.9	−2.3	334	2 30.9	−1.2	−1.5	321
Feb. 18	421B. Cet	6.8	I	5.6	Low	...	...	...	22 19.3	−0.4	+1.0	23
Feb. 22	ζ Tau	3.0	I	8.7	2 05.0	+0.8	−2.9	146	1 11.9	—	—	164
Feb. 22	ζ Tau	3.0	E	8.7	Low	...	...	...	1 26.0	—	—	194
Feb. 22	μ Gem	3.2	E	9.4	18 59.1	−1.7	+0.5	275	17 43.6	−1.5	+0.4	286
Feb. 22	+22° 1352	6.8	I	9.5	21 48.2	−1.7	−0.8	95	20 30.4	−1.8	−0.3	94
Feb. 23	+22° 1687	6.9	I	10.5	No Occ.	...	...	...	18 20.6	−2.0	−2.3	150
Feb. 23/24	+22° 1735	6.9	I	10.6	0 54.6	−2.0	+1.1	42	23 36.3	−1.9	+0.5	55
Feb. 24	η Cnc	5.5	I	11.6	22 03.1	−1.4	−3.2	154	20 45.8	−1.5	−2.9	154
Feb' 25	39 Cnc	6.5	I	11.7	2 02.0	−0.5	−2.2	132	0 54.9	−0.5	−2.6	143
Feb. 25	40 Cnc	6.5	I	11.7	2 07.6	−0.3	−2.4	139	1 01.8	−0.3	−2.9	151
Mar. 17	+13° 535	7.4	I	4.0	Low	...	...	...	21 08.9	0.0	−1.7	101
Mar. 18	+17° 703	7.5	I	5.0	Low	...	...	...	22 17.3	−0.2	−0.5	60
Mar. 20	η Gem f.	3.2	I	7.0	21 37.4	−1.0	−1.7	105	20 24.7	−1.3	−1.7	109
Mar. 20	η Gem f.	3.2	E	7.0	22 43.1	−0.8	−1.0	259	21 32.7	−1.1	−0.6	252
Mar. 21	μ Gem	3.2	I	7.1	1 07.5	+0.1	−1.0	80	0 06.4	−0.1	−1.2	88
Mar. 22	+22° 1687	6.9	I	8.2	Low	...	...	...	1 51.1	+0.4	−1.7	126
Mar. 23	+19° 2187	6.9	I	10.0	23 32.3	—	—	32	22 01.8	−2.6	+1.4	57
Mar. 23	+19° 2187	6.9	E	10.0	23 44.0	—	—	13				
Mar. 24	+15° 2167	7.2	I	11.0	21 07.2	−1.5	−1.2	133	19 52.1	−1.3	−1.0	137
Mar. 26	ν Vir	4.2	I	12.9	18 59.0	−0.5	+1.1	99	Sun	...	...	...
Apr. 5	208B. Sgr	6.2	E	22.3	4 04.2	−1.7	+1.5	251	Low	...	...	...
Apr. 14	150B. Tau	6.9	I	2.5	Low	...	...	...	20 23.1	+0.5	−3.0	135
Apr. 16	141 Tau	6.3	I	4.6	22 55.6	+0.1	−1.2	92	21 55.0	0.0	−1.5	99
Apr. 17	44 Gem	5.9	I	5.6	23 39.5	+0.5	−2.1	136	22 42.1	+0.5	−2.6	147
Apr. 18	7 Cnc	6.8	I	6.6	22 44.5	−1.4	+0.1	50	21 30.7	−1.4	−0.4	64
Apr. 18/19	μ Cnc	5.4	I	6.6	0 22.3	+0.1	−1.6	110	23 21.2	0.0	−1.8	118
Apr. 21/22	228B. Leo	6.8	I	9.6	0 12.9	−1.1	−1.5	101	23 00.1	−1.2	−1.6	112
Apr. 29	ψ Oph	4.6	E	16.8	3 40.0	−1.7	−1.7	316	2 22.2	−1.7	−1.1	312
May 14	+23° 1425	6.8	I	3.1	20 24.4	−0.3	−1.2	88	Sun	...	...	...
May 15	192B. Gem	6.3	I	4.2	21 42.8	+0.1	−1.8	121	20 41.3	0.0	−2.1	131
May 16	109B. Cnc m.	6.6	I	5.1	20 40.7	+0.3	−3.6	166	No Occ.	...	...	...
May 16	125B. Cnc	6.9	I	5.2	No Occ.	...	...	...	21 43.3	−1.4	+0.2	45
May 18	78H[1] Leo	7.5	I	7.2	23 13.4	−0.4	−1.9	121	22 06.7	−0.6	−2.1	131
May 20	39B. Vir	6.8	I	9.2					20 06.0	—	—	44
May 20	39B. Vir	6.8	E	9.2					20 20.6	—	—	24
May 22/23	186G. Vir	6.9	I	11.3	0 36.4	−1.8	−0.9	76	23 16.5	−2.0	−0.8	87
May 22/23	88 Vir	6.6	I	11.3	1 13.4	−1.4	−1.2	80	23 56.9	−1.7	−1.1	88
June 13	+18° 2182 m.	7.1	I	3.9	Low	...	...	...	21 53.4	+0.4	−1.9	142
June 18/19	80 Vir	5.8	I	9.0	0 28.2	−0.7	−1.2	71	23 17.6	−1.2	−1.2	74
June 19/20	−9° 3915	7.4	I	10.0	0 59.1	−0.7	−1.9	117	23 48.6	−1.0	−1.9	118
June 30	τ Aqr	4.2	I	20.2	Sun	...	...	...	3 06.5	−1.8	+0.9	74
July 10	Mercury	0.7	I	1.0	No Occ.	...	...	...	5 48.1	−0.6	−1.3	158
July 10	Mercury	0.7	E	1.0	No Occ.	...	...	...	6 09.9	+1.4	+3.9	204
July 12	228B. Leo	6.8	I	3.6	Low	...	...	...	20 47.7	0.0	−1.8	123
July 16	94 Vir	6.6	I	7.6	Low	...	...	...	22 34.0	−0.7	−1.9	119
July 17	22B. Lib	6.4	I	8.5	20 37.4	−1.8	−1.2	110	Sun	...	...	...
July 19	ψ Oph	4.6	I	10.6	21 16.8	+2.5	+0.3	67	19 52.7	−2.3	+0.7	77
July 25	ε Cap	4.7	I	16.7	22 26.2	—	—	153				
July 25	ε Cap	4.7	E	16.7	22 42.7	—	—	178				
July 26	κ Cap	4.8	E	16.8	3 00.3	−0.9	+0.7	214	1 49.0	−1.4	+0.6	229
July 29	24B. Cet	6.0	E	19.8	2 34.7	−2.0	+0.7	271	1 15.7	−1.9	+0.7	287
Aug. 1	85 Cet	6.3	E	22.8	3 07.0	−0.8	+1.8	238	2 01.4	−0.6	+1.7	250
Aug. 2	30B. Tau	6.5	E	23.9	3 13.2	−0.4	+2.0	231	2 11.4	−0.3	+1.8	243

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	°
Aug. 4	+21° 918	6.3	E	25.9	3 26.6	—	—	179	2 38.9	+0.6	+2.4	205
Aug. 28	389B. Cet	6.3	E	20.5	No Occ.	...	...	...	1 38.5	−0.1	+3.0	188
Aug. 30	85H^1 Tau	6.0	E	22.5	3 17.6	−0.9	+1.8	240	2 10.7	−0.8	+1.6	255
Sept. 1	35B. Gem	6.0	E	24.6	Sun	...	...	...	3 40.2	−0.8	+1.1	275
Sept. 2	58 Gem	6.0	E	25.5	2 35.3	+0.4	+1.8	237	Low	...	...	...
Sept. 14	70B. Sgr	6.4	I	8.8	20 45.3	−2.3	−2.3	142	19 22.2	−2.1	−1.3	135
Sept. 16	−24° 15814	7.5	I	10.9	21 03.1	—	—	141	19 37.1	−2.2	−0.6	130
Sept. 25	147B. Ari	5.8	E	19.1	No Occ.	...	...	...	0 01.8	+0.5	+3.7	180
Sept. 27	330B. Tau	6.3	E	21.1	2 35.4	−0.8	+2.2	227	1 29.2	−0.8	+1.8	242
Sept. 27	105 Tau	6.0	E	21.2	4 45.4	−1.8	+0.4	262	3 28.1	−1.7	+0.4	273
Sept. 27/28	1 Gem	4.3	I	22.1	0 52.1	−0.1	+1.9	60	23 54.8	+0.3	+2.0	47
Sept. 28	1 Gem	4.3	E	22.1	1 50.7	−0.8	+1.2	274	0 44.2	−0.7	+0.9	289
Oct. 15	ε Cap	4.7	I	10.5	No Occ.	...	...	...	23 07.6	—	—	139
Oct. 18	30 Psc	4.7	I	13.4	20 23.1	−0.8	+2.1	24	19 18.3	−0.5	+2.6	11
Oct. 18	33 Psc	4.7	I	13.4	22 23.8	−1.7	+0.6	69	21 09.3	−1.4	+1.3	54
Oct. 24	175H^1 Tau	6.5	E	19.5	23 08.4	+0.1	+2.4	216	22 11.2	+0.1	+2.0	231
Oct. 26	82 Gem	6.2	E	21.5	23 37.4	0.0	+1.2	273	Low	...	...	...
Nov. 11	χ Cap	5.3	I	7.6	18 01.6	—	—	14	17 02.7	—	—	347
Nov. 11	χ Cap	5.3	E	7.6					17 11.1	—	—	336
Nov. 12	161B. Cap	6.4	I	8.7	20 02.9	−2.8	−1.7	114	18 37.8	−2.2	−0.2	95
Nov. 13	τ Aqr	4.2	I	9.7	18 54.8	−1.2	+1.5	33	17 45.6	−0.9	+2.1	18
Nov. 14	252G Aqr	6.8	I	10.7	19 03.5	—	—	359	No Occ.	...	...	...
Nov. 15	64B. Cet	7.0	I	11.7	20 35.0	+0.1	+3.1	358	No Occ.	...	...	...
Nov. 20	109 Tau	5.1	E	16.9	23 43.6	—	—	182	22 46.3	−0.4	+3.0	208
Nov. 21	9 Gem	6.3	E	17.8	20 46.6	−0.2	+1.0	283	19 45.4	−0.2	+0.7	297
Nov. 24	γ Cnc	4.7	E	20.1	5 07.6	−1.9	0.0	265	3 48.9	−1.9	+0.7	260
Nov. 26	46 Leo	5.7	E	22.0	2 02.1	−0.7	+1.2	277	0 57.8	−0.4	+1.0	283
Dec. 12	24B. Cet	6.0	I	9.0	20 13.4	−1.6	+0.1	68	18 58.9	−1.4	+0.9	51
Dec. 14	26 Cet	6.2	I	10.1	0 17.3	—	—	351	No Occ.	...	...	...
Dec. 15	421B. Cet	6.8	I	11.9	No Occ.	...	...	...	16 56.4	−1.4	+0.5	122
Dec. 18*	408B. Tau	7.0	I	15.1	22 21.2	−1.5	+0.7	91	21 09.7	−1.0	+1.3	78
Dec. 18*	408B. Tau	7.0	E	15.1	23 31.6	−1.5	+1.2	245	22 18.4	−1.4	+1.1	256
Dec. 19/20	ω Gem	5.2	E	16.1	0 54.4	−1.7	0.0	274	23 38.0	−1.6	+0.2	280
Dec. 23	42 Leo	6.1	E	19.3	6 37.4	−0.8	−2.1	318	5 25.8	−1.2	−1.6	306
Dec. 27	80 Vir	5.8	E	23.3	2 49.5	−0.4	+0.3	305	Low	...	...	...
Dec. 30	β Sco	2.9	I	26.5	Sun	...	...	...	6 23.6	+0.3	−1.6	170

*Lunar eclipse.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1964

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. 1	η Cnc	5.5	E	16.2	2 44.1	−2.2	+1.2	242	1 17.8	−1.6	+1.1	255
Jan. 17	56 Aqr	6.4	I	3.1	Low	...	...	...	17 59.6	−1.0	−0.9	76
Jan. 18	−10° 6098	7.5	I	4.1	19 48.2	−0.5	−0.3	58	18 41.9	−0.2	+1.1	18
Jan. 19	24B. Cet	6.0	I	5.1	18 24.1	−2.1	−1.4	100	Sun	...	...	...
Jan. 24	+18° 684	7.1	I	10.2	No Occ.	...	...	...	17 50.6	−1.9	−0.4	131
Jan. 25	312B. Tau	6.2	I	10.4	No Occ.	...	...	...	0 18.5	−0.6	−4.2	141
Jan.31/Feb. 1	ν Vir	4.2	I	17.4	1 06.9	−1.5	+0.2	111	23 50.6	−0.8	+1.1	102
Feb. 1	ν Vir	4.2	E	17.4	2 25.3	−1.5	−1.0	309	0 59.5	−1.0	−0.2	310
Feb. 15	70B. Psc	6.8	I	2.5	Low	...	...	...	19 04.3	−0.3	0.0	42
Feb. 18	421B. Cet	6.8	I	5.6	22 15.4	−0.5	+0.6	34	21 14.3	—	—	3
Feb. 18	434B. Cet	6.7	I	5.6	Low	...	...	...	22 11.9	−0.4	−1.5	89
Feb. 18	85 Cet	6.3	I	5.6	Low	...	...	...	22 30.8	−0.3	−0.5	57
Feb. 19	30B. Tau	6.5	I	6.6	23 53.5	−0.3	0.0	45	22 45.8	−0.7	+0.6	32
Feb. 22	+22° 1352	6.8	I	9.5	20 20.2	−1.9	−0.2	99	18 56.7	−1.2	+1.5	70
Feb. 23	+22° 1735	6.9	I	10.6	23 25.0	−1.9	+0.1	69	21 57.0	−1.7	+1.5	57
Feb. 24	η Cnc	5.5	I	11.6	20 43.3	—	—	167	19 07.9	−1.0	+0.1	126
Feb. 24/25	39 Cnc	6.5	I	11.7	0 57.8	−0.3	−3.5	159	23 25.7	−0.8	−3.5	159
Feb. 24/25	40 Cnc	6.5	I	11.7	1 07.5	—	—	170	23 37.0	—	—	172
Mar. 17	+13° 535	7.4	I	4.0	21 11.8	−0.1	−2.1	111	19 52.1	−0.7	−1.5	93
Mar. 18	+17° 703	7.5	I	5.0	22 16.9	−0.3	−0.7	70	21 03.0	−0.8	−0.5	61
Mar. 18	+18° 629	6.7	I	5.1	Low	...	...	...	22 37.4	−0.3	−0.6	59
Mar. 20	η Gem f.	3.2	I	7.0	20 20.1	−1.5	−2.0	119	18 43.8	−1.6	−0.3	98
Mar. 20	η Gem f.	3.2	E	7.0	21 25.7	−1.5	0.0	241	19 58.7	−1.5	0.0	254

