THE OBSERVER'S HANDBOOK 1963

Fifty-fifth Year of Publication
THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 — Royal Charter 1903

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THE OBSERVER'S HANDBOOK 1963

EDITOR
RUTH J. NORTHCOTT

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252 COLLEGE STREET, TORONTO 2B, ONTARIO

CONTENTS

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THE OBSERVER'S HANDBOOK for 1963 is the 55th issue. The tables of the principal elements of the solar system and of the satellites have been revised to give the accepted values used in the national ephemerides; the inclination of the equator of each planet to its orbital plane has been added. Dimensions of Saturn's rings are included. The predictions for the minima of Algol are based on the period and epoch used previously; from recent observations, these may be of the order of three quarters of an hour *late*.

Cordial thanks are offered to those who assisted in the preparation of this volume, to those who are named and to David Crampton, Harlan Creighton, Barbara Gaizauskas, Isabel Williamson, and Dorothy Yane. Special thanks are due to Gordon E. Taylor and the British Astronomical Association, concerning the prediction of planetary appulses and occultations and to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of the times of maxima of the long-period variables.

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

RUTH J. NORTHCOTT

ANNIVERSARIES AND FESTIVALS, 1963

New Year's Day	Tue.	Jan. 1	Pentecost (Whit Sunday)		June 2
Epiphany	Sun.	Jan. 6	Trinity Sunday		June 9
Accession of Queen Elizabeth (1952)	Wed.	Feb. 6	Corpus Christi	Thu.	June 13
Septuagesima Sunday		Feb. 10	St. John Baptist (Mid-summer Day)	Mon.	June 24
Quinquagesima (Shrove Sunday)		Feb. 24	Dominion Day	Mon.	July 1
Ash Wednesday		Feb. 27	Birthday of Queen Mother Elizabeth (1900)	Sun.	Aug. 4
St. David	Fri.	Mar. 1	Labour Day	Mon.	Sept. 2
St. Patrick	Sun.	Mar. 17	Hebrew New Year (Rosh Hashanah)	Thu.	Sept. 19
Palm Sunday		Apr. 7	St. Michael (Michael-mas Day)	Sun.	Sept. 29
Good Friday		Apr. 12	Thanksgiving	Mon.	Oct. 14
Easter Sunday		Apr. 14	All Saints' Day	Fri.	Nov. 1
Birthday of Queen Elizabeth (1926)	Sun.	Apr. 21	Remembrance Day	Mon.	Nov. 11
St. George	Tue.	Apr. 23	St. Andrew	Sat.	Nov. 30
Rogation Sunday		May 19	First Sunday in Advent		Dec. 1
Victoria Day	Mon.	May 20	Christmas Day	Wed.	Dec. 25
Ascension Day	Thu.	May 23			

JULIAN DAY CALENDAR, 1963

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

Jan. 1	8,031	May 1	8,151	Sept. 1	8,274
Feb. 1	8,062	June 1	8,182	Oct. 1	8,304
Mar. 1	8,090	July 1	8,212	Nov. 1	8,335
Apr. 1	8,121	Aug. 1	8,243	Dec. 1	8,365

The Julian Day commences at noon. Thus J.D. 2,438,031.0 = 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

A, α Alpha	I, ι Iota	P, ρ Rho
B, β Beta	K, κ Kappa	Σ, σ Sigma
Γ, γ Gamma	Λ, λ Lambda	T, τ Tau
Δ, δ Delta	M, μ Mu	Υ, υ Upsilon
E, ϵ Epsilon	N, ν Nu	Φ, ϕ Phi
Z, ζ Zeta	Ξ, ξ Xi	X, χ Chi
H, η Eta	O, o 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. 2437208.7224 and period 2.8674 days as published in *Sky and Telescope*, 1961.

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 English Names with Abbreviations

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

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

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

1 Angstrom unit = 10^{-8} cm.
1 micron, μ = 10^{-4} cm. = 10^{4} A.
1 metre = 10^{2} cm. = 3.28084 feet
1 centimetre = 0.393700 inch
1 kilometre = 10^{5} cm. = 0.62137 miles
1 mile = 1.60935×10^{5} cm. = 1.60935 km.
1 astronomical unit = 1.49504×10^{13} cm. = 92,897,416 miles
1 light year = 9.463×10^{17} cm. = 5.880×10^{12} miles = 0.3069 parsecs
1 parsec = 30.84×10^{17} cm. = 19.16×10^{12} miles = 3.259 l.y.
1 megaparsec = 30.84×10^{23} cm. = 19.16×10^{18} miles = 3.259×10^{6} l.y.

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
Synodical month = 29*d* 12*h* 44*m*; sidereal month = 27*d* 07*h* 43*m*
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* 53*m*

The Earth

Equatorial radius, a = 3963.35 miles; flattening, c = (a − b)/a = 1/297.0
Polar radius, b = 3950.01 miles
1° of latitude = $69.057 - 0.349 \cos 2\phi$ miles (at latitude ϕ)
1° of longitude = $69.232 \cos \phi - 0.0584 \cos 3\phi$ miles
Mass of earth = 6.6×10^{21} tons; velocity of escape from $\oplus$ = 6.94 miles/sec.

Earth's Orbital Motion

Solar parallax = 8.″80; constant of aberration = 20.″47
Annual general precession = 50.″26; obliquity of ecliptic = 23° 26′ 40″ (1960)
Orbital velocity = 18.5 miles/sec.; parabolic velocity at $\oplus$ = 26.2 miles/sec.

Solar Motion

Solar apex, R.A. 18*h* 04*m*; Dec. + 31°
Solar velocity = 12.2 miles/sec.

The Galactic System

North pole of galactic plane R.A. 12*h* 49*m*, Dec. + 27.°4 (1950)
Centre of galaxy R.A. 17*h* 42.4*m*, Dec. −28° 55′ (1950) (zero pt. for new gal. coord.)
Distance to centre ~10,000 parsecs; diameter ~30.000 parsecs
Rotational velocity (at sun) ~ 262 km./sec.
Rotational period (at sun) ~ 2.2×10^{8} years
Mass ~ 2×10^{11} solar masses

External Galaxies

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

Radiation Constants

Velocity of light = 299,860 km./sec. = 186,324 miles/sec.
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512; log ratio = 0.4000
Radiation from a star of zero apparent magnitude = 2.4×10^{-6} metre candles
Total energy emitted by a star of zero absolute magnitude = 5×10^{25} horsepower

Miscellaneous

Constant of gravitation, G = 6.670×10^{-8} c.g.s. units
Mass of the electron, m = 9.1083×10^{-28} gm.; mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, h = 6.6234×10^{-27} erg. sec.
Loschmidt's number = 2.6872×10^{19} molecules/cu. cm. of gas at N.T.P.
Absolute temperature = T° K = T° C+273° = 5/9 (T° F+459°)
1 radian = 57°.2958 = 3437′.75 = 206,265″
π = 3.141,592,653,6
No. of square degrees in the sky = 41,253
1 gram = 0.03527 oz.

1963 EPHEMERIS OF THE SUN AT 0h U.T.

Date 1963	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.	Date 1963	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′		h m s	m s	° ′
Jan. 1	18 42 50	+ 3 08	−23 04.7	July 3	6 45 07	+ 3 55	+23 02.3
4	18 56 04	+ 4 32	−22 49.0	6	6 57 29	+ 4 28	+22 47.1
7	19 09 14	+ 5 53	−22 29.3	9	7 09 48	+ 4 57	+22 28.4
10	19 22 21	+ 7 10	−22 05.6	12	7 22 03	+ 5 23	+22 06.2
13	19 35 22	+ 8 21	−21 38.1	15	7 34 15	+ 5 45	+21 40.6
16	19 48 18	+ 9 27	−21 06.7	18	7 46 22	+ 6 02	+21 11.6
19	20 01 08	+10 28	−20 31.7	21	7 58 25	+ 6 16	+20 39.4
22	20 13 51	+11 22	−19 53.2	24	8 10 23	+ 6 24	+20 04.1
25	20 26 28	+12 09	−19 11.4	27	8 22 16	+ 6 27	+19 25.8
28	20 38 58	+12 49	−18 26.4	30	8 34 03	+ 6 24	+18 44.6
31	20 51 21	+13 22	−17 38.4				
				Aug. 2	8 45 44	+ 6 16	+18 00.6
Feb. 3	21 03 35	+13 47	−16 47.6	5	8 57 20	+ 6 02	+17 14.0
6	21 15 43	+14 05	−15 54.1	8	9 08 50	+ 5 42	+16 24.8
9	21 27 43	+14 15	−14 58.2	11	9 20 15	+ 5 18	+15 33.3
12	21 39 36	+14 18	−14 00.0	14	9 31 36	+ 4 49	+14 39.5
15	21 51 22	+14 15	−12 59.8	17	9 42 51	+ 4 14	+13 43.7
18	22 03 02	+14 05	−11 57.6	20	9 54 02	+ 3 36	+12 45.8
21	22 14 35	+13 49	−10 53.7	23	10 05 08	+ 2 52	+11 46.1
24	22 26 03	+13 27	− 9 48.3	26	10 16 11	+ 2 05	+10 44.8
27	22 37 25	+12 59	− 8 41.6	29	10 27 09	+ 1 14	+ 9 41.9
Mar. 2	22 48 42	+12 27	− 7 33.7	Sept. 1	10 38 04	+ 0 19	+ 8 37.7
5	22 59 54	+11 49	− 6 24.8	4	10 48 56	− 0 38	+ 7 32.2
8	23 11 03	+11 08	− 5 15.1	7	10 59 46	− 1 38	+ 6 25.6
11	23 22 07	+10 23	− 4 04.9	10	11 10 34	− 2 40	+ 5 18.1
14	23 33 09	+ 9 35	− 2 54.1	13	11 21 21	− 3 42	+ 4 09.8
17	23 44 08	+ 8 44	− 1 43.1	16	11 32 07	− 4 46	+ 3 00.7
20	23 55 05	+ 7 52	− 0 32.0	19	11 42 53	− 5 50	+ 1 51.2
23	0 06 01	+ 6 58	+ 0 39.2	22	11 53 39	− 6 53	+ 0 41.3
26	0 16 57	+ 6 04	+ 1 50.1	25	12 04 26	− 7 56	− 0 28.8
29	0 27 52	+ 5 10	+ 3 00.6	28	12 15 14	− 8 58	− 1 39.0
Apr. 1	0 38 47	+ 4 15	+ 4 10.7	Oct. 1	12 26 03	− 9 58	− 2 49.0
4	0 49 43	+ 3 22	+ 5 20.0	4	12 36 55	−10 56	− 3 58.8
7	1 00 41	+ 2 29	+ 6 28.4	7	12 47 50	−11 50	− 5 08.1
10	1 11 39	+ 1 38	+ 7 35.9	10	12 58 49	−12 42	− 6 16.9
13	1 22 41	+ 0 50	+ 8 42.1	13	13 09 52	−13 28	− 7 24.9
16	1 33 45	+ 0 05	+ 9 47.1	16	13 20 59	−14 11	− 8 32.1
19	1 44 52	− 0 38	+10 50.7	19	13 32 12	−14 48	− 9 38.1
22	1 56 03	− 1 16	+11 52.6	22	13 43 30	−15 19	−10 43.0
25	2 07 19	− 1 51	+12 52.9	25	13 54 54	−15 45	−11 46.3
28	2 18 38	− 2 21	+13 51.2	28	14 06 24	−16 05	−12 48.1
				31	14 18 00	−16 18	−13 48.0
May 1	2 30 02	− 2 47	+14 47.4				
4	2 41 30	− 3 08	+15 41.4	Nov. 3	14 29 44	−16 24	−14 46.0
7	2 53 03	− 3 25	+16 33.1	6	14 41 35	−16 23	−15 41.8
10	3 04 42	− 3 36	+17 22.3	9	14 53 33	−16 14	−16 35.3
13	3 16 25	− 3 42	+18 08.9	12	15 05 39	−15 57	−17 26.2
16	3 28 14	− 3 43	+18 52.7	15	15 17 53	−15 33	−18 14.5
19	3 40 08	− 3 39	+19 33.7	18	15 30 15	−15 01	−19 00.0
22	3 52 07	− 3 30	+20 11.8	21	15 42 44	−14 22	−19 42.3
25	4 04 11	− 3 15	+20 46.7	24	15 55 20	−13 35	−20 21.5
28	4 16 19	− 2 57	+21 18.4	27	16 08 03	−12 42	−20 57.2
31	4 28 31	− 2 34	+21 46.7	30	16 20 53	−11 42	−21 29.4
June 3	4 40 48	− 2 07	+22 11.7	Dec. 3	16 33 49	−10 36	−21 57.9
6	4 53 07	− 1 38	+22 33.2	6	16 46 50	− 9 24	−22 22.7
9	5 05 29	− 1 05	+22 51.1	9	16 59 57	− 8 07	−22 43.5
12	5 17 54	− 0 30	+23 05.4	12	17 13 07	− 6 46	−23 00.3
15	5 30 21	+ 0 07	+23 16.1	15	17 26 22	− 5 21	−23 13.1
18	5 42 49	+ 0 46	+23 23.0	18	17 39 39	− 3 54	−23 21.6
21	5 55 18	+ 1 25	+23 26.3	21	17 52 58	− 2 25	−23 26.0
24	6 07 47	+ 2 05	+23 25.9	24	18 06 17	− 0 55	−23 26.1
27	6 20 15	+ 2 43	+23 21.7	27	18 19 36	+ 0 34	−23 22.0
30	6 32 42	+ 3 20	+23 13.8	30	18 32 54	+ 2 02	−23 13.7

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

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

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

PHYSICAL ELEMENTS

Object	Equatorial Diameter miles	Oblateness	Mass ⊕ = 1	Mean Density water = 1	Surface Gravity ⊕ = 1	Rotation Period	Inclination of Equator to Orbit °	Albedo*
☉ Sun	864,000	0	333,000	1.41	27.9	25d–35d†		
☾ Moon	2,160	0	0.0123	3.34	0.16	27d 07h 43m	6.7	0.067
☿ Mercury	3,100	0	0.056	5.13	0.36	88d	?	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	23d 56h 04m	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?	?	6.39d ?	?	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	Revolution Period h	Revolution Period m	Orbit Incl. ° ‡	Discovery
SATELLITE OF THE EARTH									
Moon	−12.7	2160	238,900	...	27	07	43	6.7§	
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.

§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.

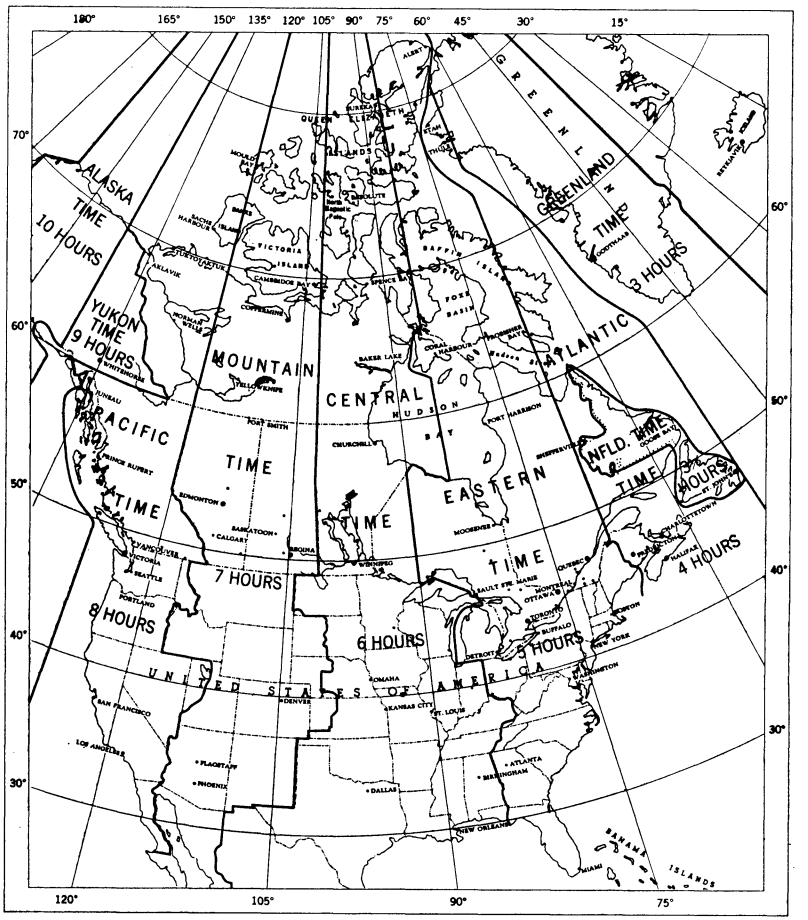
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

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 1962 will be about 34 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	+31M	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°		Latitude 36°		Latitude 40°		Latitude 44°		Latitude 46°		Latitude 48°		Latitude 50°		Latitude 54°	
		Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
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°		Latitude 36°		Latitude 40°		Latitude 44°		Latitude 46°		Latitude 48°		Latitude 50°		Latitude 54°	
		Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset	Sunrise	Sunset
		h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m	h m
March	2	6 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
June	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
	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, 1963 (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		11 16	23 09	11 21	23 06	11 25	23 03	11 30	22 59	11 36	22 56
2	☽	11 52	.. ..	11 54	.. ..	11 55	.. ..	11 56	.. ..	11 57	.. ..
3		12 28	00 15	12 26	00 15	12 24	00 16	12 21	00 16	12 19	00 17
4		13 05	01 21	12 59	01 24	12 54	01 28	12 47	01 33	12 41	01 38
5		13 44	02 27	13 36	02 34	13 27	02 42	13 16	02 51	13 06	03 00
6		14 27	03 34	14 16	03 43	14 05	03 55	13 50	04 08	13 35	04 21
7		15 14	04 40	15 01	04 52	14 47	05 05	14 30	05 22	14 12	05 38
8		16 06	05 44	15 52	05 57	15 36	06 12	15 17	06 31	14 58	06 49
9	○	17 02	06 43	16 49	06 56	16 33	07 12	16 14	07 32	15 54	07 51
10		18 01	07 36	17 49	07 49	17 34	08 04	17 16	08 22	16 58	08 41
11		19 01	08 23	18 50	08 34	18 37	08 48	18 22	09 04	18 07	09 20
12		20 00	09 05	19 52	09 13	19 41	09 25	19 29	09 38	19 18	09 50
13		20 58	09 41	20 51	09 47	20 44	09 56	20 36	10 06	20 27	10 15
14		21 53	10 13	21 50	10 18	21 46	10 23	21 41	10 30	21 36	10 36
15		22 48	10 43	22 48	10 46	22 47	10 48	22 45	10 51	22 44	10 54
16		23 43	11 12	23 45	11 12	23 47	11 12	23 48	11 11	23 51	11 11
17	☾	.. ..	11 41	.. ..	11 39	.. ..	11 35	.. ..	11 31	.. ..	11 28
18		00 37	12 11	00 42	12 06	00 47	12 00	00 52	11 53	00 58	11 46
19		01 33	12 43	01 39	12 36	01 47	12 27	01 56	12 16	02 05	12 06
20		02 29	13 19	02 37	13 09	02 48	12 58	03 01	12 44	03 13	12 30
21		03 26	13 59	03 37	13 47	03 50	13 34	04 06	13 17	04 21	13 00
22		04 24	14 45	04 36	14 31	04 51	14 16	05 10	13 58	05 27	13 39
23		05 21	15 37	05 34	15 23	05 50	15 07	06 10	14 47	06 30	14 27
24		06 16	16 35	06 29	16 21	06 45	16 07	07 04	15 47	07 24	15 27
25	●	07 07	17 38	07 20	17 26	07 34	17 13	07 52	16 55	08 09	16 38
26		07 55	18 44	08 05	18 35	08 17	18 23	08 31	18 10	08 45	17 57
27		08 37	19 51	08 46	19 45	08 54	19 37	09 05	19 27	09 15	19 18
28		09 17	20 59	09 22	20 56	09 27	20 51	09 35	20 46	09 41	20 41
29		09 54	22 07	09 56	22 07	09 58	22 05	10 01	22 05	10 03	22 04
30		10 30	23 14	10 29	23 16	10 27	23 19	10 26	23 23	10 25	23 27
31		11 06	.. ..	11 02	.. ..	10 57	.. ..	10 52	.. ..	10 47	.. ..
Feb.											
1	☽	11 44	00 20	11 37	00 25	11 29	00 32	11 19	00 40	11 10	00 48
2		12 25	01 26	12 16	01 34	12 04	01 45	11 51	01 57	11 38	02 08
3		13 09	02 31	12 58	02 42	12 44	02 55	12 28	03 11	12 11	03 26
4		13 59	03 35	13 46	03 47	13 31	04 02	13 11	04 20	12 53	04 38
5		14 52	04 34	14 39	04 47	14 23	05 03	14 03	05 22	13 44	05 41
6		15 49	05 28	15 37	05 41	15 21	05 57	15 02	06 16	14 44	06 34
7		16 48	06 16	16 37	06 29	16 23	06 43	16 06	07 00	15 50	07 17
8	○	17 47	07 00	17 38	07 10	17 26	07 22	17 13	07 36	17 00	07 51
9		18 45	07 37	18 39	07 46	18 30	07 55	18 20	08 06	18 10	08 18
10		19 43	08 12	19 38	08 17	19 33	08 24	19 26	08 32	19 19	08 39
11		20 38	08 43	20 36	08 46	20 34	08 50	20 31	08 54	20 28	08 59
12		21 33	09 12	21 34	09 13	21 35	09 14	21 35	09 15	21 36	09 16
13		22 27	09 41	22 31	09 40	22 34	09 38	22 38	09 35	22 43	09 33
14		23 21	10 10	23 27	10 07	23 34	10 01	23 42	09 56	23 50	09 50
15		.. ..	10 42	.. ..	10 35	.. ..	10 27	.. ..	10 18	.. ..	10 09
16	☾	00 17	11 15	00 25	11 06	00 35	10 56	00 45	10 43	00 57	10 31
17		01 13	11 52	01 23	11 41	01 35	11 29	01 49	11 13	02 04	10 58
18		02 10	12 34	02 21	12 22	02 36	12 07	02 53	11 49	03 10	11 31
19		03 06	13 22	03 19	13 09	03 35	12 53	03 54	12 34	04 13	12 14
20		04 01	14 17	04 15	14 04	04 31	13 48	04 51	13 28	05 11	13 08
21		04 54	15 18	05 07	15 05	05 23	14 50	05 41	14 32	06 00	14 14
22		05 44	16 23	05 55	16 13	06 09	16 00	06 25	15 44	06 40	15 29
23	●	06 29	17 31	06 38	17 23	06 49	17 14	07 02	17 03	07 14	16 52
24		07 11	18 41	07 17	18 36	07 25	18 30	07 33	18 23	07 42	18 17
25		07 50	19 51	07 53	19 49	07 57	19 47	08 02	19 45	08 06	19 42
26		08 28	21 00	08 28	21 02	08 28	21 04	08 28	21 06	08 28	21 08
27		09 05	22 09	09 02	22 15	08 58	22 20	08 55	22 26	08 50	22 33
28		09 43	23 18	09 37	23 26	09 30	23 34	09 22	23 45	09 13	23 56

