THE OBSERVER'S HANDBOOK 1967

Fifty-ninth Year of Publication

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Price One Dollar

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

Incorporated 1890 — Royal Charter 1903

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

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

Publications of the Society are free to members, and include the JOURNAL (6 issues per year) and the OBSERVER'S HANDBOOK (published annually in November). Annual fees of $7.50 are payable October 1 and include the publications for the following year.

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Monday to Friday, daytime, no programme.
Saturday evenings, April through November.

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Planetariums:

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

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

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

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

THE OBSERVER'S HANDBOOK

1967

EDITOR

RUTH J. NORTHCOTT

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OF CANADA

252 COLLEGE STREET, TORONTO 2B, ONTARIO

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THE OBSERVER'S HANDBOOK for 1967 is the 59th edition. The times of sunrise and sunset, and of twilight, are again the values for the current year. The tables of star clusters and galaxies have been revised and expanded.

Cordial thanks are offered to all individuals who assisted in the preparation of this edition, to those whose names appear in the various sections and to Barbara Gaizauskas, Helen Sawyer Hogg, Joan Hube, Adriana Huyer, Albert Semelman, William Sherwood, Maude Town, Isabel Williamson, and Dorothy Yane. Special thanks are extended to Margaret W. Mayall, Director of the A.A.V.S.O., for the predictions of Algol and the variable stars and to Gordon E. Taylor and the British Astronomical Association for the prediction of planetary appulses and occultations.

My deep indebtedness to the British Nautical Almanac Office and to the *American Ephemeris* is gratefully acknowledged.

RUTH J. NORTHCOTT

ANNIVERSARIES AND FESTIVALS, 1967

New Year's Day	Sun.	Jan. 1
Epiphany	Fri.	Jan. 6
Septuagesima Sunday		Jan. 22
Quinquagesima (Shrove Sunday)		Feb. 5
Accession of Queen Elizabeth (1952)	Mon.	Feb. 6
Ash Wednesday		Feb. 8
St. David	Wed.	Mar. 1
St. Patrick	Fri.	Mar. 17
Palm Sunday		Mar. 19
Good Friday		Mar. 24
Easter Sunday		Mar. 26
Birthday of Queen Elizabeth (1926)	Fri.	Apr. 21
St. George	Sun.	Apr. 23
Rogation Sunday		Apr. 30
Ascension Day	Thu.	May 4
Pentecost (Whit Sunday)		May 14
Trinity Sunday		May 21
Victoria Day	Mon.	May 22
Corpus Christi	Thu.	May 25
St. John Baptist (Midsummer Day)	Sat.	June 24
Dominion Day	Sat.	July 1
Birthday of Queen Mother Elizabeth (1900)	Fri.	Aug. 4
Labour Day	Mon.	Sept. 4
St. Michael (Michaelmas Day)	Fri.	Sept. 29
Hebrew New Year (Rosh Hashanah)	Thu.	Oct. 5
Thanksgiving	Mon.	Oct. 9
All Saints' Day	Wed.	Nov. 1
Remembrance Day	Sat.	Nov. 11
St. Andrew	Thu.	Nov. 30
First Sunday in Advent		Dec. 3
Christmas Day	Mon.	Dec. 25

JULIAN DAY CALENDAR, 1967

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

Jan. 1	9,492	May 1	9,612	Sept. 1	9,735
Feb. 1	9,523	June 1	9,643	Oct. 1	9,765
Mar. 1	9,551	July 1	9,673	Nov. 1	9,796
Apr. 1	9,582	Aug. 1	9,704	Dec. 1	9,826

The Julian Day commences at noon. Thus J.D. 2,439,492.0 = Jan. 1.5 U.T.

SYMBOLS AND ABBREVIATIONS

SUN, MOON AND PLANETS

☉ The Sun	☾ The Moon generally	♃ Jupiter
🌑 New Moon	☿ Mercury	♄ Saturn
🌕 Full Moon	♀ Venus	♅ Uranus
☽ First Quarter	⊕ Earth	♆ Neptune
☾ Last Quarter	♂ Mars	♇ Pluto

ASPECTS AND ABBREVIATIONS

☌ Conjunction, or having the same Longitude or Right Ascension.
☍ Opposition, or differing 180° in Longitude or Right Ascension.
□ Quadrature, or differing 90° in Longitude or Right Ascension.
☊ Ascending Node; ☋ Descending Node.
α or R.A., Right Ascension; δ or Dec., Declination.
h, m, s, Hours, Minutes, Seconds of Time.
° ′ ″, Degrees, Minutes, Seconds of Arc.

SIGNS OF THE ZODIAC

♈ Aries.......... 0°	♌ Leo..........120°	♐ Sagittarius ...240°
♉ Taurus........30°	♍ Virgo........150°	♑ Capricornus ..270°
♊ Gemini........60°	♎ Libra........180°	♒ Aquarius.....300°
♋ Cancer........90°	♏ Scorpius.....210°	♓ Pisces........330°

THE GREEK ALPHABET

Α, α	Alpha	Ι, ι	Iota	Ρ, ρ	Rho
Β, β	Beta	Κ, κ	Kappa	Σ, σ	Sigma
Γ, γ	Gamma	Λ, λ	Lambda	Τ, τ	Tau
Δ, δ	Delta	Μ, μ	Mu	Υ, υ	Upsilon
Ε, ε	Epsilon	Ν, ν	Nu	Φ, φ	Phi
Ζ, ζ	Zeta	Ξ, ξ	Xi	Χ, χ	Chi
Η, η	Eta	Ο, ο	Omicron	Ψ, ψ	Psi
Θ, θ, ϑ	Theta	Π, π	Pi	Ω, ω	Omega

THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 33, 35, etc.), O represents the disk of the planet, d signifies that the satellite is on the disk, * signifies that the satellite is behind the disk or in the shadow. Configurations are for an inverting telescope.

CALCULATIONS FOR ALGOL

The calculations for the minima of Algol are based on the epoch J.D. 2437965.6985 and period 2.8673285 days as published in *Sky and Telescope*, 1963.

CELESTIAL DISTANCES

Celestial distances given herein are based on the standard value of 8.80″ for the sun's parallax, and the astronomical unit of 92.9 million miles.

THE CONSTELLATIONS

Latin Names with Pronunciations and Abbreviations

Andromeda, ăn-drŏm′ē-dȧ	And	Andr
Antlia, ănt′lĭ-ȧ	Ant	Antl
Apus, ā′pŭs	Aps	Apus
Aquarius, ȧ-kwâr′ĭ-ŭs	Aqr	Aqar
Aquila, ăk′wĭ-lȧ	Aql	Aqil
Ara, ā′rȧ	Ara	Arae
Aries, ā′rĭ-ēz	Ari	Arie
Auriga, ô-rī′gȧ	Aur	Auri
Boötes, bō-ō′tēz	Boo	Boot
Caelum, sē′lŭm	Cae	Cael
Camelopardalis, kȧ-mĕl′ō-pär′dȧ-lĭs	Cam	Caml
Cancer, kăn′sẽr	Cnc	Canc
Canes Venatici, kā′ nēz vē-năt′ĭ-sī	CVn	CVen
Canis Major, kā′nĭs mā′jẽr	CMa	CMaj
Canis Minor, kā′nĭs′ mī′nẽr	CMi	CMin
Capricornus, kăp′rĭ-kôr′nŭs	Cap	Capr
Carina, kȧ-rī′nȧ	Car	Cari
Cassiopeia, kăs′ĭ-ō-pē′yȧ′	Cas	Cass
Centaurus, sĕn-tô′rŭs	Cen	Cent
Cepheus, sē′fūs	Cep	Ceph
Cetus, sē′tŭs	Cet	Ceti
Chamaeleon, kȧ-mē′lē-ŭn	Cha	Cham
Circinus, sûr′sĭ-nŭs	Cir	Circ
Columba, kō-lŭm′bȧ	Col	Colm
Coma Berenices, kō′mȧ bĕr′ē-nī′sēz	Com	Coma
Corona, Australis, kō-rō′nȧ ôs-trā′lĭs	CrA	CorA
Corona Borealis, kȧ-rō nȧ bō′rē-ā′lĭs	CrB	CorB
Corvus, kôr′vŭs	Crv	Corv
Crater, krā′tẽr	Crt	Crat
Crux, krŭks	Cru	Cruc
Cygnus, sĭg′nŭs	Cyg	Cygn
Delphinus, dĕl-fī′nŭs	Del	Dlph
Dorado, dō-rä′dō	Dor	Dora
Draco, drā′kō	Dra	Drac
Equuleus, ē-kwōō′lē-ŭs	Equ	Equl
Eridanus, ē-rĭd′ȧ-nŭs	Eri	Erid
Fornax, fôr′năks	For	Forn
Gemini, jĕm′ĭ-nī	Gem	Gemi
Grus, grŭs	Gru	Grus
Hercules, hûr′kū-lēz	Her	Herc
Horologium, hŏr′ō-lō′jĭ-ŭm	Hor	Horo
Hydra, hī′drȧ	Hya	Hyda
Hydrus, hī′drŭs	Hyi	Hydi
Indus, ĭn′dŭs	Ind	Indi
Lacerta, lȧ-sûr′tȧ	Lac	Lacr
Leo, lē′ō	Leo	Leon
Leo Minor, lē′ō mī′nẽr	LMi	LMin
Lepus, lē′pŭs	Lep	Leps
Libra, lī′brȧ	Lib	Libr
Lupus, lū′pŭs	Lup	Lupi
Lynx, lĭngks	Lyn	Lync
Lyra, lī′rȧ	Lyr	Lyra
Mensa, mĕn′sȧ	Men	Mens
Microscopium, mī′krō-skō′pĭ-ŭm	Mic	Micr
Monoceros, mō-nŏs′ẽr-ŏs	Mon	Mono
Musca, mŭs′kȧ	Mus	Musc
Norma, nôr′mȧ	Nor	Norm
Octans, ŏk′tănz	Oct	Octn
Ophiuchus, ŏf′ĭ-ū′kŭs	Oph	Ophi
Orion, ō-rī′ŏn	Ori	Orio
Pavo, Pā′vō	Pav	Pavo
Pegasus, pĕg′ȧ-sŭs	Peg	Pegs
Perseus, pûr′sūs	Per	Pers
Phoenix, fē′nĭks	Phe	Phoe
Pictor, pĭk′tẽr	Pic	Pict
Pisces, pĭs′ēz	Psc	Pisc
Piscis Austrinus, pĭs′ĭs ôs-trī′nŭs	PsA	PscA
Puppis, pŭp′ĭs	Pup	Pupp
Pyxis, pĭk′sĭs	Pyx	Pyxi
Reticulum, rē-tĭk′ū-lŭm	Ret	Reti
Sagitta, sȧ-jĭt′ȧ	Sge	Sgte
Sagittarius, săj′ĭ-tā′rĭ-ŭs	Sgr	Sgtr
Scorpius, skôr′pĭ-ŭs	Sco	Scor
Sculptor, skŭlp′tẽr	Scl	Scul
Scutum, skū′tŭm	Sct	Scut
Serpens, sûr′pĕnz	Ser	Serp
Sextans, sĕks′tănz	Sex	Sext
Taurus, tô′rŭs	Tau	Taur
Telescopium, tĕl′ē-skō′pĭ-ŭm	Tel	Tele
Triangulum, trī-ăng′gū-lŭm	Tri	Tria
Triangulum Australe, trī-ăng′gū-lŭm ôs-trā′lē	TrA	TrAu
Tucana, tū-kā′nȧ	Tuc	Tucn
Ursa Major, ûr′sȧ mā′jẽr	UMa	UMaj
Ursa Minor, ûr′sȧ mi′nẽr	UMi	UMin
Vela, vē′lȧ	Vel	Velr
Virgo, vûr′gō	Vir	Virg
Volans, vō′lănz	Vol	Voln
Vulpecula, vŭl-pĕk′ū-lȧ	Vul	Vulp

ā fāte; ȧ chȧotic; ă tăp; ă finăl; ȧ ȧsk; ȧ ideȧ; â câre; ä älms; au aught; ē bē; ē crēate; ĕ ĕnd; ĕ angĕl; ẽ makẽr; ī tīme; ĭ bĭt; ĭ anĭmal; ō nōte; ō anatōmy; ŏ hŏt; ŏ ŏccur; ô ôrb; ōō mōōn; ŏŏ bŏŏk; ou out; ū tūbe; ū ūnite; ŭ sun; ŭ sŭbmit; û hûrl.

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

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

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

Units of Time

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

The Earth

Equatorial radius, a = 6378.39 km. = 3963.35 mi.; flattening, $c = (a-b)/a = 1/297$
Polar radius, b = 6356.91 km. = 3950.01 mi.
1° of latitude = $111.137 - 0.562 \cos 2\phi$ km. = $69.057 - 0.349 \cos 2\phi$ mi. (at lat. ϕ)
1° of longitude = $111.418 \cos\phi - 0.094 \cos 3\phi$ km. = $69.232 \cos\phi - 0.0584 \cos 3\phi$ mi.
Mass of earth = 5.98×10^{24} kgm. = 13.2×10^{24} lb.
Velocity of escape from ⊕ = 11.2 km./sec. = 6.94 mi./sec.

Earth's Orbital Motion

Solar parallax = 8″.80 (adopted); recent determination = 8″.794 (radar, ♀, 1962)
Constant of aberration = 20″.47 (adopted)
Annual general precession = 50″.26; obliquity of ecliptic = 23° 26′ 40″ (1960)
Orbital velocity = 29.8 km./sec. = 18.5 mi./sec.
Parabolic velocity at ⊕ = 42.3 km./sec. = 26.2 mi./sec.

Solar Motion

Solar apex, R.A. 18*h* 04*m*, Dec. + 30°; solar velocity = 19.4 km./sec. = 12.1 mi./sec.

The Galactic System

North pole of galactic plane R.A. 12*h* 49*m*, Dec. + 27.°4 (1950)
Centre of galaxy R.A. 17*h* 42.4*m*, Dec. − 28° 55′ (1950) (zero pt. for new gal. coord.)
Distance to centre ~ 10,000 parsecs; diameter ~ 30,000 parsecs
Rotational velocity (at sun) ~ 262 km./sec.
Rotational period (at sun) ~ 2.2×10^8 years
Mass ~ 2×10^{11} solar masses

External Galaxies

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

Radiation Constants

Velocity of light, c = 299,860 km./sec. = 186,324 mi./sec. (adopted);
recent value, 299,792.50 ± 0.10 km./sec. (Froome, *Nature*, 1958)
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512 . . . ; log ratio = exactly 0.4
Stefan's constant = 5.6694×10^{-5} c.g.s. units

Miscellaneous

Constant of gravitation, $G = 6.670 \times 10^{-8}$ c.g.s. units
Mass of the electron, $m = 9.1083 \times 10^{-28}$ gm.; mass of the proton = 1.6724×10^{-24} gm.
Planck's constant, $h = 6.625 \times 10^{-27}$ erg. sec.
Loschmidt's number = 2.6872×10^{19} molecules/cu. cm. of gas at S.T.P.
Absolute temperature = $T°$ K = $T°$ C + 273° = 5/9 ($T°$ F + 459°)

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

1967 EPHEMERIS OF THE SUN AND CORRECTION TO SUN-DIAL

Date		Apparent R.A. 0h E.T.	Corr. to Sun-dial 12h E.T.	Apparent Dec. 0h E.T.
		h m s	m s	° ′
Jan.	1	18 42 57	+ 3 22	−23 04.7
	4	18 56 11	+ 4 45	−22 49.0
	7	19 09 22	+ 6 06	−22 29.3
	10	19 22 28	+ 7 22	−22 05.5
	13	19 35 30	+ 8 33	−21 37.9
	16	19 48 26	+ 9 39	−21 06.5
	19	20 01 16	+10 38	−20 31.5
	22	20 14 00	+11 30	−19 52.9
	25	20 26 36	+12 16	−19 11.1
	28	20 39 05	+12 54	−18 26.1
	31	20 51 27	+13 25	−17 38.1
Feb.	3	21 03 42	+13 49	−16 47.2
	6	21 15 49	+14 06	−15 53.7
	9	21 27 50	+14 15	−14 57.8
	12	21 39 43	+14 18	−13 59.6
	15	21 51 29	+14 13	−12 59.2
	18	22 03 09	+14 02	−11 57.0
	21	22 14 42	+13 45	−10 53.2
	24	22 26 09	+13 21	− 9 47.8
	27	22 37 31	+12 52	− 8 41.0
Mar.	2	22 48 48	+12 18	− 7 33.2
	5	23 00 00	+11 40	− 6 24.3
	8	23 11 08	+10 58	− 5 14.6
	11	23 22 13	+10 13	− 4 04.3
	14	23 33 15	+ 9 25	− 2 53.5
	17	23 44 14	+ 8 34	− 1 42.4
	20	23 55 12	+ 7 42	− 0 31.2
	23	0 06 08	+ 6 48	+ 0 39.9
	26	0 17 03	+ 5 53	+ 1 50.7
	29	0 27 57	+ 4 58	+ 3 01.2
Apr.	1	0 38 52	+ 4 04	+ 4 11.2
	4	0 49 48	+ 3 10	+ 5 20.5
	7	1 00 46	+ 2 18	+ 6 29.0
	10	1 11 45	+ 1 28	+ 7 36.5
	13	1 22 47	+ 0 41	+ 8 42.8
	16	1 33 51	− 0 04	+ 9 47.8
	19	1 44 59	− 0 46	+10 51.4
	22	1 56 10	− 1 24	+11 53.3
	25	2 07 24	− 1 58	+12 53.4
	28	2 18 43	− 2 28	+13 51.7
May	1	2 30 07	− 2 53	+14 47.9
	4	2 41 35	− 3 14	+15 41.9
	7	2 53 09	− 3 29	+16 33.6
	10	3 04 48	− 3 39	+17 22.8
	13	3 16 32	− 3 44	+18 09.4
	16	3 28 21	− 3 44	+18 53.3
	19	3 40 14	− 3 39	+19 34.3
	22	3 52 13	− 3 29	+20 12.2
	25	4 04 17	− 3 14	+20 47.1
	28	4 16 25	− 2 55	+21 18.7
	31	4 28 37	− 2 32	+21 47.1
June	3	4 40 54	− 2 04	+22 12.0
	6	4 53 13	− 1 34	+22 33.5
	9	5 05 36	− 1 00	+22 51.4
	12	5 18 02	− 0 24	+23 05.7
	15	5 30 29	+ 0 14	+23 16.3
	18	5 42 57	+ 0 52	+23 23.3
	21	5 55 26	+ 1 31	+23 26.5
	24	6 07 54	+ 2 10	+23 26.0
	27	6 20 22	+ 2 48	+23 21.8
	30	6 32 49	+ 3 25	+23 13.9
July	3	6 45 14	+ 4 00	+23 02.3
	6	6 57 36	+ 4 32	+22 47.1
	9	7 09 56	+ 5 02	+22 28.4
	12	7 22 12	+ 5 27	+22 06.1
	15	7 34 23	+ 5 49	+21 40.4
	18	7 46 31	+ 6 05	+21 11.4
	21	7 58 33	+ 6 17	+20 39.2
	24	8 10 30	+ 6 24	+20 03.9
	27	8 22 22	+ 6 26	+19 25.5
	30	8 34 09	+ 6 22	+18 44.3
Aug.	2	8 45 51	+ 6 13	+18 00.3
	5	8 57 27	+ 5 59	+17 13.6
	8	9 08 58	+ 5 39	+16 24.4
	11	9 20 24	+ 5 14	+15 32.8
	14	9 31 44	+ 4 44	+14 39.0
	17	9 42 59	+ 4 08	+13 43.1
	20	9 54 10	+ 3 28	+12 45.2
	23	10 05 15	+ 2 44	+11 45.6
	26	10 16 17	+ 1 56	+10 44.2
	29	10 27 16	+ 1 04	+ 9 41.3
Sept.	1	10 38 11	+ 0 09	+ 8 37.1
	4	10 49 04	− 0 48	+ 7 31.5
	7	10 59 54	− 1 48	+ 6 24.9
	10	11 10 43	− 2 50	+ 5 17.3
	13	11 21 29	− 3 53	+ 4 08.9
	16	11 32 15	− 4 57	+ 2 59.9
	19	11 43 01	− 6 01	+ 1 50.4
	22	11 53 46	− 7 05	+ 0 40.5
	25	12 04 33	− 8 08	− 0 29.6
	28	12 15 21	− 9 09	− 1 39.7
Oct.	1	12 26 11	−10 08	− 2 49.8
	4	12 37 03	−11 05	− 3 59.6
	7	12 47 59	−11 59	− 5 09.0
	10	12 58 57	−12 49	− 6 17.8
	13	13 10 00	−13 35	− 7 25.8
	16	13 21 07	−14 17	− 8 32.9
	19	13 32 19	−14 54	− 9 38.9
	22	13 43 37	−15 25	−10 43.7
	25	13 55 01	−15 50	−11 47.0
	28	14 06 31	−16 08	−12 48.8
	31	14 18 08	−16 20	−13 48.7
Nov.	3	14 29 52	−16 24	−14 46.7
	6	14 41 44	−16 21	−15 42.6
	9	14 53 42	−16 11	−16 36.0
	12	15 05 48	−15 53	−17 27.0
	15	15 18 02	−15 28	−18 15.2
	18	15 30 23	−14 55	−19 00.6
	21	15 42 52	−14 15	−19 42.9
	24	15 55 28	−13 27	−20 22.0
	27	16 08 11	−12 32	−20 57.7
	30	16 21 02	−11 31	−21 29.9
Dec.	3	16 33 58	−10 23	−21 58.4
	6	16 47 00	− 9 10	−22 23.1
	9	17 00 07	− 7 52	−22 43.9
	12	17 13 17	− 6 30	−23 00.7
	15	17 26 31	− 5 06	−23 13.3
	18	17 39 48	− 3 38	−23 21.8
	21	17 53 06	− 2 10	−23 26.2
	24	18 06 25	− 0 40	−23 26.2
	27	18 19 45	+ 0 50	−23 22.1
	30	18 33 03	+ 2 18	−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	25^d–35^d†		
☾ Moon	2,160	0	0.0123	3.34	0.16	$27^d\ 07^h\ 43^m$	6.7	0.067
☿ Mercury	3,100	0	0.056	5.13	0.36	58.65^d	?	0.056
♀ Venus	7,700	0	0.817	4.97	0.87	244^d	10	0.76
⊕ Earth	7,927	1/297	1.000	5.52	1.00	$23^h\ 56^m\ 04^s$	23.4	0.36
♂ Mars	4,200	1/192	0.108	3.94	0.38	24 37 23	24.0	0.16
♃ Jupiter	88,700	1/16	318.0	1.33	2.64	9 50 30	3.1	0.73
♄ Saturn	75,100	1/10	95.2	0.69	1.13	10 14	26.7	0.76
♅ Uranus	29,200	1/16	14.6	1.56	1.07	10 49	97.9	0.93
♆ Neptune	27,700	1/50	17.3	2.27	1.41	14 ?	28.8	0.84
♇ Pluto	3,500?	?	0.06?	4?	0.3?	6.387^d	?	0.14?

†Depending on latitude. For the physical observations of the sun, p. 63, the sidereal period of rotation is 25.38 m.s.d.