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	Toronto a	Toronto b	Toronto P	Winnipeg C.S.T.	Winnipeg a	Winnipeg b	Winnipeg P
				d	h m	m	m	°	h m	m	m	°
Mar. 20/21	μ Gem	3.2	I	7.1	0 08.3	−0.1	−1.4	99	22 52.2	−0.6	−1.6	100
Mar. 20/21	μ Gem	3.2	E	7.1	1 03.6	+0.1	−1.2	270	23 53.6	−0.4	−1.3	266
Mar. 22	+22° 1687	6.9	I	8.2	1 57.2	+0.5	−2.0	136	0 49.0	+0.2	−2.5	143
Mar. 23	η Cnc	5.5	I	9.3	Low	...	...	...	3 11.8	+0.1	−1.4	92
Mar. 23	+19° 2187	6.9	I	10.0	21 46.1	−2.3	+0.6	74	20 18.4	−1.7	+2.0	63
Mar. 24	+18° 2182 m.	7.1	I	10.2	No Occ.	...	...	...	1 07.9	−1.8	+0.1	51
Mar. 24	+18° 2207	7.5	I	10.3	Low	...	...	...	3 31.7	−0.4	−1.0	62
Mar. 24	+15° 2167	7.2	I	11.0	19 46.8	−1.3	−1.5	147	Sun	...	...	...
Apr. 16	141 Tau	6.3	I	4.6	21 57.7	0.0	−1.7	110	20 41.3	−0.5	−1.9	110
Apr. 17	44 Gem	5.9	I	5.6	22 52.2	—	—	167	21 43.8	—	—	183
Apr. 17	44 Gem	5.9	E	5.6					21 49.9	—	—	192
Apr. 18	7 Cnc	6.8	I	6.6	21 23.6	−1.4	−0.7	78	Sun	...	...	...
Apr. 18	μ Cnc	5.4	I	6.6	23 24.6	−0.0	−2.0	129	22 07.0	−0.4	−2.4	135
Apr. 21	+15° 2167	7.2	I	8.8	Low	...	...	...	1 55.0	−0.3	−1.4	80
Apr. 21	228B. Leo	6.8	I	9.6	22 56.1	−1.2	−1.8	124	21 23.9	−1.2	−1.4	133
Apr. 29	ψ Oph	4.6	E	16.8	2 13.9	−1.8	−0.8	304	0 45.6	−1.3	+0.3	294
May 13	+21° 918	6.3	I	2.2	Low	...	...	...	21 10.1	+0.6	−2.2	135
May 14	69B. Gem	6.8	I	3.2	Low	...	...	...	21 30.0	+0.3	−2.0	129
May 15	192B. Gem	6.3	I	4.2	20 45.6	+0.1	−2.6	144	Sun	...	...	...
May 15	84 Gem	7.1	I	4.3	Low	...	...	...	23 21.4	−0.1	−0.7	55
May 16	125B. Cnc	6.9	I	5.2	21 36.5	−1.1	−0.5	62	Sun	...	...	...
May 16	+20° 2232	6.8	I	5.3	Low	...	...	...	23 40.5	0.0	−1.3	87
May 18	78H[1] Leo	7.5	I	7.2	22 07.4	−0.6	−2.3	141	Sun	...	...	...
May 19	376B. Leo	6.8	I	8.2	21 28.1	−2.8	+0.3	67	Sun	...	...	...
May 22	186G. Vir	6.9	I	11.3	23 06.3	−2.0	−0.8	98	21 30.6	−1.5	−0.2	111
May 22	88 Vir	6.6	I	11.3	23 48.5	−1.9	−1.1	97	22 11.6	−1.6	−0.5	110
June 12	+21° 1844	7.0	I	3.0	Low	...	...	...	21 58.3	+0.1	−1.3	89
June 13	+18° 2182 m.	7.1	I	3.9	21 59.5	+0.4	−2.2	151	Sun	...	...	...
June 18	80 Vir	5.8	I	9.0	23 12.3	−1.4	−1.2	82	21 35.9	−1.8	−0.9	92
June 19	−9° 3915	7.4	I	10.0	23 45.6	−1.2	−1.9	123	22 12.1	−1.3	−1.4	129
June 28	χ Cap	5.3	E	18.2	No Occ.	...	...	...	2 01.9	—	—	196
June 30	69 Aqr	5.8	E	20.2	No Occ.	...	...	...	1 12.4	−0.9	+2.5	195
June 30	τ Aqr	4.2	I	20.2	2 54.4	−1.7	+1.2	71	1 40.0	−1.0	+1.8	55
June 30	τ Aqr	4.2	E	20.2	Sun	...	...	...	2 54.4	−1.5	+1.1	258
July 12	228B. Leo	6.8	I	3.6	20 50.8	−0.1	−1.9	130	Sun	...	...	...
July 13	ν Vir	4.2	I	4.6					21 31.8	—	—	36
July 13	ν Vir	4.2	E	4.6					21 41.7	—	—	17
July 16	94 Vir	6.6	I	7.6	22 33.0	−0.9	−2.0	122	Sun	...	...	...
July 21	−22° 4336	7.4	I	11.8	Low	...	...	...	0 22.2	−1.3	−1.2	92
July 26	κ Cap	4.8	E	16.8	1 38.8	−1.6	+0.8	233	0 15.3	−1.5	+1.1	253
July 29	24B. Cet	6.0	E	19.8	1 03.8	−1.7	+0.7	291	Low	...	...	...
Aug. 1	85 Cet	6.3	E	22.8	1 55.0	−0.5	+1.6	253	0 58.5	−0.2	+1.4	275
Aug. 2	30B. Tau	6.5	E	23.9	2 06.9	−0.2	+1.7	245	1 15.5	0.0	+1.4	267
Aug. 4	+21° 918	6.3	E	25.9	2 38.5	+0.7	+2.2	208	Low	...	...	...
Aug. 5	+23° 1491	6.5	E	26.9	3 37.5	—	—	339	No Occ.	...	...	...
Aug. 15	ν Sco m.	4.3	I	8.3	Low	...	...	...	21 05.0	−1.7	−0.3	51
Aug. 25	30 Psc	4.7	E	17.5	4 24.0	−0.7	+1.0	209	3 07.4	−1.4	−0.1	249
Aug. 28	389B. Cet	6.3	E	20.5	1 32.4	−0.2	+2.8	194	0 40.0	−0.4	+2.0	227
Aug. 30	85H[1] Tau	6.0	E	22.5	2 03.7	−0.7	+1.5	258	1 02.0	−0.5	+1.1	290
Aug. 30	234B. Tau	6.0	E	22.6	4 21.1	−1.0	+2.0	228	3 13.4	−0.9	+1.4	264
Aug. 30	ϵ Tau	3.6	I	22.7	No Occ.	...	...	...	3 56.4	−1.3	+1.0	93
Aug. 30	ϵ Tau	3.6	E	22.7	No Occ.	...	...	...	5 00.9	+1.0	+2.0	224
Aug. 31	o Tau	4.8	E	23.6	Sun	...	...	...	4 28.6	−0.9	+1.6	253
Sept. 1	36B. Gem	6.0	E	24.6	3 33.8	−0.7	+1.1	277	2 27.0	−0.7	+0.2	318
Sept. 14	70B. Sgr	6.4	I	8.8	19 12.6	−2.0	−1.2	138	Sun	...	...	...
Sept. 16	−24° 15814	7.5	I	10.9	19 26.0	−2.0	−0.5	133	Sun	...	...	...
Sept. 19	τ Aqr	4.2	I	14.0	No Occ.	...	...	...	22 11.9	−1.7	+0.6	91
Sept. 24	147B. Ari	5.8	E	19.1	23 57.4	+0.2	+3.1	187	23 09.8	−0.2	+2.0	224
Sept. 25	162B. Tau	6.3	E	20.0	No Occ.	...	...	...	22 05.4	+0.4	+2.0	209
Sept. 27	330B. Tau	6.3	E	21.1	1 21.9	−0.6	+1.8	245	0 21.3	−0.5	+1.3	278
Sept. 27	105 Tau	6.0	E	21.2	3 17.1	−1.7	+0.6	274	No Occ.	...	...	...
Sept. 27	1 Gem	4.3	I	22.1	23 53.2	+0.4	+2.0	44	No Occ.	...	...	...
Sept. 28	1 Gem	4.3	E	22.1	0 39.1	−0.5	+0.8	292	No Occ.	...	...	...
Sept. 28	3 Gem m.	5.8	I	22.2	2 28.1	—	—	158				
Sept. 28	3 Gem m.	5.8	E	22.2	2 39.6	—	—	178	2 01.5	−0.3	+2.1	235
Oct. 15	ϵ Cap	4.7	I	10.5	22 57.6	—	—	129	21 13.5	−1.6	−0.3	82
Oct. 18	30 Psc	4.7	I	13.4	19 10.5	−0.5	+2.8	7	No Occ.	...	...	...
Oct. 18	33 Psc	4.7	I	13.4	20 58.9	−1.3	+1.6	49	19 54.0	−0.6	+2.1	22
Oct. 23	148B. Tau	6.0	E	17.7	No Occ.	...	...	...	3 46.1	−0.8	+3.3	191
Oct. 24	175H[1] Tau	6.5	E	19.5	22 08.5	+0.2	+1.8	234	21 21.4	+0.2	+1.4	262
Oct. 25	87B. Gem	5.8	E	20.6	No Occ.	...	...	...	23 51.3	+0.2	+2.3	226
Oct. 26	ω Gem	5.2	E	20.8	Sun	...	...	...	4 32.7	—	—	338
Oct. 27	9 Cnc	6.2	E	21.8	Sun	...	...	...	5 35.5	−1.7	+1.5	243

Date		Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
						E.S.T.	a	b	P	C.S.T.	a	b	P
					d	h m	m	m	°	h m	m	m	°
Oct.	31	ν Vir	4.2	I	25.8	6 16.5	−0.6	−2.2	166	4 58.6	−0.5	−0.4	147
Oct.	31	ν Vir	4.2	E	25.8	Sun				5 54.8	−0.9	+1.8	264
Nov.	11	φ Cap	5.4	I	7.8	21 10.9	−0.4	+0.3	37	No Occ.	...	...	...
Nov.	12	161B. Cap	6.4	I	8.7	18 24.9	−2.2	+0.2	90	Sun	...	...	...
Nov.	13	τ Aqr	4.2	I	9.7	17 35.8	−0.9	+2.5	14	No Occ.	...	...	...
Nov.	20	109 Tau	5.1	E	16.9	22 39.0	−0.3	+2.8	211	21 44.4	−0.4	+1.7	249
Nov.	23	82 Gem	6.2	E	19.2	Sun	...	...	...	6 17.3	−1.9	+1.1	227
Nov.	24	γ Cnc	4.7	E	20.1	3 36.1	−1.9	+1.5	251	2 17.7	−1.1	+1.0	273
Nov.	26	46 Leo	5.7	E	22.0	0 54.1	−0.2	+1.1	279	Low	...	...	...
Nov.	28	16 Vir	5.1	E	24.2	5 05.6	−0.2	−3.3	358	No Occ.	...	...	...
Dec.	5	Mercury	0.1	I	1.9	Low	...	...	...	16 29.6	−0.7	−0.2	39
Dec.	8	−22° 5572	7.5	I	4.9	18 50.8	−1.3	−1.1	84	17 25.8	−1.2	+0.1	50
Dec.	12	24B. Cet	6.0	I	9.0	18 49.0	−1.4	+1.3	46	17 44.1	−0.4	+2.3	7
Dec.	18*	408B. Tau	7.0	I	15.1	21 01.6	−0.9	+1.4	76	20 06.5	0.0	+2.3	40
Dec.	18*	408B. Tau	7.0	E	15.1	22 08.6	−1.2	+1.3	256	20 54.1	−1.1	+0.6	294
Dec.	19	ω Gem	5.2	E	16.1	23 28.3	−1.5	+0.5	277	22 04.8	−1.4	−0.4	316
Dec.	20	9 Cnc	6.2	E	17.1	No Occ.	...	...	...	21 05.2	+0.1	+2.1	237
Dec.	23	42 Leo	6.1	E	19.3	5 20.5	−1.5	−1.2	293	3 48.6	−1.4	−0.3	290

*Lunar eclipse.