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

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

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

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

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

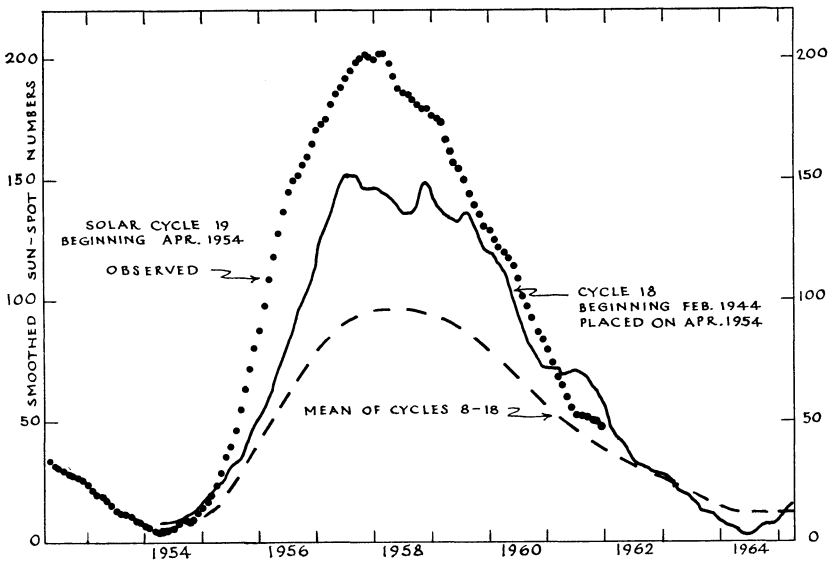
THE SUN AND PLANETS FOR 1963

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 1963

Elong. East—Evening Star			Elong. West—Morning Star		
Date	Dist.	Mag.	Date	Dist.	Mag.
Jan. 4	19°	−0.3	Feb. 13	26°	+0.2
Apr. 25	20	+0.4	June 13	23	+0.7
Aug. 24	27	+0.5	Oct. 5	18	−0.1
Dec. 18	20	−0.2			

The most favourable elongations to observe are: in the evening, Apr. 25, and in the morning, Oct. 5.

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.

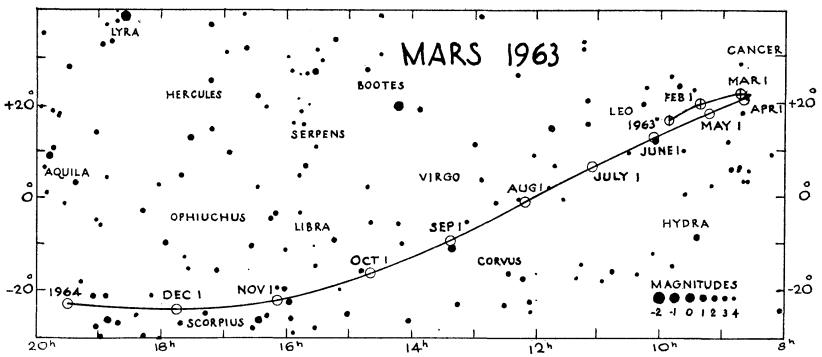
On Jan. 1, 1963, Venus is a brilliant object in the morning sky, crossing the meridian about 3 hours before the sun; its declination is −15°, and its stellar magnitude is −4.3. Greatest western elongation occurs on Jan. 22, after which the planet approaches the sun, reaching superior conjunction on Aug. 29. Then it moves east of the sun and is an evening star for the rest of the year, but poorly placed for observation. On Dec. 31 it is in declination −20° and transits the meridian about 2 hours after the sun. Its stellar magnitude is −3.4. Because Venus is poorly placed for observation during much of the year, the customary map of its path among the stars is omitted.

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 Dec. 30, 1960; the next is on Feb. 4, 1963.

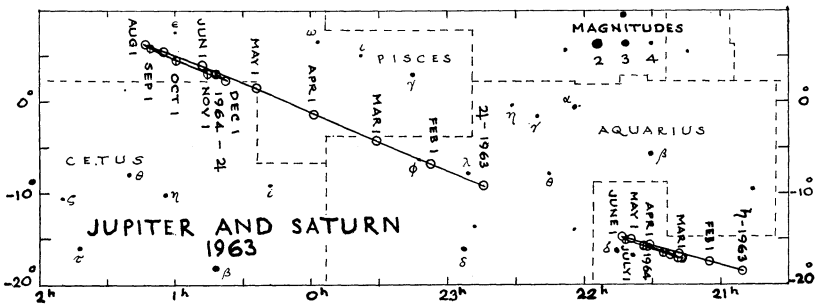
On Jan. 1, 1963, Mars is retrograding in Leo (direct motion resumes on Mar. 17); it rises shortly after sunset and is visible the rest of the night. Its stellar magnitude at this time is -0.4, which brightens to -1.0 at opposition on Feb. 4. It is in the evening sky for the rest of the year. On Dec. 31 it is in declination $-23°$, in Sagittarius, but is following the sun by less than an hour and is thus difficult to observe.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is $2\frac{1}{2}$ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). 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, 1963, Jupiter is in the early evening sky in Aquarius; its stellar magnitude is −1.8. On Mar. 16 it reaches conjunction with the sun and moves into the morning sky. It comes into opposition with the sun on Oct. 8 when it is visible all night. It is then in Pisces, with stellar magnitude −2.5. It retrogrades from Aug. 10 to Dec. 5 (see map; circles with vertical lines denote retrograde motion). On Dec. 31 it is still in Pisces, in the southern sky at sunset in declination −3°; its stellar magnitude has faded to −2.1.



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 1963 the northern face of the rings is visible, with a tilt fluctuating between 18° and 13°; the ellipse of the outer edge of the rings has an apparent major axis of about 40″ and a minor axis of about 10″.

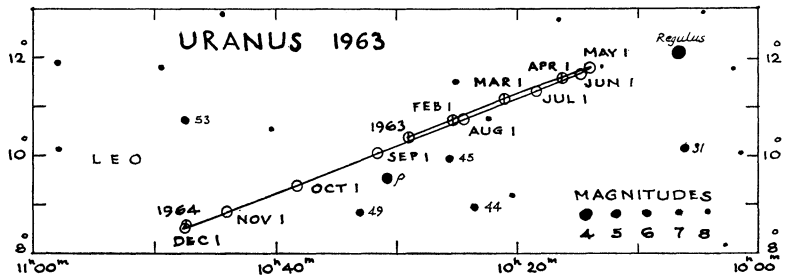
On Jan. 1, 1963, Saturn is low in the evening sky in Capricornus; by Feb. 3 it is in conjunction with the sun. It reaches opposition with the sun on Aug. 13, when its stellar magnitude is +0.5 and it is visible all night. It retrogrades from June 3 to Oct. 21 (see map; circles with vertical lines denote retrograde motion). On Dec. 31 it is still in Capricornus and is in the south-west at sunset; stellar magnitude is +1.0.

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.

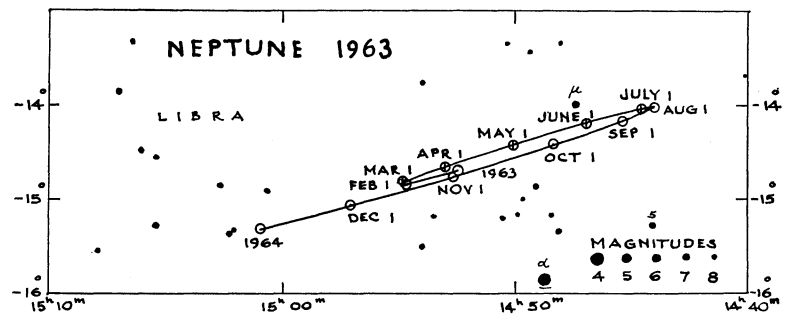
During 1963 Uranus is in Leo (see map). At the beginning of the year it rises before midnight and is retrograding (direct motion is resumed on May 9). It is



in opposition with the sun on Feb. 22, and is above the horizon all night; its apparent diameter is 4.0″ and its stellar magnitude is +5.7. When conjunction occurs on Aug. 29 its magnitude has faded to +5.9. It is in the morning sky the rest of the year, and resumes retrograde motion commencing on Dec. 16. Mars passes close to the planet during the evening of June 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 1963 Neptune is in Libra (see map). It is in opposition to the sun on May 5, 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 of from 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 8 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 16 to July 26.

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. 1, at which time its astrometric position is R.A. $11^h\ 11^m$, Dec. $+20°\ 23'$.

THE SKY MONTH BY MONTH

By J. F. Heard

THE SKY FOR JANUARY 1963

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 43m to 20h 55m and its Decl. changes from 23° 05′ S. to 17° 22′ S. The equation of time changes from −3m 08s to −13m 31s. The earth is in perihelion or nearest the sun on the 4th. There is an annular eclipse of the sun on the 25th invisible in North America. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 20h 30m, Decl. 17° 06′ S., and transits at 12h 49m. It is at greatest eastern elongation on the 4th, and at that time may be seen low in the south-west just after sunset. This is only a moderately favourable elongation, Mercury's altitude being about 12° at sunset. By the 20th it is at inferior conjunction.

Venus on the 15th is in R.A. 16h 26m, Decl. 17° 45′ S., mag. −4.2, and transits at 8h 51m. It is a morning star of great brilliance, visible for several hours before sunrise in the south-east. Greatest western elongation is on the 22nd.

Mars on the 15th is in R.A. 9h 44m, Decl. 18° 03′ N., mag. −0.7, and transits at 2h 08m. In Leo, unusually bright as it approaches opposition, it rises in the early evening and is visible all the rest of the night.

Jupiter on the 15th is in R.A. 22h 54m, Decl. 8° 12′ S., mag. −1.7, and transits at 15h 17m. In Aquarius, it is past the meridian at sunset and sets about three hours later. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 20h 57m, Decl. 18° 04′ S. and transits at 13h 19m. It is too close to the sun for easy observation, being very low in the south-west at sunset.

Uranus on the 15th is in R.A. 10h 28m, Decl. 10° 30′ N. and transits at 2h 51m. It rises about three hours after sunset.

Neptune on the 15th is in R.A. 14h 54m, Decl. 14° 46′ S. and transits at 7h 17m. It rises about two hours after midnight.

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

JANUARY E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 19h 00m	Sun's Selen. Colong. 0h U.T.
	d	h	m	h m		°
Tue.	1		.....	22 54	34102	336.19
Wed.	2		♀ at perihelion.....		4201*	348.36
		20	02 ☽ First Quarter.....			
Thu.	3		Quadrantid meteors.....		42103	0.52
Fri.	4		⊕ at perihelion.....	19 43	40123	12.67[b]
			Dist. from ☉, 91,343,000 mi.			
		3	☾ at perigee. Dist. from ⊕, 229,800 mi.			
		3	☿ greatest elongation E., 19°.....			
		20	☍ Pallas ☉ See p. 65.....			
			Dist. from ⊕, 132,800,000 mi.			
Sat.	5		.....		41023	24.82
Sun.	6		.....		42301	36.96
Mon.	7		.....	16 33	432O*	49.09
Tue.	8		☿ at ♌.....		34102	61.22
Wed.	9	18	09 ♍ Full Moon. Penumbral eclipse, see p. 61		3201*	73.35
Thu.	10	21	☿ stationary in R.A.....	13 22	21034	85.48
Fri.	11		.....		O2134	97.60[l]
Sat.	12	10	☌♂☾ ♂ 2° N.....		1O234	109.73
Sun.	13		☿ at perihelion.....	10 11	23O14	121.86
		6	☌♁☾ ♁ 2° S.....			
Mon.	14		.....		32104	134.00
Tue.	15		.....		31024	146.14
Wed.	16		.....	7 01	d3O14	158.28
Thu.	17	3	☾ at apogee. Dist. from ⊕, 251,300 mi.		d2103	170.44
		15	35 ☾ Last Quarter.....			
Fri.	18		.....		4O213	182.59[b]
Sat.	19	3	☌♆☾ ♆ 4° S.....	3 50	41023	194.76
Sun.	20	6	☌☿☉ inferior.....		42301	206.93
		13	Juno stationary in R.A.....			
Mon.	21	13	☌♀☾ ♀ 0.1° S.....		4321O	219.10
Tue.	22	7	Ceres stationary in R.A.....	0 40	d43O2	231.28
		22	♀ greatest elongation W., 47°.....			
Wed.	23		☿ greatest hel. lat. N.....		43O2*	243.47
			♀ greatest hel. lat. N.....			
Thu.	24		.....	21 29	42103	255.66[l]
Fri.	25	8	42 ♍ New Moon. Eclipse of ☉, see p. 61		4O13*	267.85
Sat.	26		.....		1O423	280.04
Sun.	27		.....	18 18	2O314	292.23
Mon.	28	2	☌♃☾ ♃ 3° N.....		32104	304.42
Tue.	29	2	☾ at perigee. Dist. from ⊕, 228,500 mi.		3O124	316.61
Wed.	30		.....	15 08	3O24*	328.79
Thu.	31	16	☿ stationary in R.A.....		21034	340.96[b]

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Jan. 11, +5.05°; Jan. 24, −5.43°. [b]Jan. 4, +6.74°; Jan. 18, −6.86°; Jan. 31, +6.72°.

THE SKY FOR FEBRUARY 1963

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

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

The Sun—During February the sun's R.A. increases from 20h 55m to 22h 45m and its Decl. changes from 17° 22′ S. to 7° 56′ S. The equation of time changes from −13m 31s to a minimum of −14m 18s on the 12th and then to −12m 38s 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 07m, Decl. 20° 04′ S., and transits at 10h 30m. It is at greatest western elongation on the 13th, and so at this time it may be seen low in the south-east just before sunrise. Mercury's altitude is about 11° at sunrise, so that this is not a favourable elongation.

Venus on the 15th is in R.A. 18h 43m, Decl. 20° 43′ S., mag. −3.8, and transits at 9h 06m. It is a morning star of great brilliance visible in the south-east for two or more hours before sunrise.

Mars on the 15th is in R.A. 8h 59m, Decl. 21° 48′ N., mag. −0.9, and transits at 23h 15m. In Cancer, it rises at about sunset and is visible all night. It is nearest to the earth on the 2nd and in opposition on the 4th. At this time it is unusually bright.

Jupiter on the 15th is in R.A. 23h 19m, Decl. 5° 33′ S., mag. −1.6, and transits at 13h 40m. In Aquarius, it is well down in the west at sunset and sets soon after. 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 12m, Decl. 17° 03′ S., and transits at 11h 32m. It is too close to the sun for observation, being in conjunction on the 3rd.

Uranus on the 15th is in R.A. 10h 23m, Decl. 10° 56′ N., mag. + 5.7, and transits at 0h 45m. It rises about at sunset. Opposition is on the 22nd.

Neptune on the 15th is in R.A. 14h 55m, Decl. 14° 50′ S., and transits at 5h 16m. 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. 18h 30m	Sun's Selen. Colong. 0h U.T.
					h m		°
Fri.	1	3	50	☽ First Quarter		O134*	353.13[b]
Sat.	2	22		♂ nearest ⊕. Dist. from ⊕, 62,280,000 mi.	11 57	1O423	5.29
Sun.	3	4		☌♄☉		24O31	17.45
		23		Vesta stationary in R.A.			
Mon.	4			□♆☉ west			
		7		☍☌☉ Dist. from ⊕, 62,300,000 mi.		4321O	29.59
Tue.	5				8 47	43O12	41.74
Wed.	6					431O2	53.88[l]
Thu.	7					d42O*	66.01
Fri.	8	1		☌☌☾ ♂ 3° N.	5 36	42O13	78.15
		9	52	☍ Full Moon			
Sat.	9	12		☌♁☾ ♁ 2° S.		41O23	90.28
		23		Pallas stationary in R.A.			
Sun.	10					42O13	102.42
Mon.	11				2 26	2134O	114.55
Tue.	12					3O214	126.69
Wed.	13	10		☿ greatest elongation W., 26°	23 15	31O24	138.84
		23		☾ at apogee. Dist. from ⊕, 251,600 mi.			
Thu.	14			♂ greatest hel. lat. N.		23O14	150.99[b]
Fri.	15	11		☌♆☾ ♆ 3° S.		2O34*	163.14
Sat.	16			☿ at ♉	20 05	1O234	175.30
		12	39	☾ Last Quarter			
		14		♆ stationary in R.A.			
Sun.	17					dO134	187.47
Mon.	18					213O4	199.64
Tue.	19				16 54	3O214	211.82
Wed.	20	10		☌♀☾ ♀ 0.8° N.		314O2	224.01[l]
Thu.	21					423O1	236.20
Fri.	22	1		☌☿☾ ☿ 0.1° S.	13 43	421O3	248.40
		10		☍♁☉ Dist. from ⊕, 1,609,000,000 mi.			
		14		☌♄☾ ♄ 0.7° N.			
Sat.	23	21	06	● New Moon		41O23	260.60
Sun.	24	21		☌♃☾ ♃ 3° N.		4O123	272.80
Mon.	25	19		☾ at perigee. Dist. from ⊕, 225,000 mi.	10 33	4213O	285.00
Tue.	26			☿ at aphelion		43O1*	297.20
Wed.	27						309.40
Thu.	28	4		☌☿♄ ☿ 0.8° S.	7 22		321.60[b]

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

[l]Feb. 6, +4.98°; Feb. 20, −6.62°. [b]Feb. 1, +6.72°; Feb. 14, −6.79°; Feb. 28, +6.65°.

THE SKY FOR MARCH 1963

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

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

The Sun—During March the sun's R.A. increases from 22h 45m to 0h 39m and its Decl. changes from 7° 56′ S. to 4° 11′ N. The equation of time changes from −12m 38s to −4m 15s. On the 21st at 3h 20m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries, and spring commences. This is the vernal equinox. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 22h 48m, Decl. 10° 02′ S., and transits at 11h 22m. It is too close to the sun all month for observation; superior conjunction is on the 30th.

Venus on the 15th is in R.A. 20h 58m, Decl. 16° 46′ S., mag. −3.6, and transits at 9h 31m. It is a brilliant morning star visible in the south-east for about two hours before sunrise.

Mars on the 15th is in R.A. 8h 35m, Decl. 22° 27′ N., mag. −0.2, and transits at 21h 03m. In Cancer, still very bright, it is well up at sunset and is visible most of the night. On the 17th it is stationary in right ascension and resumes eastward motion among the stars.

Jupiter on the 15th is in R.A. 23h 44m, Decl. 2° 54′ S., mag. −1.6, and transits at 12h 14m. It is too close to the sun for observation, being in conjunction on the 16th.