SATELLITES OF THE SOLAR SYSTEM

Name	Mag. * †	Diam. miles †	Mean Distance from Planet: 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	Var.§	
SATELLITES OF MARS									
Phobos	11.6	(10)	5,800	25	0	07	39	1.0	Hall, 1877
Deimos	12.8	(<10)	14,600	62	1	06	18	1.3	Hall, 1877
SATELLITES OF JUPITER									
V	13.0	(100)	112,000	59	0	11	57	0.4	Barnard, 1892
Io	4.8	2020	262,000	138	1	18	28	0	Galileo, 1610
Europa	5.2	1790	417,000	220	3	13	14	0	Galileo, 1610
Ganymede	4.5	3120	665,000	351	7	03	43	0	Galileo, 1610
Callisto	5.5	2770	1,171,000	618	16	16	32	0	Galileo, 1610
VI	13.7	(50)	7,133,000	3765	250	14		27.6	Perrine, 1904
VII	16	(20)	7,295,000	3850	259	16		24.8	Perrine, 1905
X	18.6	(<10)	7,369,000	3888	263	13		29.0	Nicholson, 1938
XII	18.8	(<10)	13,200,000	6958	631	02		147	Nicholson, 1951
XI	18.1	(<10)	14,000,000	7404	692	12		164	Nicholson, 1938
VIII	18.8	(<10)	14,600,000	7715	738	22		145	Melotte, 1908
IX	18.3	(<10)	14,700,000	7779	758			153	Nicholson, 1914
SATELLITES OF SATURN									
Mimas	12.1	300:	116,000	30	0	22	37	1.5	W. Herschel, 1789
Enceladus	11.8	400:	148,000	38	1	08	53	0.0	W. Herschel, 1789
Tethys	10.3	600	183,000	48	1	21	18	1.1	G. Cassini, 1684
Dione	10.4	600:	235,000	61	2	17	41	0.0	G. Cassini, 1684
Rhea	9.8	810	327,000	85	4	12	25	0.4	G. Cassini, 1672
Titan	8.4	2980	759,000	197	15	22	41	0.3	Huygens, 1655
Hyperion	14.2	(100)	920,000	239	21	06	38	0.4	G. Bond, 1848
Iapetus	11.0	(500)	2,213,000	575	79	07	56	14.7	G. Cassini, 1671
Phoebe	(14)	(100)	8,053,000	2096	550	11		150	W. Pickering, 1898
SATELLITES OF URANUS									
Miranda	16.5	(200)	77,000	9	1	09	56	0	Kuiper, 1948
Ariel	14.4	(500)	119,000	14	2	12	29	0	Lassell, 1851
Umbriel	15.3	(300)	166,000	20	4	03	38	0	Lassell, 1851
Titania	14.0	(600)	272,000	33	8	16	56	0	W. Herschel, 1787
Oberon	14.2	(500)	365,000	44	13	11	07	0	W. Herschel, 1787
SATELLITES OF NEPTUNE									
Triton	13.6	2300	220,000	17	5	21	03	160.0	Lassell, 1846
Nereid	18.7	(200)	3,461,000	264	359	10		27.4	Kuiper, 1949

*At mean opposition distance.
†From D. L. Harris in "Planets and Satellites", *The Solar System*, vol. 3, 1961, ***except*** numbers in brackets which are rough estimates.
‡Inclination of orbit referred to planet's equator; a value greater than 90° indicates retrograde motion.
§Varies 18° to 29°. The eccentricity of the mean orbit of the moon is 0.05490.
Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV respectively, in order of distance from the planet.

SOLAR, SIDEREAL AND EPHEMERIS TIME

Any recurring event may be used to measure time. The various times commonly used are defined by the daily passages of the sun or stars caused by the rotation of the earth on its axis. The more uniform revolution of the earth about the sun, causing the return of the seasons, defines ephemeris time.

A sun-dial indicates *apparent solar time*, but this is far from uniform because of the earth's elliptical orbit and the inclination of the ecliptic. If the real sun is replaced by a fictitious mean sun moving uniformly in the equator, we have *mean* (solar) *time*. *Apparent time—mean time = equation of time.* This is the same as *correction to sun-dial* on page 7, with reversed sign.

If instead of the sun we use stars, we have *sidereal time*. The sidereal time is zero when the vernal equinox or first of Aries is on the meridian. As the earth makes one more revolution with respect to the stars than it does with respect to the sun, sidereal time gains on mean time 3^m56^s per day or 2 hours per month. Right Ascension (R.A.) is measured east from the vernal equinox, so that the R.A. of a body on the meridian is equal to the sidereal time.

Sidereal time is equal to mean time plus 12 hours plus the R.A. of the fictitious mean sun, so that by observation of one kind of time we can calculate the other. Sidereal time = Standard time (0h at midnight) − correction for longitude (p. 12) + 12 h + R. A. sun (p. 7) − correction to sun-dial (p. 7). (Note that it is necessary to obtain R. A. of the sun at the standard time involved.)

The foregoing refers to *local* time, in general different in different places on the earth. The local mean time of Greenwich, now known as *Universal Time* (UT) is used as a common basis for timekeeping. Navigation and surveying tables are generally prepared in terms of UT. When great precision is required, UT 1 and UT 2 are used differing from UT by polar variation and by the combined effects of polar variation and annual fluctuation respectively.

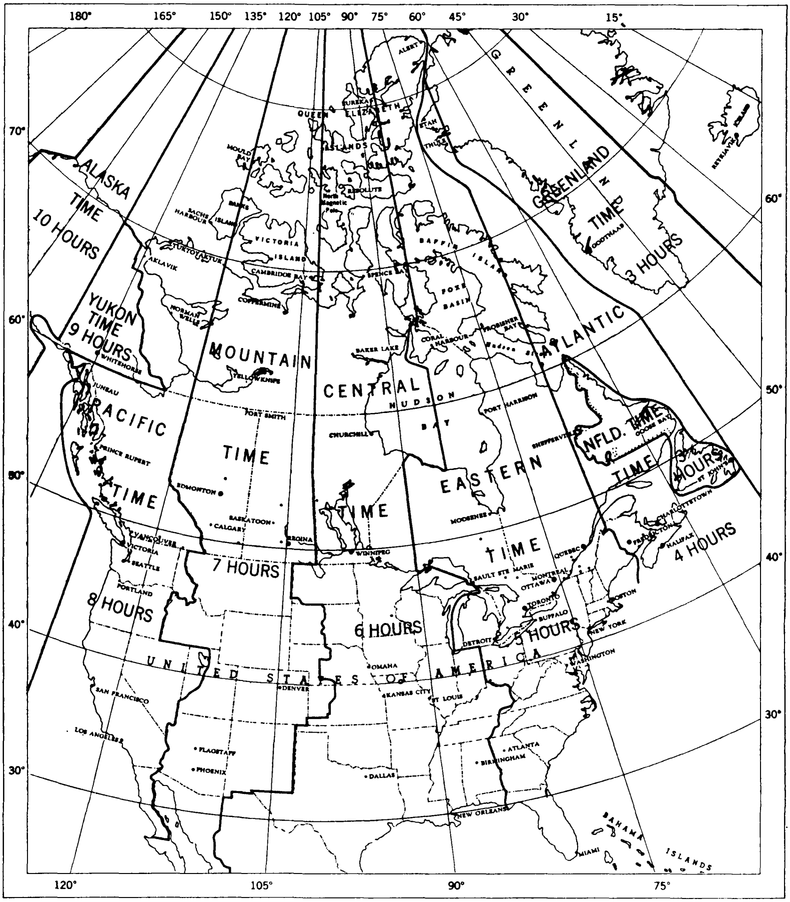
To avoid the inconveniences to travellers of a changing, local time, *standard time* is used. The earth is divided into 24 zones, each ideally 15 degrees wide, the zero zone being centered on the Greenwich meridian. All clocks within the same zone will read the same time.

In Canada and the United States there are 8 standard time zones as follows: Newfoundland (N), 3^h30^m slower than Greenwich; 60th meridian or Atlantic (A), 4 hours; 75th meridian or Eastern (E), 5 hours; 90th meridian or Central (C), 6 hours; 105th meridian or Mountain (M), 7 hours; 120th meridian or Pacific (P), 8 hours; 135th meridian or Yukon (Y), 9 hours; and 150th meridian or Alaska (AL), 10 hours slower than Greenwich.*

Universal time, even after the corrections mentioned have been applied, is still somewhat variable, as shown by atomic clocks or the orbital motion of the moon. *Ephemeris Time* (ET) is used when these irregularities must be avoided. The second, formerly defined as 1/86,400 of the mean solar day, is now defined as 1/31,556,925.9747 of the tropical year for 1900 Jan. 0 at 12 hours E.T. The difference, ΔT, between UT and ET is measured as a small error in the observed longitude of the moon, in the sense $\Delta T = ET - UT$. The moon's position is tabulated in ET, but observed in UT. ΔT was zero near the beginning of the century, but in 1966 will be about 36 seconds.

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

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 30° to 54° are given on pages 13 to 18, and of twilight on page 19. The times of moonrise and moonset for the 5 h meridian are given on pages 20 to 25. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean Time to Standard Time for the cities and towns named.

The tabulated values are computed for the sea horizon for the rising and setting of the upper limb of the sun and moon, and are corrected for refraction. Because variations from the sea horizon usually exist on land, the tabulated times can rarely be observed.

The Standard Times for Any Station

To derive the Standard Time of rising and setting phenomena for the places named, from the list below find the approximate latitude of the place and the correction in minutes which follows the name. Then find in the monthly table the Local Mean Time of the phenomenon for the proper latitude on the desired day. Finally apply the correction to get the Standard Time. The correction is the number of minutes of time that the place is west (plus) or east (minus) of the standard meridian. The corrections for places not listed may be obtained by converting the longitude found from an atlas into time (360° = 24 h).

CANADIAN CITIES AND TOWNS						AMERICAN CITIES		
	Lat.	Corr.		Lat.	Corr.		Lat.	Corr.
Athabasca	55°	+33M	Penticton	49°	−02P	Atlanta	34°	+37E
Baker Lake	64	+24C	Peterborough	44	+13E	Baltimore	39	+06E
Brandon	50	+40C	Port Harrison	59	+13E	Birmingham	33	−13C
Brantford	43	+21E	Port Arthur	48	+57E	Boston	42	−16E
Calgary	51	+36M	Prince Albert	53	+63C	Buffalo	43	+15E
Charlottetown	46	+12A	Prince Rupert	54	+41P	Chicago	42	−10C
Churchill	59	+17C	Quebec	47	−15E	Cincinnati	39	+38E
Cornwall	45	− 1E	Regina	50	+58C	Cleveland	42	+26E
Edmonton	54	+34M	St. Catharines	43	+17E	Dallas	33	+27C
Fort William	48	+57E	St. Hyacinthe	46	−08E	Denver	40	00M
Fredericton	46	+27A	Saint John, N.B.	45	+24A	Detroit	42	+32E
Gander	49	+ 8N	St. John's, Nfld.	48	+01N	Fairbanks	65	−10AL
Glace Bay	46	00A	Sarnia	43	+29E	Flagstaff	35	+27M
Goose Bay	53	+ 2A	Saskatoon	52	+67C	Indianapolis	40	−15C
Granby	45	−09E	Sault Ste. Marie	47	+37E	Juneau	58	+58P
Guelph	44	+21E	Shawinigan	47	−09E	Kansas City	39	+18C
Halifax	45	+14A	Sherbrooke	45	−12E	Los Angeles	34	−07P
Hamilton	43	+20E	Stratford	43	+24E	Louisville	38	−17C
Hull	45	+03E	Sudbury	47	+24E	Memphis	35	00C
Kapuskasing	49	+30E	Sydney	46	+01A	Miami	26	+21E
Kingston	44	+06E	The Pas	54	+45C	Milwaukee	43	−09C
Kitchener	43	+22E	Timmins	48	+26E	Minneapolis	45	+13C
London	43	+25E	Toronto	44	+18E	New Orleans	30	00C
Medicine Hat	50	+23M	Three Rivers	46	−10E	New York	41	−04E
Moncton	46	+19A	Trail	49	−09P	Omaha	41	+24C
Montreal	46	−06E	Truro	45	+13A	Philadelphia	40	+01E
Moosonee	51	+23E	Vancouver	49	+12P	Phoenix	33	+28M
Moose Jaw	50	+62C	Victoria	48	+13P	Pittsburgh	40	+20E
Niagara Falls	43	+16E	Whitehorse	61	00Y	St. Louis	39	+01C
North Bay	46	+18E	Windsor	42	+32E	San Francisco	38	+10P
Ottawa	45	+03E	Winnipeg	50	+29C	Seattle	48	+09P
Owen Sound	45	+24E	Yellowknife	62	+38M	Washington	39	+08E

Example—Find the time of sunrise at Owen Sound, on February 12.

In the above list Owen Sound is under "45°", and the correction is + 24 min. On page 13 the time of sunrise on February 12 for latitude 45° is 7.07; add 24 min. and we get 7.31 (Eastern Standard Time).

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

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

TIME OF MOONRISE AND MOONSET, 1967 (Local Mean Time)

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

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

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

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

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

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

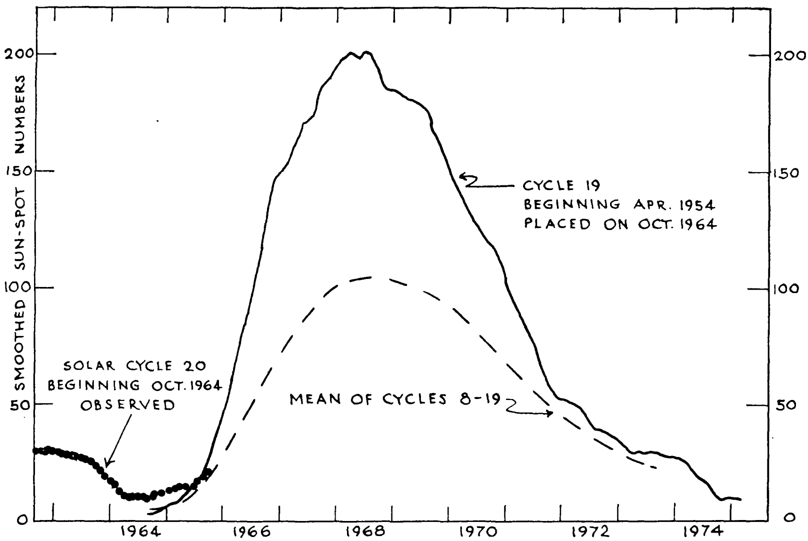
THE SUN AND PLANETS FOR 1967

THE SUN

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

The present cycle reached its maximum in January 1958 and since then has been declining slowly with the minimum in 1964.

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



MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. The amount of heat and light from the sun received by it per square mile is, on the average, 6.7 times the amount received by the earth. By a radar technique in 1965, the period of rotation on its axis was found to be 59 days.

Mercury's orbit is well within that of the earth, and the planet, as seen from the earth, appears to move quickly from one side of the sun to the other several times in the year. Its quick motion earned for it the name it bears. Its greatest elongation (i.e., its maximum angular distance from the sun) varies between 18° and 28°, and on such occasions it is visible to the naked eye for about two weeks.

When the elongation of Mercury is east of the sun it is an evening star, setting soon after the sun. When the elongation is west, it is a morning star and rises shortly before the sun. Its brightness when it is treated as a star is considerable but it is always viewed in the twilight sky and one must look sharply to see it.

The most suitable times to observe Mercury are at an eastern elongation in the spring and at a western elongation in the autumn. The dates of greatest elongation this year, together with the planet's separation from the sun and its stellar magnitude, are given in the following table:

MAXIMUM ELONGATIONS OF MERCURY DURING 1967

Elong. East—Evening Sky			Elong. West—Morning Sky		
Date	Dist.	Mag.	Date	Dist.	Mag.
Feb. 16	18°	−0.2	Mar. 31	28°	+0.5
June 12	24°	+0.7	July 29	20°	+0.5
Oct. 8	25°	+0.2	Nov. 17	19°	−0.3

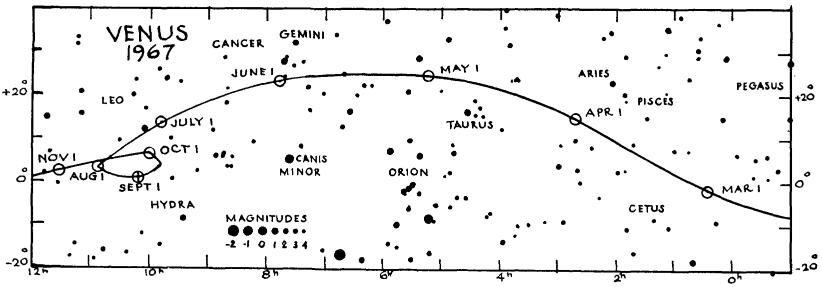
The most favourable elongations are: in the evening, June 12; in the morning, Nov. 17.

The apparent diameter of the planet ranges from about 5″ to 12″.

VENUS

Venus is the next planet in order from the sun. In size and mass it is almost a twin of the earth. Venus being within the earth's orbit, its apparent motion is similar to Mercury's but much slower and more stately. The orbit of Venus is almost circular with radius of 67 million miles, and its orbital speed is 22 miles per sec.

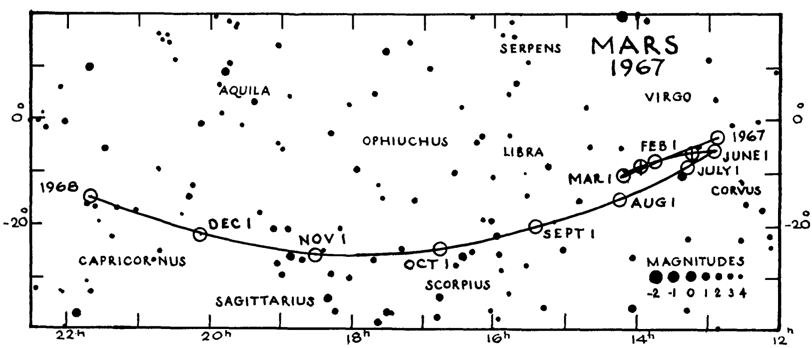
On Jan. 1, 1967, Venus crosses the meridian an hour after the sun, and is low in the south-western sky at sunset; its declination is −23°. The planet reaches greatest elongation east, 45°, on June 20 when it crosses the meridian over 3 hours after the sun at declination +18°. Greatest brilliancy, mag. −4.2, occurs on July 24 and inferior conjunction on Aug. 29 when it moves into the morning sky.



Greatest brilliancy, mag. −4.3, occurs on Oct. 5, and greatest elongation west, 47°, on Nov. 9, when it crosses the meridian over 3 hours before the sun at declination +1°. At the end of the year it is low in the south-eastern sky at dawn. For its positions near elongations, see the map. The apparent diameter of the planet ranges from 10″ on Jan. 1 to a maximum of 59″ at the end of Aug., decreasing to 16″ at the end of the year.

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

MARS



The orbit of Mars is outside that of the earth and consequently its planetary phenomena are quite different from those of the two inferior planets discussed above. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24h. 37m. 22.6689s. has been accurately determined. Perhaps the most surprising result of the space programme so far is the revelation by Mariner IV that the surface of Mars contains craters much like those on the Moon.

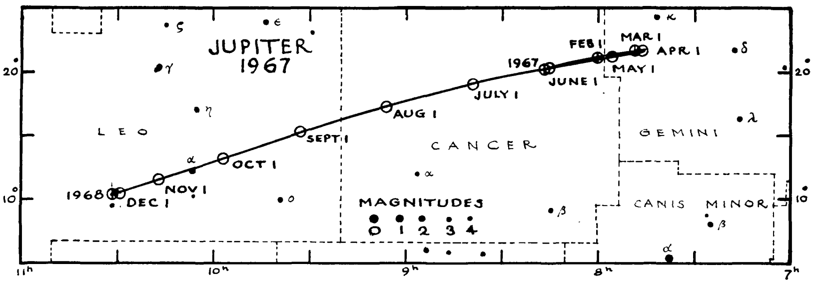
The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. At the opposition on Sept. 10, 1956, the planet was closer to the earth than it will be for some years. In contrast, the opposition distance on Mar. 9, 1965, was almost a maximum.

On Jan. 1, 1967, Mars is in Virgo and is past the meridian at sunrise; its declination is −4° and its stellar magnitude is +1.1. It retrogrades from Mar. 8 to May

27, with opposition occurring on Apr. 15. It is closest to the earth on Apr. 21, (56 million miles), when its magnitude brightens to −1.3. It is in the evening sky for the rest of the year. On Dec. 31 it is in Capricornus, and is low in the south-western sky at sunset; its stellar magnitude is +1.3. See the map. The apparent diameter of the planet ranges from 16″ at nearest approach to 5″ at the end of the year.

JUPITER

Jupiter is the giant of the family of the sun. Its mean diameter is 87,000 miles and its mass is 2½ times that of all the rest of the planets combined! Its mean distance is 483 million miles and the revolution period is 11.9 years. This planet is known to possess 12 satellites, the last discovered in 1951 (see p. 9). Bands of clouds may be observed on Jupiter, interrupted by irregular spots which may be



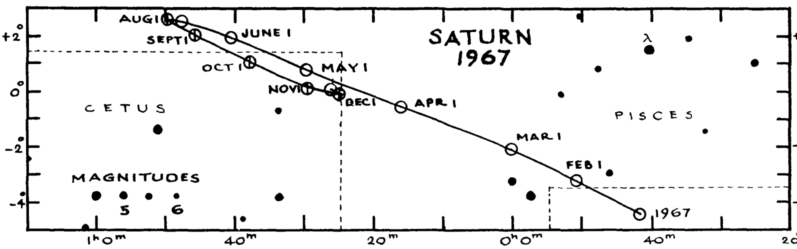
short-lived or persist for weeks. The atmosphere contains ammonia and methane at a temperature of about −200°F. Intense radiation belts (like terrestrial Van Allen belts) have been disclosed by observations at radio wave-lengths. A correlation of radio bursts with the orbital position of the satellite Io has now been found.

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

On Jan. 1, 1967, Jupiter is retrograding in Cancer, and rises about 2 hours after sunset (direct motion resumes on Mar. 21). Opposition occurs on Jan. 20 when it is visible all night; its stellar magnitude is −2.2. On Aug. 8 it is in conjunction with the sun and moves into the morning sky for the rest of the year. Retrograde motion commences on Dec. 22. On Dec. 31 Jupiter is in Leo in the south-west sky at sunrise; its stellar magnitude is −1.9. The apparent polar diameter ranges from a maximum of 43″ in Jan. to a minimum of 29″ in Aug.

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

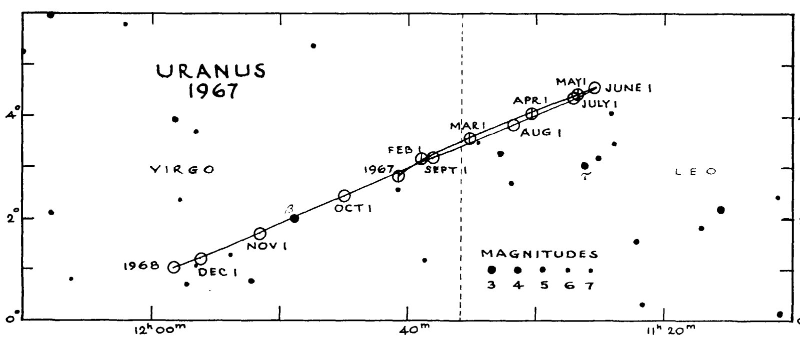


the planet's orbit, and twice during the planet's revolution period of $29\frac{1}{2}$ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. The rings were edgewise in 1950, and were again in 1966; the northern face of the rings was at maximum in 1958 and the southern will be in 1973. See p. 59.

On Jan. 1, 1967, Saturn is in Aquarius near Pisces and is about on the meridian at sunset; its stellar magnitude is +1.4 and its declination −4°. On Mar. 23 it is in conjunction with the sun and moves into the morning sky. It reaches opposition on Oct. 2 when it is visible all night and its stellar magnitude brightens to +0.6. It retrogrades from July 26 to Dec. 10 (see map; circles with lines denote retrograde motion). At the end of the year it has stellar magnitude +1.1 and is nearing the meridian at sunset. The apparent diameter of the ball of the planet ranges from 14″ in Mar. to 18″ in Oct.

URANUS

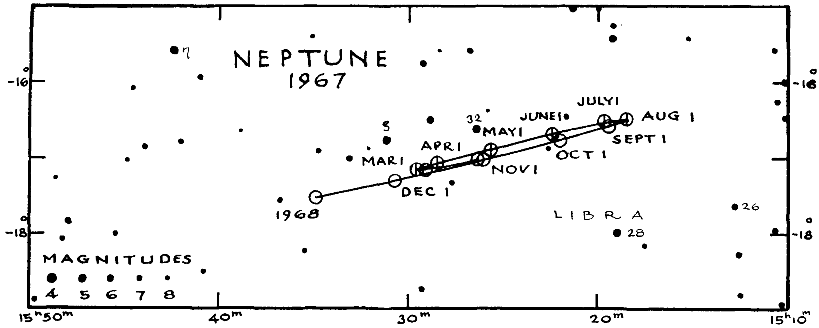
Uranus was discovered in 1781 by Sir William Herschel by means of a $6\frac{1}{4}$-in. mirror-telescope made by himself. The object did not look just like a star and he observed it again four days later. It had moved amongst the stars, and he assumed it to be a comet. He could not believe that it was a new planet. However, computation later showed that it was a planet nearly twice as far from the sun as Saturn. Its period of revolution is 84 years and it rotates on its axis in about 11 hours. Its five satellites are visible only in a large telescope.