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1964

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	°
Dec.31/Jan.1		η Cnc	5.5	E	16.2	0 00.9	−1.1	+1.1	268	22 45.4	−0.9	+1.6	258
Jan.	7	566B. Vir	6.5	E	22.4	No Occ.	...	...	...	2 50.6	—	—	9
Jan.	21	311B. Psc	7.1	I	7.3	20 14.6	—	—	136	19 05.4	—	—	142
Jan.	21	311B. Psc	7.1	E	7.3					19 16.6	—	—	159
Jan.	21	+6° 324	6.9	I	7.4	23 24.2	−0.4	−0.6	56	22.22.0	−0.6	−0.7	68
Jan.	24	312B. Tau	6.2	I	10.4	22 49.9	−1.3	−2.4	125	21 47.3	—	—	144
Jan.	25	333B. Tau m.	6.5	I	10.6	3 35.8	+0.4	−2.3	129	2 59.5	—	—	173
Jan.	25	333B. Tau m.	6.5	E	10.6					3 01.3	—	—	177
Jan.	26	14B. Gem	6.0	I	11.6	No Occ.	...	...	...	3 35.0	—	—	20
Jan.	31	ν Vir	4.2	I	17.4	22 45.6	−0.4	+1.6	92	Low	...	...	...
Jan.	31	ν Vir	4.2	E	17.4	23 46.3	−0.6	+0.1	314	22 39.0	−0.5	+0.6	298
Feb.	15	30 Psc	4.7	I	2.5	18 52.3	−0.8	−2.1	103	17 50.9	−1.3	−2.3	109
Feb.	18	434B. Cet	6.7	I	5.6	20 58.2	−0.7	−1.0	77	19 53.3	−1.1	−1.1	87
Feb.	18	85 Cet	6.3	I	5.6	21 21.9	−0.6	−0.1	46	20 15.0	−0.9	−0.2	58
Feb.	19	30B. Tau	6.5	I	6.6	21 36.6	−0.9	+1.6	20	20 22.2	−1.1	+1.0	37
Feb.	21	+21° 918	6.3	I	8.7	No Occ.	...	...	...	22 16.7	−1.5	+1.6	33
Feb.	22	+22° 1364	7.2	I	9.6	18 42.6	−1.8	−1.8	144	Sun	...	...	...
Feb.	23	+22° 1735	6.9	I	10.6	20 41.0	−1.2	+3.0	42	19 19.2	−1.0	+2.4	55
Feb.	24	39 Cnc	6.5	I	11.7	21 58.5	−1.1	−2.5	154	No Occ.	...	...	...
Feb.	24	40 Cnc	6.5	I	11.7	22 09.2	—	—	167	No Occ.	...	...	...
Mar.	6	116B. Oph	6.3	E	22.0	4 51.3	−0.4	−0.6	339	3 46.5	−0.7	+0.1	317
Mar.	18	+17° 703	7.5	I	5.0	19 47.5	−1.0	+0.1	53	Sun	...	...	...
Mar.	18	+18° 629	6.7	I	5.1	21 27.5	−0.6	−0.5	58	20 22.9	−0.9	−0.8	74
Mar.	20	μ Gem	3.2	I	7.1	21 33.9	−1.0	−1.5	101	20 29.9	−1.2	−2.0	119
Mar.	20	μ Gem	3.2	E	7.1	22 40.0	−0.8	−1.2	262	21 33.0	−1.3	−0.2	242
Mar.	21/22	+22° 1352	6.8	I	7.2	0 51.8	−0.2	−1.2	77	23 55.3	−0.2	−1.5	94
Mar.	21	+22° 1364	7.2	I	7.2	1 50.2	—	—	167	No Occ.	...	...	...
Mar.	21	+22° 1687	6.9	I	8.2	23 40.5	+0.1	−3.3	154	No Occ.	...	...	...
Mar.	23	η Cnc	5.5	I	9.3	2 05.6	−0.2	−1.6	100	1 10.4	−0.3	−1.9	116
Mar.	23/24	+18° 2182 m.	7.1	I	10.2	23 40.2	−1.6	−0.1	67	22 25.2	−1.6	−0.5	91
Mar.	24	+18° 2207	7.5	I	10.3	2 19.3	−0.7	−1.3	74	1 17.5	−0.8	−1.4	92
Apr.	14	162B. Tau	6.3	I	2.6	20 38.1	−0.3	−0.5	52	Sun	...	...	...
Apr.	18	μ Cnc	5.4	I	6.6	20 49.5	−0.7	−2.6	143	20 03.0	—	—	182
Apr.	18	μ Cnc	5.4	E	6.6					20 17.9	—	—	205
Apr.	20/21	+15° 2167	7.2	I	8.8	0 41.8	−0.6	−1.5	90	23 41.0	−0.8	−1.7	107
May	15	84 Gem	7.1	I	4.3	22 14.1	−0.4	−1.1	66	21 14.7	−0.4	−1.3	84
May	16	+20° 2232	6.8	I	5.3	22 32.4	−0.3	−1.6	96	21 35.6	−0.4	−1.8	112
June	26	χ Sgr	5.0	E	16.2	1 52.4	−1.5	+0.1	251	0 34.4	−1.8	+0.7	248
June	30	τ Aqr	4.2	E	20.2	1 39.0	−1.0	+1.5	268	Low	...	...	...
July	15	−30° 3462	7.1	I	6.7	22 15.7	−0.8	−1.5	78	21 12.0	−1.1	−1.5	88
July	20	−22° 4336	7.4	I	11.8	22 55.5	−1.6	−0.5	88	21 39.7	−1.8	−0.1	95

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	°
Aug. 17	−23° 13678	6.8	I	10.4	Low	...	...	...	21 13.1	−1.8	+0.5	42
Aug. 25	30 Psc	4.7	E	17.5	1 41.7	−1.8	+0.2	278	0 21.5	−1.9	+0.5	285
Aug. 25	33 Psc	4.7	E	17.6	3 53.0	−1.0	+0.1	236	2 40.3	−1.3	+0.4	239
Aug. 27	389B. Cet	6.3	E	20.5	23 41.9	−0.2	+1.8	242	22 33.6	0.0	+1.7	244
Aug. 29	$85H^1$ Tau	6.0	E	22.5	23 58.7	−0.4	+0.6	316	Low	...	...	...
Aug. 30	243B. Tau	6.0	E	22.6	2 04.3	−0.8	+1.1	290	0 53.1	−0.6	+1.0	295
Aug. 30	ε Tau	3.6	I	22.7	2 47.6	−0.5	+1.7	69	1 36.3	−0.3	+1.8	65
Aug. 30	ε Tau	3.6	E	22.7	3 52.5	−0.9	+1.6	250	2 38.1	−0.7	+1.6	253
Aug. 31	ο Tau	4.8	E	23.6	3 21.1	−0.7	+1.3	277	2 10.1	−0.5	+1.2	280
Sept. 15	χ Sgr	5.0	I	10.1	Low	...	...	...	21 58.6	−1.1	−0.4	58
Sept. 17	χ Cap	5.3	I	12.0	21 51.7	−1.8	−0.3	111	20 33.1	−1.9	+0.2	108
Sept. 19	τ Aqr	4.2	I	14.0	20 53.0	−1.1	+1.3	77	19 36.5	−1.0	+1.6	78
Sept. 24	147B. Ari	5.8	E	19.1	22 13.7	−0.1	+1.8	240	21 06.7	+0.1	+1.7	242
Sept. 26	330B. Tau	6.3	E	21.1	23 19.0	−0.3	+1.0	302	22 13.1	−0.1	+0.7	306
Sept. 27/28	3 Gem m.	5.8	E	22.2	1 04.5	−0.2	+1.6	258	23 57.6	0.0	+1.5	261
Oct. 12	127G. Sgr	6.4	I	7.4	Low	...	...	...	18 29.3	—	—	26
Oct. 15	ε Cap	4.7	I	10.5	19 50.0	−1.4	+0.6	64	18 31.8	−1.5	+1.2	62
Oct. 15	κ Cap	4.8	I	10.6	Low	...	...	...	22 21.6	−0.9	−0.2	53
Oct. 18	33 Psc	4.7	I	13.4	18 54.8	−0.3	+2.4	5	Low	...	...	...
Oct. 23	148B. Tau	6.0	E	17.7	2 38.4	−1.0	+1.4	220	1 21.5	−1.0	+1.9	218
Oct. 25	1 Gem	4.3	I	19.8	5 24.0	−1.2	−4.0	146	No Occ.	...	...	...
Oct. 25	1 Gem	4.3	E	19.8	5 59.6	−1.5	+2.8	206	No Occ.	...	...	...
Oct. 25	87B. Gem	5.8	E	20.6	23 00.6	+0.2	+1.7	250	21 56.8	+0.3	+1.5	252
Oct. 27	9 Cnc	6.2	E	21.8	4 18.2	−1.2	+1.4	256	3 00.4	−0.9	+2.0	246
Oct. 31	ν Vir	4.2	E	25.8	4 50.4	−0.4	+1.5	273	Low	...	...	...
Nov. 20	109 Tau	5.1	E	16.9	20 44.4	−0.3	+1.4	271	19 37.2	−0.1	+1.3	275
Nov. 23	82 Gem	6.2	E	19.2	4 53.0	−1.7	+1.9	225	No Occ.	...	...	...
Nov. 23/24	γ Cnc	4.7	E	20.1	1 06.1	−0.8	+0.8	291	23 55.9	−0.5	+1.0	286
Dec. 5	Mercury	0.1	I	1.9	15 22.1	—	—	10	13 58.4	—	—	22
Dec. 5	Mercury	0.1	E	1.9	15 33.3	—	—	355	14 24.9	—	—	348
Dec. 9	154B. Cap	6.1	I	6.0	19 17.9	−1.1	−0.8	73	18 07.6	−1.4	−0.3	68
Dec. 15	39B. Ari	6.6	I	11.3	1 34.8	−0.4	−0.8	65	0 32.6	−0.7	−1.0	77
Dec. 20	9 Cnc	6.2	E	17.1	20 13.7	+0.2	+1.5	261	Low	...	...	...
Dec. 23	42 Leo	6.1	E	19.3	2 28.2	−1.1	+0.3	292	1 14.6	−1.0	+1.1	276
Dec. 23	46 Leo	5.7	E	19.5	No Occ.	...	...	...	6 47.4	+0.3	−3.5	358

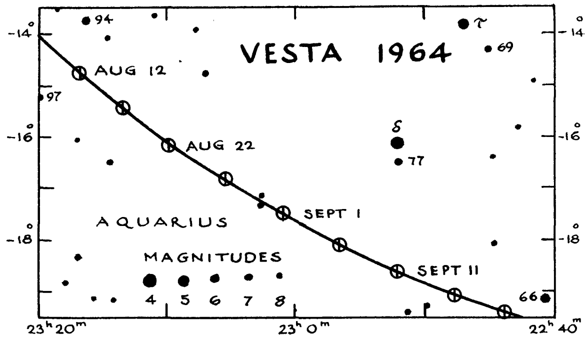
PLANETARY APPULSES AND OCCULTATIONS

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 1964, according to Mr. Gordon E. Taylor of the British Astronomical Association.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1964

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. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.



OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1964

PALLAS (No. 2)
Opp. May 18 in Her — Mag. 8.5

Apr.	28	16h	38.6m	+22°44′
May	3	16	35.5	+23 40
	8	16	32.0	+24 30
	13	16	28.1	+25 12
	18	16	24.0	+25 47
	23	16	19.7	+26 13
	28	16	15.4	+26 30
June	2	16	11.2	+26 38
	7	16	07.1	+26 38

JUNO (No. 3)
Opp. May 18 in Ser — Mag. 10.1

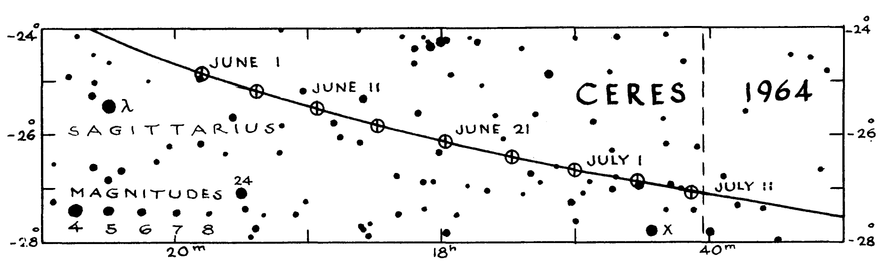
Apr.	28	16h	10.3m	−04°30′
May	3	16	06.9	−04 03
	8	16	03.2	−03 38
	13	15	59.2	−03 14
	18	15	55.1	−02 53
	23	15	51.0	−02 35
	28	15	46.9	−02 20
June	2	15	42.9	−02 09
	7	15	39.2	−02 01

CERES (No. 1)
Opp. June 21 in Sgr — Mag. 7.0

June	1	18h	17.8m	−24°53′
	6	18	13.7	−25 13
	11	18	09.3	−25 32
	16	18	04.5	−25 50
	21	17	59.6	−26 08
	26	17	54.7	−26 24
July	1	17	49.9	−26 39
	6	17	45.4	−26 52
	11	17	41.2	−27 04

VESTA (No. 4)
Opp. Sept. 1 in Aqr — Mag. 6.0

Aug.	12	23h	16.8m	−14°46′
	17	23	13.5	−15 27
	22	23	09.7	−16 10
	27	23	05.5	−16 51
Sept.	1	23	01.0	−17 30
	6	22	56.5	−18 06
	11	22	51.9	−18 38
	16	22	47.6	−19 04
	21	22	43.7	−19 25



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 1964. The Leonid shower should be increasing in strength during the next few years and will be of particular interest, but unfortunately the maximum this year comes at the time of full moon.

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.

Meteor Showers for 1964

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Normal Duration to ¼ strength of Max.
				Position at Max.		Daily Motion			
	Date	E.S.T.	Moon	α	δ	α	δ		
				h m	°	m	°		(days)
Quadrantids	Jan. 4	01^h	L.Q.	15 28	+50	—	—	40	0.6
Lyrids	Apr. 21	18	F.Q.	18 16	+34	+4.4	0.0	15	2.3
η Aquarids	May 4	18	L.Q.	22 24	00	+3.6	+0.4	20	1.8
δ Aquarids	July 29	02	L.Q.	22 36	−17	+3.4	+0.17	20	20
Perseids	Aug. 11	21	F.Q.	03 04	+58	+5.4	+0.12	50	5.0
Orionids	Oct. 20	09	F.M.	06 20	+15	+4.9	+0.13	25	8
Taurids	Nov. 5	09	N.M.	03 32	+14	+2.7	+0.13	25	(30)
Leonids	Nov. 16	08	F.M.	10 08	+22	+2.8	−0.42	15	4
Geminids	Dec. 13	02	F.Q.	07 32	+32	+4.2	−0.07	50	6.0
Ursids	Dec. 22	07	F.M.	14 28	+76	—	—	15	2.2

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

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.