Saturn on the 15th is in R.A. 21h 24m, Decl. 16° 08′ S., mag. +1.0, and transits at 9h 55m. In Capricornus, it rises just before the sun. Venus passes a degree north of it on the 20th.

Uranus on the 15th is in R.A. 10h 19m, Decl. 11° 22′ N., and transits at 22h 47m. It is well up in the east at sunset.

Neptune on the 15th is in R.A. 14h 54m, Decl. 14° 45′ S., and transits at 3h 25m. 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		Sun's Selen. Colong. 0h U.T.
					h m		°
Fri.	1	23		☌ ☿ ☉ Dist. from ⊕, 2,985,000,000 mi.			333.79
Sat.	2	7		☌ Ceres ☉ See p. 65			345.97
				Dist. from ⊕, 147,600,000 mi.			
		12	18	☽ First Quarter			
Sun.	3				4 12		358.14
Mon.	4						10.31
Tue.	5						22.48[l]
Wed.	6	17		☌ ♂ ☾ ♂ 3° N.	1 01		34.64
Thu.	7						46.79
Fri.	8	17		☌ ♃ ☾ ♃ 2° S.	21 51		58.94
Sat.	9						71.09
Sun.	10	2	49	♍ Full Moon			83.24
		3		☌ Juno ☉ See p. 65			
				Dist. from ⊕, 163,800,000 mi.			
Mon.	11				18 40		95.39
Tue.	12						107.54
Wed.	13	15		☾ at apogee. Dist. from ⊕, 252,200 mi.			119.69
Thu.	14	18		☌ Ψ ☾ Ψ 3° S.	15 29		131.84[b]
Fri.	15	0		☌ Vesta ☉ See p. 65			144.00
				Dist. from ⊕, 122,600,000 mi.			
Sat.	16	17		☌ ♀ ☉			156.17
Sun.	17	7		♂ stationary in R.A.	12 19		168.34
Mon.	18			☿ greatest hel. lat. S.			180.52
		7	08	☾ Last Quarter			
Tue.	19						192.70
Wed.	20			♀ at ♉	9 08		204.89
		18		☌ ♀ ♄ ♀ 0.9° N.			
Thu.	21	3	20	☉ enters ♈. Spring commences			217.09[l]
Fri.	22	5		☌ ♄ ☾ ♄ 1° N.			229.29
		8		☌ ♀ ☾ ♀ 2° N.			
Sat.	23			♂ at aphelion	5 57		241.50
Sun.	24						253.71
Mon.	25	7	10	♍ New Moon			265.93
Tue.	26	3		☾ at perigee. Dist. from ⊕, 222,600 mi.	2 47		278.15
Wed.	27						290.37[b]
Thu.	28				23 36		302.58
Fri.	29						314.79
Sat.	30	17		☌ ☿ ☉ superior			327.00
Sun.	31	22	15	☽ First Quarter	20 25		339.20

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 Feb. 27 and May 4.

[l]Mar. 5, +6.08°; Mar. 21, −7.62°. [b]Mar. 14, −6.63°; Mar. 27, +6.54°.

THE SKY FOR APRIL 1963

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 39m to 2h 30m and its Decl. changes from 4° 11′ N. to 14° 47′ N. The equation of time changes from −4m 15s to +2m 47s, being zero on the 16th. 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 27m, Decl. 16° 10′ N., and transits at 13h 00m. Greatest eastern elongation is on the 25th, and so for some days at this time Mercury may be seen low in the west just after sunset. This is a good elongation, Mercury's altitude being about 19° at sunset.

Venus on the 15th is in R.A. 23h 22m, Decl. 5° 30′ S., mag. −3.4, and transits at 9h 52m. It is a morning star visible low in the east for about an hour before sunrise.

Mars on the 15th is in R.A. 8h 52m, Decl. 20° 14′ N., mag. +0.5, and transits at 19h 20m. Now declining appreciably in brightness, it is in Cancer, near the meridian at sunset, and sets at about midnight.

Jupiter on the 15th is in R.A. 0h 11m, Decl. 0° 02′ N., mag. −1.6, and transits at 10h 39m. It is a morning star but too close to the sun for easy observation. Venus passes less than a degree south of it on the 28th.

Saturn on the 15th is in R.A. 21h 36m, Decl. 15° 19′ S., mag . +1.0, and transits at 8h 04m. In Capricornus, it rises about two hours before the sun.

Uranus on the 15th is in R.A. 10h 15m, Decl. 11° 43′ N., and transits at 20h 41m. It is approaching the meridian at sunset.

Neptune on the 15th is in R.A. 14h 52m, Decl. 14° 33′ S., and transits at 1h 21m. 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		Sun's Selen. Colong. 0h U.T.
					h m		°
Mon.	1			.....			351.39[1]
Tue.	2			.....			3.58
Wed.	3	0		☌☌☾ ♂ 2° N.....	17 15		15.77
Thu.	4	21		☌♁☾ ♁ 2° S.....			27.94
Fri.	5			.....			40.12
Sat.	6			☿ at ♌.....	14 04		52.29
Sun.	7			.....			64.45
Mon.	8	19	57	☍ Full Moon.....			76.62
Tue.	9	22		☾ at apogee. Dist. from ⊕, 252,500 mi.	10 53		88.78
Wed.	10			.....			100.95[2]
Thu.	11			☿ at perihelion.....			113.12
		0		☌Ψ☾ Ψ 3° S.....			
Fri.	12			.....	7 43		125.29
Sat.	13			.....			137.46
Sun.	14			.....			149.64
Mon.	15			.....	4 32		161.82
Tue.	16	21	53	☾ Last Quarter.....			174.01
Wed.	17			.....			186.21
Thu.	18	18		☌♄☾ ♄ 1° N.....	1 21		198.41[1]
Fri.	19			.....			210.62
Sat.	20			.....	22 10		222.83
Sun.	21			☿ greatest hel. lat. N.....			235.06
		4		☌♀☾ ♀ 3° N.....			
		16		☌♃☾ ♃ 4° N.....			
Mon.	22			Lyrid meteors.....			247.28
		20		Ceres stationary in R.A.....			
Tue.	23	14		☾ at perigee. Dist. from ⊕, 221,800 mi.	19 00		259.52[2]
		15	29	● New Moon.....			
Wed.	24			♀ at aphelion.....			271.75
		22		☌☿☾ ☿ 7° N.....			
Thu.	25	21		☿ greatest elongation E., 20°.....			283.98
Fri.	26	18		Juno stationary in R.A.....	15 49		296.22
Sat.	27			.....			308.45
Sun.	28	12		☌♀♃ ♀ 0.6° S.....			320.67
Mon.	29			.....	12 38		332.89
Tue.	30	10	08	☽ First Quarter.....			345.10[1]
		21		☌☌☾ ♂ 0.2° N.....			

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 Feb. 27 and May 4.

[1]Apr. 1, +7.13°; Apr. 18, −7.94°; Apr. 30, +7.48°. [2]Apr. 10, −6.55°; Apr. 23, + 6.49°.

THE SKY FOR MAY 1963

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 30m to 4h 33m and its Decl. changes from 14° 47′ N. to 21° 55′ N. The equation of time changes from +2m 47s to a maximum of +3m 44s on the 15th and then to +2m 25s 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. 3h 44m, Decl. 19° 49′ N., and transits at 12h 12m. It is too close to the sun all month for observation, inferior conjunction being on the 17th.

Venus on the 15th is in R.A. 1h 36m, Decl. 8° 07′ N., mag. −3.3, and transits at 10h 08m. It is a morning star visible low in the east for about an hour before sunrise.

Mars on the 15th is in R.A. 9h 36m, Decl. 16° 11′ N., mag. +1.0, and transits at 18h 05m. Still declining rapidly in brightness, it is in Leo, west of the meridian at sunset. On the night of May 31st–June 1 it passes about 1° north of Regulus.

Jupiter on the 15th is in R.A. 0h 36m, Decl. 2° 36′ N., mag. −1.7, and transits at 9h 06m. In Pisces, near the vernal equinox, it rises about two hours before the sun. 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 42m, Decl. 14° 52′ S., mag. +1.0, and transits at 6h 12m. In Capricornus, it is well up towards the meridian by sunrise.

Uranus on the 15th is in R.A. 10h 14m, Decl. 11° 47′ N. and transits at 18h 42m. It is a little past the meridian at sunset.

Neptune on the 15th is in R.A. 14h 49m, Decl. 14° 18′ S., mag. +7.7, and transits at 23h 16m. It is low in the south-east at sunset. Opposition is on the 5th.

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

	d	h	m	MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 3h 30m	Sun's Selen. Colong. 0h U.T.
					h m		°
Wed.	1			.....			357.31
Thu.	2	2		☌♁☾ ♁ 2° S.....	9 27		9.51
Fri.	3	1		Vesta stationary in R.A.....			21.71
Sat.	4			.....		43210	33.90
Sun.	5			η Aquarid meteors	6 16	42031	46.09
		8		☍♆☉ Dist. from ⊕, 2,723,000,000 mi.			
Mon.	6	23		☾ at apogee. Dist. from ⊕, 252,500 mi.		41023	58.27
Tue.	7	5		☿ stationary in R.A.....		d4013	70.46[b]
Wed.	8	4		☌♆☾ ♆ 3° S.....	3 05	21043	82.64
		12	24	☽ Full Moon.....			
Thu.	9	12		♁ stationary in R.A.....		31024	94.82
Fri.	10			.....	23 55	30124	107.00
Sat.	11			□♂☉ east.....		32104	119.18
Sun.	12			.....		2014*	131.37
Mon.	13			.....	20 44	10234	143.56
Tue.	14			□♄☉ west.....		02134	155.75
Wed.	15			☿ at ♉.....		21043	167.95
Thu.	16			♀ greatest hel. lat. S.....	17 33	d3402	180.16[l]
		4		☌♄☾ ♄ 2° N.....			
		8	37	☾ Last Quarter.....			
Fri.	17	22		☌☿☉ inferior.....		34012	192.37
Sat.	18			.....		43210	204.59
Sun.	19	11		☌♃☾ ♃ 4° N.....	14 22	42301	216.82
Mon.	20			.....		41023	229.05
Tue.	21	0		☌♀☾ ♀ 4° N.....		40213	241.29[b]
		23		☾ at perigee. Dist. from ⊕, 223,000 mi.			
Wed.	22			□♁☉ east.....	11 11	42103	253.54
		23	00	● New Moon.....			
Thu.	23			.....		4301*	265.78
Fri.	24			.....		31402	278.03
Sat.	25			☿ at aphelion.....	8 00	32104	290.28
Sun.	26	11		♇ stationary in R.A.....		23014	302.52
Mon.	27			.....		10234	314.76
Tue.	28			.....	4 49	01234	326.99[l]
Wed.	29	3		☌♂☾ ♂ 2° S.....		21034	339.22
		9		☌♁☾ ♁ 3° S.....			
		23	56	☽ First Quarter.....			
Thu.	30	4		☿ stationary in R.A.....		3014*	351.45
Fri.	31			.....	1 38	31024	3.66

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 Feb. 27 and May 4.

[l]May 16, −7.39°; May 28, +7.11°. [b]May 7, −6.59°; May 21, +6.56°.

THE SKY FOR JUNE 1963

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 33m to 6h 37m and its Decl. changes from 21° 55′ N. to 23° 10′ N. The equation of time changes from +2m 25s to −3m 32s, being zero on the 14th. The summer solstice is on the 21st at 22h 04m. 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. 3h 54m, Decl. 16° 53′ N., and transits at 10h 24m. It is at greatest western elongation on the 13th, and at this time it may be seen low in the east before sunrise. However, this elongation is unfavourable, Mercury's altitude being only about 10° at sunrise.

Venus on the 15th is in R.A. 4h 03m, Decl. 19° 39′ N., mag. −3.3, and transits at 10h 34m. It is a morning star rising in the east about an hour before sunrise.

Mars on the 15th is in R.A. 10h 33m, Decl. 10° 21′ N., mag. +1.4, and transits at 17h 01m. In Leo, no longer prominent, it is well past the meridian at sunset. It passes about half a degree north of Uranus on the 5th.

Jupiter on the 15th is in R.A. 0h 57m, Decl. 4° 43′ N., mag. −1.9, and transits at 7h 25m. In Pisces, it rises about three hours before the sun. 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 43m, Decl. 14° 53′ S., mag. +0.8, and transits at 4h 11m. In Capricornus, it rises before midnight and reaches the meridian about at sunrise. On the 3rd it is stationary in right ascension and begins to retrograde, i.e. move westward among the stars.

Uranus on the 15th is in R.A. 10h 16m, Decl. 11° 34′ N., and transits at 16h 42m. It is well past the meridian at sunset. It is about half a degree south of Mars on the 5th.

Neptune on the 15th is in R.A. 14h 46m, Decl. 14° 06′ S., and transits at 21h 11m. 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 00m	Sun's Selen. Colong. 0h U.T.
					h m		°
Sat.	1			.....		d32O4	15.87
Sun.	2			.....	22 27	234O1	28.08
Mon.	3	9		☾ at apogee. Dist. from ⊕, 252,100 mi.		41O32	40.28[b]
		20		♄ stationary in R.A.....			
Tue.	4	9		☌♆☾ ♆ 3° S.....		4O123	52.48
Wed.	5	14		☌♂♁ ♂ 0.6° N.....	19 16	421O3	64.68
Thu.	6			.....		42O31	76.87
Fri.	7	3	31	☍ Full Moon.....		431O2	89.06
Sat.	8			.....	16 05	d43O1	101.25
Sun.	9	2		☌☿♀ ☿ 3° S.....		342O*	113.44
Mon.	10			.....		14O32	125.64
Tue.	11			.....	12 54	O1243	137.84
Wed.	12	10		☌♄☾ ♄ 2° N.....		21O34	150.04[l]
Thu.	13	1		☿ greatest elongation W., 23°.....		2O314	162.24
Fri.	14			☿ greatest hel. lat. S.....	9 42	31O24	174.46
		15	54	☾ Last Quarter.....			
Sat.	15			.....		3O124	186.67
Sun.	16	2		☌⚳☾ ⚳ 4° N.....		32O4*	198.90
Mon.	17			.....	6 31	1O324	211.14[b]
Tue.	18			.....		O4123	223.38
Wed.	19	3		☾ at perigee. Dist. from ⊕, 225,500 mi.		412O3	235.62
		16		☌☿☾ ☿ 1° N.....			
		20		☌♀☾ ♀ 3° N.....			
Thu.	20			.....	3 20	42O13	247.87
Fri.	21	6	46	● New Moon.....		431O2	260.12
		22	04	☉ enters ♋. Summer commences.....			
Sat.	22			.....		43O12	272.38
Sun.	23			.....	0 09	4321O	284.63
Mon.	24			.....		d43O*	296.88
Tue.	25	19		☌♁☾ ♁ 3° S.....	20 58	4O123	309.13[l]
Wed.	26	14		☌♂☾ ♂ 3° S.....		412O3	321.37
Thu.	27	20		☌☿♀ ☿ 0.6° S.....		2O413	333.61
Fri.	28	15	24	◑ First Quarter.....	17 47	13O24	345.84
Sat.	29			.....		3O124	358.07
Sun.	30			.....		321O4	10.29[b]

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]June 12, −6.19°; June 25, +6.26°. [b]June 3, −6.73°; June 17, +6.72°; June 30, −6.84°.

THE SKY FOR JULY 1963

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 37m to 8h 42m and its Decl. changes from 23° 10′ N. to 18° 16′ N. The equation of time changes from −3m 32s to −6m 19s. On the 4th the earth is at aphelion or farthest from the sun. There is a total eclipse of the sun visible in North America on the 20th. 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. There is a partial eclipse of the moon (not visible in North America) on the 6th–7th.

Mercury on the 15th is in R.A. 7h 41m, Decl. 23° 01′ N., and transits at 12h 16m. It is too close to the sun all month for observation, superior conjunction being on the 13th.

Venus on the 15th is in R.A. 6h 40m, Decl. 23° 15′ N., mag. −3.4, and transits at 11h 13m. It may be seen low in the east for a very short time before sunrise.

Mars on the 15th is in R.A. 11h 34m, Decl. 3° 27′ N., mag. +1.5, and transits at 16h 04m. Moving from Leo into Virgo, it is well down in the west at sunset.

Jupiter on the 15th is in R.A. 1h 10m, Decl. 5° 59′ N., mag. −2.1, and transits at 5h 40m. In Pisces, 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. 21h 38m, Decl. 15° 22′ S., mag. +0.7, and transits at 2h 09m. In Capricornus, it rises during the evening and is visible for the rest of the night.

Uranus on the 15th is in R.A. 10h 21m, Decl. 11° 06′ N., and transits at 14h 49m. It is low in the west at sunset.

Neptune on the 15th is in R.A. 14h 44m, Decl. 14° 01′ S., and transits at 19h 12m. It is past the meridian at sunset.

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

JULY. 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		°
Mon.	1	1		☾ at apogee. Dist. from ⊕, 251,500 mi.	14 36	O14**	22.50
		15		☌♆☾ ♆ 3° S.			
Tue.	2					O324*	34.71
Wed.	3			☿ at ♌		12O34	46.92
Thu.	4			⊕ at aphelion	11 24	2O134	59.12
				Dist. from ☉, 94,450,000 mi.			
Fri.	5					13O42	71.32
Sat.	6	16	56	☍ Full Moon. Eclipse of ☾, see p. 61		34O12	83.51
Sun.	7				8 13	4321O	95.71
Mon.	8			☿ at perihelion		432O1	107.90
Tue.	9	14		☌♄☾ ♄ 2° N.		4O32*	120.10[1]
Wed.	10			□♃☉ west	5 02	d41O3	132.29
Thu.	11			♀ at ♌		42O13	144.49
Fri.	12					d41O2	156.70
Sat.	13	14		☌♃☾ ♃ 4° N.	1 51	34O12	168.91
		17		☌☿☉ superior			
		20	58	☾ Last Quarter			
Sun.	14					312O4	181.13[b]
Mon.	15				22 39	32O14	193.36
Tue.	16	13		☾ at perigee. Dist. from ⊕, 228,600 mi.		1O324	205.59
Wed.	17					dO234	217.83
Thu.	18			☿ greatest hel. lat. N.	19 28	2O134	230.07
Fri.	19					1O324	242.32
Sat.	20	15	43	● New Moon. Eclipse of ☉, see p. 61		3O124	254.57
Sun.	21				16 17	312O4	266.83
Mon.	22					324O1	279.08
Tue.	23	6		☌♇☾ ♇ 3° S.		41O32	291.33[1]
Wed.	24				13 06	4O123	303.58
Thu.	25	5		☌♂☾ ♂ 5° S.		42O3*	315.82
Fri.	26	4		♆ stationary in R.A.		41O3*	328.06
Sat.	27				9 54	43O12	340.30[b]
Sun.	28	8	13	☽ First Quarter		4312O	352.52
		19		☾ at apogee. Dist. from ⊕, 251,200 mi.			
		23		☌♆☾ ♆ 3° S.			
Mon.	29			δ Aquarid meteors		432O1	4.74
Tue.	30				6 43	14O32	16.96
Wed.	31					O1423	29.17

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[1]July 9, −5.17°; July 23, +5.35°. [b]July 14, +6.78°; July 27, −6.83°.

THE SKY FOR AUGUST 1963

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 42m to 10h 38m and its Decl. changes from 18° 16′ N. to 8° 38′ N. The equation of time changes from −6m 19s to −0m 19s. 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 12m, Decl. 4° 33′ N., and transits at 13h 41m. It is at greatest eastern elongation on the 24th, so it could be seen very low in the west after sunset at this time. However, this is a particularly unfavourable elongation, Mercury's altitude being only about 8° at sunset.

Venus on the 15th is in R.A. 9h 21m, Decl. 16° 45′ N., mag. −3.5, and transits at 11h 51m. It is a morning star until the 29th when it is in superior conjunction; however it is too close to the sun most of the month for easy observation.

Mars on the 15th is in R.A. 12h 43m, Decl. 4° 24′ S., mag. +1.6, and transits at 15h 11m. In Virgo, it is very low in the west at sunset and sets soon after.

Jupiter on the 15th is in R.A. 1h 14m, Decl. 6° 14′ N., mag. −2.3, and transits at 3h 42m. In Pisces, it rises in the late evening and reaches the meridian just before sunrise. On the 10th it is stationary in right ascension and begins to retrograde, i.e. move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 21h 30m, Decl. 16° 06′ S., mag. +0.5, and transits at 23h 54m. In Capricornus, it rises at about sunset and sets at about sunrise. Opposition is on the 13th.

Uranus on the 15th is in R.A. 10h 27m, Decl. 10° 27′ N., and transits at 12h 54m. It is too close to the sun for observation; conjunction is on the 29th.