During 1967 Uranus is in Leo and Virgo (see map). At the beginning of the year it rises before midnight and is retrograding (direct motion resumes on May 29). It is in opposition on Mar. 13 and is above the horizon all night; its apparent diameter is 4.0″; its stellar magnitude is +5.7. When conjunction occurs on Sept. 18 its magnitude has faded to +5.9. It is in the morning sky the rest of the year. It is overtaken by Venus on Nov. 7.

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 1967 Neptune is in Libra (see map). It is in opposition on May 14, when it is above the horizon all night. Its stellar magnitude is then +7.7 and during the year fades slightly to +7.8. Thus it is too faint to be seen with the naked eye. In the telescope it shows a greenish tint and an apparent diameter 2.5″ to 2.3″. It is in conjunction with the sun on Nov. 16 and moves into the morning sky for the rest of the year. It retrogrades from Feb. 25 to Aug. 3. It is overtaken by Mars on Aug. 29 and by Venus on Dec. 28.

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 14th mag. star in the constellation Leo. It is in opposition to the sun on Mar. 10, at which time its astrometric position is R.A. 11h 45m, Dec. +18° 22′.

THE SKY MONTH BY MONTH

By John F. Heard

THE SKY FOR JANUARY 1967

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 56m and its Decl. changes from 23° 05′ S. to 17° 21′ S. The equation of time changes from −3m 27s to −13m 27s. These values of the equation of time are for noon E.S.T. on the first and last days of the month in this and in the following months. The earth is at perihelion or nearest the sun on the 2nd at a distance of 91,347,000 mi. For changes in the length of the day, see p. 13.

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

Mercury on the 1st is in R.A. 18h 00m, Decl. 24° 16′ S. and on the 15th is in R.A. 19h 37m, Decl. 23° 30′ S. It is too close to the sun for observation, superior conjunction being on the 17th.

Venus on the 1st is in R.A. 19h 39m, Decl. 22° 43′ S., and on the 15th is in R.A. 20h 53m, Decl. 19° 06′ S., when it has mag. −3.3, and transits at 13h 18m. It is an evening star seen low in the south-west just after sunset.

Mars on the 15th is in R.A. 13h 18m, Decl. 5° 55′ S., mag. +0.9, and transits at 5h 42m. In Virgo, it rises about at midnight and is well past the meridian at dawn.

Jupiter on the 15th is in R.A. 8h 10m, Decl. 20° 38′ N., mag. −2.2, and transits at 0h 34m. In Cancer, it rises about as the sun sets, being in opposition on the 20th, and it dominates the sky all night. Its distance from the earth is then 397,300,000 mi.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 45m, Decl. 4° 00′ S. mag. +1.4, and transits at 16h 07m. In Aquarius, it is past the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 11h 40m, Decl. 2° 59′ N. and transits at 4h 04m.

Neptune on the 15th is in R.A. 15h 28m, Decl. 17° 05′ S. and transits at 7h 51m.

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

d	h	m	JANUARY E.S.T.	Min. of Algol (h m)	Config. of Jupiter's Sat. 0h 35m	Sun's Selen. Colong. 0h U.T. (°)
Sun. 1			Venus at aphelion..............		43102	146.64
	5		Moon at perigee, 229,400 mi.....			
Mon. 2			Earth at perihelion.............		43021	158.78
	0		Uranus 3° S. of moon...........			
Tue. 3			Quadrantid meteors...........	6 30	43210	170.93
			Mercury at aphelion...........			
	9	19	☾ Last Quarter................			
	14		Mars 0.4° S. of moon..........			
Wed. 4					4201*	183.09
Thu. 5					41023	195.25
Fri. 6	10		Neptune 3° N. of moon........	3 20	d4013	207.42
Sat. 7					2043*	219.59
Sun. 8			Mars in quadrature W..........		31024	231.77
Mon. 9				0 10	30124	243.96
Tue. 10	13	06	● New Moon..................		32104	256.14[l]
Wed. 11	19		Venus 4° N. of moon...........	21 00	23014	268.33
Thu. 12					10234	280.52
Fri. 13					02134	292.71[b]
Sat. 14				17 50	2034*	304.89
Sun. 15	18		Saturn 2° N. of moon..........		13042	317.07
Mon. 16	16		Moon at apogee, 251,500 mi.....		34012	329.25
Tue. 17	21		Mercury in superior conjunction	14 40	43210	341.42
Wed. 18	14	42	☽ First Quarter...............		42301	353.59
Thu. 19					41023	5.75
Fri. 20	0		Jupiter at opposition...........	11 30	40213	17.90
Sat. 21					42103	30.05
Sun. 22					d430*	42.19
Mon. 23			Venus greatest hel. lat. S........	8 20	34012	54.33[l]
Tue. 24			Mercury greatest hel. lat. S.....		32104	66.46
Wed. 25	13		Jupiter 4° S. of moon..........		23014	78.59
Thu. 26	1	41	○ Full Moon..................	5 10	10324	90.72
	23		Juno at opposition.............			
Fri. 27					02134	102.84[b]
Sat. 28	10		Moon at perigee, 226,000 mi....		21034	114.97
Sun. 29	7		Uranus 3° S. of moon..........	2 00	d2014	127.10
Mon. 30					30124	139.24
Tue. 31	16		Mars 1° N. of moon...........	22 50	32104	151.38

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Jan. 10, +4.69°; Jan. 23, −6.53°. [b]Jan. 13, +6.57°; Jan. 27, −6.50°.

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 56m to 22h 45m and its Decl. changes from 17° 21′ S. to 7° 56′ S. The equation of time changes from −13m 36s to a maximum of −14m 18s on the 11th and then to −12m 39s at the end of the month.

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

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

Mercury on the 1st is in R.A. 21h 37m, Decl. 16° 03′ S. and on the 15th is in R.A. 22h 58m, Decl. 5° 53′ S. It is at greatest eastern elongation on the 16th, visible then in the south-west just after sunset (altitude 16° at sunset). For a week before and after this date it may be glimpsed as an evening star very low in the south-west.

Venus on the 1st is in R.A. 22h 16m, Decl. 12° 22′ S., and on the 15th is in R.A. 23h 21m, Decl. 5° 36′ S., when it has mag. −3.3, and transits at 13h 45m. It is a prominent evening star visible low in the south-west for an hour or more after sunset.

Mars on the 15th is in R.A. 13h 57m, Decl. 9° 22′ S., mag. +0.2, and transits at 4h 19m. In Virgo, it rises before midnight and is well down in the south-west at dawn.

Jupiter on the 15th is in R.A. 7h 54m, Decl. 21° 28′ N., mag. −2.1, and transits at 22h 11m. In Cancer, it is well up in the east at sunset and dominates the sky all night.

For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 23h 56m, Decl. 2° 44′ S. mag. +1.3, and transits at 14h 16m. In Pisces, it is well down in the south-west at sunset and sets a few hours later.

Uranus on the 15th is in R.A. 11h 37m, Decl. 3° 19′ N. and transits at 1h 59 m.

Neptune on the 15th is in R.A. 15h 30m, Decl. 17° 10′ S. and transits at 5h 51m.

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

			FEBRUARY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 23h 35m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	18	03	☾ Last Quarter		41032	163.53
Thu. 2	16		Neptune 3° N. of moon		40213	175.68
Fri. 3				19 40	42103	187.85
Sat. 4					42031	200.02
Sun. 5					43102	212.19[l]
Mon. 6				16 20	dd430	224.38
Tue. 7					34201	236.56
Wed. 8	3		Ceres stationary		1032*	248.76
Thu. 9	5	44	● New Moon	13 10	01243	260.95[b]
Fri. 10	13		Mercury 5° N. of moon		21034	273.14
Sat. 11	4		Venus 3° N. of moon		20314	285.34
Sun. 12			Mercury at ascending node	10 00	31024	297.53
	8		Saturn 1° N. of moon			
Mon. 13			Neptune in quadrature W.			
	10		Moon at apogee, 252,000 mi.		d3024	309.72
Tue. 14					32014	321.91
Wed. 15				6 50	1024*	334.09
Thu. 16			Mercury at perihelion		04123	346.27
	11		Mercury greatest elong. E., 18°			
Fri. 17	10	57	☽ First Quarter		42103	358.44
Sat. 18				3 40	42031	10.61
Sun. 19					43102	22.77
Mon. 20					43012	34.93[l]
Tue. 21	18		Jupiter 4° S. of moon	0 30	4320*	47.07
Wed. 22	9		Mercury stationary		4130*	59.22
Thu. 23	7		Venus 1.1° N. of Saturn	21 20	40123	71.36[b]
Fri. 24	12	44	○ Full Moon		41203	83.49
Sat. 25	3		Neptune stationary		20413	95.63
	15		Uranus 3° S. of moon			
	16		Moon at perigee, 223,000 mi.			
Sun. 26				18 10	31024	107.77
Mon. 27			Mercury greatest hel. lat. N.		30124	119.91
Tue. 28	10		Mars 2° N. of moon		32104	132.05

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

[l]Feb. 5, +5.48°; Feb. 20, −7.63°. [b]Feb. 9, +6.54°; Feb. 23, −6.57°.

THE SKY FOR MARCH 1967

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 28s to −4m 18s. On the 21st at 2h 37m E.S.T. the sun crosses the equator on its way north, enters the sign of Aries and spring commences. This is the vernal equinox. For changes in the length of the day, see p. 14.

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

Mercury on the 1st is in R.A. 23h 04m, Decl. 2° 07′ S. and on the 15th is in R.A. 22h 24m, Decl. 8° 03′ S. Early in the month it is too close to the sun for observation, inferior conjunction being on the 4th. By the 31st it is in greatest western elongation, but this is a very poor elongation, Mercury standing only at 7° altitude in the south-east at sunrise.

Venus on the 1st is in R.A. 0h 24m, Decl. 1° 39′ N., and on the 15th is in R.A. 1h 27m, Decl. 8° 49′ N., when it has mag. −3.4, and transits at 14h 00m. It is a prominent evening star seen low in the south-west for about two hours after sunset.

Mars on the 15th is in R.A. 14h 07m, Decl. 10° 05′ S., mag. −0.6, and transits at 2h 38m. In Virgo, it rises soon after sunset and is visible all night. On the 8th it is stationary in right ascension and begins to retrograde, i.e. to move westward among the stars.

Jupiter on the 15th is in R.A. 7h 46m, Decl. 21° 48′ N., mag. −2.0, and transits at 20h 14m. In Gemini it is high in the sky at sunset and sets a few hours after midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 0h 08m, Decl. 1° 23′ S. and transits at 12h 38m. It is too close to the sun for easy observation, being in conjunction on the 23rd.

Uranus on the 15th is in R.A. 11h 33m, Decl. 3° 47′ N. and transits at 0h 05m, mag. 5.7. Opposition is on the 13th, at which time its distance from the earth is 1,606,000,000 mi.

Neptune on the 15th is in R.A. 15h 29m, Decl. 17° 08′ S. and transits at 4h 00m.

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

			MARCH E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 22h 50m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	22		Neptune 3° N. of moon.........	15 00	d3204	144.20
Thu. 2					01234	156.36
Fri. 3	4	11	☾ Last Quarter...............		12034	168.52
Sat. 4	3		Mercury in inferior conjunction.	11 50	20143	180.70[l]
Sun. 5					d1302	192.88
Mon. 6	11		Juno stationary...............		34021	205.06
Tue. 7				8 40	43210	217.25
Wed. 8	14		Mars stationary...............		43201	229.45[b]
Thu. 9	17		Mercury 8° N. of moon........		4032*	241.65
Fri. 10	10		Pluto at opposition............	5 30	d4103	253.86
	23	30	● New Moon.................			
Sat. 11					42013	266.07
Sun. 12	20		Moon at apogee, 252,500 mi.....		d4102	278.27
Mon. 13	11		Uranus at opposition...........	2 20	34012	290.48
	16		Venus 1° N. of moon...........			
Tue. 14					32104	302.69
Wed. 15				23 10	32014	314.89
Thu. 16	11		Mercury stationary............		0324*	327.09
Fri. 17					d1034	339.29
Sat. 18				19 50	20134	351.48
Sun. 19	3	32	☽ First Quarter...............		10324	3.66
Mon. 20					30124	15.84[l]
Tue. 21			Venus at ascending node.......	16 40	32104	28.01
	2		Jupiter 5° S. of moon..........			
	2	37	Equinox. Spring begins.........			
	4		Jupiter stationary.............			
Wed. 22			Mercury at descending node....		32401	40.18[b]
Thu. 23	14		Saturn in conjunction with sun..		41032	52.34
Fri. 24				13 30	d4023	64.50
Sat. 25	0		Uranus 3° S. of moon..........		42013	76.65
	22	21	○ Full Moon.................			
Sun. 26	3		Moon at perigee, 221,700 mi.....		4103*	88.81
Mon. 27	17		Mars 2° N. of moon...........	10 20	43012	100.96
Tue. 28					43120	113.11
Wed. 29	7		Neptune 3° N. of moon........		34201	125.27
Thu. 30				7 10	1032*	137.44
Fri. 31	11		Mercury greatest elong. W., 28°..		01243	149.61

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Mar. 4, +6.71°; Mar. 20, −8.09°. [b]Mar. 8, +6.65°; Mar. 22, −6.69°.

THE SKY FOR APRIL 1967

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° 48′ N. The equation of time changes from −4m 00s to +2m 47s, being zero on the 15th. For changes in the length of the day, see p. 14.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 21. There is a total eclipse of the moon, not visible in North America except for the beginning of the penumbral phase, on the night of the 23rd–24th.

Mercury on the 1st is in R.A. 22h 59m, Decl. 8° 15′ S. and on the 15th is in R.A. 0h 06m, Decl. 2° 09′ S. Passing greatest western elongation on Mar. 31, it is too close to the sun for observation for most of the month.

Venus on the 1st is in R.A. 2h 45m, Decl. 16° 35′ N. and on the 15th is in R.A. 3h 53m, Decl. 21° 34′ N., when it has mag. −3.5, and transits at 14h 24m. It is a prominent evening star in the west for about two hours after sunset.

Mars on the 15th is in R.A. 13h 36m, Decl. 7° 46′ S., mag. −1.3, and transits at 0h 05m. In Virgo, now very brilliant it rises as the sun sets, opposition being on the 15th when its distance from the earth is 56,220,000 mi. It is nearest the earth on the 21st at 55,850,000 mi.

Jupiter on the 15th is in R.A. 7h 50m, Decl. 21° 39′ N., mag. −1.7, and transits at 18h 16m. Moving back into Cancer, it is about on the meridian at sunset and sets soon after midnight. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 0h 22m, Decl. 0° 07′ N., and transits at 10h 50m. It is too close to the sun for easy observation.

Uranus on the 15th is in R.A. 11h 28m, Decl. 4° 16′ N. and transits at 21h 54m.

Neptune on the 15th is in R.A. 15h 27m, Decl. 16° 59′ S. and transits at 1h 56m.

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

d	h	m	APRIL E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 22h 10m	Sun's Selen. Colong. 0h U.T. °
Sat. 1			Mercury at aphelion		2034*	161.78
	15	59	☾ Last Quarter			
Sun. 2				4 00	1034*	173.97[l]
Mon. 3					30124	186.16
Tue. 4	17		Vesta stationary		31204	198.36[b]
Wed. 5				0 50	32014	210.57
Thu. 6					1024*	222.78
Fri. 7	4		Mercury 2° N. of moon	21 40	01423	234.99
Sat. 8	10		Saturn 0.8° N. of moon		2403*	247.21
	22		Moon at apogee, 252,600 mi.			
Sun. 9	17	21	● New Moon		42103	259.44
Mon. 10				18 30	43012	271.66
Tue. 11					d4310	283.88
Wed. 12					43201	296.11
Thu. 13	1		Venus 0.8° S. of moon	15 20	41302	308.33
Fri. 14					40123	320.55
Sat. 15	7		Mars at opposition		42103	332.76
Sun. 16			Jupiter in quadrature E.	12 10	d2043	344.97
Mon. 17	11		Jupiter 5° S. of moon		30124	357.18[l]
	15	48	☽ First Quarter			
	22		Mercury 0.5° S. of Saturn			
Tue. 18					d3104	9.38
Wed. 19				9 00	32014	21.57[b]
Thu. 20					13024	33.76
Fri. 21	9		Uranus 3° S. of moon		01324	45.94
	13		Mars nearest the earth			
Sat. 22			Lyrid meteors	5 50	21034	58.11
			Mercury greatest hel. lat. S.			
Sun. 23			Venus at perihelion			
	12		Mars 0.4° N. of moon		20134	70.28
	14		Moon at perigee, 222,300 mi.			
Mon. 24	7	04	○ Full Moon. Eclipse of ☾, see p. 64		d042*	82.45
Tue. 25	16		Neptune 3° N. of moon	2 30	34102	94.62
Wed. 26					43201	106.79
Thu. 27				23 20	4310*	118.96
Fri. 28					40312	131.14
Sat. 29					41203	143.33
Sun. 30				20 10	42013	155.52[l]

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

[l]Apr. 2, +7.33°; Apr. 17, −7.69° Apr. 30, +7.25°. [b]Apr. 4, +6.79°; Apr. 19, −6.78°.

THE SKY FOR MAY 1967

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° 48′ N. to 21° 56′ N. The equation of time changes from +2m 55s to a maximum of +3m 44s on the 14th and then to +2m 30s at the end of the month. For changes in the length of the day, see p. 15. There is a partial eclipse of the sun, visible in North America, on the 9th.

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

Mercury on the 1st is in R.A. 1h 47m, Decl. 9° 17′ N. and on the 15th is in R.A. 3h 40m, Decl. 20° 14′ N. It is too close to the sun for observation, being in superior conjunction on the 11th.

Venus on the 1st is in R.A. 5h 13m, Decl. 25° 02′ N., and on the 15th is in R.A. 6h 24m, Decl. 25° 47′ N., when it has mag. −3.6, and transits at 14h 57m. It dominates the western sky for about three hours after sunset.

Mars on the 15th is in R.A. 13h 00m, Decl. 5° 29′ S., mag. −0.9, and transits at 21h 26m. In Virgo, still a brilliant object, it is now well up in the south-east at sunset and sets after midnight. On the 27th it is stationary in right ascension and resumes its eastward motion among the stars.

Jupiter on the 15th is in R.A. 8h 04m, Decl. 21° 00′ N., mag. −1.6, and transits at 16h 33m. In Cancer, it is well past the meridian at sunset and sets 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. 0h 35m, Decl. 1° 22′ N., mag. +1.1, and transits at 9h 05m. In Pisces, it is now a morning star, rising an hour or more before the sun.

Uranus on the 15th is in R.A. 11h 26m, Decl. 4° 32′ N. and transits at 19h 54m.

Neptune on the 15th is in R.A. 15h 24m, Decl. 16° 47′ S. and transits at 23h 51m, mag. 7.7. Opposition is on the 14th, when its distance from the sun is 2,723,000,000 mi.

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

			MAY E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 21h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Mon. 1	5	33	☾ Last Quarter...............		41032	167.72[b]
Tue. 2					d3402	179.92
Wed. 3				17 00	32014	192.13
Thu. 4					31204	204.35
Fri. 5			η Aquarid meteors.............		03124	216.57
	23		Saturn 0.5° N. of moon........			
Sat. 6	6		Moon at apogee, 252,300 mi.....	13 50	12034	228.80
Sun. 7					20134	241.03
Mon. 8					10324	253.27
Tue. 9	9	56	● New Moon..................	10 40	30124	265.51
			Eclipse of ☉, see p. 64.			
Wed. 10					3204*	277.75
Thu. 11			Mercury at ascending node.....		d3210	289.99
	11		Mercury in superior conjunction			
Fri. 12				7 30	43012	302.22
Sat. 13	2		Venus 2° S. of moon...........		d4103	314.46
Sun. 14	7		Neptune at opposition.........		42013	326.69
	23		Jupiter 5° S. of moon..........			
Mon. 15			Mercury at perihelion..........	4 20	41023	338.92[l]
			Venus at greatest hel. lat. N....			
	16		Vesta at opposition............			
Tue. 16					43012	351.14[b]
Wed. 17	0	18	☽ First Quarter...............		4320*	3.36
Thu. 18	16		Uranus 3° S. of moon..........	1 10	43210	15.57
Fri. 19					43012	27.77
Sat. 20	11		Mars 2° S. of moon............	22 00	10243	39.96
Sun. 21	21		Moon at perigee, 224,600 mi....		20134	52.15
Mon. 22					10234	64.34
Tue. 23	2		Neptune 3° N. of moon........	18 40	30124	76.52
	15	23	○ Full Moon.................			
Wed. 24					32104	88.71
Thu. 25					d3204	100.89
Fri. 26			Mercury greatest hel. lat. N.....	15 30	30124	113.08
Sat. 27	10		Mars stationary..............		10243	125.27
Sun. 28					24013	137.46[l,b]
Mon. 29	1		Uranus stationary............	12 20	4103*	149.66
Tue. 30	20	52	☾ Last Quarter...............		43012	161.87
Wed. 31					43210	174.08

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]May 15, −6.61°; May 28, +6.58°. [b]May 1, +6.84°; May 16, −6.78°; May 28, +6.73°.

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° 56′ N. to 23° 10′ N. The equation of time changes from +2m 21s to −3m 27s, being zero on the 14th. The solstice is on the 21st at 21h 23m E.S.T. For changes in the length of the day, see p. 15.

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

Mercury on the 1st is in R.A. 6h 02m, Decl. 25° 38′ N. and on the 15th is in R.A. 7h 15m, Decl. 23° 04′ N. Greatest eastern elongation is on the 12th at which time the planet stands about 17° above the western horizon at sunset. For about ten days before and after this date Mercury can be seen low in the west just after sunset.

Venus on the 1st is in R.A. 7h 45m, Decl. 23° 48′ N., and on the 15th is in R.A. 8h 46m, Decl. 20° 13′ N., when it has mag. −3.9, and transits at 15h 16m. A brilliant object, it dominates the western sky for three or more hours after sunset. Greatest eastern elongation is on the 20th.

Mars on the 15th is in R.A. 13h 03m, Decl. 7° 05′ S., mag. −0.3, and transits at 19h 30m. In Virgo, declining noticeably in brightness, it is about on the meridian at sunset and sets soon after midnight.

Jupiter on the 15th is in R.A. 8h 26m, Decl. 19° 50′ N., mag. −1.4, and transits at 14h 53m. In Cancer, it is well down in the west at sunset and sets a few 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. 0h 45m, Decl. 2° 17′ N., mag. +1.0, and transits at 7h 12m. In Pisces, it rises about three hours before the sun.

Uranus on the 15th is in R.A. 11h 26m, Decl. 4° 30′ N. and transits at 17h 52m.

Neptune on the 15th is in R.A. 15h 21m, Decl. 16° 36′ S. and transits at 21h 46m.

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

			JUNE E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 20h 55m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Thu. 1				9 10	43201	186.30
Fri. 2	12		Saturn 0.1° N. of moon........		4302*	198.52
	21		Moon at apogee, 251,600 mi.....			
Sat. 3					41023	210.76
Sun. 4			Mars at descending node.......	6 00	42013	222.99
	18		Pluto stationary...............			
Mon. 5					12403	235.23
Tue. 6					03142	247.48
Wed. 7	23		Pallas in conjunction with sun..	2 50	31204	259.73
Thu. 8	0	14	● New Moon.................		32014	271.97
	21		Venus 1.8° N. of Jupiter........			
Fri. 9				23 40	31024	284.22
Sat. 10	0		Mercury 3° S. of moon.........		10324	296.47
Sun. 11			Uranus in quadrature E........		20134	308.72[l]
	12		Jupiter 5° S. of moon..........			
	17		Venus 3° S. of moon...........			
Mon. 12	5		Mercury greatest elong. E., 24°..	20 30	12034	320.96[b]
Tue. 13					03142	333.20
Wed. 14	22		Uranus 3° S. of moon..........		d3140	345.43
Thu. 15	6	12	☽ First Quarter...............	17 10	34201	357.66
Fri. 16	22		Mars 2° S. of moon...........		43102	9.88
Sat. 17					d4032	22.09
Sun. 18			Mercury at descending node....	14 00	42013	34.30
	15		Moon at perigee, 227,600 mi....			
Mon. 19	10		Neptune 3° N. of moon.........		42103	46.50
Tue. 20	19		Venus greatest elong. E., 45°....		40132	58.69
Wed. 21	21	23	Solstice. Summer begins........	10 50	43102	70.88
	23	57	○ Full Moon.................			
Thu. 22					3201*	83.07
Fri. 23					3104*	95.26
Sat. 24				7 40	0124*	107.46
Sun. 25	12		Mercury stationary............		2034*	119.65[lb]
Mon. 26					21034	131.85
Tue. 27				4 30	01234	144.05
Wed. 28			Mercury at aphelion...........		31024	156.26
Thu. 29	13	40	☾ Last Quarter...............		32014	168.48
	23		Saturn 0.4° S. of moon.........			
Fri. 30	15		Moon at apogee, 251,000 mi.....	1 20	3104*	180.70

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

[l]June 11, −5.44°; June 25, +5.71°. [b]June 12, −6.67°; June 25, +6.62°.