	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification	Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
Star	R.A. 1960	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 06.3	+28 52	2.06	−0.08	B9p	0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.0	+58 56	2.26	+0.34	F2 IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.2	+14 58	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	γ Peg = *Algenib*
β Hyi	23.7	−77 29	2.78	+0.62	*G1 IV*	0.153	+3.7	21	2.255	+22.8		
α Phe	24.3	−42 31	2.39	+1.08	*K0 III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.2	+30 39	3.25:	+1.26	K3 III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.2	+56 19	2.16	+1.18	K0 II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	41.6	−18 12	2.02	+1.03	K1 III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	46.7	+57 36	3.47	+0.56	G0 V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.3	+60 30	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 04.3	−46 56	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	06.6	−10 24	3.47	+1.16	K3 III	0.032	+1.0	102	0.250	+11.5		
β And	07.5	+35 25	2.02	+1.57	M0 III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.2	+60 02	2.67	+0.13	A5 V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* 0.08:^{m} 759^d	
γ Phe	26.6	−43 31	3.44	+1.56	*K5 Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.2	−57 26	0.51	−0.16	*B5 IV:*	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.2	−16 09	3.50	+0.72	G8 Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
α Tri	01 50.8	+29 23	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	−*12.6*	
ε Cas	51.5	+63 28	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1	
β Ari	52.4	+20 37	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	−*01.9*	
α UMi *A*	55.5	+89 05	1.99v	+0.60v	F8 Ib	0.003	−4.6	680	0.046	−*17.4*	Cep., R 0.11^m 4.0^d, B 8.9^m 18″ *Polaris*
α Hyi	57.5	−61 46	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07	
γ And *A*	02 01.4	+42 08	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	γ And = *Almach* B 5.4^m C 6.2^m A–BC 10″ B–C 0.7″
α Ari	04.9	+23 16	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3	*Hamal*
β Tri	07.2	+34 48	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	+*09.9*	
ο Cet *A*	17.3	−03 09	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*	41.2	+03 04	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*	56.7	−40 28	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 00.2	+03 56	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9	*Menkar*
γ Per	01.9	+53 21	2.91:	+0.72:	G8III: +A3:	0.011	+0.3	113	0.004	+*02.5*	
ρ Per	02.6	+38 41	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. R 3.2–3.8
β Per	05.6	+40 48	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	21.5	+49 43	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4	*Mirfak*
δ Per	40.1	+47 40	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	−09	
η Tau	45.1	+23 59	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades *Alcyone*
γ Hyi	47.8	−74 22	3.30	+1.61	*M2 II–III*	−.001	−1.5	300	0.125	+16.0	
ζ Per *A*	51.6	+31 46	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	B 9.36^m 13″
ε Per *A*	55.2	+39 54	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	−01	B 7.99^m 9″
γ Eri	56.2	−13 37	3.01	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7	
α Ret *A*	04 13.9	−62 34	3.33	+0.91	*G6 II*	0.008	−2.1	390	0.064	+35.6	B 12^m 49″
ε Tau	26.3	+19 06	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6	
θ² Tau	26.4	+15 47	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	+*39.5*	
α Dor	33.1	−55 08	3.28	−0.08	*A0 IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star
α Tau *A*	33.6	+16 26	0.86v	+1.52	K5 III	0.048	−0.7	68	0.202	+54.1	Irr.? R0.78–0.93, B13^{m}31″ **Aldebaran**
π³ Ori	47.7	+06 54	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3	
ι Aur	54.4	+33 06	2.64:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5	

α UMi, *Polaris:* R.A. 1 h 58.6 m; Dec. +89° 06′ (1964).

Star	R.A. 1960	Dec.	V	B−V	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
ε Aur	04 59.1	+43 46	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. *R* 0.81^m 9886^d
η Aur	05 03.7	+41 11	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
ε Lep	03.8	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
β Eri	05.9	−05 08	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	11.1	−16 15	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	12.6	−08 15	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	13.7	+45 58	0.05	+0.80	G8III: +F	0.073	−0.6	45	0.435	*+30.2*	***Capella***
η Ori *AB*	22.5	−02 26	3.32v	−0.18	B0.5 V	0.004	−3.7	940	0.008	*+19.8*	Ecl. *R* 3.32–3.50, 8.0^d, *A* 3.59^m *B* 4.98^m 1″
γ Ori	23.0	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	*Bellatrix*
β Tau	23.8	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	*Elnath*
β Lep *A*	26.5	−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*	30.0	−00 20	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	31.0	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	32.9	+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*	33.5	−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	34.2	−01 14	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	*Alnilam*
ζ Tau	35.3	+21 07	3.07:	−0.13:	B2 III: p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col *A*	38.2	−34 06	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^m 12″
ζ Ori *AB*	38.7	−01 58	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	45.9	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.5	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.0	+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	56.6	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur *AB*	57.0	+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 12.5	+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	18.8	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	20.5	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^m
β CMa	20.9	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.1	−52 40	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	***Canopus***
γ Gem	35.4	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1960	Dec.	V	B−V	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ν Pup	06 36.5	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ε Gem	41.5	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	43.0	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	43.4	−16 40	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66^m 1960: 9″, θ = 90°	***Sirius***
α Pic	47.8	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6		
τ Pup	48.9	−50 34	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*		
ε CMa *A*	57.1	−28 55	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5^m 8″	***Adhara***
o^2 CMa	07 01.4	−23 46	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	06.8	−26 20	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.3	−44 34			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141^d	
π Pup	15.7	−37 01	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.5	−29 13	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.0	+08 22	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.0	−43 13	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4^m 22″	
α Gem *A*	32.0	+31 59	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*	32.0	+31 59	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.2	+05 20	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	42.9	+28 07	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	47.6	−24 45	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	55.8	−52 52	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.2	−39 53	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	05.8	−24 11	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.3	−47 14	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31^m 41″	
ε Car	21.7	−59 23	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		*Avior*
o UMa *A*	27.0	+60 51	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15^m 7″	
δ Vel *AB*	43.6	−54 34	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*	44.7	+06 34	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	53.3	+06 06	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	56.5	+48 12	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8^m 7″	

Star	R.A. 1960	Dec.	V	B−V	Type		π	M_V	D	μ	R		
	h m	° ′					″		l.y.	″	km./sec.		
λ Vel	09 06.5	−43 16	2.24	+1.64:	*K5*	*Ib*	0.015	−4.6	750	0.026	+18.4		*Suhail*
a Car	09.9	−58 48	3.43	−0.17	*B3*	*IV*		−2.9	590	0.028	+*23.3*		
β Car	12.8	−69 33	1.67	+0.01	*A0*	*III*	0.038	−0.4	86	0.183	−05		*Miaplacidus*
ι Car	16.0	−59 06	2.25	+0.17	*F0*	*Ib*		−4.6	750	0.019	+13.3		
α Lyn	18.6	+34 34	3.17	+1.54	M0	III	0.021	−0.5	180	0.217	+37.6		
κ Vel	20.9	−54 50	2.45	−0.15	*B2*	*IV*	0.007	−3.4	470	0.012	+*21.9*		
α Hya	25.6	−08 29	1.98	+1.44	K4	III	0.017	−0.3	94	0.034	−04.3		*Alphard*
N Vel	30.0	−56 51	3.19	+1.56	(gK5)		0.015	−0.4	170	0.036	−13.9		
θ UMa *A*	30.2	+51 52	3.19	+0.46	F6	IV	0.052	+1.8	63	1.094	+15.4	*B* 14ᵐ 5″	
ε Leo	43.6	+23 58	2.99	+0.81	G0	II	0.002	−2.1	340	0.048	+05.0		
l Car	44.1	−62 19	4.1		(cG0)		0.019	−5.5	2700	0.016	+*04.0*	Cep. max. 3.4ᵐ min. 4.8ᵐ, 35.52ᵈ	
υ Car *AB*	46.1	−64 53	2.95	+0.26	*A7*	*II*	0.020	−2.1	340	0.012	+13.6	*A* 3.02ᵐ *B* 6.03ᵐ 5″	
α Leo *A*	10 06.2	+12 10	1.36	−0.11	B7	V	0.039	−0.7	84	0.248	+03.5	*B* 8.1ᵐ 177″	***Regulus***
ω Car	12.8	−69 50	3.33	−0.08	*B8.5*	*IV*		−1.5	300	0.029	+04		
ζ Leo	14.5	+23 37	3.46	+0.30	F0	III	0.009	+0.5	130	0.023	−15.0		
λ UMa	14.7	+43 07	3.45	+0.03	A2	IV	−.010	+0.1	150	0.170	+18.3		
q Car	15.8	−61 08	3.41v	+1.55	*K5*	*Ib*	0.018	−4.6	1300	0.023	+08.6	Var. *R* 3.38–3.44	
γ Leo *AB*	17.8	+20 03	1.99	+1.13	K0	IIIp	0.019	+0.1	90	0.350	−36.6	*A* 2.29ᵐ *B* 3.54ᵐ 4″	
μ UMa	20.0	+41 42	3.05	+1.55	M0	III	0.031	+0.5	105	0.086	−*20.5*		
p Car	30.6	−61 29	3.30v	−0.11	*B5*	*IVpe*		−2.3	430	0.021	+26.0	Var. *R* 3.22–3.39	
θ Car	41.5	−64 11	2.74	−0.22	*B0*	*Vp*		−4.0	710	0.018	+24		
μ Vel *AB*	45.0	−49 12	2.67	+0.89	*G5*	*III*		+0.1	108	0.085	+06.9	*A* 2.7ᵐ *B* 7.2ᵐ 2″	
ν Hya	47.6	−15 59	3.12	+1.25	K3	III	0.022	−0.2	150	0.221	−01.0		
β UMa	59.4	+56 36	2.37	−0.03	A1	V	0.042	+0.5	78	0.087	−12.0		*Merak*
α UMa *AB*	11 01.3	+61 58	1.81	+1.06	K0	III	0.031	−0.7	105	0.138	−08.9	*A* 1.88ᵐ *B* 4.82ᵐ 1″	*Dubhe*
ψ UMa	07.4	+44 43	3.00	+1.14	K1	III		+0.0	130	0.072	−03.8		
δ Leo	12.0	+20 45	2.57	+0.13	A4	V	0.040	+0.6	82	0.201	−20.6		
θ Leo	12.1	+15 39	3.34	0.00	A2	V	0.019	+1.1	90	0.104	+07.8		
λ Cen	33.9	−62 48	3.15	−0.05	*B9*	*III*		−2.1	370	0.039	+07.9		
β Leo	47.0	+14 48	2.14	+0.09	A3	V	0.076	+1.5	43	0.511	−00.1		*Denebola*