Neptune on the 15th is in R.A. 14h 44m, Decl. 14° 04′ S., and transits at 17h 10m. It is well down in the south-west at sunset.

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

AUGUST E.S.T.					Min. of Algol	Config. of Jupiter's Sat. 2h 15m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Thu.	1			.....		2O34*	41.38
Fri.	2			.....	3 32	dO34*	53.58
Sat.	3			.....		3O124	65.77
Sun.	4			.....		312O4	77.96
Mon.	5			☐♆☉ east.....	0 20	32O14	90.15[l]
		4	31	☽ Full Moon.....			
		18		♂♄☾ ♄ 1° N.....			
		20		♂☿♁ ☿ 0.04° S.....			
Tue.	6			.....		13O24	102.34
Wed.	7			.....	21 09	O1423	114.53
Thu.	8			.....		2413	126.72
Fri.	9	21		♂⚳☾ ⚳ 4° N.....		d423	138.91
Sat.	10	0		⚳ stationary in R.A.....	17 58	43O12	151.11[b]
		19		☾ at perigee. Dist. from ⊕, 229,500 mi.			
Sun.	11			☿ at ♉.....		d431O	163.31
Mon.	12			Perseid meteors.....		432O1	175.52
		1	22	☾ Last Quarter.....			
Tue.	13	1		☍♄☉ Dist. from ⊕, 823,600,000 mi.	14 46	41O2*	187.74
Wed.	14			♀ at perihelion.....		4O132	199.96
Thu.	15			.....		421O3	212.19
Fri.	16			.....	11 35	2O413	224.43
Sat.	17			.....		3O24*	236.67
Sun.	18			.....		31O24	248.91
Mon.	19	2	35	● New Moon.....	8 24	32O14	261.16[l]
Tue.	20			.....		13O24	273.40
Wed.	21			☿ at aphelion.....		O1324	285.64
				⚳ greatest hel. lat. S.....			
		4		♂☿☾ ☿ 7° S.....			
Thu.	22			.....	5 12	21O34	297.88
Fri.	23	0		♂♂☾ ♂ 5° S.....		2O134	310.12
Sat.	24	5		☿ greatest elongation E., 27°.....		d1O42	322.35[b]
Sun.	25	7		♂♆☾ ♆ 3° S.....	2 01	d34O2	334.58
		13		☾ at apogee. Dist. from ⊕, 251,300 mi.			
Mon.	26			.....		342O1	346.80
Tue.	27	1	54	☽ First Quarter.....	22 50	431O*	359.02
Wed.	28			.....		4O312	11.23
Thu.	29	13		♂♁☉		412O3	23.43
		20		♂♀☉ superior.....			
Fri.	30			.....	19 38	42O13	35.63
Sat.	31			♂ at ♉.....		41O32	47.82

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Aug. 5, −5.11°; Aug. 19, +4.94°. [b]Aug. 10, +6.71°; Aug. 24, −6.71°.

THE SKY FOR SEPTEMBER 1963

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 38m to 12h 26m and its Decl. changes from 8° 38′ N. to 2° 49′ S. The equation of time changes from −0m 19s to +9m 58s, being zero on the 2nd. On the 23rd at 13h 24m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra, and autumn commences. For changes in the length of the day, see p. 17.

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

Mercury on the 15th is in R.A. 12h 00m, Decl. 4° 22′ N., and transits at 12h 22m. It is too close to the sun all month for observation, inferior conjunction being on the 20th.

Venus on the 15th is in R.A. 11h 47m, Decl. 2° 57′ N., mag. −3.4, and transits at 12h 14m. It is an evening star but too close to the sun most of the month for easy observation.

Mars on the 15th is in R.A. 13h 58m, Decl. 12° 15′ S., mag. +1.7, and transits at 14h 24m. In Virgo, not far from Spica, it is very low in the south-west at sunset and sets soon after.

Jupiter on the 15th is in R.A. 1h 07m, Decl. 5° 21′ N., mag. −2.4, and transits at 1h 33m. In Pisces, 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. 21h 21m, Decl. 16° 47′ S., mag. +0.6, and transits at 21h 44m. In Capricornus it is risen by sunset and is visible all the rest of the night.

Uranus on the 15th is in R.A. 10h 35m, Decl. 9° 44′ N., and transits at 11h 00m. It rises an hour or two before the sun.

Neptune on the 15th is in R.A. 14h 47m, Decl. 14° 16′ S., and transits at 15h 10m. 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. 1h 15m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Sun.	1			.....		34O12	60.01[l]
Mon.	2	0		☌ ♄ ☾ ♄ 1° N.....	16 27	32O4*	72.19
Tue.	3	14	34	☍ Full Moon.....		312O4	84.36
Wed.	4			.....		O3124	96.54
Thu.	5			☿ greatest hel. lat. N.....	13 16	12O34	108.71
		0		☌ ☿ ☉			
Fri.	6	2		☌ ⚳ ☾ ⚳ 4° N.....		2O134	120.89[b]
		9		☿ stationary in R.A.....			
		11		☾ at perigee. Dist. from ⊕, 226,800 mi.			
Sat.	7			.....		1O324	133.07
Sun.	8			.....	10 05	3O124	145.25
Mon.	9			.....		32O4*	157.44
Tue.	10			☿ greatest hel. lat. S.....		321O4	169.64
		6	43	☾ Last Quarter.....			
Wed.	11			.....	6 53	4O312	181.84
Thu.	12			.....		d41O3	194.05
Fri.	13			.....		42O13	206.26
Sat.	14			.....	3 42	41O23	218.48[l]
Sun.	15			.....		43O12	230.71
Mon.	16	4		☌ ♁ ☾ ♁ 3° S.....		4321O	242.94
Tue.	17	15	51	● New Moon.....	0 31	d432O	255.17
Wed.	18			.....		4O12*	267.40
Thu.	19			.....	21 19	1O243	279.63
Fri.	20	0		☌ ☿ ☉ inferior.....		2O134	291.86[b]
		22		☌ ♂ ☾ ♂ 5° S.....			
Sat.	21	16		☌ ♆ ☾ ♆ 3° S.....		1O234	304.08
Sun.	22	8		☾ at apogee. Dist. from ⊕, 251,900 mi.	18 08	3O124	316.30
Mon.	23	13	24	☉ enters ♎. Autumn commences.....		321O4	328.52
Tue.	24			.....		32O14	340.73
Wed.	25	19	39	☽ First Quarter.....	14 57	3O124	352.93
Thu.	26			⚳ at perihelion.....		1O243	5.13
Fri.	27			.....		24O13	17.32
Sat.	28	8		☿ stationary in R.A.....	11 46	41O23	29.51
Sun.	29			☿ at ♌.....		43O12	41.69[l]
		7		☌ ♄ ☾ ♄ 1° N.....			
Mon.	30	15		☌ Pallas ☉.....		4312O	53.86

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Sept. 1, −5.94°; Sept. 14, +5.60°; Sept. 29, −6.99°. [b]Sept. 6, +6.55°; Sept. 20, −6.59°.

THE SKY FOR OCTOBER 1963

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 26m to 14h 22m and its Decl. changes from 2° 49′ S. to 14° 08′ S. The equation of time changes from +9m 58s to +16m 21s. For changes in the length of the day, see p. 17.

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

Mercury on the 15th is in R.A. 12h 28m, Decl. 0° 50′ S., and transits at 10h 58m. It is at greatest western elongation on the 5th, so at this time it may be seen low in the east just before sunrise. This is a favourable elongation, Mercury's altitude being about 17° at sunrise.

Venus on the 15th is in R.A. 14h 05m, Decl. 11° 57′ S., mag. −3.4, and transits at 12h 34m. It is an evening star visible very low in the west just after sunset.

Mars on the 15th is in R.A. 15h 19m, Decl. 18° 50′ S., mag. +1.6, and transits at 13h 47m. In Libra, it is so low in the south-west at sunset that it can be seen only with difficulty.

Jupiter on the 15th is in R.A. 0h 52m, Decl. 3° 51′ N., mag. −2.5, and transits at 23h 16m. In Pisces, it rises about at sunset and is visible all the rest of the night. It is in opposition on the 8th. 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 17m, Decl. 17° 05′ S., mag. +0.8, and transits at 19h 42m. In Capricornus, it is approaching the meridian at sunset and sets before sunrise. On the 21st it is stationary in right ascension and resumes eastward motion among the stars.

Uranus on the 15th is in R.A. 10h 41m, Decl. 9° 07′ N., and transits at 9h 08m. It is well up in the east at sunrise.

Neptune on the 15th is in R.A. 14h 50m, Decl. 14° 33′ S., and transits at 13h 16m. It is too close to the sun for easy observation.

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

	d	h	m	OCTOBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h 30m	Sun's Selen. Colong. 0h U.T.
					h m		°
Tue.	1			.....	8 34	43102	66.03
Wed.	2	23	44	☍ Full Moon, Harvest Moon.....		d4023	78.19
Thu.	3	7		☌☿☾ ☿ 4° N.....		42013	90.35
		22		☌♂♆ ♂ 2° S.....			
Fri.	4			☿ at perihelion.....	5 23	12043	102.50[b]
		10		☾ at perigee. Dist. from ⊕, 223,800 mi.			
Sat.	5	15		☿ greatest elongation W., 18°.....		30124	114.66
Sun.	6			.....		31204	126.82
Mon.	7			.....	2 12	32014	138.99
Tue.	8	6		☍☿☉ Dist. from ⊕, 367,200,000 mi....		31024	151.16
Wed.	9	14	28	☾ Last Quarter.....	23 01	01324	163.34
Thu.	10			.....		20134	175.52
Fri.	11			.....		21034	187.71[l]
Sat.	12			.....	19 50	03412	199.91
Sun.	13	13		☌♁☾ ♁ 3° S.....		d3410	212.11
Mon.	14			☿ greatest hel. lat. N.....		34201	224.31
Tue.	15			.....	16 39	43102	236.52
Wed.	16	0		☌☿☾ ☿ 3° S.....		40132	248.74
Thu.	17	7	43	☽ New Moon.....		4203*	260.95[b]
Fri.	18	9		☌♀☾ ♀ 4° S.....	13 27	42103	273.16
Sat.	19	1		☌♆☾ ♆ 3° S.....		40312	285.38
		21		☾ at apogee. Dist. from ⊕, 252,500 mi.			
		23		☌♂☾ ♂ 4° S.....			
Sun.	20			.....		34102	297.59
Mon.	21			Orionid meteors.....	10 16	32041	309.79
		4		☌ Juno ☉			
		15		♄ stationary in R.A.....			
Tue.	22			.....		31024	322.00
Wed.	23			.....		03124	334.20
Thu.	24	13		☌♀♆ ♀ 1.5° S.....	7 05	21034	346.39
Fri.	25	12	21	☽ First Quarter.....		d2034	358.57
Sat.	26	15		☌♄☾ ♄ 2° N.....		01324	10.75
Sun.	27			.....	3 54	31024	22.92[l]
Mon.	28			.....		32014	35.09
Tue.	29			.....		3140*	47.25
Wed.	30	12		☌☿☾ ☿ 4° N.....	0 43	4012*	59.40
Thu.	31			♀ at ♉.....		42103	71.54[b]

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Oct. 11, +6.86°; Oct. 27, −7.72°. [b]Oct. 4, +6.49°; Oct. 17, −6.56°; Oct. 31, +6.55°.

THE SKY FOR NOVEMBER 1963

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. Extimates of altitude are for an observer in latitude 45° N.

The Sun—During November the sun's R.A. increases from 14h 22m to 16h 25m and its Decl. changes from 14° 08′ S. to 21° 39′ S. The equation of time changes from +16m 21s to a maximum of +16m 24s on the 5th and then to +11m 20s 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. 15h 41m, Decl. 20° 30′ S., and transits at 12h 09m. Superior conjunction is on the 4th and Mercury remains all month too close to the sun for observation.

Venus on the 15th is in R.A. 16h 41m, Decl. 22° 48′ S., mag. −3.3, and transits at 13h 08m. It is an evening star visible low in the south-west briefly after sunset.

Mars on the 15th is in R.A. 16h 53m, Decl. 23° 20′ S., and transits at 13h 19m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 0h 40m, Decl. 2° 39′ N., mag. −2.4, and transits at 21h 02m. In Pisces, it is well up at sunset and is visible until nearly sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 21h 19m, Decl. 16° 55′ S., mag. +0.9, and transits at 17h 42m. In Capricornus, it is approaching the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 10h 46m, Decl. 8° 40′ N., and transits at 7h 11m. It rises soon after midnight.

Neptune on the 15th is in R.A. 14h 55m, Decl. 14° 53′ S., and transits at 11h 19m. It is too close to the sun for observation; conjunction is on the 8th.

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

NOVEMBER E.S.T.					Min. of Algol	Config. of Jupiter's Sat. 21h 15m	Sun's Selen. Colong. 0h U.T.
	d	h	m		h m		°
Fri.	1	8	56	☋ Full Moon, Hunter's Moon	21 32	42O13	83.69
		19		☾ at perigee. Dist. from ⊕, 221,800 mi.			
Sat.	2					4O23*	95.83
Sun.	3					431O2	107.97
Mon.	4	13		☌ Ceres ☉	18 21	432O1	120.11
		20		☌☿☉ superior			
Tue.	5					3412O	132.26
Wed.	6			Taurid meteors		43O12	144.41
Thu.	7			☿ at ♉	15 10	12O43	156.57
Fri.	8	1	37	☾ Last Quarter		2O134	168.74[l]
		8		☌♆☉			
Sat.	9			□♄☉ east		1O234	180.91
		21		☌♁☾ ♁ 4° S.			
Sun.	10				11 59	d3O24	193.09
Mon.	11					32O14	205.27
Tue.	12					321O4	217.46
Wed.	13				8 48	3O124	229.65[b]
Thu.	14					1O234	241.85
Fri.	15					24O13	254.04
Sat.	16	1		☾ at apogee. Dist. from ⊕, 252,700 mi.	5 37	41O23	266.24
		1	51	● New Moon			
Sun.	17			☿ at aphelion		43O12	278.44
				Leonid meteors			
		23		☌♀☾ ♀ 3° S.			
Mon.	18	2		☌♂☾ ♂ 3° S.		432O*	290.64
Tue.	19				2 26	4321O	302.83
Wed.	20	17		☌♀♂ ♀ 0.05° S.		43O12	315.02
Thu.	21				23 15	41O23	327.21
Fri.	22					42O13	339.40
Sat.	23	0		☌♄☾ ♄ 2° N.		1O43*	351.57
Sun.	24	2	56	☽ First Quarter	20 04	dO142	3.74[l]
Mon.	25					321O4	15.90
Tue.	26	19		☌♃☾ ♃ 4° N		321O4	28.06
Wed.	27				16 53	3O124	40.20[b]
Thu.	28					1O324	52.34
Fri.	29					2O134	64.48
Sat.	30	8		☾ at perigee. Dist. from ⊕, 221,800 mi.	13 42	1O43*	76.61
		18	55	☋ Full Moon			

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

[l]Nov. 8, +7.69°; Nov. 24, − 7.68°. [b]Nov. 13, −6.66°; Nov. 27, +6.68°.

THE SKY FOR DECEMBER 1963

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 25m to 18h 42m and its Decl. changes from 21° 39′ S. to 23° 06′ S. The equation of time changes from +11m 20s to −3m 00s, being zero on the 25th. The winter solstice is on the 22nd at 9h 02m E.S.T. For changes in the length of the day, see p. 18.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 25. There is a total eclipse of the moon, visible in North America, toward dawn on the night of the 29th–30th.

Mercury on the 15th is in R.A. 18h 53m, Decl. 24° 59′ S., and transits at 13h 23m. Greatest eastern elongation is on the 18th, so it may be seen low in the south-west just after sunset. However, this elongation is a poor one, Mercury being only about 10° above the horizon at sunset.

Venus on the 15th is in R.A. 19h 24m, Decl. 23° 40′ S., mag. −3.4, and transits at 13h 53m. It is an evening star visible very briefly low in the south-west just after sunset.

Mars on the 15th is in R.A. 18h 32m, Decl. 24° 12′ S., and transits at 13h 00m. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 0h 38m, Decl. 2° 34′ N., mag. −2.2, and transits at 19h 02m. In Pisces, it is well up at sunset and sets soon after midnight. On the 5th it is stationary in right ascension and resumes direct, or eastward, motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 57.

Saturn on the 15th is in R.A. 21h 27m, Decl. 16° 19′ S., mag. +1.0, and transits at 15h 52m. In Capricornus, it is past the meridian at sunset and sets well before midnight.

Uranus on the 15th is in R.A. 10h 48m, Decl. 8° 31′ N. and transits at 5h 14m. It rises before midnight.

Neptune on the 15th is in R.A. 14h 59m, Decl. 15° 11′ S., and transits at 9h 25m. It rises shortly before the sun.

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

	d	h	m	DECEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 19h 15m	Sun's Selen. Colong. 0h U.T.
					h m		°
Sun.	1			.....		04312	88.74
Mon.	2			☐ ♁ ☉ west.....		34120	100.87
Tue.	3			.....	10 32	43201	113.00
Wed.	4			☿ at aphelion.....		4302*	125.13
Thu.	5	20		♃ stationary in R.A.....		4102*	137.27
Fri.	6	22		☌ ☿ ♂ ☿ 1.4° S.....	7 21	42013	149.42[l]
Sat.	7			☿ greatest hel. lat. S.....		41203	161.57
		4		☌ ♁ ☾ ♁ 4° S.....			
		16	34	☾ Last Quarter.....			
Sun.	8			.....		40132	173.72
Mon.	9			.....	4 10	d4310	185.89
Tue.	10			.....		32041	198.06[b]
Wed.	11	6		☌ Vesta ☉.....		3024*	210.23
Thu.	12	17		☌ Ψ ☾ Ψ 3° S.....	0 59	1024*	222.41
Fri.	13			Geminid meteors.....		20134	234.59
		4		☾ at apogee. Dist. from ⊕, 252,500 mi.			
Sat.	14			.....	21 48	12034	246.78
Sun.	15	21	07	● New Moon.....		01324	258.97
Mon.	16	8		♁ stationary in R.A.....		31024	271.16
Tue.	17	5		☌ ☌ ☾ ☌ 1° S.....	18 38	32014	283.35
		17		☌ ☿ ☾ ☿ 1° S.....			
Wed.	18	7		☿ greatest elongation E., 20°.....		31402	295.53
		9		☌ ♀ ☾ ♀ 0.5° S.....			
Thu.	19			.....		d4302	307.72
Fri.	20	9		☌ ♄ ☾ ♄ 2° N.....	15 27	42013	319.90
Sat.	21			.....		42103	332.08
Sun.	22	9	02	☉ enters ♑. Winter commences.....		40132	344.25[l]
Mon.	23			Ursid meteors.....	12 16	41302	356.42
		14	55	◑ First Quarter.....			
		19		♇ stationary in R.A.....			
Tue.	24	3		☌ ♃ ☾ ♃ 4° N.....		43201	8.58
Wed.	25	23		☿ stationary in R.A.....		34102	20.73[b]
Thu.	26			☿ at ♌.....	9 05	34012	32.87
Fri.	27			♀ greatest hel. lat. S.....		2043*	45.01
Sat.	28	19		☾ at perigee. Dist. from ⊕, 223,800 mi.		21034	57.14
Sun.	29			.....	5 55	01234	69.27
Mon.	30	0		☌ ☿ ☌ ♂ ☿ 2° N.....		13024	81.39
		6	04	○ Full Moon. Eclipse of ☾, see p. 61			
Tue.	31			☿ at perihelion.....		32014	93.52

Explanation of symbols and abbreviations on p. 4, of time on p. 10, of colongitude on p. 57.
[l]Dec. 6, +7.62°; Dec. 22, −6.82°. [b]Dec. 10, −6.80°; Dec. 25, +6.76°.

JANUARY

d	h	m	Sat.	Phen.
2	19	50	III	OR
6	20	12	I	TI
7	20	10	II	OD
8	18	01	I	Se
9	19	26	II	Se
	19	52	IV	ER
13	18	19	III	Se
14	19	24	I	OD
15	17	42	I	SI
	19	00	I	Te
	19	57	I	Se
16	19	24	II	SI
20	18	47	III	Te
	19	07	III	SI
22	18	45	I	TI
	19	38	I	SI
23	19	03	I	ER
30	17	57	I	OD
31	18	18	I	Se

FEBRUARY

d	h	m	Sat.	Phen.
1	18	08	II	OD

Jupiter being near the sun, phenomena of the satellites are not given between Feb. 15 and May 25.