THE SKY FOR JULY 1967

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° 15′ N. The equation of time changes from −3m 39s to −6m 19s. On the 5th the earth is in aphelion or farthest from the sun, 94,455,000 mi. For changes in the length of the day, see p. 16.

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

Mercury on the 1st is in R.A. 7h 29m, Decl. 18° 39′ N. and on the 15th is in R.A. 6h 57m, Decl. 17° 57′ N. Early in the month it is too close to the sun for observation, being in inferior conjunction on the 9th. By the 29th it has reached greatest western elongation and then stands about 13° above the eastern horizon at sunrise. For about a week before and after this date it could be glimpsed low in the east just before sunrise.

Venus on the 1st is in R.A. 9h 45m, Decl. 14° 41′ N., and on the 15th is in R.A. 10h 24m, Decl. 9° 21′ N., when it has mag. −4.1, and transits at 14h 54 m. It is still a prominent object in the western sky during the early evening though it is rapidly approaching the sun. Greatest brilliancy is on the 24th.

Mars on the 15th is in R.A. 13h 41m, Decl. 11° 35′ S., mag. +0.2, and transits at 18h 11m. In Virgo, not far from Spica, it is now past the meridian at sunset and is no longer very prominent.

Jupiter on the 15th is in R.A. 8h 51m, Decl. 18° 18′ N., mag. −1.3. and transits at 13h 20m. In Cancer, it is seen but briefly, just after sunset, low in the west.

Saturn on the 15th is in R.A. 0h 49m, Decl. 2° 39′ N., mag. +0.9, and transits at 5h 19m. In Pisces, it rises about at midnight and is nearly to the meridian by sunrise. On the 26th it begins to retrograde, i.e. move westward among the stars.

Uranus on the 15th is in R.A. 11h 29m, Decl. 4° 09′ N. and transits at 15h 57m.

Neptune on the 15th is in R.A. 15h 19m, Decl. 16° 29′ S. and transits at 19h 46m.

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

JULY E.S.T.				Min. of Algol	Sun's Selen. Colong. 0h U.T.
d	h	m		h m	°
Sat. 1	0		Vesta stationary...............		192.92
Sun. 2				22 10	205.16
Mon. 3					217.39
Tue. 4			Saturn in quadrature W........		229.64
Wed. 5			Earth at aphelion.............	19 00	241.88
Thu. 6					254.13
Fri. 7	12	01	● New Moon.................		266.39[l]
Sat. 8				15 40	278.64
Sun. 9	5		Jupiter 5° S. of moon..........		290.89[b]
	7		Mercury in inferior conjunction..		
Mon. 10			Venus at descending node......		303.14
	19		Venus 5° S. of moon...........		
Tue. 11				12 30	315.39
Wed. 12	5		Uranus 3° S. of moon..........		327.63
Thu. 13					339.87
Fri. 14	10	53	☽ First Quarter...............	9 20	352.10
	15		Moon at perigee, 229,800 mi.....		
	20		Mars 2° S. of moon............		
Sat. 15					4.32
Sun. 16	16		Neptune 4° N. of moon........		16.54
Mon. 17				6 10	28.74
Tue. 18					40.95
Wed. 19			Mercury greatest hel. lat. S.....		53.14
Thu. 20	3		Mercury stationary............	3 00	65.34
Fri. 21	9	40	○ Full Moon.................		77.53
Sat. 22				23 50	89.72[lb]
Sun. 23					101.91
Mon. 24	5		Venus at greatest brilliancy, −4.1		114.10
Tue. 25				20 40	126.30
Wed. 26			Mars in quadrature E..........		138.50
	3		Saturn stationary..............		
Thu. 27	9		Saturn 0.9° S. of moon.........		150.70
Fri. 28	9		Moon at apogee, 251,100 mi.....	17 30	162.91
Sat. 29			δ Aquarid meteors.............		175.13
	7	15	☾ Last Quarter...............		
	22		Mercury greatest elong. W., 20°.		
Sun. 30					187.35
Mon. 31				14 10	199.58

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]July 7, −5.14°; July 22, +5.08°. [b]July 9, −6.56°; July 22, +6.55°.

THE SKY FOR AUGUST 1967

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° 15′ N. to 8° 37′ N. The equation of time changes from −6m 16s to −0m 24s. For changes in the length of the day, see p. 16.

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

Mercury on the 1st is in R.A. 7h 20m, Decl. 20° 40′ N. and on the 15th is in R.A. 8h 57m, Decl. 18° 37′ N. For the first week of the month it may be seen with some difficulty as a morning star very low in the east just before sunrise. Later it is too close to the sun for observation, being in superior conjunction on the 24th.

Venus on the 1st is in R.A. 10h 51m, Decl. 3° 31′ N., and on the 15th is in R.A. 10h 48m, Decl. 0° 42′ N., when it has mag. −3.8, and transits at 13h 13m. Early in the month it is still to be seen in the west after sunset, but by the 29th it is in inferior conjunction.

Mars on the 15th is in R.A. 14h 44m, Decl. 17° 20′ S., mag. +0.6, and transits at 17h 11m. Moving from Virgo into Libra, it is well down in the south-west at sunset.

Jupiter on the 15th is in R.A. 9h 18m, Decl. 16° 23′ N., mag. −1.3, and transits at 11h 45m. It is too close to the sun for easy observation, being in conjunction on the 8th.

Saturn on the 15th is in R.A. 0h 49m, Decl. 2° 25′ N., mag. +0.8, and transits at 3h 16m. In Pisces, it rises a few hours after sunset and is visible during the rest of the night.

Uranus on the 15th is in R.A. 11h 34m, Decl. 3° 33′ N. and transits at 14h 01 m.

Neptune on the 15th is in R.A. 15h 19m, Decl. 16° 30′ S. and transits at 17h 44m.

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

			AUGUST E.S.T.	Min. of Algol		Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Tue. 1						211.81
Wed. 2						224.04
Thu. 3	23		Neptune stationary............	11 00		236.29
Fri. 4	10		Mercury 6° S. of moon.........			248.53[l]
Sat. 5	21	49	● New Moon.................			260.78[b]
Sun. 6	1		Venus stationary..............	7 50		273.03
Mon. 7			Mercury at ascending node.....			285.28
	20		Venus 10° S. of moon..........			
Tue. 8	14		Jupiter in conjunction with sun..			297.53
	14		Uranus 3° S. of moon...........			
Wed. 9	10		Moon at perigee, 227,900 mi.....	4 40		309.77
Thu. 10						322.01
Fri. 11			Mercury at perihelion..........			334.24
Sat. 12			Perseid meteors...............	1 30		346.47
	3		Mars 0.4° S. of moon...........			
	15	45	☽ First Quarter...............			
	21		Neptune 4° N. of moon.........			
Sun. 13						358.69
Mon. 14			Venus at aphelion..............	22 20		10.90
			Neptune in quadrature E........			
Tue. 15						23.10
Wed. 16						35.30
Thu. 17				19 10		47.49
Fri. 18						59.68[lb]
Sat. 19	21	27	○ Full Moon.................			71.87
Sun. 20				15 50		84.05
Mon. 21						96.24
Tue. 22			Mercury greatest hel. lat. N......			108.42
Wed. 23	7		Ceres in conjunction with sun....	12 40		120.61
	15		Saturn 1° S. of moon...........			
Thu. 24	11		Mercury in superior conjunction.			132.80
Fri. 25	4		Moon at apogee, 251,600 mi.....			144.99
Sat. 26				9 30		157.19
Sun. 27						169.39
Mon. 28	0	35	☾ Last Quarter...............			181.60
Tue. 29	8		Mars 3° S. of Neptune..........	6 20		193.81
	17		Venus in inferior conjunction....			
Wed. 30						206.03
Thu. 31						218.26[l]

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

[l]Aug. 4, −5.66°; Aug. 18, +5.29°; Aug. 31, −6.56°. [b]Aug. 5, −6.53°; Aug. 18, +6.59.

THE SKY FOR SEPTEMBER 1967

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° 37′ N. to 2° 50′ S. The equation of time changes from −0m 05s to +9m 53s. On the 23rd at 12h 38m E.S.T. the sun crosses the equator moving southward, enters the sign of Libra and autumn commences. For changes in the length of the day, see p. 17.

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

Mercury on the 1st is in R.A. 11h 06m, Decl. 7° 18′ N. and on the 15th is in R.A. 12h 31m, Decl. 3° 26′ S. Early in the month it is too close to the sun for observation. By month's end it is an evening star which might be seen with difficulty near Spica, very low in the south-west just after sunset.

Venus on the 1st is in R.A. 10h 13m, Decl. 1° 51′ N., and on the 15th is in R.A. 9h 51m, Decl. 5° 05′ N., when it has mag. −3.9, and transits at 10h 15m. It is now a morning star and rises in the east an hour or more before the sun.

Mars on the 15th is in R.A. 16h 04m, Decl. 22° 23′ S., mag. +0.8, and transits at 16h 29m. Moving through Libra into Scorpius, it is now low in the south-west at sunset.

Jupiter on the 15th is in R.A. 9h 44m, Decl. 14° 20′ N., mag. −1.3, and transits at 10h 09m. In Leo, it is now a morning star visible low in the east for an hour or two before sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 56.

Saturn on the 15th is in R.A. 0h 42m, Decl. 1° 39′ N., mag. +0.6, and transits at 1h 08m. In Pisces, it rises just after sunset and is visible all night.

Uranus on the 15th is in R.A. 11h 41m, Decl. 2° 48′ N. and transits at 12h 06m.

Neptune on the 15th is in R.A. 15h 20m, Decl. 16° 38′ S. and transits at 15h 44m.

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

			SEPTEMBER E.S.T.	Min. of Algol	Config. of Jupiter's Sat. 4h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1				3 10	d2014	230.49
Sat. 2	19		Jupiter 4° S. of moon..........		32104	242.72[b]
Sun. 3					30124	254.96
Mon. 4	6	38	● New Moon.................	0 00	31024	267.20
Tue. 5			Venus greatest hel. lat. S.......		20134	279.44
	22		Mercury 0.3° N. of Uranus.....			
Wed. 6	3		Moon at perigee, 224,800 mi....	20 50	12043	291.67
Thu. 7					40123	303.91
Fri. 8					4023*	316.14
Sat. 9	4		Neptune 4° N. of moon........	17 30	43210	328.36
	16		Mars 1° N. of moon...........			
Sun. 10	22	06	☽ First Quarter...............		43021	340.58
Mon. 11					43102	352.79
Tue. 12				14 20	42031	4.99
Wed. 13	18		Pluto in conjunction with sun...		41203	17.19[l]
Thu. 14			Mercury at descending node....		40123	29.38[lb]
Fri. 15				11 10	1023*	41.56
Sat. 16					d2304	53.74
Sun. 17					3014*	65.91
Mon. 18	5		Uranus in conjunction with sun.	8 00	31024	78.08
	12	00	○ Full Moon. Harvest Moon...			
	15		Venus stationary..............			
Tue. 19	19		Saturn 1° S. of moon..........		2014*	90.26
Wed. 20					21034	102.43
Thu. 21	19		Moon at apogee, 252,200 mi.....	4 50	01234	114.60
Fri. 22					10234	126.78
Sat. 23	12	38	Equinox. Autumn begins.......		23014	138.95
Sun. 24			Mercury at aphelion...........	1 40	340**	151.13
Mon. 25	6		Juno in conjunction with sun...		43102	163.32
Tue. 26	16	44	☾ Last Quarter...............	22 30	4201*	175.51
Wed. 27					42103	187.71
Thu. 28					40123	199.91[l]
Fri. 29				19 10	41023	212.11[b]
Sat. 30	15		Jupiter 4° S. of moon..........		42301	224.33
	16		Venus 10° S. of moon..........			

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Sept. 13, 14, +6.37°; Sept. 28, −7.25°. [b]Sept. 2, −6.62°; Sept. 14, +6.71°; Sept. 29, −6.79°.

THE SKY FOR OCTOBER 1967

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° 50′ S. to 14° 08′ S. The equation of time changes from +10m 12s to +16m 20s. For changes in the length of the day, see p. 17.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 24. There is a total eclipse of the moon, visible in North America, on the night of the 17th–18th.

Mercury on the 1st is in R.A. 13h 53m, Decl. 13° 49′ S. and on the 15th is in R.A. 14h 47m, Decl. 19° 28′ S. On the 8th it is in greatest eastern elongation, but this is a poor elongation, Mercury standing less than 10° above the south-western horizon at sunset.

Venus on the 1st is in R.A. 10h 01m, Decl. 7° 14′ N., and on the 15th is in R.A. 10h 33m, Decl. 6° 42′ N., when it has mag. −4.2, and transits at 9h 01m. A morning star, it dominates the eastern sky for several hours before sunrise. Greatest brilliancy is on the 5th.

Mars on the 15th is in R.A. 17h 34m, Decl. 24° 57′ S., mag. +0.9, and transits at 16h 02m. Moving through Scorpius into Sagittarius, it is visible for a few hours after sunset low in the south-west.

Jupiter on the 15th is in R.A. 10h 07m, Decl. 12° 28′ N., mag. −1.4, and transits at 8h 33m. In Leo, near Regulus, it rises about four 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. 0h 34m, Decl. 0° 44′ N., mag. +0.6, and transits at 22h 58m. In Pisces, it is risen at sunset and is visible during the whole night. Opposition is on the 2nd, its distance from the earth then being 784, 700,000 mi. On the 16th it is occulted by the moon, visible across Canada; see pp. 64-69.

Uranus on the 15th is in R.A. 11h 48m, Decl. 2° 04′ N. and transits at 10h 14m.

Neptune on the 15th is in R.A. 15h 24m, Decl. 16° 52′ S. and transits at 13h 49m.

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

d	h	m	OCTOBER E.S.T.	Min. of Algol h m	Config. of Jupiter's Sat. 4h 00m	Sun's Selen. Colong. 0h U.T. °
Sun. 1					34210	236.54
Mon. 2	15		Uranus 2° S. of moon..........	16 00	31042	248.77
	17		Saturn at opposition...........			
Tue. 3	15	24	● New Moon................		d3014	260.99
Wed. 4	9		Moon at perigee, 222,500 mi....		21034	273.21
Thu. 5	9		Mercury 2° S. of moon.........	12 50	02134	285.44
	21		Venus at greatest brilliancy, −4.3			
Fri. 6	13		Neptune 4° N. of moon........		10234	297.66
Sat. 7					23014	309.88
Sun. 8	8		Mars 3° N. of moon...........	9 40	31204	322.09
	23		Mercury greatest elong. E., 25°..			
Mon. 9					30124	334.29
Tue. 10	7	11	☽ First Quarter...............		d304*	346.49
Wed. 11				6 30	24103	358.68[lb]
Thu. 12					40213	10.86
Fri. 13					41023	23.04
Sat. 14				3 20	42031	35.21
Sun. 15			Mercury greatest hel. lat. S.....		43210	47.38
Mon. 16	21		Saturn 1° S. of moon...........		43012	59.54
Tue. 17				0 10	4302*	71.70
Wed. 18	5	11	○ Full Moon. Hunter's Moon... Eclipse of ☾, see p. 64.		24103	83.85
Thu. 19	3		Moon at apogee, 252,400 mi.....	21 00	0413*	96.01
Fri. 20					10234	108.16
Sat. 21			Orionid meteors...............		20314	120.32
	5		Mercury stationary............			
Sun. 22				17 40	32104	132.48
Mon. 23					30124	144.64
Tue. 24					3024*	156.81
Wed. 25				14 30	21034	168.98
Thu. 26	7	04	☾ Last Quarter...............		0143*	181.15[b]
Fri. 27					10423	193.34[l]
Sat. 28	8		Jupiter 4° S. of moon..........	11 20	42031	205.52
Sun. 29	15		Venus 4° S. of moon...........		42310	217.72
Mon. 30	5		Uranus 2° S. of moon..........		43012	229.91
Tue. 31			Venus at ascending node.......	8 10	43102	242.12

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Oct. 11, +7.50°; Oct. 27, −7.41°.   [b]Oct. 11, +6.79°; Oct. 26, −6.83°.

THE SKY FOR NOVEMBER 1967

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

The Sun—During November the sun's R.A., increases from 14h 22m to 16h 25m and its Decl. changes from 14° 08′ S. to 21° 40′ S. The equation of time changes from +16m 22s to +11m 26s. For changes in the length of the day, see p. 18. There is a total eclipse of the sun, not visible in North America, on the 2nd.

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

Mercury on the 1st is in R.A. 14h 27m, Decl. 15° 20′ S. and on the 15th is in R.A. 14 h 07m, Decl. 10° 20′ S. Early in the month it is too close to the sun for observation, being in inferior conjunction on the 1st. By the 17th it is in greatest western elongation and stands 17° above the south-eastern horizon at sunrise. This is a favourable elongation, and for more than a week before and after this date Mercury may be seen easily near Spica low in the south-east just before sunrise.

Venus on the 1st is in R.A. 11h 29m, Decl. 3° 22′ N., and on the 15th is in R.A. 12h 22m, Decl. 0° 58′ S., when it has mag. −4.0, and transits at 8h 48m. It dominates the eastern sky for several hours before sunrise. Greatest western elongation is on the 9th.

Mars on the 15th is in R.A. 19h 15m, Decl. 23° 51′ S., mag. +1.1, and transits at 15h 41m. Moving through Sagittarius, it is visible for a few hours after sunset low in the south-west.

Jupiter on the 15th is in R.A. 10h 24m, Decl. 10° 58′ N., mag. −1.6, and transits at 6h 48m. In Leo, it rises after midnight and is about on the meridian at sunrise. 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. 0h 27m, Decl. 0° 03′ N., mag. +0.8, and transits at 20h 49m. In Pisces, it is well up in the east at sunset and sets before dawn. On the 12th it is occulted by the moon, visible from Western Canada; see pp. 64-69.

Uranus on the 15th is in R.A. 11h 54m, Decl. 1° 26′ N. and transits at 8h 18m.

Neptune on the 15th is in R.A. 15h 28m, Decl. 17° 09′ S. and transits at 11h 52m.

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

NOVEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 3h 30m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Wed. 1	10		Mercury in inferior conjunction.		4301*	254.33
	21		Moon at perigee, 221,800 mi....			
Thu. 2	0	49	● New Moon		4203*	266.53
			Eclipse of ☉, see p. 64.			
Fri. 3			Mercury at ascending node.....	5 00	41023	278.74
	1		Neptune 4° N. of moon........			
Sat. 4					d4013	290.95
Sun. 5			Taurid meteors................		21304	303.15
Mon. 6	4		Mars 3° N. of moon...........	1 50	30214	315.35
Tue. 7			Mercury at perihelion..........		31024	327.54
	5		Venus 0.1° S. of Uranus........			
Wed. 8	20	00	☽ First Quarter...............	22 40	23014	339.73[l,b]
Thu. 9			Mars greatest hel. lat. S........		2034*	351.91
	10		Venus greatest elong. W., 47°...			
Fri. 10	4		Mercury stationary............		d0234	4.08
Sat. 11				19 30	02134	16.24
Sun. 12	23		Saturn 0.8° S. of moon.........		21304	28.40
Mon. 13					d301*	40.56
Tue. 14				16 20	34102	52.71
Wed. 15	3		Moon at apogee, 252,400 mi.....		42301	64.85
Thu. 16	22		Neptune in conjunction with sun		42103	76.99
	23	53	○ Full Moon..................			
Fri. 17			Leonid meteors................	13 00	41023	89.13
	16		Mercury greatest elong. W., 19°.			
Sat. 18			Mercury greatest hel. lat. N.....		40123	101.27
Sun. 19					d4210	113.42
Mon. 20				9 50	4301*	125.56
Tue. 21					31402	137.70
Wed. 22					32014	149.85[b]
Thu. 23				6 40	21034	162.00
Fri. 24	19	24	☾ Last Quarter...............		01234	174.16[l]
	22		Jupiter 4° S. of moon..........			
Sat. 25					01234	186.32
Sun. 26	16		Uranus 2° S. of moon..........	3 30	21034	198.49
Mon. 27			Jupiter in quadrature W........		32014	210.67
Tue. 28	6		Venus 2° N. of moon...........		31024	222.85
Wed. 29				0 20	32014	235.04
Thu. 30	9		Moon at perigee, 223,100 mi....		21403	247.23
	11		Mercury 4° N. of moon........			

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

[l]Nov. 8, +7.90°; Nov. 24, −6.76°. [b]Nov. 8, +6.78°; Nov. 22, −6.73°.

THE SKY FOR DECEMBER 1967

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° 40′ S. to 23° 06′ S. The equation of time changes from +11m 04s to −2m 53s, being zero on the 25th. The solstice is on the 22nd at 8h 17m E.S.T. For changes in the length of the day, see p. 18.

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

Mercury on the 1st is in R.A. 15h 24m, Decl. 17° 20′ S. and on the 15th is in R.A. 16h 53m, Decl. 22° 56′ S. It is too close to the sun for observation, superior conjunction being on the 28th.

Venus on the 1st is in R.A. 13h 28m, Decl. 6° 51′ S., and on the 15th is in R.A. 14h 29m, Decl. 12° 08′ S., when it has mag. −3.7, and transits at 8h 57m. It is a prominent object in the eastern sky for several hours before sunrise.

Mars on the 15th is in R.A. 20h 52m, Decl. 18° 56′ S., mag. +1.2, and transits at 15h 20m. Moving through Capricornus, it may be seen very low in the south-west for a few hours after sunset.

Jupiter on the 15th is in R.A. 10h 32m, Decl. 10° 20′ N., mag. −1.8, and transits at 4h 58m. In Leo, it rises before midnight and is past the meridian at dawn. For the configurations of Jupiter's satellites see opposite page, and for their eclipses etc., see p. 57.

Saturn on the 15th is in R.A. 0h 25m, Decl. 0° 03′ S., mag. +1.0, and transits at 18h 49m. In Pisces, it is approaching the meridian at sunset and sets after midnight. On the 10th it is stationary in right ascension and resumes direct, or eastward, motion among the stars.

Uranus on the 15th is in R.A. 11h 58m, Decl. 1° 05′ N. and transits at 6h 24m.

Neptune on the 15th is in R.A. 15h 33m, Decl. 17° 25′ S. and transits at 9h 58m.

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

Explanation of abbreviations on p. 4, of time on p. 10, of colongitude on p. 61.
[l]Dec. 7, +7.43°; Dec. 21, −5.52°. [b]Dec. 5, +6.67°; Dec. 19 −6.57°.