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
γ UMa	11 51.7	+53 55	2.44	0.00	A0 V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.3	−50 30	2.59v	−0.15:	*B2 Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.1	−22 24	3.04	+1.33	K3 III		−0.2	140	0.069	+04.9		
δ Cru	13.0	−58 32	2.81v	−0.23	*B2 IV*		−3.4	570	0.041	+26.4	Var. *R* 2.78–2.84	
δ UMa	13.5	+57 15	3.30	+0.07	A3 V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	13.7	−17 19	2.59	−0.10	B8 III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.4	−62 53	1.39	−0.25	*B1 IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90ᵐ 89″	**Acrux**
α Cru *B*	24.4	−62 53	1.86	−0.25	(B3)		−3.4	370	0.042	*−00.6*		
δ Crv *A*	27.8	−16 18	2.97	−0.04	B9.5 V: n	0.018	+0.1	124	0.255	+09	*B* 8.26ᵐ 24″	
γ Cru	28.9	−56 53	1.69	+1.55	*M3 II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.3	−23 11	2.66	+0.89	G5 III	0.027	+0.1	108	0.059	−07.7		
α Mus	34.8	−68 55	2.70v	−0.20	*B3 IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.3	−48 44	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*	39.6	−01 14	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*	43.8	−67 53	3.06	−0.17:	*B3 V*		−2.1	470	0.041	+42	*A* 3.7ᵐ *B* 4.0ᵐ 1″	
β Cru	45.4	−59 28	1.28	−0.25	*B0 III*		−4.6	490	0.049	+20.0		**Beta Crucis**
ε UMa	52.3	+56 11	1.79	−0.03	A0pv	0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.2	+38 32	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 00.2	+11 10	2.86	+0.93	G9 II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	16.7	−22 58	2.98	+0.92	G8 III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.3	−36 30	2.76	+0.05	*A2 V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.3	+55 08	2.26	+0.02	A2 V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94ᵐ 14″	*Mizar*
α Vir	23.1	−10 57	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	32.7	−00 24	3.40	+0.10	A3 Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	37.3	−53 16	2.33	−0.23	*B1 IV*		−3.9	570	0.033	+05.6		
η UMa	46.0	+49 31	1.87	−0.20	B3 V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.1	−41 29	3.42	−0.22	B2 IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.2	−42 17	3.12v	−0.13:	B2 V: pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	52.8	+18 36	2.69	+0.59	G0 IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.0	−47 06	2.56	−0.23:	*B2 IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1960	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.0	−60 11	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7^{m} *B* 3.9^{m} 1″	***Hadar***
π Hya	04.1	−26 29	3.25	+1.13	K2 III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.3	−36 10	2.04	+1.03	K0 III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	13.8	+19 23	−0.06	+1.23	K2 IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.5	+38 29	3.05	+0.19	A7 III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.0	−41 59	2.39v	−0.21	B1.5 V:ne		−3.0	390	0.049	−00.2	Var. *R* 2.33–2.45	
α Cen *A*	36.9	−60 40	0.01	+0.68	*G2 V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	36.9	−60 40	1.40:	+0.73:	(dK1)		+5.8	4.3		−20.7		
α Cir *AB*	39.2	−64 48	3.18	+0.25	*F0 Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19^{m} *B* 8.61^{m} 16″	
α Lup	39.3	−47 13	2.32	−0.22	B1 V		−3.3	430	0.033	+07.3		
ε Boo *AB*	43.2	+27 14	2.37	+0.96	K1: III: + A	0.013	+0.0	103	0.051	−16.5	*A* 2.47^{m} *B* 5.04^{m} 3″	
α Lib *A*	48.5	−15 50	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15^{m} 231″	*Zubenelgenubi*
β UMi	50.8	+74 19	2.04	+1.47	K4 III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	55.9	−42 58	2.69	−0.23	B2 IV		−3.4	540	0.066	−00.3		
κ Cen	56.5	−41 57	3.15	−0.21	B2 V		−2.7	470	0.033	+09.1		
β Boo	15 00.4	+40 33	3.48	+0.95	G8 III	0.022	+0.3	140	0.059	−19.9		
σ Lib	01.7	−25 08	3.31	+1.65	M4 III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	09.4	−51 57	3.42	+0.90:	*K0 III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8^{m} 71″	
δ Boo *A*	13.9	+33 28	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84^{m} 105″	
β Lib	14.8	−09 14	2.61	−0.11	B8 V	−.012	−0.6	140	0.101	−35.2		
γ TrA	15.1	−68 32	2.94	−0.01	*A0 Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	18.7	−40 30	3.24	−0.23	B2 IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 59	3.08	+0.06	A3 II-III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.0	+59 06	3.28	+1.18	K2 III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	32.5	−41 02	2.80	−0.22	B2 Vn		−2.7	570	0.037	+06	*A* 3.5^{m} *B* 3.7^{m} 1″	
α CrB	33.0	+26 51	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11^{m}, 17.4^{d}	*Alphecca*
α Ser	42.3	+06 33	2.65	+1.17	K2 III	0.046	+1.0	71	0.139	+02.9		
β TrA	51.6	−63 19	2.87	+0.28:	*F2 V*	0.078	+2.3	42	0.448	−00.3		
π Sco	56.4	−26 00	2.92	−0.19	B1 V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	57.5	−38 17	3.45	−0.23	B2 V		−2.7	570	0.042	+07	*A* 3.47^{m} *B* 7.70^{m} 15″	
δ Sco	58.0	−22 51	2.34	−0.13	B0 V		−4.0	590	0.032	−14		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Sco *AB*	16 03.1	−19 42	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	12.2	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9		
ε Oph	16.2	−04 36	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3		
σ Sco *A*	18.8	−25 30	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*	23.4	+61 36	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7^m 6″	
α Sco *A*	26.9	−26 21	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	28.5	+21 35	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*		
τ Sco	33.4	−28 08	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7		
ζ Oph	35.0	−10 29	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19		
ζ Her *AB*	39.8	+31 40	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	41.5	+39 00	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	44.4	−68 57	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6		*Atria*
ε Sco	47.6	−34 13	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5		
μ^1 Sco	49.2	−37 59	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. *R* 2.99–3.09, 1.4^d	
ζ Ara	55.3	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0		
κ Oph	55.8	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6		
η Oph *AB*	17 08.1	−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*
ζ Dra	08.7	+65 46	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1		
η Sco	09.3	−43 11	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4		
α Her *AB*	12.8	+14 26	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	13.4	+24 53	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41		
π Her	13.7	+36 51	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7		
θ Oph	19.6	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6		
β Ara	22.0	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4		
γ Ara *A*	22.0	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	*B* 10^m 18″	
υ Sco	28.0	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*		
α Ara	28.7	−49 51	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*		
β Dra *A*	29.5	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	*B* 11.49^m 4″	
λ Sco	30.9	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00		*Shaula*
α Oph	33.1	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		*Rasalhague*
θ Sco	34.4	−42 58	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1960	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 39.7	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	41.5	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
ι^1 Sco	44.8	−40 07	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
μ Her *A*	44.9	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
G Sco	47.1	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.7	+51 30	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	56.8	−09 46	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.2	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	14.9	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	18.4	−29 51	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.2	−02 55	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	21.5	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	25.5	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.6	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
φ Sgr	43.2	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	48.6	+33 19	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	52.8	−26 21	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
ξ^2 Sgr	55.3	−21 10	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.4	+32 38	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.1	−29 56	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*	03.6	+13 48	2.99	+0.01	A0 V:nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.1	−04 57	3.44	−0.07	B9: V:n	0.025	−0.1	160	0.092	−14	
τ Sgr	04.4	−27 44	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	07.4	−21 05	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	12.6	+67 35	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	23.5	+03 02	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.1	+27 52	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*	43.7	+45 02	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	44.4	+10 31	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	48.8	+08 46	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1960	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
θ Aql	20 09.2	−00 56	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*		
β Cap *A*	18.8	−14 55	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	20.8	+40 08	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5		
α Pav	22.5	−56 52	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*		*Peacock*
α Ind	34.8	−47 26	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1		
α Cyg	40.1	+45 08	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6		***Deneb***
β Pav	41.4	−66 21	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8		
η Cep	44.5	+61 41	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3		
ε Cyg	44.6	+33 49	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*		
ζ Cyg	21 11.2	+30 04	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4		
α Cep	17.6	+62 25	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10		*Alderamin*
β Cep	28.2	+70 23	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	29.5	−05 45	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5		
ε Peg *A*	42.2	+09 41	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11^m 82″	*Enif*
δ Cap	44.8	−16 19	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95	
γ Gru	51.5	−37 33	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1		
α Aqr	22 03.7	−00 31	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5		
α Gru	05.7	−47 09	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8		*Al Na'ir*
ζ Cep	09.5	+58 00	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*		
α Tuc	15.8	−60 28	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*		
δ Cep *A*	27.7	+58 13	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	39.5	+10 37	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07		
β Gru	40.3	−47 06	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23	
η Peg	41.1	+30 01	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*		
δ Aqr	52.5	−16 02	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0		
α PsA	55.4	−29 50	1 19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5		***Fomalhaut***
β Peg	23 01.8	+27 52	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	02.8	+14 59	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5		*Markab*
γ Cep	37.7	+77 25	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4		

DOUBLE AND MULTIPLE STARS

By Frank Holden

Many stars may be separated into two or more components by the use of a telescope. The greater the aperture of the telescope, the closer the stars which can be separated *in good seeing conditions.* With telescopes of medium size, and for stars which are not unduly bright or faint, the minimum angle of separation—in seconds of arc—is given by $4.6/D$. The symbol D indicates the diameter of the telescope's objective in inches.

The following lists give some interesting examples of double stars. In the first list are pairs suitable for testing the performance of telescopes because the stellar components are relatively fixed over many years; in the second list are pairs of more general interest, including several binaries of shorter period for which the apparent separation or position-angle alters relatively quickly.

In both lists the columns give, successively, the star's designation in two forms; its right ascension and declination for 1960; the visual magnitudes of the combined pair and of each component; the apparent separation in 1964; the approximate position-angle in 1964; and the period, if known.

Star	A.D.S.	R.A. 1960 h	m	Dec. 1960 °	′	Magnitudes comb.	a	b	Sep. 1964.5 ″	P.A. 1964.5 °	P (app.) years
λ Cas	434	00	29.6	+54	18	4.9	5.5	5.8	0.6	180	900
α Psc	1615	01	59.9	+02	34	4.0	4.3	5.3	1.9	291	720
33 Ori	4123	05	29.1	+03	15	5.7	6.0	7.3	1.9	27	—
OΣ 156	5447	06	45.1	+18	14	6.1	6.8	7.0	0.5	255	1,060
Σ 1338	7307	09	18.5	+38	21	5.8	6.5	6.7	1.2	223	390
35 Com	8695	12	51.3	+21	28	5.1	5.3	7.3	0.9	150	675
Σ 2054	10052	16	23.3	+61	48	5.6	6.0	7.2	1.0	353	—
ϵ^1 Lyr	11635	18	43.0	+39	38	4.4	4.6	6.3	2.8	1	—
ϵ^2 Lyr	11635	18	43.0	+39	35	4.2	4.9	5.2	2.4	99	—
π Aql	12962	19	46.9	+11	42	5.6	6.0	6.8	1.4	109	—
σ Cas	17140	23	56.9	+55	32	4.9	5.4	7.5	3.1	330	—
η Cas	671	00	46.7	+57	36	3.4*	3.5	7.3	11.2	298	530
Σ 186	1538	01	53.8	+01	39	6.2	6.9	7.0	1.4	54	160
γ And AB	1630	02	01.4	+42	08	2.1*	2.1	5.4	9.9	63	—
α C Ma	5423	06	43.4	−16	40	−1.4	−1.4	8.7	10.2	79	50
α Gem	6175	07	32.0	+31	59	1.6	2.0	2.9	1.8	147	380
ζ Cnc AB	6650	08	09.9	+17	46	5.0	5.6	5.9	1.1	350	60
ζ Cnc AC	6650	08	09.9	+17	46	5.0	5.6	6.0	5.6	82	1,150
10 U Ma	Kpr	08	58.1	+41	57	4.1	4.3	6.3	0.5	298	20
γ Leo	7724	10	17.8	+20	03	2.0	2.3	3.5	4.3	122	620
ξ U Ma AB	8119	11	16.1	+31	46	3.9	4.4	4.9	2.5	136	60
γ Vir	8630	12	39.6	−01	14	2.8	3.5	3.5	4.9	306	170
Σ 1785	9031	13	47.3	+27	11	6.6	7.2	7.5	3.1	148	155
ζ Boo	9343	14	39.3	+13	54	3.9	4.6	4.6	1.2	308	125
ξ Boo	9413	14	49.6	+19	17	4.7	4.8	6.9	6.9	344	150
ζ Her	10157	16	39.8	+31	40	2.8	2.9	5.5	0.9	28	35
α Her AB	10418	17	12.8	+14	26	3.1*	3.2	5.4	4.6	109	—
Σ 2173	10598	17	28.3	−01	01	5.4	6.1	6.1	0.8	154	45
70 Oph	11046	18	03.4	+02	31	4.1	4.3	6.0	3.5	80	90
β 648	11871	18	55.6	+32	51	5.2	5.3	7.7	0.9	214	60
4 Aqr	14360	20	49.3	−05	47	6.0	6.4	7.2	1.0	5	155
τ Cyg	14787	21	13.2	+37	52	3.8	3.9	6.3	0.8	210	50
Σ 3050	17149	23	57.4	+33	30	5.8	6.5	6.5	1.5	284	320

***The two components have dissimilar colours.**

Many of the components themselves are very close visual doubles or spectroscopic binaries. (Other double stars appear in the table of The Brightest Stars, p. 70 and of The Nearest Stars, p. 83.)

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.

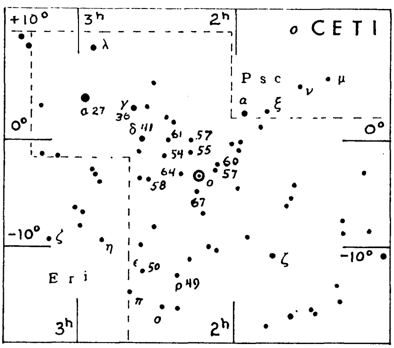
Star	1950 α		δ		Sp.	π	D	μ	W	m	L
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G2					-26.9	1.0
α Cen A	14	36	−60	38	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	26	−62	28	M5*e*					11	0.000052
Barnard's *	17	55	+ 4	33	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	54	+ 7	20	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726-8A	1	36	−18	13	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B					M6*e*					13.0	0.00003
Lal. 21185*	11	01	+36	18	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6	43	−16	39	A1	.375	8.7	1.32	18	−1.4	23.
B					*wd*					7.1	0.008
Ross 154	18	47	−23	53	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23	39	+43	55	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ε Eri	3	31	− 9	38	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11	45	+ 1	07	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21	05	+38	30	K6	.293	11.1	5.22	106	5.6	0.052
B					M0					6.3	0.028
Luy. 789-6	22	36	−15	37	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7	37	+ 5	21	F5	.288	11.3	1.25	20	0.4	5.8
B					*wd*					10.8	0.00044
ε Ind	22	00	−57	00	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18	42	+59	33	M4	.280	11.6	2.29	38	8.9	0.0028
B					M4					9.7	0.0013
Groom. 34 A	0	16	+43	44	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B					M4*e*					10.9	0.00044
τ Ceti	1	42	−16	12	G8	.275	11.8	1.92	37	3.5	0.36
Lac. 9352	23	03	−36	09	M2	.273	11.9	6.87	118	7.2	0.013
BD +5°1668	7	25	+ 5	29	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21	14	−39	04	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5	10	−45	00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22	26	+57	27	M4	.249	13.1	0.87	29	9.9	0.0013
B					M5*e*					11.4	0.00033
Ross 614 A	6	27	− 2	47	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B					?					14.8	0.000016
BD−12°4523	16	28	−12	32	M5	.244	13.4	1.24	27	10.0	0.0013
van Maanen's	0	46	+ 5	10	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12	31	+ 9	18	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B					M6*e*					12.6	0.00014
Groom. 1618	10	08	+49	42	K5	.222	14.7	1.45	41	6.8	0.030
CD−37°15492	0	02	−37	36	M3	.219	14.9	6.09	134	8.6	0.0058
CD−46°11540	17	25	−46	51	M4	.213	15.3	1.15		9.7	0.0023
BD+20°2465*	10	17	+20	07	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD−44°11909	17	34	−44	16	M5	.209	15.6	1.14		11.2	0.00058
CD−49°13515	21	30	−49	13	M3	.209	15.6	0.78		9	0.0044
AOe 17415-6	17	37	+68	23	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22	50	−14	31	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13	43	+15	10	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11	43	−64	33	*wd*	.203	16.0	2.69		11	0.0008
o² Eri A	4	13	− 7	44	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	03	+ 2	31	K1	.199	16.4	1.13	28	4.2	0.40
B					K5					5.9	0.083
Altair	19	48	+ 8	44	A7	.198	16.5	0.66	31	0.8	8.3
BD+43°4305	22	45	+44	05	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11	44	+78	57	M4	0.196	16.6	0.87	121	11.0	0.0008

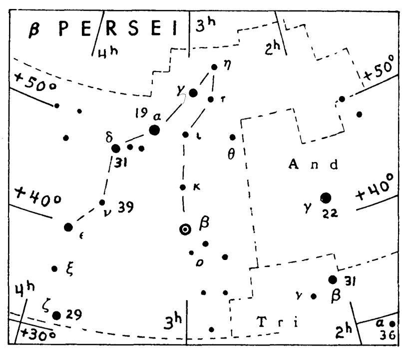
*Star has an unseen component.