MAY

d	h	m	Sat.	Phen.
30	3	07	III	Te
31	3	13	I	ED

JUNE

d	h	m	Sat.	Phen.
6	2	33	III	Se
8	2	26	I	SI
9	3	06	I	OR
15	2	20	II	SI
17	2	12	II	OR
	2	17	I	Te
24	2	02	I	TI
	2	13	II	ER
	2	24	II	OD
	2	54	I	Se
	3	20	III	OD
25	1	29	I	OR

JULY

d	h	m	Sat.	Phen.
1	1	43	III	ED
	2	15	II	ED
	2	36	I	SI
2	3	25	I	OR
3	2	12	II	Te
9	1	42	I	ED
10	1	09	I	Se
	2	03	II	Se
	2	25	II	TI
	2	30	I	Te
12	1	29	III	TI
17	0	52	I	SI
	2	09	II	SI
	2	14	I	TI
	3	03	I	Se
18	1	42	I	OR
19	1	53	II	OR
	2	31	III	Se
24	2	45	I	SI
25	0	00	I	ED
	3	35	I	OR
	23	25	I	Se
26	0	43	I	Te
	1	46	II	ER
	2	00	II	OD
	3	43	III	SI
29	23	25	III	OD
	1	49	III	OR

AUGUST

d	h	m	Sat.	Phen.
1	1	54	I	ED
	23	07	I	SI
2	0	25	I	TI
	1	18	I	Se
	1	50	II	ED
	2	34	I	Te
	23	54	I	OR
3	23	12	II	Se
	23	23	II	TI
4	1	45	II	Te
6	0	38	III	ER
	3	13	III	OD
8	3	48	I	ED
9	1	01	I	SI
	2	15	I	TI
	3	12	I	Se
10	1	44	I	OR
	22	51	I	Te
	23	20	II	SI
11	1	49	II	Se
	1	52	II	TI
12	22	30	II	OR
13	1	50	III	ED
16	2	54	I	SI
	4	04	I	TI
	22	54	III	Te
17	0	11	I	ED
	3	33	I	OR
	22	31	I	TI
	23	34	I	Se
18	0	40	I	Te
	1	57	II	SI
	22	00	I	OR
20	0	54	II	OR
23	22	31	III	Se
24	0	13	III	TI
	2	06	I	ED
	2	27	III	Te
	23	17	I	SI
25	0	18	I	TI
	1	28	I	Se
	2	27	I	Te
	23	47	I	OR
26	22	51	II	ED
27	3	14	II	OR
28	22	13	II	Te
30	23	47	III	SI
31	2	30	III	Se
	3	43	III	TI
	4	00	I	ED

SEPTEMBER

d	h	m	Sat.	Phen.
1	1	10	I	SI
	2	04	I	TI
	3	22	I	Se
	4	14	I	Te
	22	29	I	ED
2	1	34	I	OR
	21	51	I	Se
	22	40	I	Te
3	1	27	II	ED
4	22	13	II	TI
	22	59	II	Se
5	0	33	II	Te
7	3	48	III	SI
8	3	04	I	SI
	3	50	I	TI
9	0	23	I	ED
	3	19	I	OR
	21	33	I	SI
	22	16	I	TI
	23	45	I	Se
10	0	26	I	Te
	4	02	II	ED
	20	40	III	ER
	20	59	III	OD
	21	46	I	OR
	23	13	III	OR
11	23	07	II	SI
12	0	32	II	TI
	1	36	II	Se
	2	52	II	Te
13	20	59	II	OR
16	2	18	I	ED
	23	27	I	SI
17	0	01	I	TI
	1	39	I	Se
	2	10	I	Te
	20	47	I	ED
	21	57	III	ED
	23	30	I	OR
18	2	33	III	OR
	20	08	I	Se
	20	36	I	Te
19	1	44	II	SI
	2	48	II	TI
	4	13	II	Se
20	19	55	II	ED
	23	14	II	OR
23	4	13	I	ED
24	1	21	I	SI
	1	44	I	TI
	3	33	I	Se
	3	54	I	Te
	22	42	I	ED
25	1	14	I	OR
	1	59	III	ED
	19	50	I	SI
	20	10	I	TI
	22	02	I	Se
	22	20	I	Te
26	4	21	II	SI
	19	40	I	OR
27	22	31	II	ED
28	1	28	II	OR
	19	20	III	Te
29	20	07	II	Se
	20	31	II	Te

OCTOBER

d	h	m	Sat.	Phen.
1	3	16	I	SI
	3	28	I	TI
2	0	36	I	ED
	2	58	I	OR
	21	44	I	SI
	21	54	I	TI
	23	57	I	Se
3	0	04	I	Te
	19	05	I	ED
	21	24	I	OR
5	1	07	II	ED
	3	42	II	OR
	19	54	III	SI
5	20	21	III	TI
	22	34	III	Se
	22	37	III	Te
6	20	16	II	SI
	20	24	II	TI
	22	44	II	Se
	22	45	II	Te
9	2	31	I	OD
	4	44	I	ER
	23	37	I	TI
	23	39	I	SI
10	1	48	I	Te
	1	51	I	Se
	20	57	I	OD
	23	12	I	ER
11	20	13	I	Te
	20	20	I	Se
12	3	34	II	OD
	23	34	III	TI
	23	55	III	SI
13	1	53	III	Te
	2	34	III	Se
	22	38	II	TI
	22	53	II	SI
14	0	59	II	Te
	1	21	II	Se
15	19	30	II	ER
16	4	14	I	OD
17	1	21	I	TI
	1	34	I	SI
	3	31	I	Te
	3	46	I	Se
	22	40	I	OD
18	1	07	I	ER
	19	47	I	TI
	20	03	I	SI
	21	57	I	Te
	22	15	I	Se
19	19	36	I	ER
20	2	49	III	TI
	3	57	III	SI
21	0	52	II	TI
	1	30	II	SI
	3	14	II	Te
	3	57	II	Se
22	18	55	II	OD
	22	07	II	ER
23	20	45	III	ER
24	3	05	I	TI
	3	29	I	SI
25	0	24	I	OD
	3	02	I	ER
	21	31	I	TI
	21	58	I	SI
	23	42	I	Te
26	0	10	I	Se
	18	50	I	OD
	21	31	I	ER
27	18	08	I	Te
	18	39	I	Se
28	3	07	II	TI
	4	07	II	SI
29	21	11	II	OD
30	0	44	II	ER
	19	53	III	OD
31	0	46	III	ER
	18	39	II	Te
	19	52	II	Se

NOVEMBER

d	h	m	Sat.	Phen.
1	2	09	I	OD
	23	16	I	TI
	23	53	I	SI

d	h	m	Sat.	Phen.
2	1	27	I	Te
	2	05	I	Se
	20	36	I	OD
	23	26	I	ER
3	17	42	I	TI
	18	22	I	SI
	19	53	I	Te
	20	34	I	Se
4	17	55	I	ER
5	23	28	II	OD
6	23	14	III	OD
	1	43	III	OR
	2	11	III	ED
7	18	33	II	TI
	20	02	II	SI
	20	57	II	Te
	22	29	II	Se
9	1	02	I	TI
	1	49	I	SI
	22	21	I	OD
10	1	21	I	ER
	18	39	III	Se
	19	29	I	TI
	20	18	I	SI
	21	40	I	Te
	22	29	I	Se
11	19	50	I	ER
13	1	47	II	OD
14	20	52	II	TI
	22	39	II	SI
	23	17	II	Te
15	1	05	II	Se
16	19	18	II	ER
17	0	09	I	OD
	18	49	III	Te
	20	07	III	SI
	21	16	I	TI
	22	13	I	SI
	22	40	III	Se
	23	28	I	Te
18	0	25	I	Se
	18	36	I	OD
	21	46	I	ER
19	17	55	I	Te
	18	53	I	Se
21	23	14	II	TI
22	1	16	II	SI
	1	39	II	Te
23	17	20	II	OD
	21	56	II	ER
24	1	57	I	OD
	19	49	III	TI
	22	24	III	Te
	23	05	I	TI
25	0	09	I	SI
	0	10	III	SI
	1	16	I	Te
	20	24	I	OD
	23	41	I	ER
26	17	32	I	TI
	18	38	I	SI
	19	44	I	Te
	20	49	I	Se
27	18	10	I	ER
30	19	46	II	OD

DECEMBER

d	h	m	Sat.	Phen.
1	0	34	II	ER
	23	26	III	TI
2	0	55	I	TI
	17	11	II	SI
	17	17	II	Te
	19	36	II	Se
	22	14	I	OD
3	19	23	I	TI
	20	34	I	SI
	21	34	I	Te
	22	45	I	Se
4	20	05	I	ER
5	17	14	I	Se
	18	22	III	ED
	20	54	III	ER
7	22	14	II	OD
8	0	43	II	OR
	0	45	II	ED
9	17	19	II	TI
	19	45	II	Te
	19	48	II	SI
	22	12	II	Se
10	0	05	I	OD
	21	14	I	TI
	22	30	I	SI
	23	26	I	Te
11	0	40	I	Se
	18	33	I	OD
	22	00	I	ER
12	17	09	III	OD
	17	54	I	Te
12	19	09	I	Se
	19	51	III	OR
	22	24	III	ED
16	19	49	II	TI
	22	16	II	Te
	22	24	II	SI
17	23	07	I	TI
18	19	11	II	ER
	20	26	I	OD
	23	56	I	ER
19	17	36	I	TI
	18	55	I	SI
	19	47	I	Te
	20	59	III	OD
	21	05	I	Se
	23	43	III	OR
20	18	25	I	ER
23	18	48	III	Se
	22	21	II	TI
25	19	07	II	OR
	19	23	II	ED
	21	49	II	ER
	22	19	I	OD
26	19	30	I	TI
	20	51	I	SI
	21	42	I	Te
	23	01	I	Se
27	20	20	I	ER
28	17	30	I	Se
30	17	32	III	Te
	20	24	III	SI
	22	51	III	Se

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

THE OBSERVATION OF THE MOON

During 1963 the ascending node of the moon's orbit moves from the constellation Cancer into Gemini (☊ from 121° to 101°). 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 ½° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 0h U.T. starting on p. 33.)

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

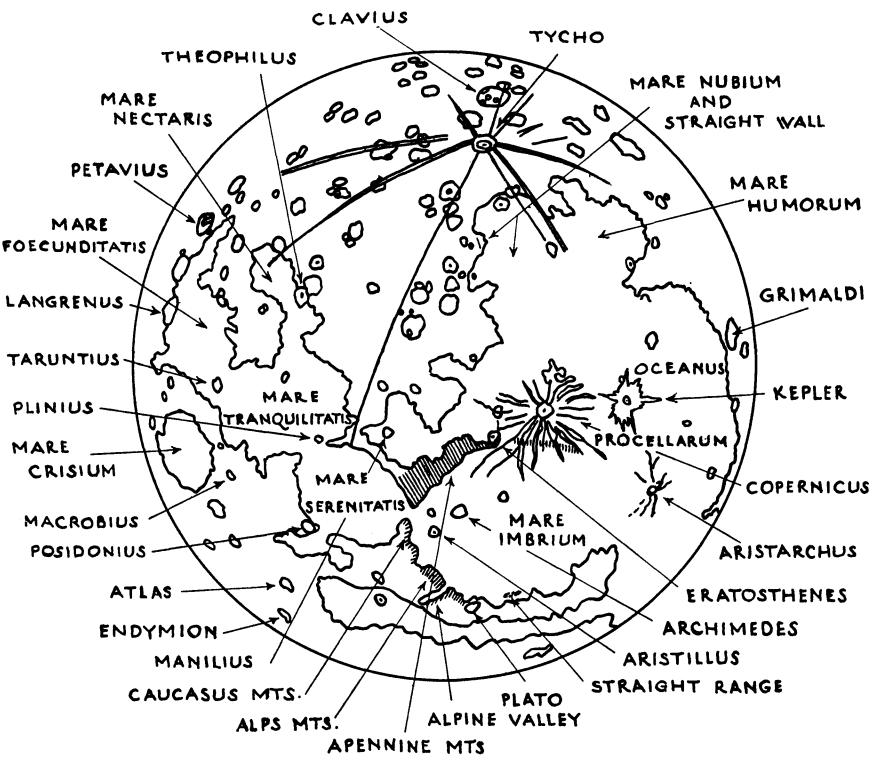
The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

By the moon's libration is meant the shifting, or rather apparent shifting, of the visible disk. Sometimes the observer sees features farther around the eastern

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

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

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. E.S.T.	SYSTEM I						SYSTEM II					
	July 29h 24h	Aug. 27h 22h	Sept. 25h 20h	Oct. 23h 18h	Nov. 22h 17h	Dec. 22h 17h	July 29h 24h	Aug. 27h 22h	Sept. 25h 20h	Oct. 23h 18h	Nov. 22h 17h	Dec. 22h 17h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	104.6	246.3	30.6	18.3	200.0	256.8	286.4	192.3	100.6	220.1	165.6	353.5
2	262.4	44.3	188.6	176.4	357.9	54.7	76.6	342.6	251.0	10.5	315.9	143.8
3	60.3	202.2	346.6	334.4	155.9	212.5	226.9	133.0	41.4	160.9	106.2	293.9
4	218.2	0.2	144.6	132.5	313.8	10.3	17.1	283.3	191.8	311.3	256.5	84.1
5	16.0	158.1	302.7	290.5	111.8	168.1	167.4	73.6	342.2	101.7	46.9	234.3
6	173.9	316.1	100.7	88.5	269.7	325.9	317.6	223.9	132.6	252.1	197.2	24.5
7	331.8	114.0	258.7	246.6	67.6	123.8	107.9	14.2	283.0	42.5	347.5	174.7
8	129.7	272.0	56.7	44.6	225.6	281.6	258.1	164.6	73.4	192.9	137.8	324.9
9	287.6	70.0	214.8	202.6	23.5	79.4	48.4	314.9	223.8	343.3	288.1	115.1
10	85.4	227.9	12.8	0.7	181.4	237.2	198.6	105.2	14.2	133.7	78.4	265.2
11	243.3	25.9	170.8	158.7	339.3	35.0	348.9	255.6	164.6	284.1	228.7	55.4
12	41.2	183.9	328.8	316.7	137.2	192.8	139.1	45.9	315.0	74.5	18.9	205.6
13	199.1	341.8	126.9	114.7	295.2	350.5	289.4	196.3	105.4	224.9	169.2	355.7
14	357.0	139.8	284.9	272.8	93.1	148.3	79.6	346.6	255.8	15.3	319.5	145.9
15	154.9	297.8	82.9	70.8	251.0	306.1	229.9	136.9	46.2	165.7	109.8	296.0
16	312.8	95.8	241.0	228.8	48.9	103.9	20.2	287.3	196.6	316.1	260.0	86.2
17	110.7	253.7	39.0	26.8	206.8	261.7	170.5	77.6	347.0	106.5	50.3	236.3
18	268.6	51.7	197.0	184.8	4.6	59.4	320.7	228.0	137.4	256.8	200.6	26.5
19	66.5	209.7	355.1	342.8	162.5	217.2	111.0	18.3	287.8	47.2	350.8	176.6
20	224.4	7.7	153.1	140.8	320.4	15.0	261.3	168.7	78.2	197.6	141.1	326.7
21	22.3	165.7	311.2	298.8	118.3	172.7	51.6	319.1	228.6	347.9	291.3	116.9
22	180.3	323.7	109.2	96.8	276.2	330.5	201.9	109.4	19.0	138.3	81.6	267.0
23	338.2	121.7	267.2	254.8	74.0	128.2	352.1	259.8	169.4	288.7	231.8	57.1
24	136.1	279.7	65.3	52.8	231.9	286.0	142.4	50.1	319.8	79.0	22.0	207.3
25	294.0	77.7	223.3	210.8	29.8	83.7	292.7	200.5	110.2	229.4	172.3	357.4
26	91.9	235.7	21.4	8.8	187.6	241.5	83.0	350.9	260.6	19.7	322.5	147.5
27	249.9	33.7	179.4	166.7	345.5	39.2	233.3	141.3	51.1	170.1	112.7	297.6
28	47.8	191.7	337.4	324.7	143.3	197.0	23.6	291.6	201.5	320.4	262.9	87.7
29	205.7	349.7	135.5	122.7	301.1	354.7	173.9	82.0	351.9	110.8	53.1	237.8
30	3.7	147.7	293.5	280.6	99.0	152.4	324.2	232.4	142.3	261.1	203.3	27.9
31	161.6	305.7		78.6		310.1	114.5	22.8		51.4		178.0

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1963
For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
	°	°	°		°	°	°
Jan. 1	+ 2.36	−3.01	176.48	July 5	− 1.20	+3.29	254.78
6	− 0.07	−3.58	110.63	10	+ 1.07	+3.81	188.60
11	− 2.48	−4.13	44.78	15	+ 3.32	+4.31	122.43
16	− 4.86	−4.64	338.94	20	+ 5.52	+4.78	56.27
21	− 7.17	−5.12	273.11	25	+ 7.67	+5.22	350.13
26	− 9.40	−5.55	207.28	30	+ 9.75	+5.62	283.99
31	−11.53	−5.94	141.45	Aug. 4	+11.75	+5.98	217.86
Feb. 5	−13.56	−6.29	75.62	9	+13.65	+6.30	151.74
10	−15.46	−6.58	9.78	14	+15.45	+6.58	85.64
15	−17.23	−6.83	303.94	19	+17.14	+6.81	19.55
20	−18.86	−7.01	238.10	24	+18.70	+7.00	313.47
25	−20.35	−7.15	172.25	29	+20.14	+7.13	247.41
Mar. 2	−21.68	−7.23	106.39	Sept. 3	+21.45	+7.22	181.36
7	−22.85	−7.25	40.52	8	+22.61	+7.25	115.33
12	−23.86	−7.22	334.64	13	+23.63	+7.23	49.30
17	−24.70	−7.13	268.74	18	+24.50	+7.16	343.29
22	−25.38	−6.99	202.82	23	+25.20	+7.03	277.29
27	−25.88	−6.79	136.89	28	+25.75	+6.86	211.31
Apr. 1	−26.20	−6.55	70.94	Oct. 3	+26.12	+6.63	145.32
6	−26.35	−6.26	4.97	8	+26.32	+6.35	79.35
11	−26.31	−5.92	298.98	13	+26.34	+6.03	13.39
16	−26.09	−5.54	232.96	18	+26.17	+5.66	307.44
21	−25.68	−5.13	166.93	23	+25.81	+5.24	241.49
26	−25.09	−4.67	100.88	28	+25.26	+4.79	175.55
May 1	−24.32	−4.18	34.81	Nov. 2	+24.51	+4.30	109.62
6	−23.37	−3.67	328.72	7	+23.56	+3.77	43.69
11	−22.24	−3.13	262.61	12	+22.42	+3.21	337.77
16	−20.94	−2.57	196.49	17	+21.09	+2.63	271.86
21	−19.48	−1.99	130.35	22	+19.57	+2.03	205.95
26	−17.86	−1.40	64.20	27	+17.87	+1.41	140.05
31	−16.10	−0.81	358.04	Dec. 2	+16.01	+0.78	74.15
June 5	−14.21	−0.20	291.87	7	+14.01	+0.14	8.26
10	−12.22	+0.40	225.69	12	+11.87	−0.50	302.37
15	−10.12	+1.00	159.51	17	+ 9.62	−1.14	236.50
20	− 7.95	+1.59	93.33	22	+ 7.29	−1.77	170.63
25	− 5.73	+2.17	27.14	27	+ 4.90	−2.38	104.77
30	− 3.47	+2.74	320.96				

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, 1963

No.	Commences	No.	Commences	No.	Commences
1463	Jan. 14.40	1468	May 30.85	1473	Oct. 14.02
1464	Feb. 10.74	1469	June 27.05	1474	Nov. 10.31
1465	Mar. 10.08	1470	July 24.25	1475	Dec. 7.63
1466	Apr. 6.38	1471	Aug. 20.48		
1467	May 3.63	1472	Sept. 16.73		

ECLIPSES, 1963

In 1963 there will be five eclipses, two of the sun and three of the moon. Of these, two are of particular interest in North America, the total eclipse of the sun on July 20, and the total eclipse of the moon on the night of December 29–30. A penumbral eclipse on the night of January 9 will occur when the moon is above the horizon in North America, but the darkening of the moon will be imperceptible to the eye.