DECEMBER E.S.T.				Min. of Algol	Config. of Jupiter's Sat. 3h 00m	Sun's Selen. Colong. 0h U.T.
d	h	m		h m		°
Fri. 1	11	10	● New Moon.................	21 10	40123	259.43
	22		Mercury 0.6° S. of Neptune.....			
Sat. 2					41023	271.62
Sun. 3					42103	283.82
Mon. 4			Venus at perihelion............	18 00	43201	296.01
			Mars at perihelion.............			
Tue. 5	3		Mars 4° N. of moon...........		43102	308.20[b]
Wed. 6					d4301	320.38
Thu. 7				14 50	42103	332.56[l]
Fri. 8	12	58	☽ First Quarter...............		0213*	344.73
Sat. 9					10243	356.90
Sun. 10	5		Saturn 0.8° S. of moon..........	11 40	20134	9.05
	5		Saturn stationary..............			
Mon. 11			Mercury at descending node....		32014	21.20
Tue. 12	13		Moon at apogee, 251,900 mi....		31024	33.35
Wed. 13			Geminid meteors..............	8 30	30214	45.49
Thu. 14					2104*	57.63
Fri. 15					0134*	69.76
Sat. 16	18	22	○ Full Moon.................	5 10	10423	81.89
Sun. 17					42013	94.02
Mon. 18					4230*	106.15
Tue. 19				2 00	43102	118.28[b]
Wed. 20					43021	130.42
Thu. 21			Mercury at aphelion...........	22 50	4210*	142.55[l]
			Uranus in quadrature W.			
Fri. 22	6		Jupiter 3° S. of moon..........		4013*	154.69
	8	17	Solstice. Winter begins.........			
	18		Jupiter stationary.............			
Sat. 23			Ursid meteors.................		41023	166.84
Sun. 24	0		Uranus 2° S. of moon..........	19 40	42013	178.99
	5	48	☾ Last Quarter...............			
Mon. 25					21304	191.15
Tue. 26			Venus greatest hel. lat. N.......		31024	203.31
Wed. 27				16 30	30124	215.49
Thu. 28			Saturn in quadrature E.........		23104	227.66
	0		Venus 5° N. of moon...........			
	2		Neptune 4° N. of moon........			
	14		Moon at perigee, 226,100 mi....			
	18		Mercury in superior conjunction.			
	21		Venus 0.7° N. of Neptune......			
Fri. 29					20134	239.85
Sat. 30	22	39	● New Moon.................	13 20	10234	252.03
Sun. 31					20134	264.22

JANUARY

d	h	m	Sat.	Phen.
3	23	03	III	ED
4	4	13	II	ED
	4	13	III	OR
	6	47	I	SI
	7	10	I	TI
	7	51	II	OR
5	3	58	I	ED
	6	38	I	OR
	22	40	II	SI
	23	23	II	TI
6	1	15	I	SI
	1	34	II	Se
	1	36	I	TI
	2	17	II	Te
	3	32	I	Se
	3	52	I	Te
	21	22	IV	OR
	22	27	I	ED
7	1	04	I	OR
	19	43	I	SI
	20	01	I	TI
	20	58	II	OR
	22	00	I	Se
	22	18	I	Te
8	19	30	I	OR
11	3	02	III	ED
	6	47	II	ED
12	5	52	I	ED
13	1	17	II	SI
	1	38	II	TI
	3	09	I	SI
	3	19	I	TI
	4	11	II	Se
	4	33	II	Te
	5	25	I	Se
	5	36	I	Te
14	0	21	I	ED
	2	48	I	OR
	20	04	II	ED
	20	32	III	Se
	21	05	III	Te
	21	37	I	SI
	21	45	I	TI
	23	11	II	OR
	23	51	IV	SI
	23	54	I	Se
15	0	01	I	Te
	0	57	IV	TI
	4	06	IV	Se
	5	18	IV	Te
	18	50	I	ED
	21	14	I	OR
16	18	22	I	Se
	18	27	I	Te
20	3	53	II	TI
	3	54	II	SI
	5	02	I	TI
	5	03	I	SI
	6	48	II	Te
	6	49	II	Se
21	2	14	I	OD
	4	34	I	ER
	20	46	III	TI
	20	59	III	SI
	22	32	II	OD
	23	28	I	TI
	23	31	I	SI
22	0	20	III	Te
	0	31	III	Se
	1	29	II	ER
	1	45	I	Te
	1	48	I	Se
	20	40	I	OD
	23	02	I	ER
23	17	54	I	TI
	18	00	I	SI
	19	55	II	Te
	20	07	II	Se
23	20	11	I	Te
	20	16	I	Se
27	6	09	II	TI
28	3	58	I	OD
29	0	02	III	TI
	0	45	II	OD
	0	58	III	SI
	1	12	I	TI
	1	25	I	SI
	3	28	I	Te
	3	35	III	Te
	3	42	I	Se
	4	04	II	ER
	4	31	III	Se
	22	24	I	OD
30	0	57	I	ER
	19	16	II	TI
	19	38	I	TI
	19	49	II	SI
	19	54	I	SI
	21	54	I	Te
	22	10	I	Se
	22	10	II	Te
	22	44	II	Se
31	19	25	IV	Te
	19	26	I	ER
	22	10	IV	Se

FEBRUARY

d	h	m	Sat.	Phen.
1	18	34	III	ER
5	2	56	I	TI
	2	59	II	OD
	3	19	I	SI
	3	19	III	TI
	4	56	III	SI
	5	12	I	Te
6	0	08	I	OD
	2	52	I	ER
	21	22	I	TI
	21	33	II	TI
	21	48	I	SI
	22	27	II	SI
	23	38	I	Te
7	0	05	I	Se
	0	27	II	Te
	1	21	II	Se
	18	35	I	OD
	21	21	I	ER
8	18	33	I	Se
	19	55	II	ER
	21	12	IV	OD
	22	34	III	ER
9	1	35	IV	OR
	1	53	IV	ED
12	4	40	I	TI
13	1	54	I	OD
	4	47	I	ER
	23	07	I	TI
	23	42	I	SI
	23	50	II	TI
14	1	04	II	SI
	1	23	I	Te
	1	59	I	Se
	2	45	II	Te
	3	59	II	Se
	20	20	I	OD
	23	16	I	ER
15	19	49	I	Te
	20	22	III	OD
	20	27	I	Se
	22	30	II	ER
16	2	33	III	ER
20	3	40	I	OD
21	0	52	I	TI
	1	37	I	SI
	2	10	II	TI
	3	09	I	Te
	3	42	II	SI
21	3	53	I	Se
	22	07	I	OD
22	1	11	I	ER
	19	19	I	TI
	20	05	I	SI
	20	40	II	OD
	21	35	I	Te
	22	22	I	Se
	23	47	III	OD
23	1	04	II	ER
	19	40	I	ER
24	19	55	II	Se
25	19	56	IV	ED
26	0	27	IV	ER
	20	29	III	Se
28	2	39	I	TI
	3	31	I	SI
	23	54	I	OD

MARCH

d	h	m	Sat.	Phen.
1	3	06	I	ER
	21	06	I	TI
	22	00	I	SI
	22	59	II	OD
	23	22	I	Te
2	0	16	I	Se
	3	16	III	OD
	3	39	II	ER
	21	35	I	ER
3	19	39	II	SI
	20	38	II	Te
	22	33	II	Se
5	20	31	III	Te
	20	50	IV	TI
	20	54	III	SI
6	0	28	III	Se
	1	06	IV	Te
8	1	43	I	OD
	22	55	I	TI
	23	55	I	SI
9	1	10	I	Te
	1	21	II	OD
	2	11	I	Se
	20	10	I	OD
	23	30	I	ER
10	19	38	I	Te
	20	09	II	TI
	20	39	I	Se
	22	17	II	SI
	23	02	II	Te
11	1	10	II	Se
12	19	32	II	ER
	20	34	III	TI
13	0	06	III	Te
	0	54	III	SI
16	0	44	I	TI
	1	49	I	SI
	22	00	I	OD
17	1	26	I	ER
	19	12	I	TI
	20	18	I	SI
	21	27	I	Te
	22	34	I	Se
	22	37	II	TI
18	0	54	II	SI
	1	30	II	Te
	19	54	I	ER
19	22	07	II	ER
20	0	15	III	TI
22	23	52	IV	SI
23	22	35	III	ER
	23	51	I	OD
24	21	03	I	TI
	22	13	I	SI
	23	18	I	Te
25	0	29	I	Se
	1	06	II	TI
	21	49	I	ER
26	19	26	II	OD
27	0	43	II	ER
28	19	43	II	Se
30	20	16	IV	OD
	21	32	III	OR
	22	58	III	ED
31	0	39	IV	**OR**
	1	43	I	OD
	22	55	I	TI

APRIL

d	h	m	Sat.	Phen.
1	0	08	I	SI
	1	10	I	Te
	20	12	I	OD
	23	45	I	ER
2	19	38	I	Te
	20	53	I	Se
	21	56	II	OD
4	19	47	II	Te
	22	21	II	Se
6	21	50	III	OD
8	0	48	I	TI
	22	05	I	OD
	22	27	IV	Se
9	20	31	I	SI
	21	32	I	Te
	22	48	I	Se
10	0	28	II	OD
	20	09	I	ER
	20	27	III	Se
11	22	05	II	SI
	22	22	II	Te
12	0	58	II	Se
16	0	00	I	OD
	21	11	I	TI
	22	26	I	SI
	23	27	I	Te
17	0	43	I	Se
	20	52	III	SI
	22	05	I	ER
18	0	27	III	Se
	22	07	II	TI
19	0	42	II	SI
20	21	48	II	ER
23	23	06	I	TI
24	0	21	I	SI
	20	25	I	OD
	23	16	III	Te
25	0	00	I	ER
	0	09	IV	TI
	21	07	I	SI

MAY

d	h	m	Sat.	Phen.
1	22	22	I	OD
	23	49	III	TI
2	20	45	I	SI
	21	48	I	Te
	23	02	I	Se
3	20	10	IV	ED
	20	24	I	ER
4	21	38	II	OD
5	22	36	III	ER
6	22	07	II	Se
9	21	29	I	TI
	22	40	I	SI
10	22	19	I	ER
12	21	45	III	OR
	22	57	III	ED
13	21	51	II	SI
	22	22	II	Te
17	20	48	I	OD
18	21	21	I	Se
19	22	23	III	OD
20	22	13	II	TI
22	21	30	II	ER
25	20	59	I	SI
	22	12	I	Te

d	h	m	Sat.	Phen.
26	20	38	I	ER
30	20	50	III	SI

JUNE

d	h	m	Sat.	Phen.
1	21	55	I	TI
6	21	02	III	TI
9	21	16	I	OD
18	20	52	I	ER

Jupiter being near the sun, phenomena of the satellites are not given between June 21 and Sept. 10.

SEPTEMBER

d	h	m	Sat.	Phen.
16	4	10	I	TI
24	4	18	II	ED

OCTOBER

d	h	m	Sat.	Phen.
1	4	34	I	ED
2	3	27	IV	OR
	4	08	I	Se
	4	58	I	Te
3	4	14	II	Se
7	3	50	III	Te
9	3	44	I	SI
	4	40	I	TI
10	3	57	II	SI
	4	09	I	OR
	4	39	IV	Se
12	3	40	II	OR
14	4	09	III	Se
	4	31	III	TI
17	2	48	I	ED
18	3	25	I	Te
21	4	31	III	SI
24	4	41	I	ED
25	2	29	III	OR
25	3	06	I	TI
	4	18	I	Se
	5	23	I	Te
26	2	33	I	OR
	4	00	II	ED
27	4	15	IV	TI
28	3	22	II	Te

NOVEMBER

d	h	m	Sat.	Phen.
1	2	03	III	ER
	3	05	III	OD
	3	54	I	SI
	5	03	I	TI
2	4	29	I	OR
3	1	49	I	Te
4	2	29	IV	ED
	3	13	II	TI
	3	44	II	Se
8	2	22	III	ED
	5	48	I	SI
9	2	56	I	ED
10	1	28	I	TI
	2	33	I	Se
	3	45	I	Te
11	3	27	II	SI
	5	51	II	TI
13	3	47	IV	Te
	3	50	II	OR
16	4	49	I	ED
17	2	10	I	SI
	3	23	I	TI
	4	27	I	Se
	5	39	I	Te
18	2	49	I	OR
	6	01	II	SI
19	1	24	III	TI
	4	58	III	Te
20	1	04	II	ED
21	1	18	IV	ER
22	0	34	II	Te
24	4	03	I	SI
	5	18	I	TI
25	1	10	I	ED
	4	42	I	OR
26	0	48	I	Se
	2	02	I	Te
	3	57	III	Se
	5	25	III	TI
27	3	39	II	ED
29	0	20	II	TI
	0	41	II	Se
	3	09	II	Te
	5	45	IV	SI

DECEMBER

d	h	m	Sat.	Phen.
1	5	57	I	SI
2	3	03	I	ED
3	0	25	I	SI
	1	38	I	TI
	2	41	I	Se
	3	55	I	Te
	4	18	III	SI
4	1	03	I	OR
	6	14	II	ED
6	0	25	II	SI
	2	53	II	TI
	3	15	II	Se
	5	41	II	Te
7	2	47	III	OR
8	0	51	II	OR
	2	26	IV	OD
9	4	56	I	ED
10	2	18	I	SI
	3	30	I	TI
	4	35	I	Se
	5	46	I	Te
	23	25	I	ED
11	2	55	I	OR
12	0	14	I	Te
13	2	59	II	SI
	5	23	II	TI
	5	49	II	Se
14	1	47	III	ER
	3	03	III	OD
	6	35	III	OR
15	3	21	II	OR
	23	41	IV	SI
16	4	21	IV	Se
17	4	11	I	SI
	5	21	I	TI
	6	28	I	Se
18	1	18	I	ED
	4	46	I	OR
	23	49	I	TI
19	0	56	I	Se
	2	05	I	Te
	23	13	I	OR
20	5	33	II	SI
21	2	08	III	ED
	5	45	III	ER
22	0	41	II	ED
	5	48	II	OR
23	23	53	II	Te
24	6	04	I	SI
	23	42	IV	OR
25	0	13	III	Te
	3	11	I	ED
	6	35	I	OR
26	0	33	I	SI
	1	38	I	TI
	2	50	I	Se
	3	54	I	Te
27	1	02	I	OR
28	6	06	III	ED
29	3	15	II	ED
30	23	30	II	TI
31	0	15	II	Se
	2	18	II	Te
	23	45	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 east side from January to June, and on the west side from September to December.

SATURN'S SATELLITES, 1967

Name	Greatest E. Elongation E.S.T.*			Mean Synodic Period	
		d	h	d	h
Mimas	Oct.	2	12.1	0	22.6
Enceladus	Oct.	2	3.2	1	8.9
Tethys	Oct.	2	4.4	1	21.3
Dione	Oct.	2	19.5	2	17.7
Rhea	Oct.	3	4.0	4	12.5
Titan	Oct.	11	18.4†	15	23.3
Hyperion	Sept.	27	1.7†	21	07.6
Iapetus	Oct.	13	6.6†	79	22.1
Phoebe				523	15.6

*Near opposition of Saturn, 1967 Oct. 2.
†See p. 58 for more information.

SATURN'S SATELLITES, TITAN, HYPERION AND IAPETUS

ELONGATIONS AND CONJUNCTIONS, E.S.T. 1967

TITAN

Elong. E.	d	h	Inf. Conj.	d	h	Elong. W.	d	h	Sup. Conj.	d	h
			Jan.	1	8.6	Jan.	5	9.0	Jan.	9	4.0
Jan.	13	3.4		17	8.4		21	8.8		25	3.9
	29	3.4	Feb.	2	8.6	Feb.	6	8.9	Feb.	10	4.1
Feb.	14	3.8		..	....		..	....		..	....
	..	....		..	....	Apr.	27	11.1	May	1	6.3
May	5	6.7	May	9	11.9	May	13	11.4		17	6.5
	21	7.1		25	12.1		29	11.4	June	2	6.5
June	6	7.1	June	10	12.1	June	14	11.2		18	6.3
	22	6.8		26	11.7		30	10.7	July	4	5.7
July	8	6.2	July	12	11.0	July	16	9.8	July	20	4.7
	24	5.1		28	9.8	Aug.	1	8.5	Aug.	5	3.3
Aug.	9	3.6	Aug.	13	8.2		17	6.8		21	1.5
	25	1.7		29	6.2	Sept.	2	4.8	Sept.	5	23.4
Sept.	9	23.4	Sept.	14	3.8		18	2.5		21	21.1
	25	21.0		30	1.3	Oct.	4	0.1	Oct.	7	18.6
Oct.	11	18.4	Oct.	15	22.8		19	21.7		23	16.2
	27	16.0		31	20.4	Nov.	4	19.4	Nov.	8	14.0
Nov.	12	13.8	Nov.	16	18.3		20	17.4		24	12.1
	28	11.9	Dec.	2	16.6	Dec.	6	15.9	Dec.	10	10.6
Dec.	14	10.5		18	15.3		22	14.7		26	9.6
	30	9.6									

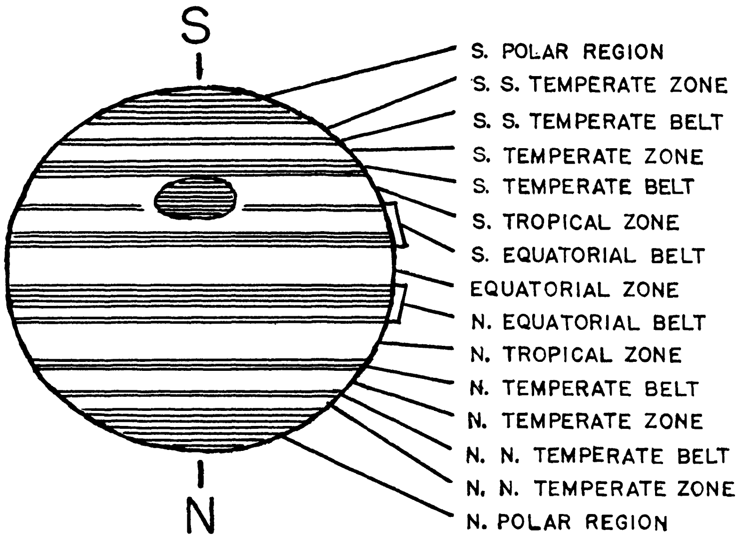
HYPERION

Elong. E.	d	h	Inf. Conj.	d	h	Elong. W.	d	h	Sup. Conj.	d	h
						Jan.	2	14.5	Jan.	7	1.6
Jan.	13	4.2	Jan.	19	11.1		24	1.2		28	13.1
Feb.	3	17.1	Feb.	9	23.0	Feb.	14	12.4		..	....
	..	....		..	....		..	....		..	....
Apr.	30	22.6	May	6	22.3	May	11	8.8	May	16	1.9
May	22	10.5		28	8.5	June	1	18.4	June	6	12.4
June	12	21.1	June	18	17.4		23	2.9		27	21.5
July	4	6.1	July	10	1.1	July	14	10.2	July	19	5.2
	25	13.4		31	7.2	Aug.	4	16.1	Aug.	9	11.3
Aug.	15	18.9	Aug.	21	12.0		25	20.8		30	15.9
Sept.	5	22.9	Sept.	11	15.5	Sept.	16	0.3	Sept.	20	19.3
	27	1.7	Oct.	2	18.2	Oct.	7	3.1	Oct.	11	21.9
Oct.	18	3.9		23	20.5		28	5.7	Nov.	2	0.5
Nov.	8	6.4	Nov.	13	23.1	Nov.	18	8.4		23	3.5
	29	9.5	Dec.	5	2.3	Dec.	9	11.7	Dec.	14	7.3
Dec.	20	13.8		26	6.3		30	15.9			

IAPETUS

Elong. E.	d	h	Inf. Conj.	d	h	Elong. W.	d	h	Sup. Conj.	d	h
						Jan.	7	0.7	Jan.	26	15.1
Feb.	15	1.7		..	....		..	....		..	....
	..	....		..	....		..	....		..	....
May	7	12.2	May	28	13.2	June	18	9.3	July	7	15.1
July	26	21.1	Aug.	16	9.7	Sept.	5	15.6	Sept.	24	10.5
Oct.	13	6.6	Nov.	2	12.5	Nov.	22	20.6	Dec.	11	22.4
Dec.	31	3.3									

JUPITER'S BELTS AND ZONES



Viewed through a telescope of 6-inch aperture or greater, Jupiter exhibits a variety of changing detail and colour in its cloudy atmosphere. Some features are of long duration, others are short-lived. The standard nomenclature of the belts and zones is given in the figure.

DIMENSIONS OF SATURN'S RINGS

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

During 1967 Saturn's rings are opening from the edge-on position, with the southern face visible. The major and minor axes of the outer edge of the outer ring have the following values during the year: Jan. 2, 38.43″, 0.27″: Aug. 6, 42.13″, 6.18″; Oct. 1, 44.43″, 5.34″; Dec. 28, 40.09″, 3.96″.

LONGITUDE OF JUPITER'S CENTRAL MERIDIAN

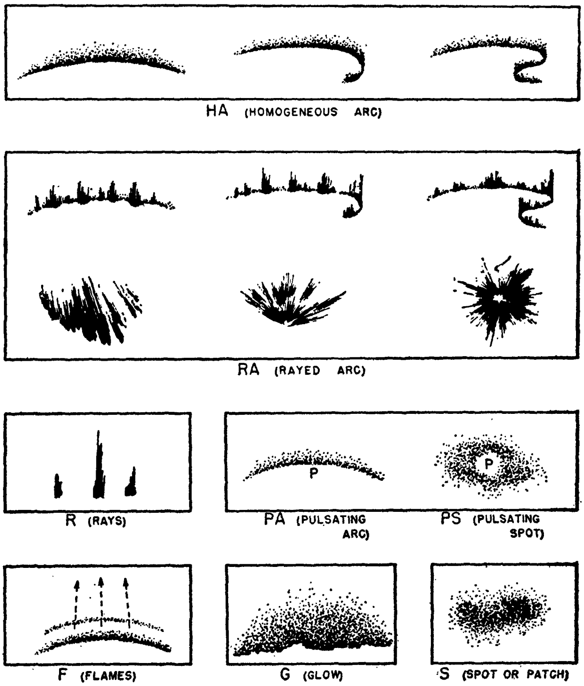
The table lists the longitude of the central meridian of the illuminated disk of Jupiter for given times daily during the period when the planet is favourably placed. System I applies to the regions between the middle of the North Equatorial Belt and the middle of the South Equatorial Belt; System II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

Month U.T.	SYSTEM I						SYSTEM II					
	Jan. 5^h	Feb. 3^h	Mar. 2^h	Apr. 2^h	Nov. 10^h	Dec. 10^h	Jan. 5^h	Feb. 3^h	Mar. 2^h	Apr. 2^h	Nov. 10^h	Dec. 10^h
Day	°	°	°	°	°	°	°	°	°	°	°	°
1	356.7	142.5	208.6	61.6	264.7	321.0	139.7	49.7	262.4	238.9	246.7	74.0
2	154.7	300.5	6.5	219.4	62.6	118.9	290.1	200.0	52.7	29.0	36.9	224.3
3	312.8	98.5	164.4	17.2	220.4	276.8	80.6	350.4	202.9	179.2	187.1	14.6
4	110.8	256.4	322.3	174.9	18.3	74.7	231.0	140.8	353.2	329.3	337.4	164.9
5	268.8	54.4	120.2	332.7	176.1	232.6	21.4	291.1	143.4	119.5	127.6	315.2
6	66.9	212.4	278.1	130.5	334.0	30.6	171.8	81.5	293.7	269.6	277.8	105.5
7	224.9	10.4	75.9	288.2	131.8	188.5	322.2	231.8	83.9	59.7	68.0	255.8
8	23.0	168.4	233.8	86.0	289.7	346.4	112.6	22.2	234.2	209.9	218.2	46.1
9	181.0	326.4	31.7	243.8	87.5	144.4	263.0	172.5	24.4	0.0	8.5	196.4
10	339.1	124.3	189.5	41.5	245.4	302.3	53.4	322.9	174.7	150.1	158.7	346.7
11	137.1	282.3	347.4	199.3	43.2	100.2	203.8	113.2	324.9	300.3	308.9	137.0
12	295.1	80.3	145.3	357.0	201.1	258.2	354.2	263.6	115.1	90.4	99.1	287.3
13	93.2	238.2	303.1	154.8	359.0	56.1	144.7	53.9	265.3	240.5	249.4	77.6
14	251.2	36.2	101.0	312.5	156.8	214.0	295.1	204.2	55.6	30.6	39.6	227.9
15	49.2	194.2	258.8	110.3	314.7	12.0	85.5	354.6	205.8	180.7	189.9	18.2
16	207.3	352.1	56.6	268.0	112.6	169.9	235.9	144.9	356.0	330.8	340.1	168.5
17	5.3	150.1	214.5	65.8	270.4	327.9	26.3	295.2	146.2	121.0	130.3	318.9
18	163.4	308.0	12.3	223.5	68.3	125.9	176.7	85.5	296.4	271.1	280.6	109.2
19	321.4	105.9	170.1	21.2	226.2	283.8	327.1	235.8	86.6	61.2	70.8	259.5
20	119.4	263.9	328.0	179.0	24.1	81.8	117.5	26.1	236.8	211.3	221.1	49.8
21	277.5	61.8	125.8	336.7	182.0	239.7	267.9	176.4	27.0	1.4	11.3	200.2
22	75.5	219.7	283.6	134.4	339.9	37.7	58.3	326.7	177.2	151.5	161.6	350.5
23	233.5	17.7	81.4	292.1	137.8	195.7	208.7	117.0	327.4	301.6	311.9	140.9
24	31.5	175.6	239.2	89.9	295.6	353.6	359.1	267.3	117.5	91.7	102.1	291.2
25	189.6	333.5	37.0	247.6	93.5	151.6	149.5	57.6	267.7	241.8	252.4	81.5
26	347.6	131.4	194.8	45.3	251.4	309.6	299.9	207.9	57.9	31.8	42.7	231.9
27	145.6	289.3	352.6	203.0	49.3	107.6	90.3	358.2	208.1	181.9	192.9	22.2
28	303.6	87.2	150.4	0.7	207.2	265.5	240.7	148.4	358.2	332.0	343.2	172.6
29	101.6		308.2	158.5	5.1	63.5	31.0		148.4	122.1	133.5	322.9
30	259.6		106.0	316.2	163.1	221.5	181.4		298.6	272.2	283.8	113.3
31	57.7		263.8			19.5	331.8		88.7			263.6

Dec. 1, 0_h U.T.: System I: 315.2°; System II: 71.4°

THE POLAR AURORA

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



THE OBSERVATION OF THE MOON

During 1967 the ascending node of the moon's orbit moves from the constellation Aries into Pisces (☊ from 43° to 24°). See p. 64 for occultations of stars.