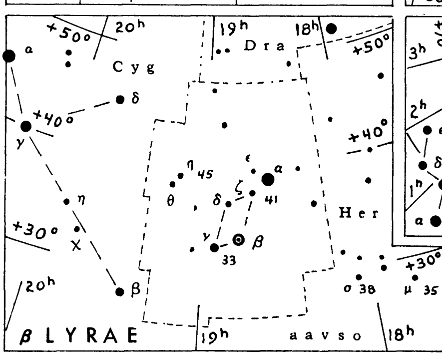
VARIABLE STARS

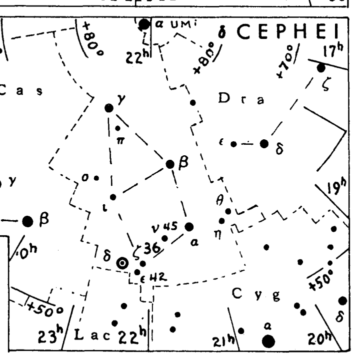
Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. Note that the decimal points are omitted: a star 36 is of mag. 3.6. Use two comparison stars, one brighter and one fainter than the variable, and estimate the 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*, 1962, International Supplement.









LONG-PERIOD VARIABLE STARS

Variable		Max. m	Per. d	Epoch 1964	Variable		Max. m	Per. d	Epoch 1964
001755	T Cas	7.8	445	. . .	151731	S CrB	7.3	361	Apr. 13
001838	R And	7.0	409	July 22	154639	V CrB	7.5	358	Jan. 19
021143	W And	7.4	397	Jan. 1	154615	R Ser	6.9	357	Feb. 14
0214*03*	*o* Cet	3.4	332	Mar. 5	160625	RU Her	8.0	484	July 31
0228*13*	U Cet	7.5	235	Aug. 10	162119	U Her	7.5	406	Feb. 12
023133	R Tri	6.2	266	May 13	1621*12*	V Oph	7.5	298	May 17
043065	T Cam	8.0	374	Oct. 11	163266	R Dra	7.6	245	Aug. 18
0455*14*	R Lep	6.8	432	Sept. 24	164715	S Her	7.6	307	Aug. 13
050953	R Aur	7.7	459	June 22	1702*15*	R Oph	7.9	302	May 11
054920	U Ori	6.3	372	June 10	171723	RS Her	7.9	219	June 13
0617*02*	V Mon	7.0	335	June 20	180531	T Her	8.0	165	May 27
065355	R Lyn	7.9	379	Dec. 9	181136	W Lyr	7.9	196	May 30
070122a	R Gem	7.1	370	Apr. 24	183308	X Oph	6.8	334	Apr. 5
070310	R CMi	8.0	338	Aug. 18	190108	R Aql	6.1	300	July 11
072708	S CMi	7.5	332	May 18	1910*17*	T Sgr	8.0	392	June 12
0850*08*	T Hya	7.8	288	Sept. 26	1910*19*	R Sgr	7.3	269	Apr. 29
093934	R LMi	7.1	372	Jan. 5	193449	R Cyg	7.5	426	Aug. 2
094211	R Leo	5.8	313	July 12	194048	RT Cyg	7.3	190	Apr. 7
103769	R UMa	7.5	302	Oct. 9	194632	χ Cyg	5.2	407	Feb. 17
1214*18*	R Crv	7.5	317	Sept. 14	200938	RS Cyg	7.2	418	May 23
122001	SS Vir	6.8	355	May 20	201647	U Cyg	7.2	465	June 30
123160	T UMa	7.7	257	Mar. 24	2044*05*	T Aqr	7.7	202	Apr. 22
123307	R Vir	6.9	146	May 26	210868	T Cep	6.0	390	Dec. 20
123961	S UMa	7.8	226	May 19	213753	RU Cep	8.0	234	Jan. 1
131546	V CVn	6.8	192	June 13	230110	R Peg	7.8	378	Sept. 22
1327*06*	S Vir	7.0	378	Oct. 7	230759	V Cas	7.9	228	June 15
134440	R CVn	7.7	328	Sept. 1	231508	S Peg	8.0	319	July 1
142584	R Cam	7.9	270	June 13	2338*15*	R Aqr	6.5	387	Apr. 24
142539	V Boo	7.9	258	Aug. 18	235350	R Cas	7.0	431	Apr. 1
143227	R Boo	7.2	223	Apr. 1	2357*15*	W Cet	7.6	351	June 25

OTHER TYPES OF VARIABLE STARS

Variable		Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1964 E.S.T.
005381	U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 1.42*
025838	ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	
030140	β Per	2.1	3.3	Ecl	B8+G	2.8674	Jan. 1.09*
035512	λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 3.10*
060822	η Gem	3.1	3.9	Semi R	M3	233.4	Feb. 1:*
061907	T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 11.33
065820	ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 1.26
154428	R Cr B	5.8	14.8	R Cr B	cFpep		
171014	α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	
1842*05*	R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633	β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 2.19*
192242	RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.54
194700	η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 7.82
222557	δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 4.40

*Minima

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 1960 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist l.y.
869		h Per	02 16.2	+56 58	Op	30	7			4,300
884		χ Per	02 19.6	+56 56	Op	30	7			4,300
1039	34	Per	02 39.4	+42 37	Op	30	9	80		1,500
Pleiades	45	Tau	03 45.1	+23 59	Op	120	4.2	250		490
Hyades		Tau	04 18	+15 31	Op	400	4.0	100		120
1912	38	Aur	05 26.0	+35 48	Op	18	9.7	100		2,800
2099	37	Aur	05 49.7	+32 33	Op	24	9.7	150		2,700
2168	35	Gem	06 06.4	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 45.3	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 37.8	+20 07	Op	90	6.5	350		490
5139		ω Cen	13 24.3	−47 16	Gl	23	12.9		3	22,000
5272	3	C Vn	13 40.4	+28 35	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 16.5	+02 13	Gl	13	14.0		3.6	35,000
6121	4	Sco	16 21.2	−26 26	Gl	14	13.9		5.2	24,000
6205	13	Her	16 40.2	+36 32	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 45.2	−01 53	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 55.0	−04 03	Gl	8	14.1		5.4	36,000
6341	92	Her	17 15.9	+43 11	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 54.6	−19 01	Op	27	10.2	120		2,200
6611	16	Ser	18 16.6	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 34.0	−23 57	Gl	17	12.9		3.6	22,000
7078	15	Peg	21 28.0	+11 59	Gl	7	14.3		5.2	43,000
7089	2	Aqr	21 31.4	−01 00	Gl	8	14.6		5.0	45,000
7092	39	Cyg	21 30.8	+48 15	Op	32	6.5	25		1,000
7654	52	Cas	23 22.4	+61 23	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 1960	δ	Cl	Size	m	m	Dist.	Name
			h m	° ′		′	n	*	l.y.	
650	76	Per	01 39.7	+51 22	Pl	1.5	11	17	15,000	
1952	1	Tau	05 32.1	+22 00		6	11	16	4,100	Crab
1976	42	Ori	05 33.3	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.9	−02 29	Drk	4			300	Horsehead
2261		Mon	06 37.0	+08 46	Dif	2				Hubble's var.
2392		Gem	07 26.8	+21 00	Pl	0.3	8	10	2,800	
2440		Pup	07 40.1	−18 07	Pl	0.9	11	16	8,600	
3587	97	UMa	11 12.5	+55 14	Pl	3.3	11	14	12,000	Owl
		Cru	12 49	−63	Drk	300			300	Coalsack
6210		Her	16 42.8	+23 52	Pl	0.3	10	12	5,600	
B72		Oph	17 21.2	−23 35	Drk	20			400	S nebula
6514	20	Sgr	18 00.0	−23 02	Dif	24			3,200	Trifid
B86		Sgr	18 00.5	−27 53	Drk	5				
6523	8	Sgr	18 01.2	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 37	Pl	0.4	9	11	3,500	
6572		Oph	18 10.2	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 13.2	−18 15	Drk	15				
6618	17	Sgr	18 18.5	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.1	+32 59	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 43.7	+50 26	Pl	0.4	9	11	3,400	
6853	27	Vul	19 57.9	+22 36	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 44.0	+30 34	Dif	60				Network
7000		Cyg	20 57.4	+44 10	Dif	100				N. America
7009		Aqr	21 02.0	−11 32	Pl	0.5	8	12	3,000	
7662		And	23 24.0	+42 19	Pl	0.3	9	13	3,900	

EXTERNAL GALAXIES

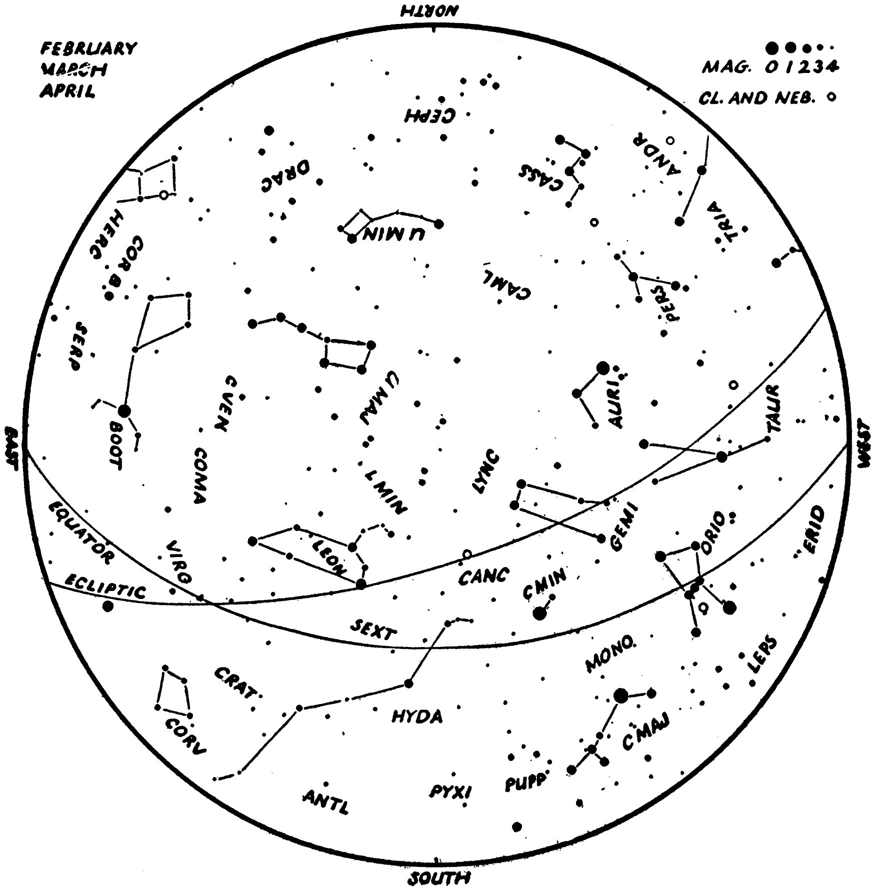
Among the hundreds of thousands of systems far beyond our own galaxy relatively few are readily seen in small telescopes. The following list contains a selection of the closer brighter objects of this kind. The first five columns give the catalogue numbers, constellation and position on the celestial 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 1960 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance millions of l.y.	Vel. km / sec
221	32	And	00 40.5	+40 39	E	3×3	8.8	1.6	− 185
224	31	And	00 40.5	+41 03	Sb	160×40	5.0	1.6	− 220
SMC		Tuc	00 53	−72 35	I	220×220	1.5	0.17	+ 170
598	33	Tri	01 31.6	+30 28	Sc	60×40	7.0	1.4	− 70
LMC		Dor	05 21	−69 26	I	430×530	0.5	0.17	+ 280
3031	81	UMa	09 52.4	+69 16	Sb	16×10	8.3	4.8	− 30
3034	82	UMa	09 52.7	+69 53	I	7× 2	9.0	5.2	+ 290
3368	96	Leo	10 44.6	+12 02	Sa	7× 4	10.0	11.4	+ 940
3623	65	Leo	11 16.8	+13 19	Sb	8× 2	9.9	10.0	+ 800
3627	66	Leo	11 18.2	+13 13	Sb	8× 2	9.1	8.6	+ 650
4258		CVn	12 17.0	+47 32	Sb	20× 6	8.7	9.2	+ 500
4374	84	Vir	12 23.0	+13 06	E	3× 2	9.9	12.0	+1050
4382	85	Com	12 23.4	+18 25	E	4× 2	10.0	7.4	+ 500
4472	49	Vir	12 27.8	+08 13	E	5× 4	10.1	11.4	+ 850
4565		Com	12 34.4	+26 12	Sb	15× 1	11.0	15.2	+1100
4594		Vir	12 37.9	−11 24	Sa	7× 2	9.2	14.4	+1140
4649	60	Vir	12 41.7	+11 46	E	4× 3	9.5	15.0	+1090
4736	94	CVn	12 49.0	+41 20	Sb	5× 4	8.4	6.0	+ 290
4826	64	Com	12 54.8	+21 54	Sb	8× 4	9.2	2.6	+ 150
5005		CVn	13 09.0	+37 16	Sc	5× 2	11.1	13.2	+ 900
5055	63	CVn	13 14.0	+42 14	Sb	8× 3	9.6	7.2	+ 450
5194	51	CVn	13 28.2	+47 24	Sc	12× 6	7.4	6.0	+ 250
5236	83	Hya	13 34.8	−29 40	Sc	10× 8	8	5.8	+ 500
6822		Sgr	19 42.7	−14 52	I	20×10	11	2.0	− 150
7331		Peg	22 35.2	+34 12	Sb	9× 2	10.4	10.4	+ 500