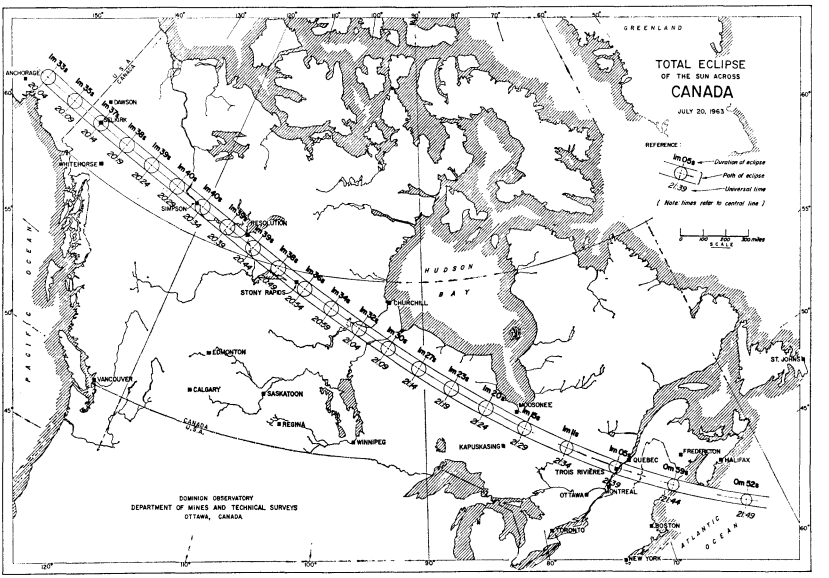
I. *A Penumbral Eclipse of the Moon* on January 9, the beginning "visible" in the northeastern part of North America, the end "visible" in all of North America.

Moon enters penumbra.....16h 05m E.S.T.
Middle of eclipse.....18h 20m E.S.T.
Moon leaves penumbra.....20h 34m E.S.T.
Penumbral magnitude of eclipse....1.043
(By this term is meant the least distance from the moon's edge to the umbra in terms of the moon's diameter).

II. *An Annular Eclipse of the Sun* on January 25 not visible in North America. The path begins in the South Pacific Ocean, crosses the southern tip of South America, the South Atlantic Ocean and the southern tip of Africa. A partial eclipse will be visible in the southern halves of South America and Africa and in Antarctica.

III. *A Partial Eclipse of the Moon* on the night of July 6, not visible in North America.

IV. *A Total Eclipse of the Sun* on July 20. The path of totality of this eclipse begins at sunrise in Japan, crosses the North Pacific, Alaska, Yukon (Selkirk at 11:14 Yukon Time), the Northwest Territories, Northern Saskatchewan (Stony Rapids at 13:52 M.S.T.), Manitoba, Ontario (between Moosonee and Kapuskasing at 16:28 E.S.T., Quebec (Three Rivers at 16:39 E.S.T.), Maine (Bar Harbor at



16:44 E.S.T.), just misses the southern tip of Nova Scotia at 17:46 A.S.T. and ends at sunset in the Atlantic. The path of totality is only about 60 miles wide, but the partial eclipse will be visible over the whole of North and Central America.

V. *A Total Eclipse of the Moon* on the night of December 29–30. The eclipse is visible generally throughout North America except that the moon will have set for the eastern parts before the eclipse is ended.

Moon enters umbra.....Dec. 30 4h 25m E.S.T.
Total eclipse begins.....5h 28m E.S.T.
Middle of eclipse.....6h 07m E.S.T.
Total eclipse ends.....6h 47m E.S.T.
Moon leaves umbra.....7h 50m E.S.T.
Magnitude of the eclipse.....1.340

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 at Toronto, Montreal, Edmonton and Vancouver. 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: Toronto, λ_0 79° 23.9′, ϕ_0+43° 39.8′; Montreal, λ_0 73° 34.7′, ϕ_0+45° 30.3′; Edmonton, λ_0 113° 05′, ϕ_0+53° 32′; Vancouver, λ_0 123° 06′, ϕ_0+49° 30′.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1963

Date	Star	Mag.	I or E	Age of Moon	Toronto				Montreal			
					E.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Dec. 31	272B. Aqr	7.1	I	5.1	19 36.1	−1.4	−1.4	97	19 40.7	−1.2	−1.6	98
Jan. 4	μ Cet	4.4	I	9.2	22 16.9	−1.4	−0.3	73	22 24.0	−1.2	−0.4	70
Jan. 5	+13° 568	7.3	I	10.0	17 59.3	−0.3	+2.8	23	18 06.7	−0.5	+2.6	27
Jan. 11	δ Cnc	4.2	I	15.4	05 24.0	−0.5	−2.2	129	05 22.8	−0.4	−2.0	118
Jan. 11	δ Cnc	4.2	E	15.4	06 24.1	−0.5	−1.3	266	06 23.8	−0.3	−1.5	275
Jan. 11	12B. Leo	6.3	E	16.2	22 26.7	−1.0	+0.3	300	22 33.4	−1.2	0.0	304
Jan. 31	ξ^2 Cet	4.3	I	6.5	20 19.4	−2.0	−3.1	122	20 24.3	−1.6	−2.8	118
Feb. 2	+15° 607	6.8	I	8.4	18 44.1	—	—	137	18 56.7	—	—	139
Feb. 2	55 Tau m.	6.9	I	8.5	20 32.0	−2.2	−2.0	119	20 40.4	−1.9	−1.9	115
Feb. 2	63 Tau	5.7	I	8.6	22 34.5	−1.3	−2.0	109	22 37.9	−1.1	−1.7	102
Feb. 3	352B. Tau	6.8	I	9.6	22 27.0	−1.7	+1.9	37	22 40.9	−1.7	+2.7	26
Feb. 5	16 Gem	6.1	I	10.7	03 12.9	0.0	−1.8	114	03 09.6	0.0	−1.6	104
Feb. 5	15 Gem	6.6	I	10.7	03 15.0	−0.7	+0.1	44	03 21.2	—	—	24

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1963

Date	Star	Mag.	I or E	Age of Moon	Toronto				Montreal			
					E.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Feb. 6	56 Gem	5.2	I	11.7	01 39.3	−0.7	−2.6	133	01 38.9	−0.7	−2.1	121
Feb. 6	61 Gem	5.9	I	11.8	04 04.7	+0.1	−2.1	127	04 00.4	+0.1	−1.8	117
Feb. 9	53 Leo	5.3	E	15.6	23 40.4	−1.9	+2.1	252	23 54.6	−2.0	+1.1	264
Feb. 19	30G. Sgr	6.2	E	24.9	05 17.7	—	—	352	No Occ.	...	...	...
Mar. 4	+21° 1426	6.7	I	8.9	Sun	...	...	...	18 19.9	−1.1	+3.7	35
Mar. 5	ζ Gem	3.8	I	9.1	No Occ.	...	...	...	00 06.7	+0.1	−3.7	154
Mar. 5	85 Gem	5.4	I	10.0	No Occ.	...	...	...	21 43.5	—	—	174
Mar. 6	217B. (Gem)	6.3	I	10.1	00 14.8	−0.9	−2.2	125	00 16.0	−0.8	−1.9	114
Mar. 6	138B. Cnc m.	6.7	I	11.0	No Occ.	...	...	...	22 01.0	—	—	163
Apr. 1	79 Gem	6.3	I	7.6	23 07.1	−0.4	−2.5	133	23 05.1	−0.4	−2.1	122
Apr. 3	δ Cnc	4.2	I	8.7	01 58.8	+0.8	−3.3	169	01 49.8	+0.5	−2.5	154
Apr. 6	308B. Leo	5.9	I	11.8	02 45.0	−0.1	−2.9	162	02 40.6	−0.1	−2.5	152
Apr. 26	352B. Tau	6.8	I	3.2	No Occ.	...	...	...	19 51.1	+0.5	−4.4	152
Apr. 26	353B. Tau	6.4	I	3.2	19 51.7	−0.4	−1.6	101	19 51.4	−0.4	−1.3	91
Apr. 27	+21° 1203	7.1	I	4.1	Sun	...	...	...	19 31.1	−0.7	−1.7	104
May 2	34 Leo m.	6.4	I	8.3	00 48.8	+0.2	−2.6	156	00 43.3	+0.2	−2.3	147
May 3	262B. Leo	7.0	I	9.3	00 33.1	−1.3	−0.8	68	00 39.1	−1.3	−0.4	54
May 13	ν^2 Sgr	5.0	E	19.4	Low	...	...	...	00 39.9	−1.1	+0.7	291
May 13	−22° 4928	6.0	E	19.5	02 01.1	—	—	347	NoOcc.	...	...	...
May 27	+18° 2090	6.6	I	4.9	21 43.8	−0.4	−1.5	99	21 43.0	−0.3	−1.4	90
May 27	176B. Cnc	6.6	I	4.9	22 13.1	0.0	−1.8	121	22 09.7	0.0	−1.7	113
June 3	186G. Vir	6.9	I	11.1	01 39.9	—	—	176	Low	...	...	...
June 3	8G. Lib	6.7	I	12.0	22 04.5	−3.0	+0.9	69	22 26.5	—	—	48
June 14	290B. Aqr	6.4	E	22.1	Low	...	...	...	01 30.6	−0.7	+2.7	197
July 29	−14° 4208	7.4	I	9.2	Sun	...	...	...	20 22.6	−2.1	−0.4	73
Aug. 1	14B. Sgr	6.9	I	12.2	Sun	...	...	...	20 00.0	−1.4	−0.3	132
Aug. 2	ν^1 Sgr	5.0	I	13.2	19 56.0	−1.9	+2.0	56	20 11.3	−2.1	+2.0	46
Aug. 2	154B. Sgr	5.9	I	13.3	21 23.3	—	—	160	21 28.4	—	—	150
Aug. 3	168B. Sgr	6.3	I	13.4	00 42.4	−1.0	+0.3	42	00 47.9	−0.8	0.0	44
Aug. 28	158G. Oph	6.7	I	9.7	19 55.6	−2.2	+0.1	74	20 07.5	−1.9	−0.1	70
Sept. 9	97 Tau	5.1	E	21.9	Low	...	...	...	23 35.6	−0.1	+1.1	281
Sept. 26	191B. Sgr	6.5	I	9.2	21 36.7	−1.6	−1.4	104	Low	...	...	...
Sept. 27	322B. Sgr	6.8	I	10.2	19 02.6	−1.9	+1.3	48	19 15.2	−1.7	+1.0	47
Oct. 5	85 (Cet)	6.3	E	17.4	03 23.6	−2.3	−2.3	297	03 31.6	−2.0	−2.6	298
Oct. 6	119H^1. Tau m.	6.2	E	19.3	23 00.3	0.0	+2.0	227	23 04.6	−0.1	+2.1	224
Oct. 7	372B. Tau	6.1	E	20.3	22 48.6	+0.3	+1.9	226	22 50.6	+0.2	+2.1	224
Oct. 9	+22° 1416	6.3	E	21.4	00 58.8	−0.7	+0.8	291	01 04.7	−0.8	+0.8	289
Oct. 11	39 Cnc	6.5	E	23.5	02 59.5	−1.3	−1.7	334	03 04.3	−1.5	−2.1	337
Oct. 11	40 Cnc	6.5	E	23.5	03 08.2	−1.1	−0.6	322	03 13.7	−1.2	−0.9	324
Oct. 11	ε Cnc	6.3	E	23.5	03 14.1	+0.1	+4.4	214	03 22.5	−0.3	+4.2	217
Oct. 11	102B. Cnc	6.5	E	23.5	03 24.6	−0.6	+2.0	251	03 32.2	−0.8	+1.9	253
Oct. 25	−21° 5782	7.3	I	8.6	21 39.1	−0.6	0.0	47	Low	...	...	...
Oct. 27	−15° 6208	7.1	I	10.5	19 17.1	−1.7	+0.9	67	19 28.4	−1.7	+0.6	69
Oct. 28	290B. Aqr	6.4	I	11.5	Sun	...	...	...	17 45.3	−1.2	+1.4	78
Oct. 28	−10° 6098	7.5	I	11.6	22 11.4	−1.7	0.0	75	22 20.4	−1.5	−0.4	79
Oct. 29	24B. (Cet)	6.0	I	12.5	18 27.3	−1.0	+1.5	79	18 36.1	−1.2	+1.4	80
Nov. 3	333B. Tau m.	6.5	E	17.6	20 45.6	0.0	+1.4	259	20 48.6	−0.1	+1.5	256
Nov. 5	δ Gem	3.5	I	19.7	23 46.1	−0.7	+0.6	115	23 51.7	−0.9	+0.6	116
Nov. 6	δ Gem	3.5	E	19.7	00 41.2	−0.4	+2.3	236	00 48.6	−0.6	+2.3	236
Nov. 7	49B. Cnc	5.9	E	20.8	01 05.5	−0.6	+1.4	267	01 11.9	−0.8	+1.4	268
Nov. 22	26 Cap	6.9	I	6.7	Sun	...	...	...	17 31.3	−2.3	−0.8	110
Nov. 23	29 Aqr m.	6.5	I	7.7	17 43.3	—	—	125	17 58.9	—	—	132
Dec. 1	ζ Tau	3.0	I	15.8	19 03.3	+0.3	+1.6	62	19 05.1	+0.1	+1.6	64
Dec. 1	ζ Tau	3.0	E	15.8	19 54.5	−0.2	+1.2	271	19 58.7	−0.4	+1.3	268
Dec. 4	μ Cnc	5.4	E	18.2	06 22.2	—	—	354	No Occ.	...	...	...
Dec. 18	329B. Sgr	6.1	I	2.8	Sun	...	...	...	16 49.5	−1.1	−0.8	75
Dec. 22	352B. Aqr	7.3	I	7.0	21 02.4	—	—	133	21 07.2	—	—	135
Dec. 23	64B. Cet	7.0	I	8.0	22 45.8	−0.5	+0.1	45	22 48.3	−0.3	+0.1	43
Dec. 26	3B. (Tau)	6.4	I	11.1	22 35.6	−1.5	+0.2	67	22 44.2	−1.3	+0.1	65
Dec. 27	+13° 535	7.4	I	11.2	02 25.3	−0.9	+3.0	8	No Occ.	...	...	...
Dec. 27	180B. Tau	6.2	I	12.0	21 08.7	−0.7	+3.0	21	21 18.6	−0.9	+2.8	22
Dec. 27	193B. Tau	6.3	I	12.1	23 24.9	−2.1	−2.8	125	23 31.0	−1.7	−2.4	119
Dec. 28	106 Tau	5.3	I	13.0	19 43.7	+0.2	+3.6	15	19 49.6	−0.1	+3.4	19
Dec. 30*	+22° 1364	7.2	I	14.3	04 54.2	−0.2	−1.9	117	04 52.2	−0.2	−1.6	106

*Total lunar eclipse.

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	−10° 6082	7.0	I	5.2	Low	...	...	...	19 59.7	−0.4	+0.5	31
Jan. 3/4	311B. Psc	7.1	I	8.3	00 38.5	−0.3	−1.1	76	23 39.3	−0.6	−1.4	88
Jan. 4	μ Cet	4.4	I	9.2	19 53.1	−0.2	+3.4	4	18 38.4	—	—	1
Jan. 5	+13° 579	6.9	I	10.1	18 26.2	−0.8	+1.6	71	17 12.2	−0.6	+1.7	68
Jan. 8	χ^1 Ori	4.6	I	12.5	04 16.3	−1.0	+0.8	28	03 07.0	−0.9	−0.3	54
Jan. 11	δ Cnc	4.2	I	15.4	02 34.4	−1.1	−2.0	138	01 35.2	—	—	164
Jan. 11	δ Cnc	4.2	E	15.4	03 37.8	−1.5	−0.3	252	02 15.3	—	—	225
Jan. 27	74 Aqr	5.9	I	2.5	Low	...	...	...	17 47.9	−1.3	−2.0	109
Jan. 28	376B. Aqr	6.3	I	3.5	19 12.4	−0.2	+1.0	17	18 05.5	−0.4	+1.1	20
Jan. 31	ξ^2 Cet	4.3	I	6.5	17 22.1	−1.1	+1.3	54	Sun	...	...	...
Feb. 1	+13° 568	7.3	I	7.7	23 10.7	−0.7	−0.3	54	22 03.8	−1.0	−0.5	67
Feb. 2	+13° 579	6.9	I	7.8	Low	...	...	...	00 59.1	+0.2	−2.5	123
Feb. 2	63 Tau	5.7	I	8.6	19 39.4	−1.3	+1.1	63	18 21.8	−1.3	+1.4	65
Feb. 4/5	16 Gem	6.1	I	10.7	00 38.6	−0.9	−2.0	115	23 38.2	−1.1	−2.9	135
Feb. 4/5	15 Gem	6.6	I	10.7	00 39.6	−1.4	+0.5	47	23 24.2	−1.5	+0.1	67
Feb. 5	56 Gem	5.2	I	11.7	22 38.5	−1.4	−1.1	120	21 28.3	−1.7	−1.7	136
Feb. 6	61 Gem	5.9	I	11.8	01 32.8	−0.6	−2.6	136	00 42.2	—	—	167
Feb. 9	53 Leo	5.3	E	15.6	21 21.1	−0.5	+1.3	280	20 12.0	−0.2	+1.5	270
Feb. 17	χ Oph	4.8	E	23.0	06 46.6	−1.6	+0.2	271	05 26.6	−1.9	+1.1	255
Feb. 19	14 Sgr	5.7	E	25.0	Sun	...	...	...	05 52.6	−0.7	+0.2	314
Feb. 28	+11° 445	5.9	I	5.0	18 52.9	—	—	135	Sun	...	...	...
Mar. 1	+15° 592	7.2	I	6.1	20 50.4	—	—	146	No Occ.	...	...	...
Mar. 1	+15° 607	6.8	I	6.2	23 42.8	—	—	152	No Occ.	...	...	...
Mar. 1	55 Tau m.	6.9	I	6.2	Low	...	...	...	23 54.6	+0.2	−2.0	112
Mar. 2	104 Tau m.	5.0	I	7.0	20 21.4	—	—	154	No Occ.	...	...	...
Mar. 4	ζ Gem	3.8	I	9.1	21 12.8	—	—	158	No Occ.	...	...	...
Mar. 5	217B. (Gem)	6.3	I	10.1	21 14.6	−1.4	−0.9	119	20 03.9	−1.6	−1.4	135
Mar. 19	28 Sgr	5.8	E	23.5	Sun	...	...	...	04 54.2	−1.4	+1.3	257
Mar. 30	203B. Ori	6.6	I	5.7	22 02.8	−0.4	−2.0	110	21 07.4	−0.5	−2.8	130
Mar. 30	χ^1 Ori	4.6	I	5.7	22 33.4	−0.2	−2.1	116	21 41.2	−0.2	−3.1	138
Mar. 31	+21° 1426	6.7	I	6.7	23 33.8	—	—	28	22 21.9	−1.1	−0.4	58
Apr. 1	79 Gem	6.3	I	7.6	20 13.9	−1.2	−2.1	134	Sun	...	...	...
Apr. 2	85 Gem	5.4	I	7.8	01 37.0	+0.2	−1.9	123	00 47.6	+0.2	−2.4	140
Apr. 3	138B. Cnc m.	6.7	I	8.8	02 07.2	0.0	−1.8	113	01 14.7	0.0	−2.1	127
Apr. 12	θ Lib.	4.3	I	18.0	04 04.8	−2.0	+0.1	56	02 42.7	−2.2	+0.4	73
Apr. 12	θ Lib	4.3	E	18.0	04 54.3	−1.1	−2.0	340	03 49.8	−1.3	−1.6	328
Apr. 29	+19° 2027	6.7	I	6.4	23 55.3	−0.1	−2.1	130	23 05.8	+0.2	−2.6	148
Apr. 30	+17° 2065	6.8	I	7.3	22 30.5	—	—	178	No Occ.	...	...	...
Apr.30/May 1	12B. Leo	6.3	I	7.4	00 10.6	−0.4	−1.6	91	23 13.0	−0.5	−1.8	106
May 1	34 Leo m.	6.4	I	8.3	22 25.6	—	—	188	No Occ.	...	...	...
May 2	262B. Leo	7.0	I	9.3	21 31.5	−1.6	−0.5	92	20 17.6	−1.6	−0.7	113
May 3	+9° 2441	7.1	I	9.4	00 24.1	—	—	192	No Occ.	...	...	...
May 3/4	10B. Vir	6.7	I	10.4	00 06.1	−1.0	−1.7	110	23 02.0	−1.1	−1.8	126
May 11	ξ Oph	4.5	I	17.6	Sun	...	...	...	03 11.8	—	—	38
May 11	ξ Oph	4.5	E	17.6	Sun	...	...	...	03 51.6	—	—	340
May 25	120B. Gem	6.5	I	3.0	Low	...	...	...	21 36.5	+0.1	−1.2	84
May 28	+15° 2136	7.5	I	6.1	22 07.1	−0.3	−2.1	126	21 12.6	−0.3	−2.4	143
May 29/30	53 Leo	5.3	I	7.1	00 05.5	+0.1	−2.3	151	23 16.9	+0.2	−2.8	166
June 29	80 Vir	5.8	I	8.8	23 47.4	−0.5	−2.3	147	22 51.3	−0.6	−2.5	156
July 2	θ Lib	4.3	I	11.8	No Occ.	...	...	...	22 40.2	—	—	47
July 3	131B. (Sco)	5.6	I	12.8	22 56.1	−1.1	−1.1	151	21 51.9	—	—	169
July 12	30 Psc	4.7	E	21.0	Sun	...	...	...	02 24.9	−1.2	+1.4	256
July 13	20 Cet	4.9	E	21.9	02 40.6	−0.5	+2.0	210	01 27.5	−0.4	+2.2	211
Aug. 11	ξ^2 Cet	4.3	I	21.6	02 34.8	−0.8	+1.5	76	01 21.3	−0.6	+1.7	73
Aug. 11	ξ^2 Cet	4.3	E	21.6	03 39.6	−0.8	+1.7	231	02 24.6	−0.7	+1.8	235
Aug. 14	353B. Tau	6.4	E	24.6	Sun	...	...	...	03 24.8	−0.4	+1.6	260
Aug. 27	68B. Oph	5.9	I	8.9	21 02.3	−1.3	−1.1	99	19 51.2	−1.7	−0.8	104
Aug. 28	−22° 4405	6.6	I	9.8	20 33.6	−1.5	−0.4	91	Sun	...	...	...
Aug. 28	−22° 4423	6.2	I	9.9	Low	...	...	...	21 47.6	−1.8	−2.4	150
Aug. 29	−23° 14580	6.8	I	10.9	21 08.5	−1.5	−0.6	121	19 54.4	−1.6	−0.4	127
Sept. 28	η Cap	4.9	I	11.3	21 35.7	−1.3	0.0	71	20 20.2	−1.6	+0.5	69
Oct. 7	302B. Tau	6.1	E	19.5	02 50.3	−0.8	+2.1	220	01 34.0	−0.6	+2.3	220
Oct. 9	36 Gem	5.2	E	21.6	04 34.0	−0.9	+3.3	214	03 12.2	−0.3	+4.4	204
Oct. 11	ϵ Cnc	6.3	E	23.5	01 34.1	+0.1	+1.3	276	Low	...	...	...
Oct. 12	8 Leo	5.9	E	24.6	02 47.9	+0.3	+2.8	231	Low	...	...	...
Oct. 24	−23° 15691	7.4	I	7.6	18 47.3	−1.3	+0.1	50	Sun	...	...	...
Oct. 27	56 Aqr	6.4	I	10.6	20 44.5	−1.7	−0.3	103	19 26.6	−1.8	+0.3	99
Oct. 28	−10° 6098	7.5	I	11.6	19 42.1	−0.7	+1.8	19	18 26.9	−0.7	+2.3	15
Oct. 28	336B. Aqr	6.5	I	11.7	23 37.4	−1.6	−1.7	109	22 25.6	−1.9	−1.2	105
Nov. 3	68 Tau	4.2	I	16.9	04 13.3	−1.2	−1.9	113	03 08.3	−1.7	−2.8	128