The sun's selenographic colongitude is essentially a convenient way of indicating the position of the sunrise terminator as it moves across the face of the moon. It provides an accurate method of recording the exact conditions of illumination (angle of illumination), and makes it possible to observe the moon under exactly the same lighting conditions at a later date.

The sun's selenographic colongitude is numerically equal to the selenographic longitude of the sunrise terminator reckoned eastward from the mean centre of the disk. Its value increases at the rate of nearly 12.2° per day or about $\frac{1}{2}$° per hour; it is approximately 270°, 0°, 90° and 180° at New Moon, First Quarter, Full Moon and Last Quarter respectively. (See the tabulated values for 0h U.T. starting on p. 33.)

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

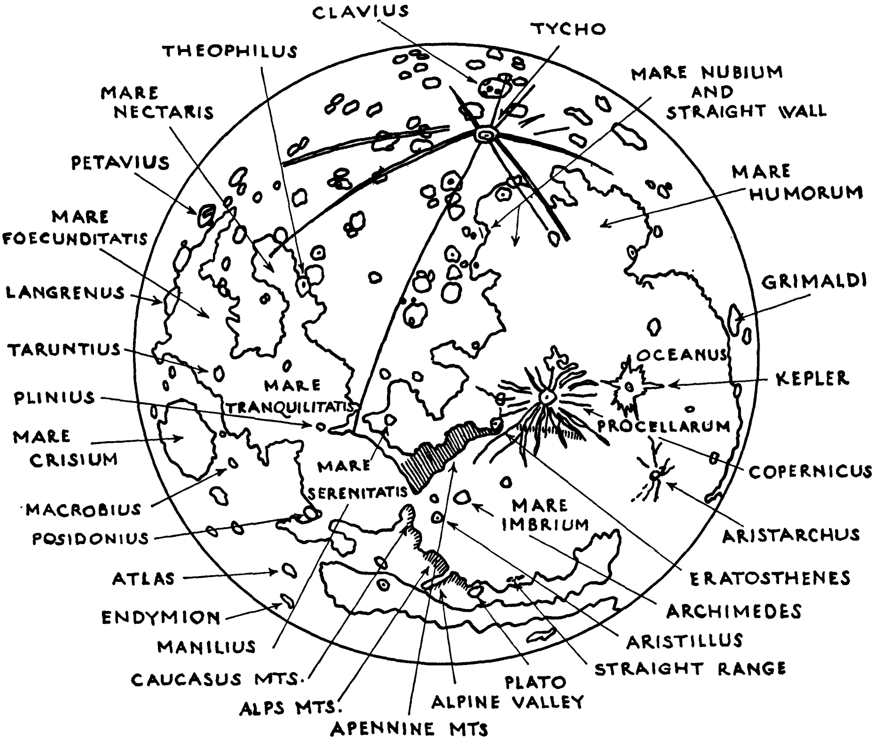
The sun's selenographic latitude varies between $+1\frac{1}{2}°$ and $-1\frac{1}{2}°$ during the year.

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

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

Two areas suspected of showing changes are Alphonsus and Aristarchus.

MAP OF THE MOON



South appears at the top.

EPHEMERIS FOR THE PHYSICAL OBSERVATIONS OF THE SUN, 1967

For 0h U.T.

Date	P	B_0	L_0	Date	P	B_0	L_0
Jan. 1	+ 2.35	−3.01	333.05	July 5	− 1.19	+3.28	51.34
6	− 0.08	−3.58	267.20	10	+ 1.08	+3.81	345.17
11	− 2.50	−4.13	201.35	15	+ 3.33	+4.31	279.00
16	− 4.87	−4.64	135.52	20	+ 5.53	+4.78	212.84
21	− 7.18	−5.12	69.68	25	+ 7.68	+5.22	146.69
26	− 9.41	−5.55	3.85	30	+ 9.76	+5.62	80.55
31	−11.54	−5.94	298.01	Aug. 4	+11.76	+5.98	14.42
Feb. 5	−13.56	−6.29	232.18	9	+13.66	+6.30	308.31
10	−15.47	−6.58	166.35	14	+15.46	+6.58	242.21
15	−17.24	−6.82	100.51	19	+17.14	+6.81	176.12
20	−18.87	−7.01	34.67	24	+18.71	+7.00	110.04
25	−20.35	−7.15	328.82	29	+20.15	+7.13	43.98
Mar. 2	−21.68	−7.23	262.96	Sept. 3	+21.45	+7.22	337.93
7	−22.85	−7.25	197.09	8	+22.62	+7.25	271.90
12	−23.86	−7.22	131.20	13	+23.63	+7.23	205.88
17	−24.70	−7.13	65.31	18	+24.50	+7.16	139.86
22	−25.38	−6.99	359.39	23	+25.20	+7.03	73.86
27	−25.88	−6.80	293.46	28	+25.75	+6.86	7.87
Apr. 1	−26.20	−6.55	227.50	Oct. 3	+26.12	+6.63	301.90
6	−26.34	−6.26	161.53	8	+26.32	+6.35	235.93
11	−26.30	−5.93	95.54	13	+26.33	+6.03	169.97
16	−26.08	−5.55	29.53	18	+26.16	+5.66	104.01
21	−25.68	−5.13	323.50	23	+25.80	+5.25	38.06
26	−25.09	−4.67	257.44	28	+25.25	+4.79	332.12
May 1	−24.32	−4.19	191.37	Nov. 2	+24.50	+4.30	266.19
6	−23.36	−3.67	125.28	7	+23.55	+3.77	200.26
11	−22.23	−3.13	59.18	12	+22.41	+3.22	134.34
16	−20.93	−2.57	353.06	17	+21.08	+2.64	68.43
21	−19.47	−2.00	286.92	22	+19.56	+2.03	2.52
26	−17.85	−1.41	220.77	27	+17.86	+1.41	296.62
31	−16.09	−0.81	154.60	Dec. 2	+16.00	+0.78	230.72
June 5	−14.20	−0.21	88.43	7	+13.99	+0.14	164.83
10	−12.20	+0.40	22.26	12	+11.85	−0.50	98.95
15	−10.11	+1.00	316.08	17	+ 9.61	−1.14	33.07
20	− 7.94	+1.59	249.89	22	+ 7.28	−1.76	327.20
25	− 5.72	+2.17	183.71	27	+ 4.89	−2.38	261.34
30	− 3.46	+2.74	117.52				

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, 1967

No.	Commences	No.	Commences	No.	Commences
1517	Jan. 26.29	1522	June 11.68	1527	Oct. 25.89
1518	Feb. 22.63	1523	July 8.88	1528	Nov. 22.19
1519	Mar. 21.95	1524	Aug. 5.09	1529	Dec. 19.51
1520	Apr. 18.24	1525	Sept. 1.33		
1521	May 15.48	1526	Sept. 28.60		

ECLIPSES DURING 1967

In 1967 there will be four eclipses, two of the sun and two of the moon. Of these, the partial eclipse of the sun on May 9, and the total eclipse of the moon on the night of October 17–18 will be seen well in North America.

1. A total eclipse of the moon on the night of April 23–24, only the beginning of the penumbral phase being visible generally in North America just before moonset.

Moon enters penumbra......April 24, 4h 28m E.S.T.

2. A partial eclipse of the sun on May 9, visible in all of North America except in Newfoundland, Nova Scotia and Florida.

Near Fredericton the eclipse begins about 9:45 a.m. A.S.T. and lasts about an hour. Near Toronto it starts shortly after 8 a.m. E.S.T. and continues for an hour and a half. The eclipse begins about an hour earlier for each time zone towards the west. Further north it lasts somewhat longer, so that near Edmonton the duration is a little over two hours.

3. A total eclipse of the moon on the night of October 17–18, visible in North America.

Moon enters penumbra....	October 18, 2h 10m E.S.T.
Moon enters umbra..................	3h 25m E.S.T.
Total eclipse begins..................	4h 45m E.S.T.
Middle of eclipse....................	5h 15m E.S.T.
Total eclipse ends....................	5h 46m E.S.T.
Moon leaves umbra..................	7h 05m E.S.T.
Moon leaves penumbra...............	8h 20m E.S.T.

4. A total eclipse of the sun on November 2, visible in Antarctica.

LUNAR OCCULTATIONS

When the moon passes between the observer and a star that star is said to be occulted by the moon and the phenomenon is known as a lunar occultation. The passage of the star behind the east limb of the moon is called the immersion and its re-appearance from behind the west limb the emersion. As in the case of eclipses, the times of immersion and emersion and the duration of the occultation are different for different places on the earth's surface. The tables given below, are adapted from data supplied by the British Nautical Almanac Office and give the times of immersion or emersion or both for occultations visible from six stations distributed across Canada. Stars of magnitude 7.5 or brighter are included as well as daytime occultations of very bright stars and planets. Since an occultation at the bright limb of the moon is difficult to observe the predictions are limited to phenomena occurring at the dark limb.

The terms a and b are for determining corrections to the times of the phenomena for stations within 300 miles of the standard stations. Thus if λ_0, ϕ_0, be the longitude and latitude of the standard station and λ, ϕ, the longitude and latitude of the neighbouring station then for the neighbouring station we have:

Standard Time of phenomenon = Standard Time of phenomenon at the standard station $+a(\lambda-\lambda_0)+b(\phi-\phi_0)$

where $\lambda-\lambda_0$ and $\phi-\phi_0$ are expressed in degrees. The quantity P is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

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

LUNAR OCCULTATIONS VISIBLE AT HALIFAX AND MONTREAL, 1967

Date	Star	Mag.	I or E	Age of Moon	Halifax				Montreal			
					A.S.T.	*a*	*b*	*P*	E.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Jan. 18	34B. Ari	6.8	I	08.4	Low	...	...	...	23 49.7	−0.1	−1.8	096
Jan. 19	+14°439	7.4	I	09.2	18 15.5	−1.8	+1.1	071	Sun	...	...	...
Jan. 21/22	+23°701	7.1	I	11.4	0 38.4	−0.5	−2.8	123	23 28.8	−0.9	−3.2	127
Jan. 23	+25°879	6.3	I	12.6	4 26.5	+0.5	−1.7	117	3 29.7	+0.5	−2.1	128
Jan. 23/24	+27°1122	6.5	I	13.4	0 32.1	−1.5	−0.9	092	23 15.5	−1.7	−0.7	095
Feb. 14	288B. Psc	6.7	I	05.5	20 13.4	−0.9	−1.4	085	19 01.4	−1.3	−0.8	076
Feb. 16	+18° 459	7.3	I	07.7	Low	...	...	...	23 44.3	0.0	−1.0	074
Feb. 18	+25° 746*m*.	7.2	I	09.5	18 54.9	−1.2	+3.2	029	Sun	...	...	...
Feb. 20	+26° 1082	7.0	I	10.8	2 43.3	+0.4	−1.6	115	1 45.0	+0.3	−2.0	126
Feb. 20	+27° 1270	7.0	I	11.6	20 52.7	——	——	026	Graze	...	...	...
Feb. 20	+27° 1296	7.2	I	11.7	No Occ.	...	...	...	22 22.0	——	——	028
Feb. 21	+26° 1481	6.8	I	11.9	3 58.2	+0.2	−1.1	085	2 58.1	0.0	−1.3	095
Feb. 21	ω Cnc	5.9	I	12.7	21 57.7	−2.0	+1.1	070	20 39.8	−1.8	+1.4	071
Feb. 21	4 Cnc	6.2	I	12.7	22 29.2	−1.5	−1.5	124	21 12.4	−1.6	−1.3	127
Feb. 26	38 Vir	6.2	E	17.8	No Occ.	...	...	...	23 49.9	+0.1	−2.5	001
Feb. 27	91 G. Vir	6.5	E	17.8	2 07.8	−2.2	+0.4	267	0 44.6	——	——	244
Mar. 4	163G. Oph	6.4	E	23.0	Sun	...	...	...	4 41.3	−1.2	+0.5	294
Mar. 18	112B. (Aur)*m*	5.7	I	07.9	22 37.9	−1.6	+1.0	034	21 23.3	−1.5	+0.4	047
Mar. 18	+26° 884	6.5	I	07.9	23 16.2	−0.1	−1.8	108	22 12.6	−0.3	−2.2	118
Mar. 19	+27° 1164*m*	6.9	I	08.9	22 49.9	−0.9	−1.2	086	21 38.7	−1.1	−1.4	096
Mar. 21	76 Gem	5.4	I	10.0	2 16.1	−0.1	−0.9	070	1 13.0	−0.3	−1.2	082
Mar. 21	ν^1 Cnc	5.7	I	10.8	19 42.2	−1.9	+1.5	071	Sun	...	...	...
Mar. 21	ν^2 Cnc	6.4	I	10.9	No Occ.	...	...	...	19 30.3	——	——	038
Mar. 28	ι Lib	4.7	E	18.0	23 38.3	−0.9	+1.0	277	Low	...	...	...
Mar. 28	25 Lib	6.0	E	18.0	23 53.3	−0.2	−0.5	333	Low	...	...	...
Apr. 1	58G. Sgr	6.1	E	21.2	3 48.5	−0.9	0.0	316	Low	...	...	...
Apr. 15	26B. Gem	6.7	I	06.1	22 13.1	−0.1	−1.7	107	21 10.1	−0.2	−2.1	117
Apr. 16	134B. Gem	6.5	I	07.1	22 26.7	−0.4	−1.6	103	21 20.8	−0.5	−1.9	114
Apr. 16	+27° 1362	6.9	I	07.2	No Occ.	...	...	...	22 37.4	−1.4	+0.2	043
Apr. 17/18	λ Cnc	5.9	I	08.2	0 51.5	+0.4	−1.8	134	23 53.4	+0.4	−2.1	144
Apr. 28	210B. (Sco)	6.0	E	18.4	3 58.8	−2.0	+0.6	229	2 38.6	−2.3	+1.3	225
May 13	+27° 1296	7.2	I	04.4	21 43.6	——	——	031	20 32.2	−1.0	−0.4	053
May 14	ω Cnc	5.9	I	05.4	No Occ.	...	...	...	21 33.9	——	——	039
May 14	4 Cnc	6.2	I	05.5	22 46.3	+0.1	−1.4	095	21 44.9	−0.1	−1.6	105
May 15	+22° 2029	7.0	I	06.4	22 20.6	0.0	−2.0	135	21 18.8	0.0	−2.4	148
May 18	424B. Leo	7.0	I	09.4	21 28.7	——	——	063	20 03.2	−2.2	−0.1	087
May 20	237B. Vir	7.0	I	10.6	Low	...	...	...	1 23.6	−0.4	−1.7	111
May 28	40B. Cap	6.2	E	18.7	3 10.8	−2.1	+0.1	298	1 53.2	−1.5	+0.5	301
May 29	35 Cap	6.0	E	19.7	Sun	...	...	...	2 27.9	−1.6	+0.9	287
June 10	76 Gem	5.4	I	02.8	21 04.9	−0.1	−0.9	066	20 02.1	−0.3	−1.1	078
June 18	10 Lib	6.8	I	10.9	21 29.4	−1.3	−0.9	135	Sun	...	...	...
July 16	−21° 4135	7.0	I	09.4	21 27.2	−1.7	−0.8	099	Sun	...	...	...
July 25	ψ^1 Aqr	4.5	I	17.6	Sun	...	...	...	3 50.3	——	——	339
July 31	14 H^1. Tau	6.4	E	23.6	2 24.3	−0.1	+1.9	241	1 25.2	0.0	+1.7	253
Aug. 14	−27° 11527	6.6	I	08.9	19 58.4	−1.8	−0.3	107	Sun	...	...	...
Aug. 15	62B. Sgr	6.0	I	09.9	20 57.8	−1.9	+0.5	056	19 38.9	−2.0	+0.9	058
Aug. 16/17	234B. Sgr	5.9	I	11.1	0 21.7	−1.5	−1.1	096	23 05.5	−1.6	−0.6	082
Aug. 23	10 Cet	6.4	E	17.2	Sun	...	...	...	3 16.9	−1.0	+1.4	211
Aug. 24	80 Psc	5.7	E	18.2	4 06.1	−1.8	+0.5	246	2 46.3	−2.3	+0.3	266
Aug. 25	54 (Cet)	5.9	E	19.2	3 20.4	——	——	289	No Occ.	...	...	...
Aug. 25/26	29 Ari	6.1	E	20.1	0 30.1	+0.9	+3.4	175	23 37.2	+0.3	+2.6	195
Sept. 1	ω Cnc	5.9	E	26.2	3 19.8	−0.3	+0.3	308	Low	...	...	...
Sept. 1	4 Cnc	6.2	E	26.2	3 42.1	+0.3	+2.0	241	2 46.4	+0.3	+1.5	256
Sept. 15	154B. Cap	6.1	I	11.7	23 23.1	−1.3	+0.4	049	22 11.9	−1.1	+1.0	033
Sept. 20	263 B. Psc	6.4	E	16.6	20.45.0	−0.4	+1.7	262	Low	...	...	...
Sept. 23	δ Ari	4.5	I	18.9	5 18.8	−1.5	+1.0	047	4 05.2	−1.4	+1.9	036
Sept. 23	133B. Tau	5.9	E	19.7	23 14.5	−0.4	+1.7	257	22 12.7	−0.3	+1.5	270
Sept. 24	33 Tau	6.0	E	19.8	3 57.6	−2.4	−0.4	278	2 31.2	−3.0	−1.2	299
Sept. 24	+24° 674	6.3	E	20.7	22 27.0	−0.2	+0.9	295	Low	...	...	...
Sept. 25/26	112B.(Aur)*m*	5.7	E	21.7	0 02.0	+0.6	+2.5	213	23 08.8	+0.4	+1.9	229
Oct. 7	α Sco	1.2	I	04.0	15 11.7	−1.2	−0.6	143	14 02.2	−0.6	−0.7	156
Oct. 7	α Sco	1.2	E	04.0	16 15.6	−2.0	−0.1	254	14 55.2	−2.2	+0.7	245

Date	Star	Mag.	I or E	Age of Moon	Halifax A.S.T.	a	b	P	Montreal E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Oct. 8	−28° 13418	7.0	I	05.1	Low	...	...	...	17 52.5	−1.9	−1.3	133
Oct. 12	38 Cap	7.0	I	09.2	20 40.7	−1.1	+1.0	033	19 32.0	−0.8	+1.6	016
Oct. 14	56 Aqr	6.4	I	10.3	Low	...	...	...	0 13.0	−1.0	−1.0	077
Oct. 14	−10° 6082	7.0	I	11.3	23 39.9	−1.6	−0.3	072	22 25.3	−1.4	+0.6	053
Oct. 15	ψ^1 Aqr	4.5	I	11.4	1 49.0	−0.9	−1.3	084	0 38.5	−1.0	−0.6	068
Oct. 16	27 Psc	5.1	I	12.4	1 29.5	−1.4	−1.2	085	0 14.6	−1.4	−0.2	067
Oct. 16	29 Psc	5.2	I	12.4	Low	...	...	...	2 34.5	−0.7	−1.1	077
Oct. 16	Saturn	0.6	I	13.2	20 05.7	−1.4	+1.5	087	18 56.2	−0.8	+1.8	076
Cct. 16	Saturn	0.6	E	13.2	21 08.2	−0.6	+2.4	198	20 03.5	−0.7	+2.2	214
Oct. 19	π Ari	5.4	E	16.3	23 55.2	−2.0	+0.9	264	22 34.7	−2.3	+0.5	288
Oct. 21	62 Tau	6.4	E	18.3	21 39.4	+0.1	+2.0	231	20 41.9	+0.1	+1.8	244
Oct. 24	47 Gem	5.6	E	21.3	23 00.0	—	—	192	22 14.7	+0.8	+2.3	220
Oct. 24	+27° 1337*m*	6.4	E	21.3	23 58.8	−0.6	+0.8	292	22 54.2	−0.5	+0.4	309
Oct. 27	90H^1. Cnc	6.1	E	23.5	4 25.2	−1.3	−1.5	327	3 11.1	−1.2	−1.5	333
Nov. 6	234B. Sgr	5.9	I	04.7	Low	...	...	...	18 33.0	−0.1	+0.8	020
Nov. 10	75 Aqr	7.2	I	08.7	18 10.3	−1.8	+1.2	077	Sun	...	...	...
Nov. 12	10 Cet	6.4	I	10.9	No Ccc.	...	...	...	21 49.4	—	—	114
Nov. 13	77 Psc	6.8	I	11.8	No Occ.	...	...	...	18 58.8	—	—	113
Nov. 13	80 Psc	5.7	I	11.9	22 32.1	−2.2	−0.1	083	21 13.1	−1.7	+1.1	063
Nov. 14	88 Psc	6.2	I	12.0	Low	...	...	...	2 44.3	−0.4	+2.1	009
Nov. 14	54 (Cet)	5.9	I	12.9	22 00.4	−1.6	+1.4	058	20 49.0	−1.0	+2.1	039
Nov. 19	415B. (Tau)	6.1	E	17.9	23 18.2	−0.8	+2.1	243	22 12.1	−0.7	+1.7	257
Nov. 22	ω Cnc	5.9	E	20.1	3 39.6	−2.3	+2.2	240	2 21.1	−1.8	+2.5	240
Dec. 6	154B. Cap	6.1	I	05.3	19 35.9	−1.8	−1.5	098	18 18.6	−1.6	−0.5	077
Dec. 9	4 (Cet)	6.3	I	08.3	18 07.5	−2.6	+0.4	096	16 47.8	−1.7	+1.4	077
Dec. 9	5 (Cet)	6.3	I	08.3	18 32.7	−2.7	+0.2	096	17 11.9	−1.7	+1.3	075
Dec. 9	19B. (Cet)	7.3	I	08.3	19 03.3	−1.9	+0.7	072	17 47.5	−1.4	+1.5	053
Dec. 9	−2° 19	7.3	I	08.4	22 41.6	−0.6	+0.6	037	21 36.5	−0.5	+1.3	022
Dec. 10	155B. Psc	6.5	I	09.3	18 59.4	−2.3	+0.7	086	17 41.9	−1.5	+1.6	066
Dec. 12	+9° 206	7.4	I	10.5	1 40.1	−0.4	−1.8	095	0 32.8	−0.8	−1.7	091
Dec. 13/14	δ Ari	4.5	I	12.5	0 31.8	−1.5	−0.1	064	23 16.5	−1.6	+0.6	057
Dec. 14	133B. Tau	5.9	I	13.3	17 11.2	0.0	+1.8	066	Sun	...	...	...
Dec. 23	308B. Leo	5.9	E	21.6	1 44.5	−1.0	+0.9	281	0 37.4	−0.6	+1.1	281