TABLE OF PRECESSION FOR 50 YEARS

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

STAR MAP 1

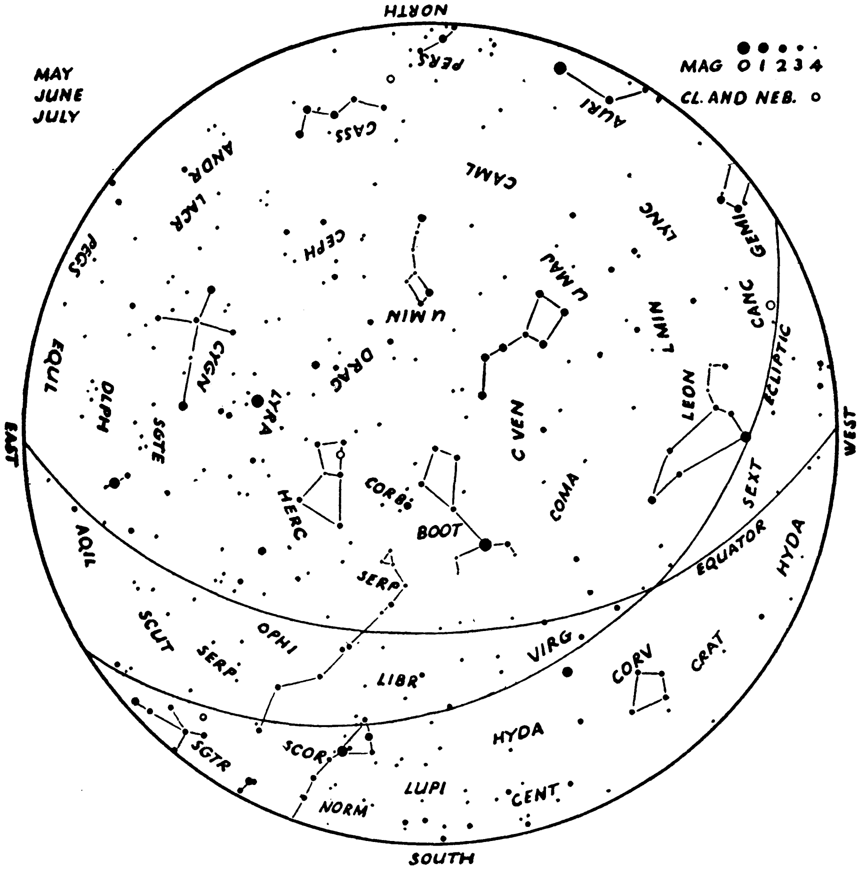


The above map represents the evening sky at

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

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

STAR MAP 2

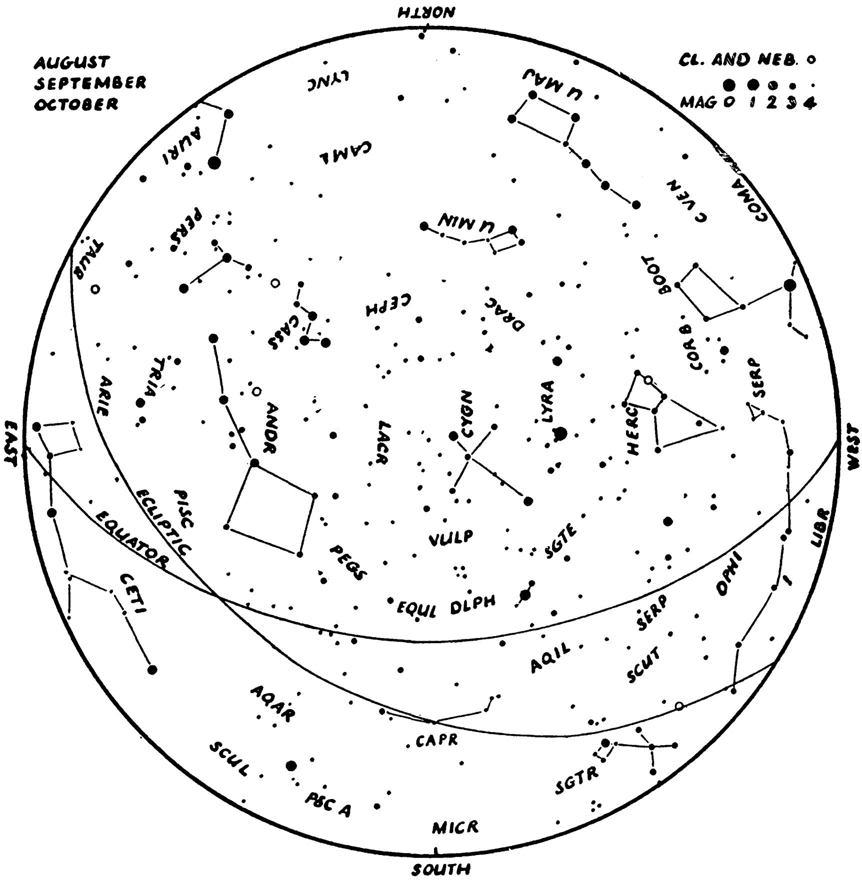


The above map represents the evening sky at

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

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

STAR MAP 3

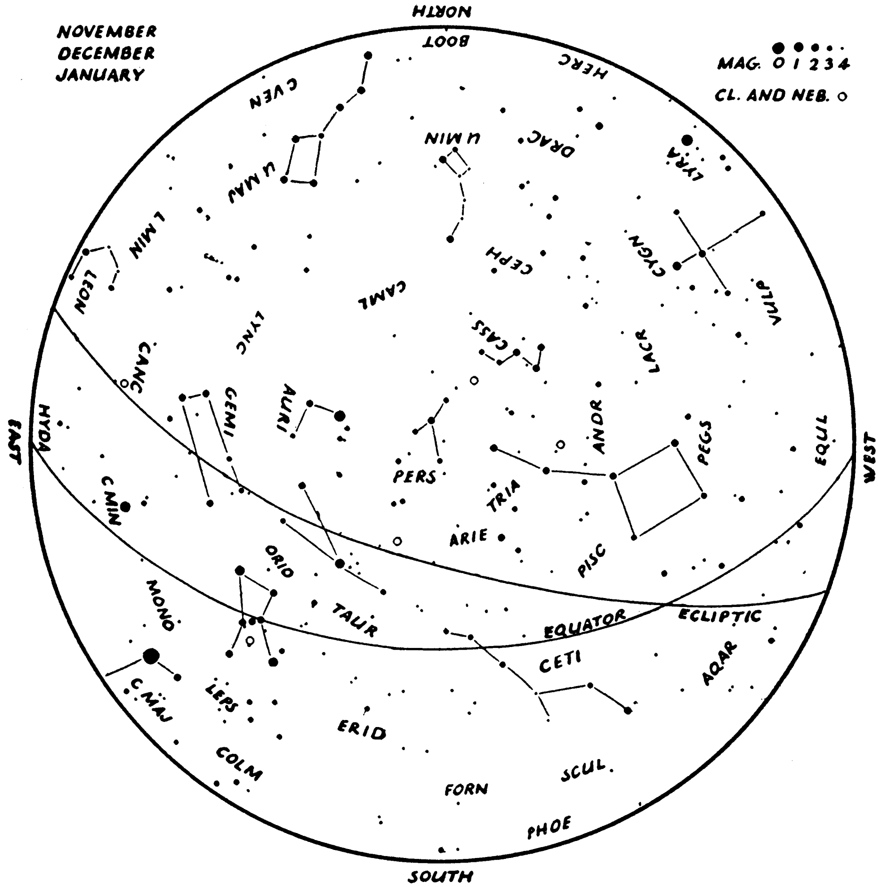


The above map represents the evening sky at

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

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

STAR MAP 4



The above map represents the evening sky at

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

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

The *exact* definitions of the inch, yard, and mile, listed on page 6, were recommended by Canada for international use in 1951 (Hodgson report H.M.S.O. Cmd. 8219). A joint announcement (Jan. 1, 1959) by the National Standards Laboratories of U.S.A., U.K., Canada, Australia, New Zealand and South Africa agreed to recommend the use of the following definitions:

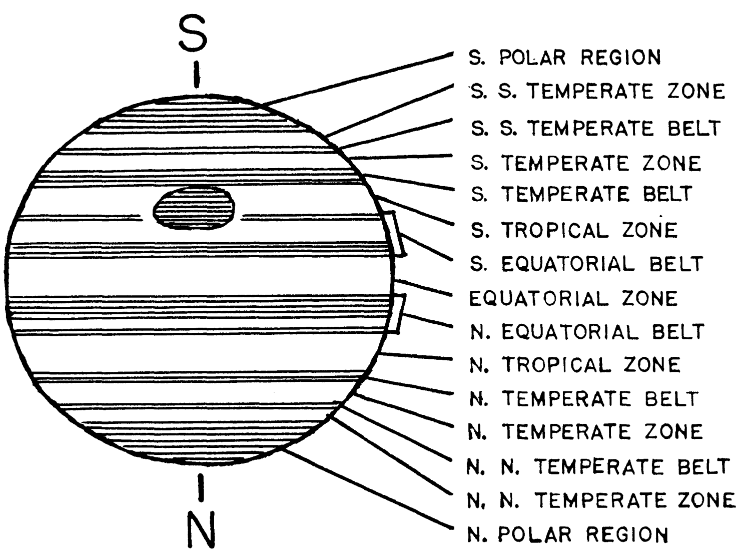
International yard equals 0.9144 metre.

International pound equals 0.45359237 kilogram.

This agreement is purely for scientific and technological purposes and in no way constitutes a legal definition except in Canada. The international yard as defined above is identical with the *Canadian legal yard* according to the Weights and Measures Act, *Revised Statutes of Canada*, vol. 4, ch. 292, p. 17, 1952. Legislation of this yard is expected in the U.K. in 1964 and in all the above countries in time.

Among the miscellaneous astronomical data on page 6 are a number of the conventionally-adopted values of the "system of astronomical constants". Some of these have been shown to be in error by recent observations. However, these errors do not in any way impair the usefulness of the system. It is important that there be continuity in an ephemeris, and at a conference on the fundamental constants of astronomy held in Paris in 1950, it was unanimously recommended to retain the present system; this was approved by the International Astronomical Union in 1952. It is agreed that eventually the "system of astronomical constants" should be revised *as a whole.*

Three different values of any constant may be distinguished: (*a*) the conventional value which is part of the reference system; (*b*) the observed value which changes with each new determination; (*c*) an adjusted value which rigorously satisfies the theoretical relations among the constants and agrees with the observed value within the tolerance set by the observational errors. Recent *observed* values of the solar parallax and velocity of light are included on page 6.



JUPITER'S BELTS AND ZONES

NEW UNITRON CLOCK DRIVE MODELS

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

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

1.6" ALTAZIMUTH — **$75**
with eyepieces for 78x, 56x, 39x

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

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

3" ALTAZIMUTH — **$265**
with eyepieces for 171x, 131x, 96x, 67x, 48x

3" EQUATORIAL — **$435**
with eyepieces for 200x, 131x, 96x, 67x, 48x

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

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

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

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

4" 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**

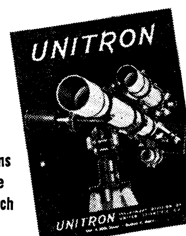
Get UNITRON's FREE Observer's Guide and Catalog on ASTRONOMICAL TELESCOPES

This valuable 38-page book is yours for the asking!

With artificial satellites already launched and space travel almost a reality, astronomy has become today's fastest growing hobby. Exploring the skies with a telescope is a relaxing diversion for father and son alike. UNITRON's handbook contains full-page illustrated articles on astronomy, observing, telescopes and accessories. It is of interest to both beginners and advanced amateurs.

Contents include—

- Observing the sun, moon, planets and wonders of the sky
- Constellation map
- Hints for observers
- Glossary of telescope terms
- How to choose a telescope
- Amateur clubs and research programs



UNITRON

66 NEEDHAM STREET, NEWTON HIGHLANDS 61, MASS.

Please rush to me, free of charge, UNITRON's new Observer's Guide and Telescope Catalog.

Name ____________________

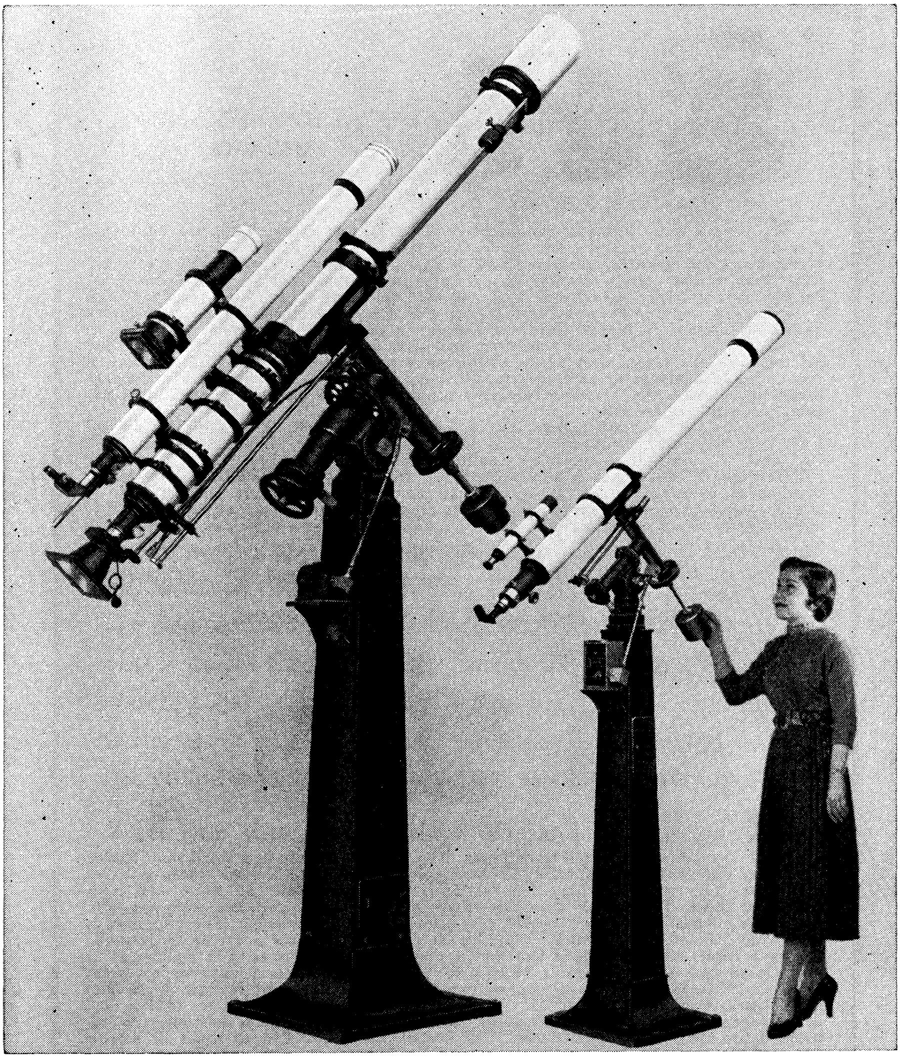
Street ____________________

City ______________ State ____________

HOW TO ORDER

Send check or money order in full. Shipments made express collect. Send 20% deposit for C.O.D. shipment. UNITRON instruments are fully guaranteed for quality workmanship, and performance.