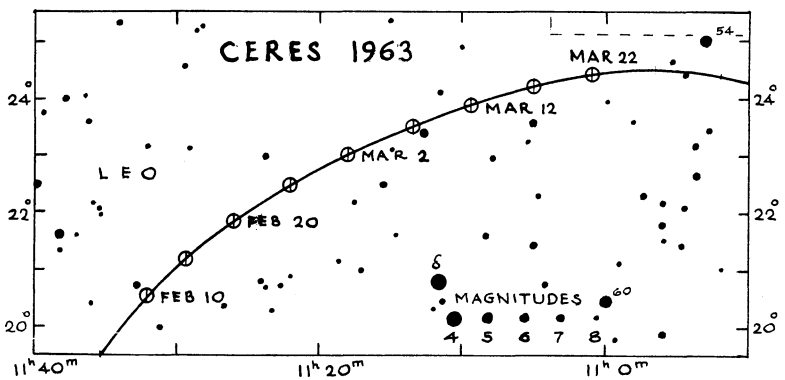
Date	Star	Mag	I or E	Age of Moon	Edmonton				Vancouver			
					M.S.T.	a	b	P	P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Nov. 3	68 Tau	4.2	E	16.9	05 06.5	−1.0	+0.6	220	03 50.3	−1.1	+2.4	201
Nov. 5	δ Gem	3.5	E	19.7	22 46.3	−0.1	+1.0	292	Low	...	...	...
Nov. 7	η Cnc	5.5	E	21.0	05 00.7	−1.3	−1.5	319	03 50.5	−1.5	−0.4	303
Nov. 23	−17° 6451	7.4	I	7.8	18 39.6	−2.1	−0.7	118	17 20.3	−2.0	0.0	112
Nov. 23	143B. Aqr	6.6	I	7.9	Low	...	...	...	21 17.2	−1.3	−1.8	103
Nov. 25	70B. Psc	6.8	I	10.0	23 27.0	0.0	+1.8	6	22 19.4	−0.1	+1.9	8
Nov. 25/26	30 Psc	4.7	I	10.0	00 10.2	−0.7	−1.7	95	23 07.8	−1.2	−1.7	99
Dec. 3	44 Gem	5.9	E	17.1	No Occ.	...	...	...	02 41.1	−1.5	−2.7	321
Dec. 4	μ Cnc	5.4	E	18.2	No Occ.	...	....	...	02 26.3	−1.5	−2.6	329
Dec. 8	ν Vir	4.2	I	22.3	05 46.2	−1.8	+1.6	74	04 25.5	−1.4	+0.9	98
Dec. 8	ν Vir	4.2	E	22.3	06 41.7	−0.6	−2.2	344	05 39.0	−1.2	−1.1	319
Dec. 22	352B Aqr	7.3	I	7.0	17 59.3	−1.1	+0.7	52	Sun	...	...	...
Dec. 22	252G. Aqr	6.8	I	7.0	19 17.8	−1.4	−0.5	84	18 03.1	−1.7	+0.1	79
Dec. 22	−8° 6166	7.1	I	7.1	21 29.0	+0.1	+1.6	7	20 22.3	−0.1	+1.7	9
Dec. 24	+2° 207	7.0	I	9.1	22 38.2	−0.6	+0.8	26	21 27.9	−0.8	+1.0	31
Dec. 27	193B. Tau	6.3	I	12.1	20 31.3	−0.9	+1.5	60	19 16.2	−0.7	+1.8	58
Dec. 28	68 Tau	4.2	I	12.3	02 57.2	−0.4	−2.2	113	02 04.2	−0.4	−3.7	136
Dec. 29	ζ Tau	3.0	I	13.5	Low	...	...	...	05 35.1	0.0	−1.2	85
Dec. 30*	+22° 1416	6.3	I	14.4	05 25.9	0.0	−2.4	133	04 41.1	—	—	165

*Total lunar eclipse.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1963

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.



PALLAS (No. 2)

Opp. Jan. 5 in CMa — Mag. 7.5

Dec.	16	6h	53.4m	−32°13′
	21	6	49.8	−32 31
	26	6	45.7	−32 36
	31	6	41.5	−32 26
Jan.	5	6	37.1	−32 02
	10	6	32.9	−31 24
	15	6	29.0	−30 31
	20	6	25.5	−29 25
	25	6	22.6	−28 07

CERES (No. 1)

Opp. Mar. 2 in Leo — Mag. 7.1

Feb.	10	11h	32.2m	+20°31′
	15	11	29.3	+21 11
	20	11	25.9	+21 50
	25	11	22.1	+22 27
Mar.	2	11	17.9	+23 01
	7	11	13.5	+23 30
	12	11	09.2	+23 54
	17	11	04.9	+24 12
	22	11	00.9	+24 24

JUNO (No. 3)

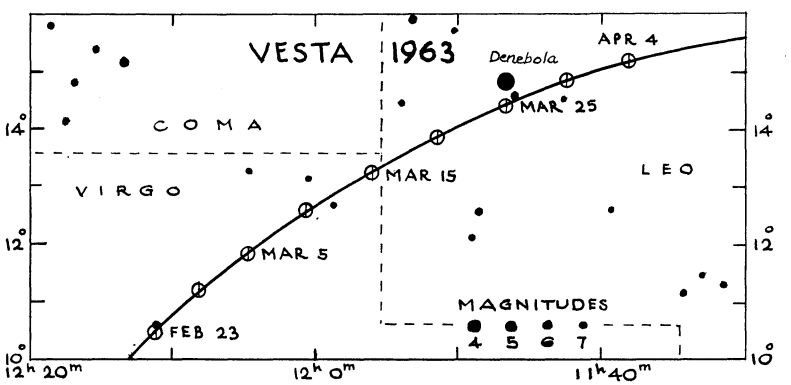
Opp. Mar. 10 in Leo — Mag. 9.7

Feb.	18	11h	33.7m	+0°47′
	23	11	30.3	+1 32
	28	11	26.5	+2 19
Mar.	5	11	22.5	+3 08
	10	11	18.5	+3 57
	15	11	14.5	+4 46
	20	11	10.6	+5 34
	25	11	07.0	+6 18
	30	11	03.8	+7 00

VESTA (No. 4)

Opp. Mar. 15 in Leo — Mag. 6.6

Feb.	23	12h	11.3m	+10°29′
	28	12	08.2	+11 11
Mar.	5	12	04.6	+11 53
	10	12	00.5	+12 35
	15	11	56.1	+13 15
	20	11	51.5	+13 52
	25	11	46.8	+14 24
	30	11	42.4	+14 51
Apr.	4	11	38.2	+15 12



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 1963, according to Mr. Gordon E. Taylor of the British Astronomical Association.

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 most important showers visible in 1963. The Leonid shower should be increasing in strength during the next few years and will be of particular interest.

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 and astronomers must rely on observations made by the general public to track it down.

Meteor Showers for 1963

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. 3	19h	F.Q.	15 28	+50	—	—	40	0.6
Lyrids	Apr. 22	12	N.M.	18 16	+34	+4.4	0.0	15	2.3
η Aquarids	May 5	12	F.M.	22 24	00	+3.6	+0.4	20	1.8
δ Aquarids	July 29	20	F.Q.	22 36	−17	+3.4	+0.17	20	20
Perseids	Aug. 12	15	L.Q.	03 04	+58	+5.4	+0.12	50	5.0
Orionids	Oct. 21	03	N.M.	06 20	+15	+4.9	+0.13	25	8
Taurids	Nov. 6	03	L.Q.	03 32	+14	+2.7	+0.13	15	(30)
Leonids	Nov. 17	02	N.M.	10 08	+22	+2.8	−0.42	15	4
Geminids	Dec. 13	20	N.M.	07 32	+32	+4.2	−0.07	50	6.0
Ursids	Dec. 23	01	F.Q.	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

TABLE OF PRECESSION FOR 50 YEARS

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

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

THE BRIGHTEST STARS

By Donald A. MacRae

The 286 stars brighter than apparent magnitude 3.55.

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

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

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

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

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

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

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

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

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

Star	Right Ascension	Declination	Visual Magnitude	Colour Index	Spectral Classification	Parallax	Absolute Magnitude	Distance light-years	Proper Motion	Radial Velocity		
	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	
β Hyi	23.7	−77 29	2.78	+0.62	*G1 IV*	0.153	+3.7	21	2.255	+22.8	γ Peg = *Algenib*	
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 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		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 = ***Almach***
γ And *A*	02 01.4	+42 08	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″
α 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*	
o 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	*A8 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	
θ^2 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.? *R* 0.78–0.93, *B* 13^{m}31″ ***Aldebaran***
π^3 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 57.9 m; Dec. +89° 06′ (1963).

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 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		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* 4.90^m 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* 8.26^m 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* 2.9^m *B* 2.9^m 1″
γ Vir *AB*	39.6	−01 14	2.76	+0.34	F0 V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″
β Mus *AB*	43.8	−67 53	3.06	−0.17:	*B3 V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 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* 5.61^m 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* 3.94^m 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, 4.0^d ***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 23i″	*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 h m	Dec. ° ′	V	$B-V$	Type	π ″	M_V	D l.y.	μ ″	R 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* 2.78m *B* 5.04m 1″, *C* 4.93m 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, 0.25d, *B* 8.49m 20″
η Dra *A*	23.4	+61 36	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	*B* 8.7m 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* 0.86m–1.02m *B* 5.07m 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* 2.91m *B* 5.46m 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, 1.4d
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* 3.0m *B* 3.4m 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* 3.2m ± 0.3 *B* 5.4m 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* 10m 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* 11.49m 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 h m	Dec. ° ′	V	$B-V$	Type	π	M_V	D	μ	R	
						″		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	F3 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 1963; the approximate position-angle in 1963; and the period, if known.

Star	A.D.S.	R.A. 1960 h	m	Dec. °	′	Magnitudes comb.	a	b	Sep. 1963.5 ″	P.A. °	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	2.0	292	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	256	1,060
Σ 1338	7307	09	18.5	+38	21	5.8	6.5	6.7	1.2	229	390
35 Com	8695	12	51.3	+21	28	5.1	5.3	7.3	0.9	148	675
Σ 2054	10052	16	23.3	+61	48	5.6	6.0	7.2	1.1	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	297	530
Σ 186	1538	01	53.8	+01	39	6.2	6.9	7.0	1.5	53	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	10.0	82	50
α Gem	6175	07	32.0	+31	59	1.6	2.0	2.9	1.8	151	380
ζ Cnc AB	6650	08	09.9	+17	46	5.0	5.6	5.9	1.2	353	60
ζ Cnc AC	6650	08	09.9	+17	46	5.0	5.6	6.0	5.7	82	1,150
10 U Ma	Kpr	08	58.1	+41	57	4.1	4.3	6.3	0.5	317	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	2.3	144	60
γ Vir	8630	12	39.6	−01	14	2.8	3.5	3.5	4.9	307	170
Σ 1785	9031	13	47.3	+27	11	6.6	7.2	7.5	3.1	147	155
ζ Boo	9343	14	39.3	+13	54	3.9	4.6	4.6	1.2	309	125
ξ Boo	9413	14	49.6	+19	17	4.7	4.8	6.9	6.9	345	150
ζ Her	10157	16	39.8	+31	40	2.8	2.9	5.5	1.1	39	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	156	45
70 Oph	11046	18	03.4	+02	31	4.1	4.3	6.0	3.7	83	90
β 648	11871	18	55.6	+32	51	5.2	5.3	7.7	1.0	217	60
4 Aqr	14360	20	49.3	−05	47	6.0	6.4	7.2	1.0	4	155
τ Cyg	14787	21	13.2	+37	52	3.8	3.9	6.3	0.8	215	50
Σ 3050	17149	23	57.4	+33	30	5.8	6.5	6.5	1.5	283	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.)

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.

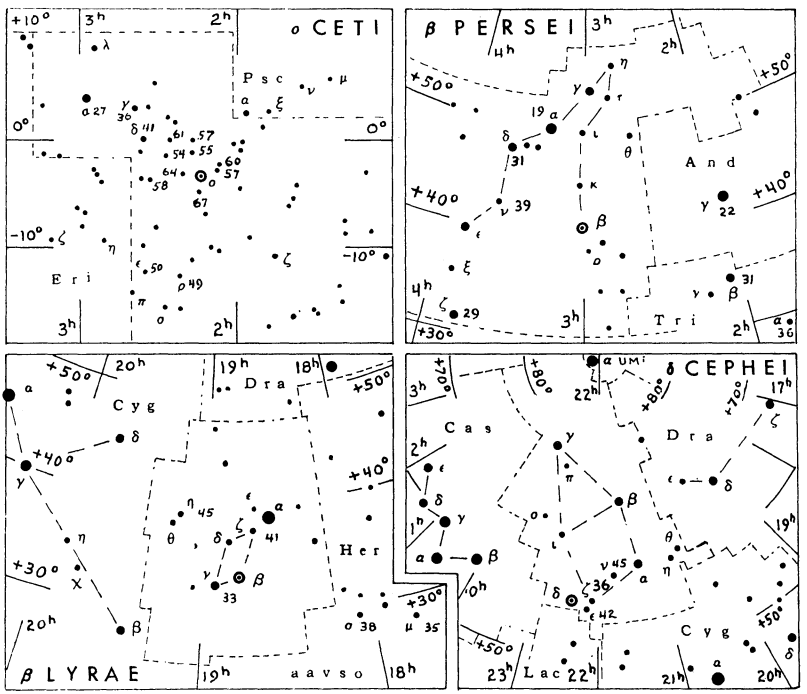
Star	1950 α h	1950 α m	1950 δ °	1950 δ ′	Sp.	π ″	D l.y.	μ ″	W km./sec.	m	L
Sun					G2					−26.9	1.0
α Cen A	14	36	−60	38	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	26	−62	28	M5*e*					11	0.000052
Barnard's *	17	55	+ 4	33	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	54	+ 7	20	M6*e*	.421	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
o^2 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 1963	Variable		Max. m	Per. d	Epoch 1963
001755	T Cas	7.8	445	Nov. 8	151731	S CrB	7.3	361	Apr. 21
001838	R And	7.0	409	June 10	154639	V CrB	7.5	358	Dec. 11
021143	W And	7.4	397	...	154615	R Ser	6.9	357	Feb. 22
021403	o Cet	3.4	332	Apr. 10	160625	RU Her	8.0	484	Mar. 15
022813	U Cet	7.5	235	Apr. 29	162119	U Her	7.5	406	...
023133	R Tri	6.2	266	Aug. 20	162112	V Oph	7.5	298	Aug. 4
043065	T Cam	8.0	374	Oct. 3	163266	R Dra	7.6	245	Apr. 15
045514	R Lep	6.8	432	July 25	164715	S Her	7.6	307	Oct. 8
050953	R Aur	7.7	459	Mar. 26	170215	R Oph	7.9	302	July 6
054920	U Ori	6.3	372	June 1	171723	RS Her	7.9	219	Mar. 30
061702	V Mon	7.0	335	July 14	180531	T Her	8.0	165	Jan. 19
065355	R Lyn	7.9	379	Nov. 28	181136	W Lyr	7.9	196	May 16
070122a	R Gem	7.1	370	Apr. 30	183308	X Oph	6.8	334	Mar. 27
070310	R CMi	8.0	338	Feb. 27	190108	R Aql	6.1	300	Oct. 5
072708	S CMi	7.5	332	June 21	191017	T Sgr	8.0	392	May 13
085008	T Hya	7.8	288	Feb. 27	191019	R Sgr	7.3	269	Aug. 6
093934	R LMi	7.1	372	Jan. 2	193449	R Cyg	7.5	426	May 28
094211	R Leo	5.8	313	Aug. 31	194048	RT Cyg	7.3	190	Mar. 30
103769	R UMa	7.5	302	Feb. 11	194632	χ Cyg	5.2	407	Jan. 7
121418	R Crv	7.5	317	Nov. 2	200938	RS Cyg	7.2	418	Apr. 1
122001	SS Vir	6.8	355	June 4	201647	U Cyg	7.2	465	Mar. 25
123160	T UMa	7.7	257	July 15	204405	T Aqr	7.7	202	Mar. 18
123307	R Vir	6.9	146	Mar. 12	210868	T Cep	6.0	390	Dec. 2
123961	S UMa	7.8	226	Feb. 19	213753	RU Cyg	8.0	234	June 5
131546	V CVn	6.8	192	May 24	230110	R Peg	7.8	378	Aug. 23
132706	S Vir	7.0	378	Sept. 25	230759	V Cas	7.9	228	Mar. 15
134440	R CVn	7.7	328	Oct. 8	231508	S Peg	8.0	319	Aug. 17
142584	R Cam	7.9	270	Sept. 17	233815	R Aqr	6.5	387	Apr. 1
142539	V Boo	7.9	258	Apr. 12	235350	R Cas	7.0	431	Feb. 8
143227	R Boo	7.2	223	Jan. 12	235715	W Cet	7.6	351	July 10

OTHER TYPES OF VARIABLE STARS

Variable		Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1963 E.S.T.
005381	U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 2.44*
025838	ρ Per	3.3	4.0	Semi R	M4	33–55	
030140	β Per	2.1	3.3	Ecl	B8+G	2.8674	Jan. 1.95*
035512	λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 4.43*
060822	η Gem	3.1	3.9	Semi R	M3	233.4	July 27:*
061907	T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 25.06
065820	ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 10.95
154428	R Cr B	5.8	14.8	R Cr B	cFpep		
171014	α Her	3.0	4.0	Semi R	M5		
184205	R Set	6.3	8.6	RVTau	G0e-K0p	144	
184633	β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 5.11*
192242	RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.30
194700	η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 6.81
222557	δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 4.49