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND WINNIPEG, 1967

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	a	b	P	Winnipeg C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 18	34B.Ari	6.8	I	08.4	23 52.7	−0.2	−2.3	106	22 31.6	−0.8	−1.3	082
Jan. 19	*o* Ari	5.8	I	09.3	No Occ.	...	...	...	19 22.4	−2.1	−0.2	093
Jan. 20	124B.Ari	6.4	I	09.5	Low	...	...	...	1 09.8	−0.4	−0.1	042
Jan. 21	22 H^1. Tau	6.0	I	10.5	Low	...	...	...	2 19.8	—	—	009
Jan. 21	+23° 701	7.1	I	11.4	23 30.7	—	—	142	21 43.3	−1.8	−1.3	106
Jan. 23	+25° 879	6.3	I	12.6	3 37.4	+0.7	−2.7	143	2 27.2	+0.4	−3.9	150
Jan. 23	125 Tau	5.0	I	12.6	Low	...	...	...	3 56.7	—	—	165
Jan. 23	+27° 1122	6.5	I	13.4	23 06.7	−1.8	−0.9	104	21 36.6	−1.5	+0.9	080
Feb. 3	57B. Sco	5.9	E	23.7	Sun	...	...	...	6 02.1	−1.3	+0.5	286
Feb. 12	42B. (Cet)	7.2	I	03.6	Low	...	...	...	19 06.0	−0.8	−1.1	075
Feb. 14	288B. Psc	6.7	I	05.5	18 54.6	−1.6	−0.7	078	Sun	...	...	...
Feb. 14	*o* Psc	4.5	I	05.6	No Occ.	...	...	...	20 52.0	−0.8	−2.9	110
Feb. 16	+18° 432	6.7	I	07.6	21 04.1	—	—	358	No Occ.	...	...	...
Feb. 16	+18° 459	7.3	I	07.7	23 46.1	−0.1	−1.2	085	22 32.3	−0.6	−1.1	076
Feb. 18	98 Tau	5.6	I	09.6	No Occ.	...	...	...	18 32.7	−2.4	−1.8	128
Feb. 20	+26° 1082	7.0	I	10.8	1 51.3	+0.5	−2.5	139	0 38.4	+0.1	−3.4	147
Feb. 20	+27° 1270	7.0	I	11.6	19 25.3	—	—	024	No Occ.	...	...	...
Feb. 20	+27° 1296	7.2	I	11.7	22 01.3	−2.3	+2.1	049	No Occ.	...	...	...
Feb. 21	+26° 1481	6.8	I	11.9	3 00.8	0.0	−1.5	105	1 47.4	−0.3	−1.9	114
Feb. 21	ω Cnc	5.9	I	12.7	20 27.5	−1.6	+1.3	078	19 21.0	−0.6	+3.5	044
Feb. 21	4 Cnc	6.2	I	12.7	21 05.7	−1.7	−1.7	137	19 35.9	−1.2	+0.4	110
Feb. 22	λ Cnc	5.9	I	13.0	Low	...	...	...	4 48.9	−0.3	−0.9	056
Feb. 26	38 Vir	6.2	E	17.8	23.52.2	−0.4	−1.4	342	22 40.7	−0.1	−1.2	347
Mar. 16	142B. Tau	6.8	I	05.9	22 37.1	−1.0	+1.7	018	21 28.5	—	—	010
Mar. 18	112B. (Aur)*m*	5.7	I	07.9	21 14.2	−1.5	−0.1	061	19 47.6	−1.7	+1.2	049
Mar. 18	+26° 884	6.5	I	07.9	22 15.7	−0.2	−2.8	131	20 47.3	−1.0	−2.7	127
Mar. 19	+27° 1164*m*	6.9	I	08.9	21 34.7	−1.2	−1.6	107	20 00.9	−1.6	−0.8	100
Mar. 20/21	76 Gem	5.4	I	10.0	1 13.7	−0.3	−1.4	092	23 55.7	−0.7	−1.6	103
Mar. 21	ν^2 Cnc	6.4	I	10.9	19 10.8	−1.8	+3.1	054	No Occ.	...	...	...

Date	Star	Mag.	I or E	Age of Moon	Toronto				Winnipeg			
					E.S.T.	*a*	*b*	*P*	C.S.T.	*a*	*b*	*P*
				d	h m	m	m	°	h m	m	m	°
Mar. 23	46 Leo	5.7	I	12.9	20 27.3	—	—	050	No Occ.	...	...	...
Apr. 2	234B. Sgr	5.9	E	22.2	4 27.1	−1.4	+1.0	272	Low	...	...	...
Apr. 12	14 H¹. Tau	6.4	I	03.2	Low	...	...	...	21 02.2	−0.1	−0.9	068
Apr. 15	26B. Gem	6.7	I	06.1	21 13.2	−0.1	−2.5	130	Sun	...	...	...
Apr. 16	134B. Gem	6.5	I	07.1	21 21.6	−0.5	−2.2	126	Sun	...	...	...
Apr. 16	+27° 1362	6.9	I	07.2	22 31.1	−1.1	−0.6	062	21 05.6	−1.3	−0.7	072
Apr. 17	+26° 1564	7.2	I	07.3	Low	...	...	...	0 54.0	+0.2	−1.4	097
Apr. 17/18	λ Cnc	5.9	I	08.2	0 00.2	+0.5	−2.5	157	22 53.0	—	—	178
Apr. 18	90 H¹. Cnc	6.1	I	09.2	21 20.4	−2.8	+0.9	060	Sun	...	...	...
Apr. 19	9B. Leo	6.7	I	09.4	Low	...	...	...	1 40.1	0.0	−1.6	110
Apr. 28	210B. (Sco)	6.0	E	18.4	2 20.0	—	—	211	No Occ.	...	...	...
May 13	+27° 1296	7.2	I	04.4	20 28.0	−0.9	−0.8	068	Sun	...	...	...
May 14	ω Cnc	5.9	I	05.4	21 26.3	−1.1	−0.5	060	Sun	...	...	...
May 14	4 Cnc	6.2	I	05.5	21 47.4	−0.1	−1.8	115	Sun	...	...	...
May 15	+22° 2029	7.0	I	06.4	21 24.3	+0.3	−2.8	162	Sun	...	...	...
May 20	237B. Vir	7.0	I	10.6	1 23.8	−0.6	−1.7	115	0 00.0	−0.9	−1.6	123
May 28	40B. Cap	6.2	E	18.7	1 44.1	−1.3	+0.6	297	Low	...	...	...
May 28	35G. Cap	6.3	E	18.8	No Occ.	...	...	...	2 49.8	—	—	187
May 29	35 Cap	6.0	E	19.7	2 17.6	−1.3	+1.0	285	Low	...	...	...
June 13	78 H¹. Leo	7.5	I	05.9	Low	...	...	...	22 20.6	−1.1	−0.9	055
July 31	14 H¹. Tau	6.4	E	23.6	1 22.6	+0.1	+1.5	256	Low	...	...	...
Aug. 3	+27° 1122	6.5	E	26.7	3 29.8	+0.9	+2.5	210	Low	...	...	...
Aug. 11	2G. Lib	6.7	I	05.9	21 13.9	−0.9	−1.9	132	Sun	...	...	...
Aug. 16	234B. Sgr	5.9	I	11.1	22 56.5	−1.8	−0.3	079	21 27.9	−1.6	+0.6	064
Aug. 23	10 Cet	6.4	E	17.2	3 08.2	−1.2	+1.4	217	1 48.6	−1.7	+0.9	257
Aug. 24	80 Psc	5.7	E	18.2	2 31.5	−2.6	+0.3	274	No Occ.	...	...	...
Aug. 25	29 Ari	6.1	E	20.1	23 34.2	+0.3	+2.4	200	22 51.3	+0.2	+1.9	222
Sept. 12	183B. Sgr	6.2	I	08.6	22 10.0	—	—	145	20 22.4	−1.8	−0.3	111
Sept. 15	154B. Cap	6.1	I	11.7	22 03.3	−1.1	+1.4	026	Graze	...	...	...
Sept. 23	54 Ari	6.5	E	18.8	No Occ.	...	...	...	0 45.4	−0.3	+2.6	207
Sept. 23	δ Ari	4.5	I	18.9	3 53.4	−1.4	+2.1	035	No Occ.	...	...	...
Sept. 23	δ Ari	4.5	E	18.9	5 11.2	−2.0	−1.0	270	No Occ.	...	...	...
Sept. 23	133B. Tau	5.9	E	19.7	22 09.0	−0.1	+1.3	274	Low	...	...	...
Sept. 24	32 Tau	5.8	E	19.8	No Occ.	...	...	...	0 21.1	+0.9	+3.6	183
Sept. 24	33 Tau	6.0	E	19.8	2 15.0	—	—	307	No Occ.	...	...	...
Sept. 25	112B. (Aur)*m*	5.7	E	21.7	23 08.1	+0.5	+1.8	233	Low	...	...	...
Sept. 26	136 Tau	4.5	I	22.0	Sun	...	...	...	5 19.3	−1.7	+0.4	089
Oct. 7	α Sco	1.2	I	04.0	14 02.6	—	—	173	No Occ.	...	...	...
Oct. 7	α Sco	1.2	E	04.0	14 38.6	—	—	231	No Occ.	...	...	...
Oct. 12	38 Cap	7.0	I	09.2	19 23.8	−0.8	+2.1	010	No Occ.	...	...	...
Oct. 12	143B. Cap	6.2	I	09.4	No Occ.	...	...	...	23 04.6	−1.4	−1.1	087
Oct. 13/14	56 Aqr	6.4	I	10.3	0 08.2	−1.2	−0.7	074	22 51.3	−0.7	+0.6	031
Oct. 14	−10° 6082	7.0	I	11.3	22 15.9	−1.4	+1.0	047	21 09.5	−0.4	+2.0	006
Oct. 14/15	ψ¹ Aqr	4.5	I	11.4	0 32.9	−1.2	−0.3	065	23 19.2	−0.6	+1.1	022
Oct. 15/16	27 Psc	5.1	I	12.4	0 05.9	−1.5	+0.2	062	22 52.3	−0.6	+1.7	019
Oct. 16	29 Psc	5.2	I	12.4	2 31.9	−0.9	−1.0	078	1 14.5	−0.8	+0.5	039
Oct. 16	Saturn	0.6	I	13.2	18 48.6	−0.6	+1.8	073	17 54.0	−0.1	+1.9	061
Oct. 16	Saturn	0.6	E	13.2	19 55.3	−0.7	+2.2	218	18 57.5	−0.5	+2.0	238
Oct. 19	π Ari	5.4	E	16.3	22 19.6	—	—	298	No Occ.	...	...	...
Oct. 21	62 Tau	6.4	E	18.3	20 39.7	+0.2	+1.6	248	Low	...	...	...
Oct. 24	+27° 1337*m*	6.4	E	21.3	22 50.9	−0.4	+0.2	313	No Occ.	...	...	...
Oct. 24	134B. Gem	6.5	E	21.4	No Occ.	...	...	...	23 35.1	—	—	198
Oct. 27	90 H¹. Cnc	6.1	E	23.5	3 06.4	−1.1	−1.0	327	No Occ.	...	...	...
Nov. 6	234B. Sgr	5.9	I	04.7	18 31.1	—	—	012	No Occ.	...	...	...
Nov. 7	374B. (Sgr)	6.6	I	05.8	No Occ.	...	...	...	19 02.2	—	—	137
Nov. 11	272B. Aqr	7.1	I	09.0	No Occ.	...	...	...	0 14.5	−0.9	−1.9	095
Nov. 12	10 Cet	6.4	I	10.9	21 32.4	−3.2	−0.9	102	20 01.6	−1.3	+1.5	057
Nov. 12	Saturn	0.8	I	10.9	No Occ.	...	...	...	21 44.9	−2.0	0.0	085
Nov. 12	Saturn	0.8	E	10.9	No Occ.	...	...	...	22 50.8	−0.5	+1.6	197
Nov. 13	77 Psc	6.8	I	11.8	18 44.4	−1.8	+1.1	104	17 36.6	−0.5	+1.9	077
Nov. 13	80 Psc	5.7	I	11.9	21 01.3	−1.5	+1.5	056	19 57.1	−0.4	+2.3	018
Nov. 14	88 Psc	6.2	I	12.0	2 38.6	−0.5	+1.6	018	No Occ.	...	...	...
Nov. 14	54 (Cet)	5.9	I	12.9	20 39.8	−0.8	+2.3	033	19 58.4	—	—	341
Nov. 19	415B. (Tau)	6.1	E	17.9	22 05.4	−0.6	+1.6	261	21 03.7	−0.5	+0.9	298
Nov. 21	+27° 1337*m*	6.4	E	19.2	Sun	...	...	...	5 36.1	−1.0	−2.1	303
Nov. 22	ω Cnc	5.9	E	20.1	2 05.9	−1.5	+3.4	231	0 59.4	−0.9	+1.6	265
Dec. 6	154B. Cap	6.1	I	05.3	18 09.6	−1.7	−0.1	071	Sun	...	...	...
Dec. 6	−18° 6037	6.6	I	05.4	Low	...	...	...	20 11.0	−0.5	0.0	043
Dec. 9	19B. (Cet)	7.3	I	08.3	17 36.7	−1.3	+1.8	047	Sun	...	...	...
Dec. 9	−2° 19	7.3	I	08.4	21 30.7	−0.6	+1.6	019	No Occ.	...	...	...
Dec. 10	155B. Psc	6.5	I	09.3	17 30.7	−1.3	+1.8	060	Sun	...	...	...
Dec. 11/12	+9° 206	7.4	I	10.5	0 31.0	−1.1	−2.0	097	23 02.5	−1.3	−0.1	063
Dec. 12	300B. (Psc)	7.0	I	10.6	Low	...	...	...	2 07.7	−0.3	−0.8	064

Date	Star	Mag.	I or E	Age of Moon	Toronto E.S.T.	a	b	P	Winnipeg C.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Dec. 13	54 Ari	6.5	I	12.4	No Occ.	...	...	...	19 14.1	—	—	133
Dec. 13	δ Ari	4.5	I	12.5	23 05.3	−1.8	+0.9	058	21 55.2	−0.6	+3.2	015
Dec. 18	76 Gem	5.4	E	17.6	No Occ.	...	...	...	23 12.1	—	—	205
Dec. 23	308B. Leo	5.9	E	21.6	0 31.9	−0.5	+1.3	273	Low	...	...	...

LUNAR OCCULTATIONS VISIBLE AT EDMONTON AND VANCOUVER, 1967

Date	Star	Mag.	I or E	Age of Moon	Edmonton M.S.T.	a	b	P	Vancouver P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 18	34B. Ari	6.8	I	08.4	21 12.5	−1.1	−0.3	063	20 00.2	−1.5	0.0	067
Jan. 19	o Ari	5.8	I	09.3	17 59.8	−1.2	+1.5	063	Sun	...	...	...
Jan. 19/20	124B. Ari	6.4	I	09.5	0 01.6	−0.7	+0.2	037	22 53.9	−0.9	−0.2	053
Jan. 20/21	22H[1]. Tau	6.0	I	10.5	1 09.9	−1.1	+2.1	013	23 56.2	−1.0	+0.4	040
Jan. 21	+23° 701	7.1	I	11.4	20 15.6	−1.4	+0.7	082	18 57.4	−1.4	+1.1	083
Jan. 22	95 Tau	6.2	I	11.6	3 05.7	+0.1	−1.8	102	2 15.0	+0.2	−2.5	123
Jan. 23	+25° 879	6.3	I	12.6	1 15.7	—	—	159	No Occ.	...	...	...
Jan. 23	+27° 1122	6.5	I	13.4	20 23.9	−0.8	+2.1	058	19 08.2	−0.6	+2.1	060
Feb. 2	25 Lib	6.0	E	22.8	6 31.9	−1.2	−0.1	295	5 17.5	−1.5	+0.5	277
Feb. 14	o Psc	4.5	I	05.6	19 27.9	−1.2	−1.4	087	18 18.6	−1.8	−1.3	092
Feb. 16	+18° 459	7.3	I	07.7	21 15.6	−1.0	−0.6	068	20 06.4	−1.4	−0.8	080
Feb. 19	+26° 1082	7.0	I	10.8	23 24.2	—	—	155	No Occ.	...	...	...
Feb. 20	47 Gem	5.6	I	11.9	No Occ.	...	...	...	23 29.5	—	—	039
Feb. 20/21	+26° 1481	6.8	I	11.9	0 32.6	−0.6	−2.1	124	23 37.1	−0.5	−3.2	149
Feb. 22	λ Cnc	5.9	I	13.0	3 38.0	−0.5	−1.2	072	2 37.8	−0.6	−1.4	091
Mar. 13	269B. Psc	6.6	I	02.9	20 10.7	−0.3	+0.8	021	19 05.3	−0.5	+0.2	038
Mar. 15	53 Ari	6.1	I	05.0	22 30.0	—	—	146	No Occ.	...	...	...
Mar. 16	142B. Tau	6.8	I	05.9	20 19.3	—	—	359	18 54.2	−1.3	+1.8	029
Mar. 17	+25° 746*m*	7.2	I	07.1	No. Occ	...	...	...	23 51.2	−0.7	+0.5	028
Mar. 18	+26° 884	6.5	I	07.9	19 18.6	−1.5	−1.8	118	Sun	...	...	...
Mar. 20	+27° 1236	6.6	I	09.1	No Occ.	...	...	...	0 09.4	−1.0	−0.3	048
Mar. 20	76 Gem	5.4	I	10.0	22 37.1	−0.9	−1.7	113	21 35.4	−0.9	−2.3	135
Mar. 22	+22° 2029	7.0	I	11.3	Low	...	...	...	3 32.0	+0.1	−1.3	082
Apr. 15	+27° 1122	6.5	I	06.3	23 33.2	+0.4	−2.1	132	22 49.3	+0.9	−3.1	157
Apr. 16	+26° 1564	7.2	I	07.3	23 50.4	0.0	−1.7	108	22 58.1	0.0	−2.0	125
Apr. 18/19	9B. Leo	6.7	I	09.4	0 32.2	−0.2	−1.9	122	23 37.9	−0.2	−2.1	138
Apr. 28	38B. Sgr	4.7	E	18.5	Sun	...	...	...	3 15.1	−1.2	−0.5	330
May 13	47 Gem	5.6	I	04.6	Graze	...	...	...	21 47.5	−0.5	−0.7	055
May 13	+26° 1481	6.8	I	04.6	22 51.2	+0.6	−2.0	145	22 10.3	—	—	173
May 17	107B. Leo	6.3	I	07.7	Low	...	...	...	0 49.4	+0.6	−2.3	176
May 17	228B. Leo	6.8	I	08.6	21 24.4	−2.3	+0.1	063	Sun	...	...	...
May 19	237B. Vir	7.0	I	10.6	22 40.4	−0.9	−1.3	137	21 38.2	−0.7	−1.6	156
June 26	161B. (Cap)	6.4	E	18.2	Sun	...	...	...	1 12.3	−1.4	+1.1	287
June 28	351B. Aqr	6.5	E	20.2	Sun	...	...	...	2 02.8	−0.9	+1.9	238
July 1	o Psc	4.5	I	23.3	Sun	...	...	...	2 06.7	−0.3	+1.7	088
July 1	o Psc	4.5	E	23.3	Sun	...	...	...	3 02.5	−0.1	+2.3	209
July 25	ψ[2] Aqr	4.6	E	17.7	2 40.3	−1.8	+0.5	274	1 18.2	−2.0	+0.9	283
Aug. 13	σ Sco	3.1	E	08.0	Low	...	...	...	20 02.2	−1.6	−0.5	270
Aug. 22/23	10 Cet	6.4	E	17.2	0 24.2	−1.8	+1.1	288	23 01.9	—	—	300
Aug. 31	47 Gem	5.6	E	25.4	Sun	...	...	...	3 25.3	−0.2	+1.5	265
Sept. 22	54 Ari	6.5	E	18.8	23 47.8	−0.4	+2.1	233	22 36.7	−0.2	+2.0	240
Sept. 23	32 Tau	5.8	E	19.8	23 36.2	+0.1	+2.3	216	22 29.4	+0.3	+2.1	222
Sept. 26	136 Tau	4.5	I	22.0	4 01.1	−1.0	+1.8	067	2 44.2	−0.8	+1.9	068
Sept. 26	136 Tau	4.5	E	22.0	5 17.3	−1.5	+0.2	276	3 59.5	−1.5	+0.9	270
Oct. 11	86B. Cap *m*	6.2	I	08.4	Low	...	...	...	21 13.1	−1.5	−0.7	084
Oct. 12	143B. Cap	6.2	I	09.4	21 42.7	−1.1	0.0	058	20 29.2	−1.3	+0.6	051
Oct. 13	56 Aqr	6.4	I	10.3	21 50.8	—	—	353	No Occ.	...	...	...
Oct. 14	ψ[2] Aqr	4.6	I	11.4	22 54.2	−1.6	−0.2	082	21 36.5	−1.7	+0.6	073
Oct. 15	−9° 6173	7.4	I	11.5	1 24.4	−1.4	−2.4	104	0 16.3	−2.0	−1.9	102
Oct. 15/16	29 Psc	5.2	I	12.4	0 10.2	−0.1	+1.9	004	23 01.3	+0.3	+2.8	354
Oct. 16	Saturn	0.6	E	13.2	17 59.8	−0.1	+1.9	245	Low	...	...	...
Oct. 22	+24° 674	6.3	E	18.6	2 51.5	−1.0	+2.7	211	1 30.7	−0.7	+3.2	208
Oct. 24	49 Aur	5.0	E	20.7	No Occ.	...	...	...	5 12.1	−1.4	−3.3	322
Oct. 24	134B. Gem	6.5	E	21.4	22 56.5	+0.5	+2.0	236	Low	...	...	...
Oct. 26	28 Cnc	6.1	E	22.7	Sun	...	...	...	5 29.0	−1.6	−0.3	288
Nov. 7	40B. Cap	6.2	I	05.9	Low	...	...	...	19 10.3	−1.0	−0.1	051
Nov. 8	35 Cap	6.0	I	06.9	20 32.7	−1.8	−1.4	106	19 18.0	−2.0	−0.6	096
Nov. 10	272B. Aqr	7.1	I	09.0	22 55.7	−0.9	−0.6	064	21 46.9	−1.2	−0.1	061
Nov. 12	10 Cet	6.4	I	10.9	18 53.0	−0.7	+1.9	034	17 38.9	−0.5	+2.2	028
Nov. 12	Saturn	0.8	I	10.9	20 23.4	−1.1	+1.3	055	19 06.3	−1.0	+1.8	046

Date	Star	Mag.	I or E	Age of Moon	Edmonton M.S.T.	a	b	P	Vancouver P.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Nov. 12	Saturn	0.8	E	10.9	21 41.0	−1.1	+0.9	229	20 24.1	−1.4	+1.3	237
Nov. 13	80 Psc	5.7	I	11.9	19 10.4	—	—	339	No Occ.	...	...	...
Nov. 21	+27° 1337*m*	6.4	E	19.2	4 09.9	−1.3	−1.6	303	2 58.4	−1.7	−0.4	285
Nov. 21	134B. Gem	6.5	E	19.3	6 25.2	—	—	216	No Occ.	...	...	...
Nov. 21	ω Cnc	5.9	E	20.1	23 52.7	−0.6	+1.1	287	22 43.5	−0.3	+1.1	285
Nov. 21/22	4 Cnc	6.2	E	20.1	0 01.0	—	—	210	22 48.7	—	—	205
Dec. 6	−18° 6037	6.6	I	05.4	19 07.3	0.0	+1.1	008	18 03.2	—	—	356
Dec. 11	73 Psc	6.2	I	09.6	1 30.9	−0.3	+0.4	029	0 26.5	−0.5	+0.1	043
Dec. 11	+9° 206	7.4	I	10.5	21 46.1	−1.0	+1.3	035	20 30.0	−1.0	+1.9	032
Dec. 11/12	300B. (Psc)	7.0	I	10.6	0 57.2	−0.7	−0.3	052	23 50.3	−1.0	−0.4	062
Dec. 12	54 (Cet)	5.9	I	10.7	Low	...	...	...	2 15.6	+0.1	−4.0	126
Dec. 14	54 Ari	6.5	I	12.4	17 54.8	−0.7	+1.6	094	Sun	...	...	...
Dec. 14	63 Ari	5.2	I	12.7	No Occ.	...	...	...	2 43.2	−1.1	+1.8	018
Dec. 14	65 Ari	5.9	I	12.8	No Occ.	...	...	...	3 30.2	−0.7	+0.4	032
Dec. 18	76 Gem	5.4	E	17.6	22 20.3	−0.4	+2.5	241	21 08.5	0.0	+2.4	238
Dec. 24	η Vir	4.0	I	22.9	No Occ.	...	...	...	6 05.5	−2.4	+0.8	076
Dec. 24	13 Vir	5.9	E	22.9	Sun	...	...	...	6 40.1	−1.4	−0.8	293
Dec. 24	η Vir	4.0	E	22.9	No Occ.	...	...	...	6 49.6	0.0	−2.5	001

PLANETARY APPULSES AND OCCULTATIONS

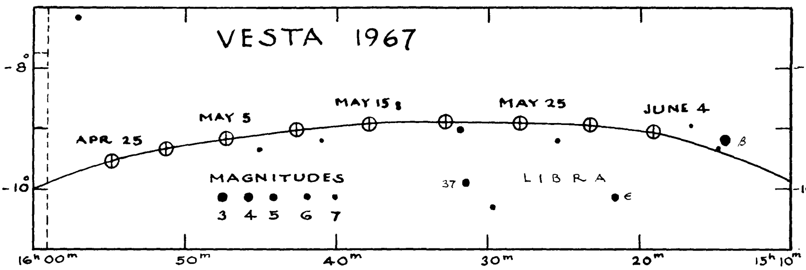
The close approach of a planet to a star is of interest to observers. Surprisingly few observable appulses of planets and stars of 9th magnitude or brighter occur during a year. An even rarer occurrence is the observable occultation of a star by a planet. No planetary appulses or occultations are observable from Canada during 1967, according to Mr. Gordon E. Taylor of the British Astronomical Association.