UNITRON INSTRUMENT COMPANY — TELESCOPE SALES DIV.
66 NEEDHAM STREET, NEWTON HIGHLANDS 61, MASS.



UNITRON'S 6" Refractor on left, 4" on right

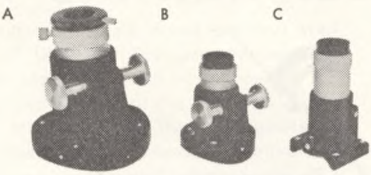
Amateur and professional astronomers alike continue to proclaim their enthusiasm and high praise for UNITRON's new 6-inch Refractor. And little wonder—for this latest and largest UNITRON offers features, precision, and performance usually associated only with custom-built observatory telescopes of much larger aperture. Here, indeed, is the ideal telescope for the serious observer and for the school and college observatory.

Imagine yourself at the controls of this 6" UNITRON—searching the skies, seeing more than you have ever seen before, photographically recording your observations—truly, the intellectual adventure of a lifetime.

Full specifications are given in the UNITRON Telescope Catalog available on request. There are three massive 6" models from which to choose with prices starting at $5125.

SEE OUR ADVERTISEMENT ON THE BACK COVER

UNITRON INSTRUMENT COMPANY — TELESCOPE SALES DIV.
66 NEEDHAM STREET, NEWTON HIGHLANDS 61, MASS.



SKY-MICRO FOCUSING MOUNTS

U.S. Patent 3,051,045

We believe these focusing mountings to be the finest made. They are all metal, precision engineered and precision made. The types "A" and "B" are a combination of the smoothest operating generated rack and pinion of zero eccentricity, plus a helical micro-vernier *slow motion focusing* at any point in stepless "tenths" (1/10,000th inch) for the most exacting seeing your telescope can command. They come equipped with a replaceable contour ring to fit different tube diameters including flat. They are beautifully finished in optical grey and instrument black baked enamel.

The Type "A" is a larger mounting and while it will fit all telescopes is intended primarily for the larger sizes where photography is to be used. The main opening is two inches in diameter to accommodate a camera lens and is equipped with a bushing, locked in, to take the American standard oculars of 1.250 inches diameter. It is not equipped with a draw tube.

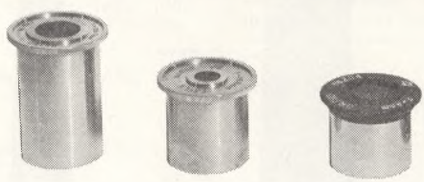
The type "B" is smaller than the "A" and is sized to fit the American standard 1.250 inch eyepieces. It comes equipped with draw tube to extend the range. The type "A" and "B" are both of the same type and the same high quality.

The type "C" is not rack and pinion but is helical only. It should not be confused with cheap focusing devices. It again is all metal, precision made and finished. It can be pulled in and out for rough focusing and then turned for fine adjustment. It automatically fits all size tubes, even flat. It comes with the same draw tube as type "B".

POSTPAID PRICES

Type "A" ....$38.00 Type "B" ....$22.50 Type "C" $14.00

SPECIFY TUBE DIAMETER WHEN ORDERING



OCULARS

These oculars are imported from Japan. The optics are made in a small shop having only three highly skilled opticians. Without qualification they are the finest we have ever used. This statement has been substantiated by practically all those who have purchased them. The outside diameter of all is 1.250 inches, the American standard. All glass-air surfaces are hard coated to improve light transmission. They all have a very wide field of approximately 50°. Five of those listed below are true Orthoscopic having a triple achromatic field lens and a single eye lens. The sixth is an Ocular of new design named the "Galoc". It is a modified Erfle with a definite improvement over the Erfle. It has a focal length of 16.3 mm (approximately 2/3 of an inch) and has an amazing angular field of 75°. Even with this wide field the flatness of this field is most excellent. It is fully achromatic and shows no color. It is especially recommended for use with a good Barlow. All oculars are guaranteed to equal or surpass the performance of all other makes regardless of type or price, or money will be refunded.

Focal Length	Type	Price	Focal Length	Type	Price
28.0 mm (1.10″)	Orthoscopic	$19.75	7.0 mm (0.28″)	Orthoscopic	$19.75
16.3 mm (0.64″)	Galoc	19.75	6.0 mm (0.24″)	Orthoscopic	19.75
10.5 mm (0.41″)	Orthoscopic	19.75	4.0 mm (0.16″)	Orthoscopic	19.75

ALL POSTPAID WRITE FOR FREE CATALOGUE

Telescopics

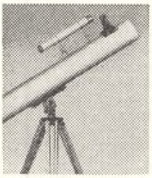
CARL C. LANGEVIN

6565 ROMAINE STREET, LOS ANGELES 38, CALIFORNIA HOllywood 9-6321

UNUSUAL OPTICAL BUYS

See the Stars, Moon, Close Up!
3″ REFLECTING TELESCOPE

60 to 180 Power—An Unusual Buy!
Famous Mt. Palomar Type



You'll see the Rings of Saturn, the fascinating planet Mars, huge craters on the Moon, Star Clusters, Moons of Jupiter in detail. Aluminized and overcoated 3″ diameter high-speed f/10 mirror. Equatorial mount with lock on both axes. An Optical Finder Telescope is also included. Sturdy, hardwood, portable tripod. Free with scope—valuable star chart and 272 page "Astronomy Book". Order by Stock No. Send check or M. O.—Money-back guarantee!

Stock No. 85,050-V $29.95 Postpaid

MARVELS OF THE UNIVERSE ON SLIDES

Forty mounted, identified 35 mm de luxe slides dramatically display awe-inspiring views of northern hemisphere constellations. Set includes title slide, 5 seasonal & regional star maps that introduce 34 constellation slides. You identify 46 constellations—marvel at highly magnified renderings of Saturn, Mars, Jupiter, solar prominence & sun spots. Wonderful for home study and as teaching aid.

Stock No. 60,167V.................. $16.00 Postpaid

DOWN GOES THE PRICE ON WAR SURPLUS LENSES

Aero Ektars and Tessars—New and Used Out They Go for 3 and 4% of Gov't Cost

Mfgd. by Bausch and Lomb and Kodak at cost to Gov't. of over $1,000 each—F/6, 24 In. Focal Length Lenses with 23″ Lens. Cones . . . now you can have them for making Big Bertha Telephoto Lenses or Cameras, Richest Field Wide Angle, Low Power (12X to 48X) Telescopes, Opaque Projectors, Camera Obscuras, Copying Cameras or 48 power Table Top Telescopes. Save real money and get far better results. These K22 Aerial Camera units with lens and diaphragms can be easily removed from cone—Focal plane 10″ outside of cone. Clear front lens dia.—4″, rear 3⅝″. Wt. of Cone: 25 lbs. Diaphragm F/6 to F/22 (adjustable from 1″ to 3½″ by flexible shaft). Picture size: 9″ x 9″. Lens elements—4 (2 to brass cell). Carrying case wt.—26 lbs. Shutter not included. Shipping wt.—51 lbs.

Stock No. 85,059-V.......Used—$39.50 f.o.b. Utah
Above Lenses in cells—out of Cone and Diaphragm. Stock No. 70,190-V $22.50 Pstpd.

Power Plus Precision
3″ Astronomical Refractor

Up to 180 Power

An excellent telescope at an amazingly low price; standard 1¼″-diameter eyepieces: ½″ (90x) and 1″ (45x). Also achromatic Barlow lens—will double or triple the eyepiece powers, giving a range of 45x to 270x (under good conditions). Equatorial mount with counterbalance for fingertip control. 60″ hardwood tripod legs. Rack-and-pinion eyepiece holder of aluminum, brass and chrome gives smooth focusing. 6x optical finder telescope with crosshairs. Overall length about 40″. INCLUDES: Setting Circles and Pointers. Free Star Chart and Star Book. Shipping wt. 30 lbs.

Stock #85,032-V......................$125.00 f.o.b

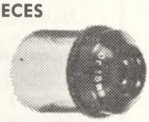
MAKE YOUR OWN POWERFUL ASTRONOMICAL TELESCOPE

GRIND YOUR OWN ASTRONOMICAL MIRROR

Kits contain mirror blank, tool, abrasives, diagonal mirror and eyepiece lenses. You build instruments ranging in value from $75.00 to hundreds of dollars.

Stock #	Mirror Dia.	Mirror Thickness	Price
70,003-V	4¼″	¾″	$ 7.50 ppd.
70,004-V	6″	1″	11.95 ppd.
70,005-V	8″	1⅜″	19.50 ppd.
70,006-V	10″	1¾″	30.75 f.o.b. Barrington
70,007-V	12½″	2⅛″	59.95 f.o.b. Barrington

ORTHOSCOPIC EYEPIECES



Wide, flat field—better correction under high magnification—excellent eye relief.

The orthoscopic eyepiece is one of the most important and best corrected eyepieces for astronomical work. These are of a four-element design, with coated lenses, and are standard 1¼″ outer diameter, precision made.

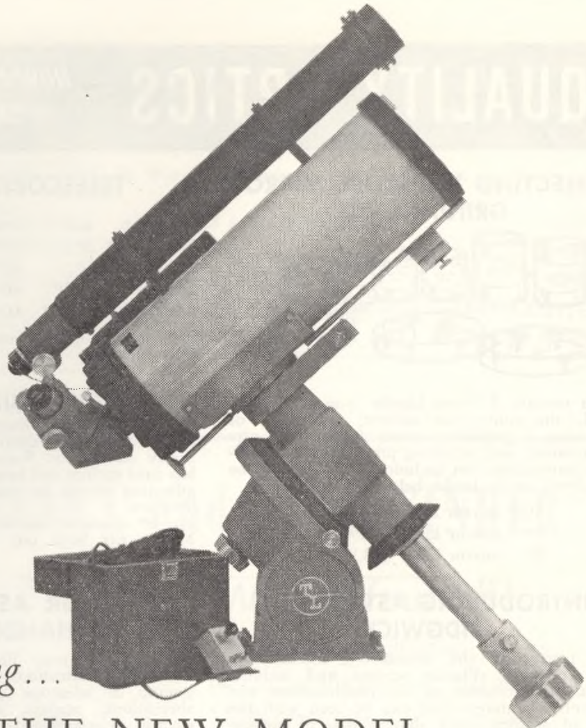
Stock #30,364-V	4 mm	$14.50 ppd.
Stock #30,404-V	6 mm	14.50 ppd.
Stock #30,405-V	12.5 mm	14.50 ppd.
Stock #30,406-V	18 mm	14.50 ppd.
Stock #30,407-V	25 mm	14.50 ppd.

MAIL COUPON FOR FREE CATALOG!

164 Pages! Over 1000 Bargains!
EDMUND SCIENTIFIC CO.,
Barrington, N.J.

Please send FREE CATALOG "V"
Name..
Address..
City......................Zone......State....................

ORDER BY STOCK NUMBER . SEND CHECK OR MONEY ORDER . SATISFACTION GUARANTEED!
EDMUND SCIENTIFIC CO., BARRINGTON, NEW JERSEY



Announcing…

THE NEW MODEL

For over a year Tinsley Laboratories has enjoyed the popularity of their 8-inch Cassegrain telescope. This popularity can only be the result of a high quality instrument. Tinsley has not stopped here, however. This was only the beginning. We are never satisfied with the best but always strive for something better. Through the year our engineers have been critically examining the 8-inch seeking improvements in design that will satisfy you, the discriminating astronomer. The hundreds of letters we have received from all over the world have been carefully studied for their helpful suggestions and comments, many of which have been put into practice. The result of these concerted efforts on your part and ours is the new Model B 8-inch Cassegrain telescope.

We haven't changed the appearance of the telescope to any great degree. We like it and we believe you do too. Looking carefully inside and out, you will soon become aware of its new features. We have replaced the aluminum tube with fiberglass for improved durability and thermal stability. It cannot scratch, dent or corrode. A new primary cell has been designed that provides the exacting adjustments so necessary for Cassegrain collimation. Its massive design further insures adequate protection for the primary mirror and maintains its position when the telescope is in transit. Carefully constructed, tapered light baffles have been added to the primary and secondary mirrors that produces the darkest field possible, a feature so important for deep sky work. An additional sliding tube counterweight balances any accessories mounted in the focal plane.

The mounting for the Model B has been extensively modified. To supply more power to the clock drive unit, friction between the R.A. bearings have been reduced to negligibility through the addition of precision ball bearings. For additional rigidity, the R.A. axis has been increased from 5 inches to 6½ inches in diameter. A remarkably smooth tangent arm declination slow motion has replaced the earlier complete gear arrangement. Its angular speed has been reduced from 4 degrees per revolution of the screw to ⅓ degree per revolution making possible the fine motions so necessary for astrophotography. A new variable speed D.C. motor has been added that provides 30 per cent more torque for further driving power and accuracy. Each motor is balanced for the smoothest possible motion.

New accessories are constantly being designed for the 8-inch telescope. These accessories maintain the telescope's reputation as one of the most versatile of its kind available. Among these accessories is a filar micrometer for double star work and lunar and planetary measurements, a solar diagonal allowing *full* aperture to be used safely, a 3-inch guiding refractor with illuminated crosshairs, an astrocamera for focal plane and eyepiece projection photographs, and a large assortment of eyepieces.

Your business is astronomy; ours is telescopes; so let's get together, shall we? Write for our comprehensive brochure today. We welcome visitors at any time to our laboratories.

TINSLEY LABORATORIES, INC.
DEPARTMENT ST-8
2448 SIXTH STREET BERKELEY 10, CALIFORNIA

CALENDAR 1964

Jan.

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

Feb.

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

Mar.

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

April

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

May

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

June

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

July

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

Aug.

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

Sept.

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

Oct.

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

Nov.

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

Dec.

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