*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

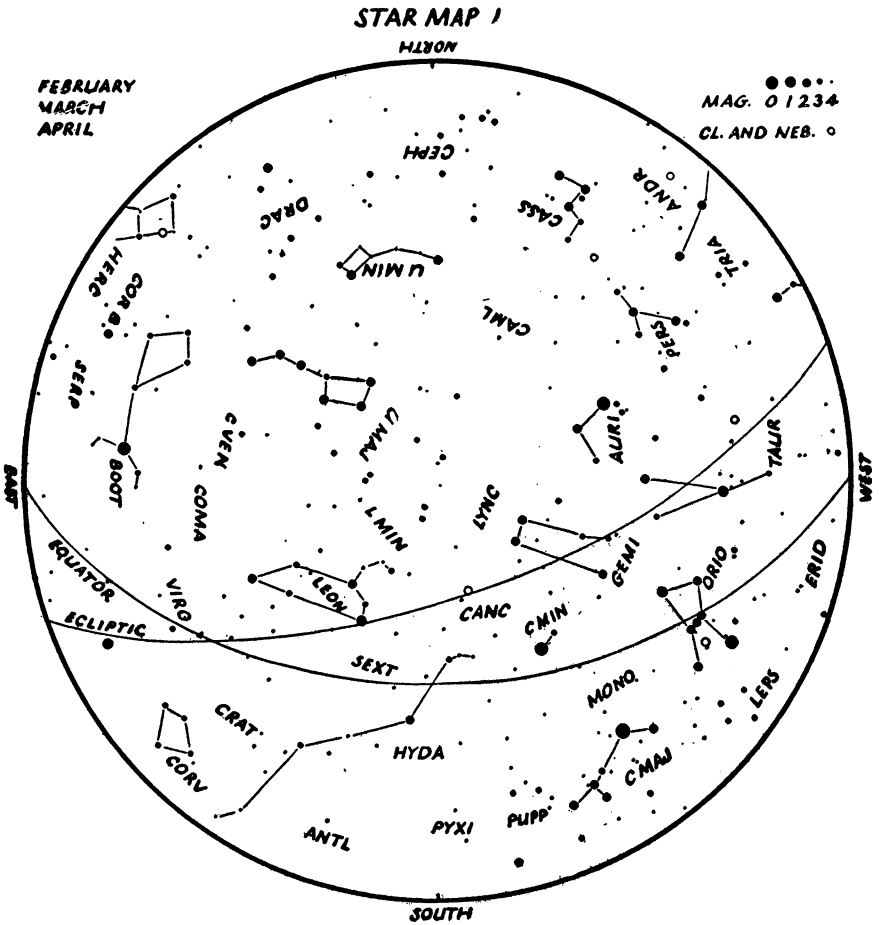
The galactic nebulae here listed have been selected to include the most readily observable representatives of planetary nebulae such as the Ring Nebula in Lyra, diffuse bright nebulae like the Orion nebula and dark absorbing nebulosities such as the Coal Sack. These objects are all located in our own 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 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
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

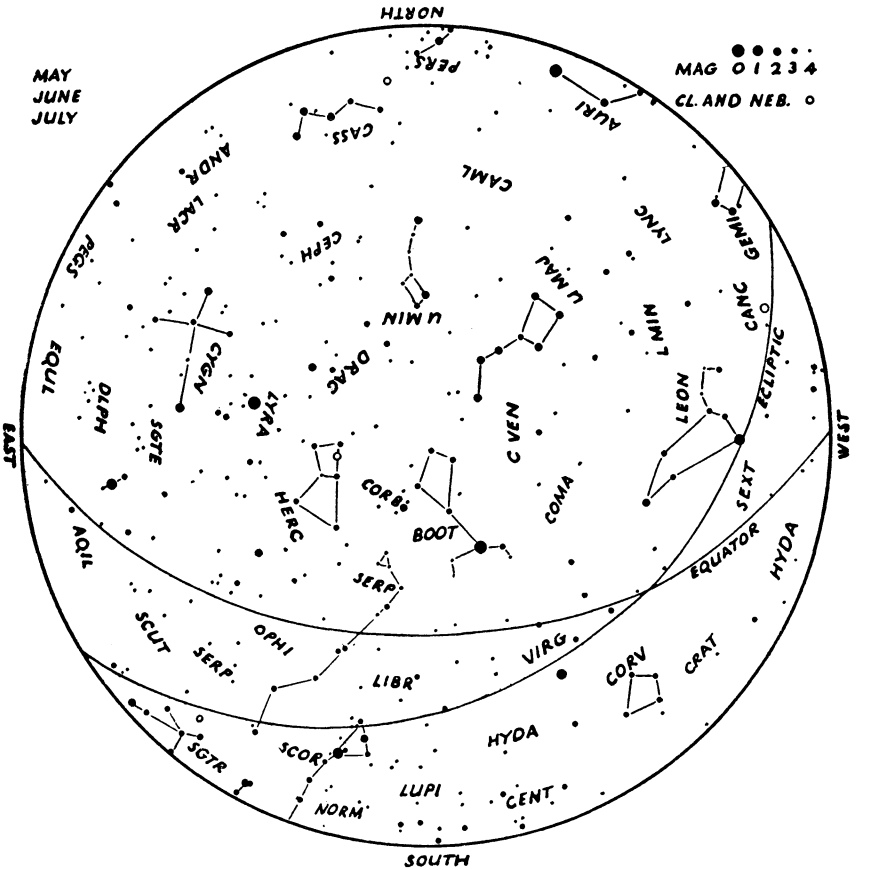


The above map represents the evening sky at

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

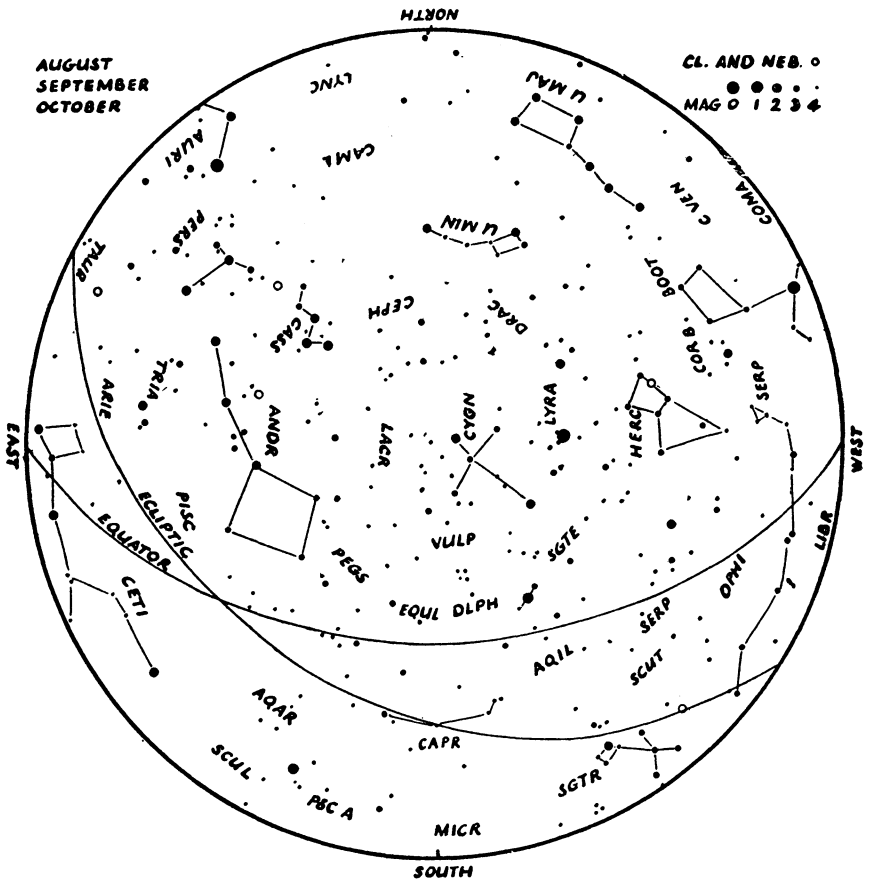


The above map represents the evening sky at

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.

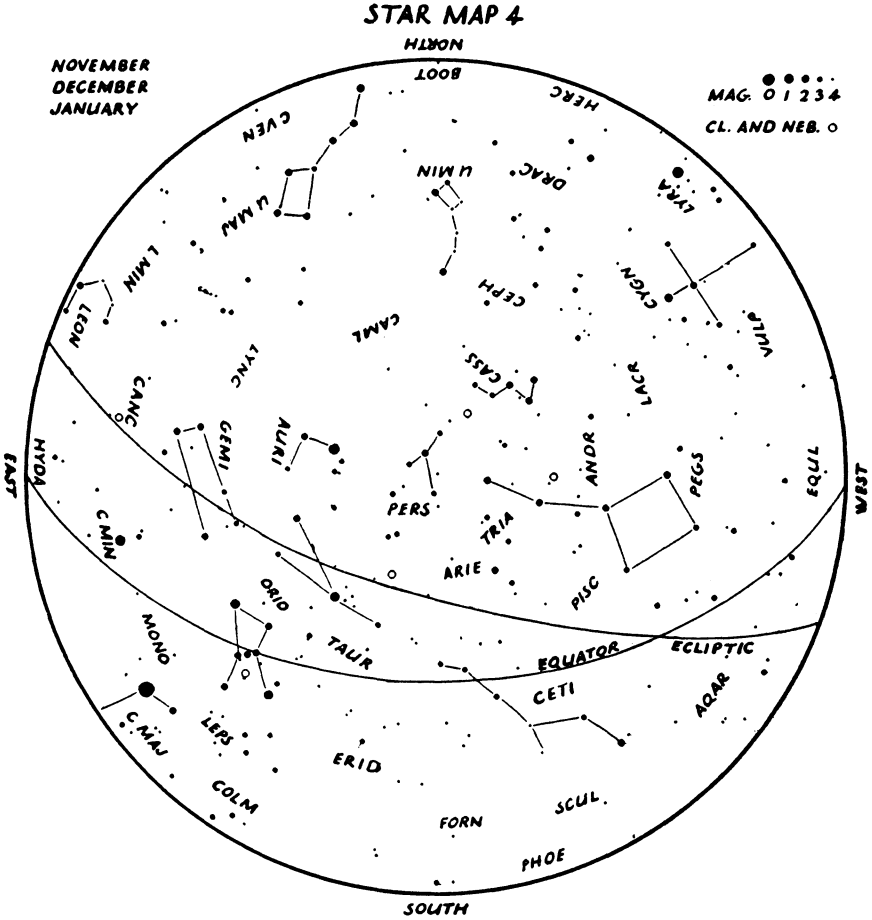
STAR MAP 3



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

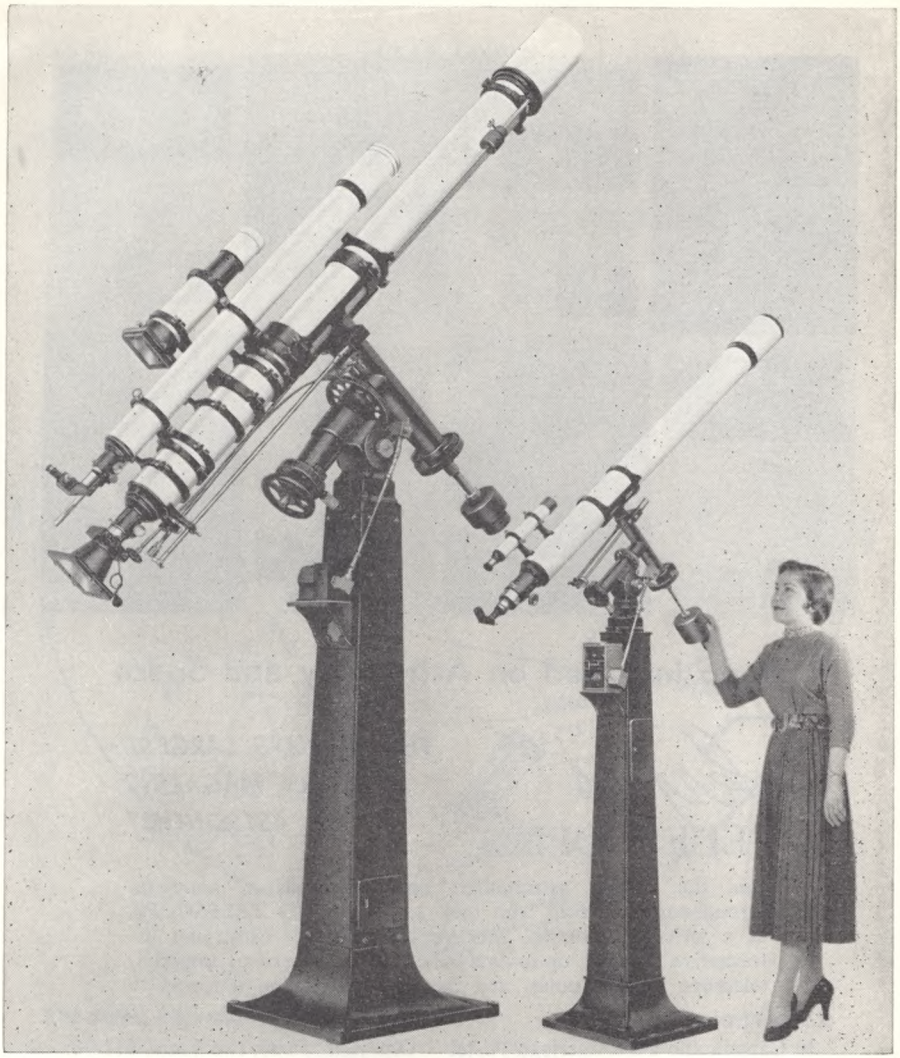
The centre of the map is the zenith, the circumference the horizon. To identify the stars hold the map so that the part of the horizon you are facing is down.



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.



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

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

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

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

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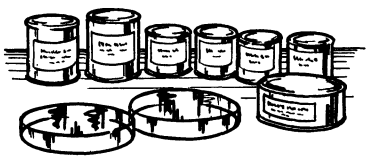
REFLECTING TELESCOPE MIRROR GRINDING KIT



Kit contains—2 pyrex blanks (one for use as tool, the other the mirror) 6 assorted abrasives from coarse to fine, polishing pitch.
Mirror grinding instructions not included as these must be in detail as in books below:

6″ Mirror Grinding Kit
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4¼″ Mirror Grinding Kit
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Stock NO.	I.D.	O.D.	APPROX. LGTH	DESCRIPTION	
2A20	4⅞″	5″	48″	Aluminum	$ 8.95
2A21	6⅞″	7″	60″	Aluminum	$13.95
2A26	4.78″	5.18″	46″	Sprl Wnd Ppr	$ 2.50
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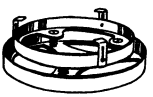
Cast Aluminum mounts designed to hold your mirror firmly and safely. Mount has three brass adjusting screws for collimation.



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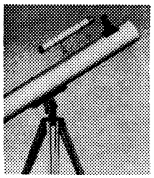

You'll see the Rings of Saturn, the fascinating planet Mars, huge craters on the Moon, Star Clusters, Moons of Jupiter in detail. Aluminized and overcoated 3" diameter high-speed f/10 mirror. Equatorial mount with lock on both axes. An Optical Finder Telescope is also included. Sturdy, hardwood, portable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

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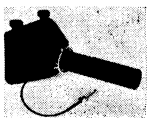
TELESCOPE ROLL-FILM CAMERA



This model uses rolls of No. 127 film. Picture area will be a circle 1-9/16" in diameter. The advantage of this model is the ease of using roll film. With each camera you get a piece of ground glass. Before loading film in camera, you focus the telescope. Then lock it in this position. For positions other than infinity, you can scribe a mark on your tube.

Stock No. 70,182-V $29.50 postpaid

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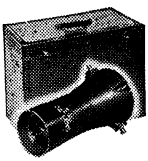

Mfgd. by Bausch and Lomb and Kodak at cost to Gov't. of over $1,000 each—F/6, 24 In. Focal Length Lenses with 23" Lens. Cones . . . now you can have them for making Big Bertha Telephoto Lenses or Cameras, Richest Field Wide Angle, Low Power (12X to 48X) Telescopes, Opaque Projectors, Camera Obscuras, 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—Was $39.50
NOW $25.00 f.o.b. Utah

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Above Lenses in cells—out of Cone and Diaphragm. Stock No. 70,190-V $22.50 Pstpd.

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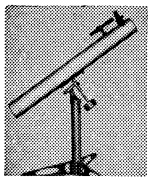
UP TO 255 POWER
New Vibration-Free Metal Pedestal Mount



With this scope you can see everything described at left but with greater power. Also, it will split closer double stars. Mirror has twice the light-gathering power. Rack-and-pinion focusing, real equatorial mounting—only one motion needed to follow the stars! Aluminum tube. 6-power finder telescope. 2 standard-size eyepieces and mounted Barlow lens give you powers of 45x—90x—135x—180x and 225x. Low-cost accessory eyepiece available for higher powers. FREE with Scope: Valuable STAR CHART plus 272-page "HANDBOOK OF THE HEAVENS" plus the book "HOW TO USE YOUR TELESCOPE" Shpg. wt. 25 lb.

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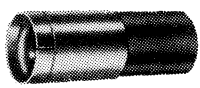

Double and triple your Telescope's power with a Barlow Lens. Ours is mounted in chrome-plated brass tubing with variable spacers—just slide this mounted negative lens into your 1¼" I.D. eyepiece holder, and use your regular eyepiece in it. Fully guaranteed to please you.

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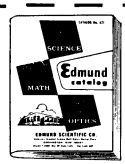

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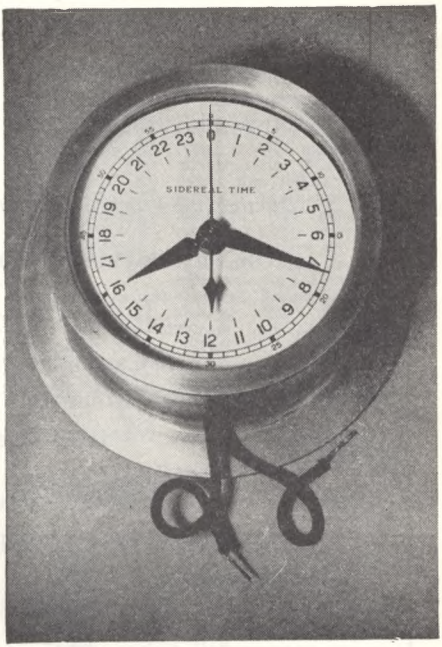

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By definition it is the hour angle of the March equinox, which is at right ascension 0 hours. At your observing station the right ascension of the celestial meridian is always your local sidereal time.

Knowing the sidereal time is an astronomical necessity, for it tells you quickly the hour angle of any celestial body to which you wish to point your telescope. Our clocks can be equipped for broadcasting time signals at some extra cost.

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Haines Electric Sidereal Clock **$62.00**

CALENDAR 1963

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	28
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	....	....

Mar.

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

April

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

May

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

June

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

July

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

Aug.

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

Sept.

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

Oct.

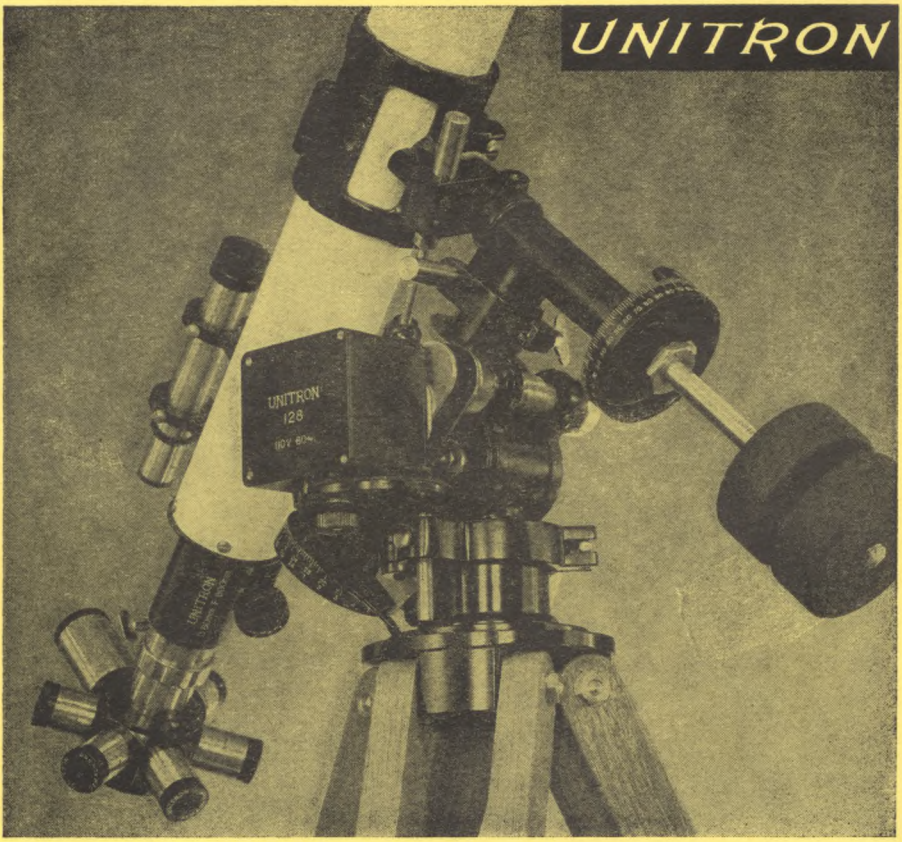
S	M	T	W	T	F	S
....	....	1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Nov.

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

Dec.

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



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