OPPOSITION EPHEMERIDES OF THE BRIGHTEST ASTEROIDS, 1967

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

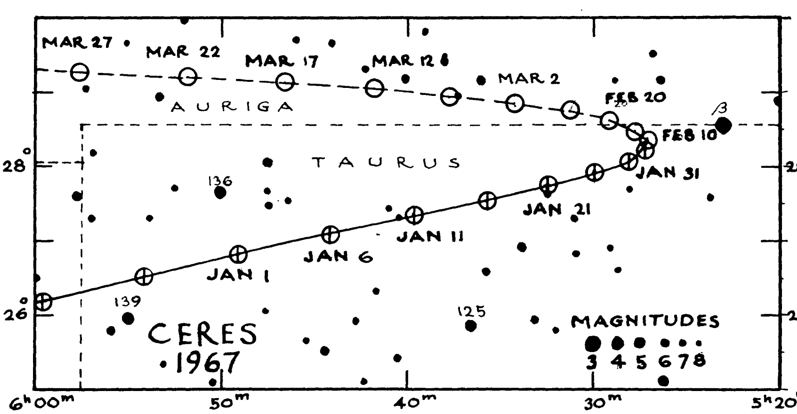
Ephemerides for the four brightest asteroids are given when the asteroids are near opposition, along with maps for Ceres and Vesta. Since Ceres was at opposition near the end of 1966, the map for this asteroid is given. Right ascensions and declinations are for 0h E.T. and equinox of 1950.0.

JUNO (No. 3) Opp. Jan. 26 in Hya			Mag. 7.9	VESTA (No. 4) Opp. May 15 in Lib			Mag. 5.6
		h m				h m	
Jan.	6	8 36.7	+0°56′	Apr.	25	15 54.9	−9°32′
	11	8 33.0	+1 20		30	15 51.3	−9 20
	16	8 28.8	+1 50	May	5	15 47.2	−9 10
	21	8 24.4	+2 27		10	15 42.6	−9 02
	26	8 20.0	+3 10		15	15 37.8	−8 56
	31	8 15.7	+3 56		20	15 32.8	−8 53
Feb.	5	8 11.6	+4 46		25	15 27.9	−8 53
	10	8 08.0	+5 37		30	15 23.3	−8 57
	15	8 04.8	+6 29	June	4	15 19.1	−9 05



CERES (No. 1)

Opp. 1966 Dec. 22					Mag. 6.6				
		h m	°	′			h m	°	′
Jan.	1	5 49.1	+26	49	Jan.	26	5 30.0	+27	55
	6	5 44.2	+27	05		31	5 28.2	+28	05
	11	5 39.7	+27	20	Feb.	5	5 27.3	+28	14
	16	5 35.7	+27	33		10	5 27.1	+28	22
	21	5 32.5	+27	45		15	5 27.8	+28	30



METEORS, FIREBALLS AND METEORITES

By Peter M. Millman

Meteoroids are small solid particles moving in orbits about the sun. On entering the earth's atmosphere at velocities ranging from 10 to 45 miles per second they become luminous and appear as meteors or fireballs and, if large enough to avoid complete vapourization, in rare cases they may fall to the earth as meteorites.

Meteors are visible on any night of the year. At certain times of the year the earth encounters large numbers of meteors all moving together along the same orbit. Such a group is known as a meteor shower and the accompanying list gives the more important showers visible in 1967. Although in 1967 we have passed the current Leonid peak, the shower should still be above average strength. However, the full moon will handicap observations of both the Leonids and the Geminids. The Perseid shower will be the best for amateur observation in 1967.

On the average an observer sees 7 meteors per hour which are not associated with any recognized shower. These have been included in the hourly rates listed in the table. The radiant is the position among the stars from which the meteors of a given shower seem to radiate. The appearance of any very bright fireball should be reported immediately to the nearest astronomical group or other organization concerned with the collection of such information. Where no local organization exists, reports should be sent to Meteor Centre, National Research Council, Ottawa 7, Ontario. Free fireball report forms and instructions for their use, printed in either French or English, may be secured at the above address. If sounds are heard accompanying a bright fireball there is a possibility that a meteorite may have fallen. Astronomers must rely on observations made by the general public to track down such an object.

Meteor Showers For 1967

Shower	Shower Maximum			Radiant				Single Observer Hourly Rate	Vel.	Normal Duration to ¼ strength of Max.
	Date	E.S.T.	Moon	Position at Max. R.A.	Position at Max. Dec.	Daily Motion R.A.	Daily Motion Dec.			
				h m	°	m	°		mi./sec.	days
Quadrantids	Jan. 3	19^h	L.Q.	15 28	+50	—	—	40	25	0.6
Lyrids	Apr. 22	11	F.M.	18 16	+34	+4.4	0.0	15	30	2.3
η Aquarids	May 5	11	L.Q.	22 24	00	+3.6	+0.4	20	40	1.8
δ Aquarids	July 29	—	L.Q.	22 36	−17	+3.4	+0.17	20	25	20
Perseids	Aug. 12	15	F.Q.	03 04	+58	+5.4	+0.12	50	37	5.0
Orionids	Oct. 21	03	F.M.	06 20	+15	+4.9	+0.13	25	41	8
Taurids	Nov. 5	—	N.M.	03 32	+14	+2.7	+0.13	15	17	(30)
Leonids	Nov. 17	01	F.M.	10 08	+22	+2.8	−0.42	25	45	4
Geminids	Dec. 13	20	F.M.	07 32	+32	+4.2	−0.07	50	22	6.0
Ursids	Dec. 23	00	L.Q.	14 28	+76	—	—	15	21	2.2

TABLE OF PRECESSION FOR 50 YEARS

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

FINDING LIST OF NAMED STARS

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

THE BRIGHTEST STARS

BY DONALD A. MACRAE

The 286 stars brighter than apparent magnitude 3.55.

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

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

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

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

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

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

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

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

Star	Right Ascension R.A. 1970 (h m)	Declination Dec. (° ′)	Visual Magnitude V	Colour Index $B-V$	Spectral Classification Type		Parallax π (″)	Absolute Magnitude M_V	Distance light-years D (l.y.)	Proper Motion μ (″)	Radial Velocity R (km./sec.)		
SUN			-26.73	+0.63	G2	V		+4.84					***Sun***
α And	00 06.8	+28 55	2.06	−0.08	B9p		0.024	−0.1	90	0.209	*−11.7*	Manganese star	*Alpheratz*
β Cas	07.6	+58 59	2.26	+0.34	F2	IV	0.072	+1.6	45	0.555	+11.8		*Caph*
γ Peg	11.7	+15 01	2.84v	−0.23	B2	IV	−.004	−3.4	570	0.010	+04.1	β CMa type, *R* in *V* 2.83–2.85, 0.15^d	
β Hyi	24.2	−77 25	2.78	+0.62	*G1*	*IV*	0.153	+3.7	21	2.255	+22.8		γ Peg = *Algenib*
α Phe	24.8	−42 28	2.39	+1.08	*K0*	*III*	0.035	+0.1	93	0.442	*+74.6*		*Ankaa*
δ And *A*	37.7	+30 42	3.25:	+1.26	K3	III	0.024	−0.2	160	0.161	−07.3	*B* 12^m 28″	
α Cas	38.8	+56 22	2.16	+1.18	K0	II–III	0.009	−1.1	150	0.058	−03.8	Var.?	*Schedar*
β Cet	42.1	−18 09	2.02	+1.03	K1	III	0.057	+0.8	57	0.234	+13.1		*Diphda*
η Cas *A*	47.3	+57 39	3.47	+0.56	G0	V	0.182	+4.8	18	1.221	+09.4	*B* 7.26^m 9″	
γ Cas *A*	54.9	+60 33	2.13v	−0.16v	B0	IV: pe	0.034	−0.3:	96:	0.026	−06.8	Var. *B* 8.18^m 2″	
β Phe *AB*	01 04.7	−46 53	3.30	+0.88	*G8*	*III*	0.017	+0.3	190	0.035	−01.1	*A* 4.1^m *B* 4.1^m 2″	
η Cet	07.1	−10 20	3.47	+1.16	K3	III	0.032	+1.0	102	0.250	+11.5		
β And	08.0	+35 28	2.02	+1.57	M0	III	0.043	+0.2	76	0.211	+00.3		*Mirach*
δ Cas	23.8	+60 05	2.67	+0.13	A5	V	0.029	+2.1	43	0.301	+06.7	Ecl.? *R* 0.08:^{m} 759^d	
γ Phe	27.1	−43 28	3.44	+1.56	*K5*	*Ib*	−.003	−4.6	1300	0.209	*+25.7*		
α Eri	36.6	−57 23	0.51	−0.16	*B5*	*IV:*	0.023	−2.3	118	0.098	+19		***Achernar***
τ Cet	42.7	−16 06	3.50	+0.72	G8	Vp	0.275	+5.70	12	1.921	−16.2		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
α Tri	01 51.4	+29 26	3.45	+0.46	F6 IV	0.050	+2.0	65	0.230	*−12.6*	
ε Cas	52.2	+63 31	3.33	−0.15	B3 IV: p	0.007	−2.7	520	0.038	−08.1	
β Ari	53.0	+20 40	2.68	+0.14	A5 V	0.063	+1.7	52	0.147	*−01.9*	
α Hyi	57.8	−61 43	2.84	+0.28	*F0 V*		+2.9	31	0.265	+07	
γ And *A*	02 02.1	+42 11	2.14:	+1.16:	K3 II	0.005	−2.4	260	0.068	−11.7	*B* 5.4^m *C* 6.2^m *A–BC* 10″ *B–C* 0.7″
α UMi *A*	02 02.5	+89 08	1.99v	+0.60v	F8 Ib	0.003	−4.6	680	0.046	*−17.4*	Cep., *R* 0.11^m 4.0^d, *B* 8.9^m 18″ *Polaris*
											γ And = *Almach*
α Ari	05.5	+23 19	2.00	+1.15	K2 III	0.043	+0.2	76	0.241	−14.3	*Hamal*
β Tri	07.8	+34 51	3.00	+0.13	A5 III	0.012	−0.1	140	0.156	*+09.9*	
ο Cet *A*	17.8	−03 07	2.0v		(gM6e)	0.013	−0.5	103	0.232	+63.8	LP, *R* 2.0–10.1, 332^d, *B* 10^m 1″ *Mira*
γ Cet *AB*	41.7	+03 07	3.48	+0.11	A2 V	0.048	+2.0	68	0.203	−05.1	*A* 3.57^m *B* 6.23^m 3″
θ Eri *AB*	57.1	−40 25	2.92	+0.13	*A3 V*	0.028	+1.7	65	0.061	*+11.9*	*A* 3.25^m *B* 4.36^m 8″ *Acamar*
α Cet	03 00.7	+03 58	2.54	+1.63	M2 III	0.003	−0.5	130	0.075	−25.9	*Menkar*
γ Per	02.6	+53 23	2.91:	+0.72:	G8III: +A3:	0.011	+0.3	113	0.004	*+02.5*	
ρ Per	03.1	+38 43	3.5v		M4 II–III	0.008	−1.0	260	0.172	+28.2	Irr. *R* 3.2–3.8
β Per	06.0	+40 50	2.06v	−0.07	B8 V	0.031	−0.5	105	0.006	*+04.0*	Ecl. *R* 2.06–3.28, 2.87^d *Algol*
α Per	22.2	+49 45	1.80	+0.48	F5 Ib	0.029	−4.4	570	0.035	−02.4	*Mirfak*
δ Per	40.8	+47 42	3.03	−0.14	B5 III	0.007	−3.3	590	0.046	−09	
η Tau	45.7	+24 01	2.86	−0.09	B7 III	0.005	−3.2	541	0.050	+10.1	in Pleiades *Alcyone*
γ Hyi	47.7	−74 20	3.30	+1.61	*M2 II–III*	−.001	−1.5	300	0.125	+16.0	
ζ Per *A*	52.1	+31 48	2.83	+0.13	B1 Ib	0.007	−6.1	1000	0.015	+20.6	*B* 9.36^m 13″
ε Per *A*	55.8	+39 55	2.88	−0.17	B0.5 V	−.001	−3.7	680	0.036	−01	*B* 7.99^m 9″
γ Eri	56.6	−13 36	3.01	+1.58	M0 III	0.003	−0.5	160	0.126	+61.7	
α Ret *A*	04 14.0	−62 33	3.33	+0.91	*G6 II*	0.008	−2.1	390	0.064	+35.6	*B* 12^m 49″
ε Tau	26.9	+19 07	3.54	+1.02	K0 III	0.018	+0.1	160	0.118	+38.6	
θ² Tau	26.9	+15 48	3.42	+0.17	A7 III	0.025	+0.2	140	0.108	*+39.5*	
α Dor	33.3	−55 06	3.28	−0.08	*A0 IIIp*	0.011	−1.2	260	0.051	+25.6	Silicon star
α Tau *A*	34.2	+16 27	0.86v	+1.52	K5 III	0.048	−0.7	68	0.202	+54.1	Irr.? *R*0.78–0.93, *B*13^{m}31″ ***Aldebaran***
π³ Ori	48.2	+06 55	3.17	+0.45	F6 V	0.125	+3.65	26	0.468	+24.3	
ι Aur	55.0	+33 07	2.64:	+1.49	K3 II	0.015	−2.4	330	0.021	+17.5	

α UMi, ***Polaris:*** **R.A. 2 h 00.9 m; Dec. +89° 07′ (1967).**

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
ε Aur	04 59.8	+43 47	3.0v	+0.50:	F0 Iap	0.004	−7.1	3400	0.008	*−02.5*	Ecl. *R* 0.81^m 9886^d
ε Lep	05 04.2	−22 25	3.21	+1.46	*K5 III*	0.006	−0.4	170	0.077	+01.0	
η Aur	04.4	+41 12	3.17	−0.18	B3 V	0.013	−2.1	370	0.077	+07.4	
β Eri	06.4	−05 07	2.79	+0.13	A3 III	0.042	+0.9	78	0.122	−08	
μ Lep	11.6	−16 14	3.29	−0.09	*B9 IIIp*	0.018	−2.1	390	0.049	+27.7	Manganese star
β Ori *A*	13.1	−08 14	0.14v	−0.04	B8 Ia	−.003	−7.1	900	0.001	*+20.7*	Irr.? *R* 0.08–0.20, *B* 6.65^m 9″ **_Rigel_**
α Aur	14.5	+45 58	0.05	+0.80	G8III: +F	0.073	−0.6	45	0.435	*+30.2*	**_Capella_**
η Ori *AB*	23.0	−02 25	3.32v	−0.18	B0.5 V	0.004	−3.7	940	0.008	*+19.8*	Ecl. *R* 3.32–3.50, 8.0^d, *A* 3.59^m *B* 4.98^m 1″
γ Ori	23.5	+06 19	1.64	−0.23	B2 III	0.026	−4.2	470	0.015	+18.2	*Bellatrix*
β Tau	24.4	+28 35	1.65	−0.13	B7 III	0.018	−3.2	300	0.178	+08.0	*Elnath*
β Lep *A*	27.0	−20 47	2.81	+0.82	G5 III	0.014	+0.1	113	0.090	−13.5	*B* 9.4^m 3″
δ Ori *A*	30.5	−00 19	2.20v	−0.20	O9.5 II	0.004	−6.1	1500	0.002	*+16.0*	Ecl. *R* 2.20–2.35 5.7^d, *B* 6.74^m 53″
α Lep	31.4	−17 51	2.58	+0.22	F0 Ib	0.002	−4.6	900	0.006	+24.7	
λ Ori *AB*	33.5	+09 55	3.40	−0.18	O8	0.006	−5.1	1800	0.006	+33.5	*A* 3.56^m *B* 5.54^m 4″ *C* 10.92^m 29″
ι Ori *AB*	34.0	−05 56	2.76	−0.24	O9 III	0.021	−6.1	2000	0.005	*+21.5*	*A* 2.78^m *B* 7.31^m 11″
ε Ori	34.7	−01 13	1.70	−0.19	B0 Ia	−.007	−6.8	1600	0.000	+26.1	*Alnilam*
ζ Tau	35.9	+21 08	3.07:	−0.13:	B2 III: p	−.002	−4.2	940	0.023	*+24.3*	Shell star
α Col *A*	38.6	−34 05	2.64	−0.11	*B8 Ve*	−.005	−0.6	140	0.026	+35	*B* 12^m 12″
ζ Ori *AB*	39.2	−01 57	1.79	−0.22	O9.5 Ib	0.022	−6.6	1600	0.004	+18.1	*A* 1.91^m *B* 4.05^m 3″
κ Ori	46.3	−09 41	2.06	−0.17	B0.5 Ia	0.009	−6.9	2100	0.004	+20.6	
β Col	49.9	−35 47	3.12	+1.16	(gK1)	0.023	+0.0	140	0.402	+89.4	
α Ori	53.5	+07 24	0.41v	+1.87:	M2 Iab	0.005	−5.6	520	0.028	*+21.0*	Irr.? *R* 0.06:–0.75:^{m} **_Betelgeuse_**
β Aur	57.3	+44 57	1.86	+0.06	A2 V	0.037	−0.3	88	0.051	*−18.2*	
θ Aur *AB*	57.7	+37 13	2.65	−0.07	B9.5pv	0.018	+0.1	108	0.097	+29.3	Silicon star *A* 2.67^m *B* 7.14^m 3″
η Gem *A*	06 13.1	+22 31	3.33v	+1.58	M3 III	0.013	−0.6	200	0.066	*+19.0*	*R* 0.27^m, *B* 6.70^m 1″
ζ CMa	19.2	−30 03	3.04	−0.18	B2.5 V	−.003	−2.4	390	0.004	*+32.2*	
μ Gem	21.1	+22 32	2.92v	+1.63	M3 III	0.021	−0.6	160	0.129	+54.8	*R* 0.14^m
β CMa	21.4	−17 56	1.96	−0.24	B1 II–III	0.014	−4.8	750	0.004	*+33.7*	β CMa type variable
α Car	23.3	−52 41	−0.72	+0.16	F0 Ib–II	0.018	−3.1	98	0.025	+20.5	**_Canopus_**
γ Gem	36.0	+16 26	1.93	0.00	A0 IV	0.031	−0.6	105	0.066	*−12.5*	

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
ν Pup	06 36.8	−43 10	3.19	−0.10	*B7 III*		−3.2	620	0.010	+28.2		
ε Gem	42.1	+25 10	3.00	+1.39	G8 Ib	0.009	−4.6	1080	0.016	+09.9		
ξ Gem	43.6	+12 56	3.38	+0.43	F5 IV	0.051	+1.9	64	0.224	+25.3		
α CMa *A*	43.8	−16 41	−1.42	+0.01	A1 V	0.375	+1.45	8.7	1.324	*−07.6*	*B* 8.66ᵐ 1960: 9″, θ = 90°	***Sirius***
α Pic	48.1	−61 54	3.27	+0.21	*A5 V*		+2.1	57	0.272	+20.6		
τ Pup	49.2	−50 35	2.97	+1.17	*K0 III*		+0.1	124	0.079	*+36.4*		
ε CMa *A*	57.4	−28 56	1.48:	−0.18:	B2 II		−5.1	680	0.004	+27.4	*B* 7.5ᵐ 8″	***Adhara***
o^2 CMa	07 01.8	−23 47	3.02	−0.09	B3 Ia		−7.1	3400	0.000	+48.4		
δ CMa	07.2	−26 21	1.85	+0.65	F8 Ia	−.018	−7.1	2100	0.005	+34.3		
L_2 Pup	12.6	−44 36			(gM5e)	0.016	−3.1	650	0.342	+53.0	LP, *R* 3.4–6.2, 141ᵈ	
π Pup	16.1	−37 03	2.81	+1.56:	(gK4)	0.023	−0.3	140	0.008	+15.8		
η CMa	22.9	−29 14	2.46	−0.08	B5 Ia		−7.1	2700	0.008	+41.1		
β CMi	25.7	+08 21	2.91	−0.09	B7 V	0.020	−1.1	210	0.065	+22		
σ Pup *A*	28.3	−43 14	3.28	+1.49	(gK5)	0.013	−0.4	180	0.195	*+88.1*	*B* 9.4ᵐ 22″	
α Gem *A*	32.7	+31 57	1.97	+0.00:	A1 V	0.072	+1.3	45	0.199	+06.0	} 5″, *B−V*+0.02, *C* 9.08vᵐ 73″	*Castor*
α Gem *B*	32.7	+31 57	2.95	+0.07:	A5m	0.072	+2.3	45	0.199	−01.2		
α CMi *A*	37.7	+05 18	0.37	+0.41	F5 IV–V	0.288	+2.7	11.3	1.250	−03.2	*B* 10.7ᵐ 5″	***Procyon***
β Gem	43.5	+28 06	1.16	+1.02	K0 III	0.093	+1.0	35	0.625	+03.3		***Pollux***
ξ Pup	48.0	−24 48	3.34	+1.23	G3 Ib	−.003	−4.6	1240	0.005	*+02.7*		
χ Car	56.0	−52 54	3.48	−0.18	(B3)		−2.1	430	0.039	+19.1		
ζ Pup	08 02.5	−39 55	2.23	−0.26	O5f		−7.1	2400	0.033	−24		
ρ Pup	06.3	−24 13	2.80v	+0.42	F6 IIp	0.031	+0.3:	105:	0.098	+46.6	Var. *R* 2.72–2.87	
γ Vel *A*	08.6	−47 16	1.88	−0.26	*WC7*		−4.1	520	0.011	+35	*B* 4.31ᵐ 41″	
ε Car	21.9	−59 24	1.97	+1.14:	(K0 + B)		−3.1:	340	0.030	+11.5		*Avior*
o UMa *A*	27.8	+60 49	3.37	+0.83	G5 III	0.004	+0.1	150	0.171	+19.8	*B* 15ᵐ 7″	
δ Vel *AB*	43.9	−54 36	1.95	+0.05	*A0 V*	0.043	+0.2	76	0.086	+02.2	*A* 2.0ᵐ *B* 5.1ᵐ 3″ *CD* 10ᵐ 69″	
ε Hya *ABC*	45.2	+06 32	3.39	+0.68	G0 comp.	0.010	+0.6	140	0.198	*+36.4*	*A*3.7ᵐ*B*5.2ᵐ0.2″15ʸ, *C*6.8ᵐ3″*D*12ᵐ20″	
ζ Hya	53.8	+06 04	3.11	+1.00	K0 II–III	0.029	−1.1	220	0.101	+22.8		
ι UMa *A*	57.2	+48 09	3.12	+0.19	A7 V	0.066	+2.2	49	0.505	+12.2	*BC* 10.8ᵐ 7″	

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

Star	R.A. 1970	Dec.	*V*	*B–V*	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
γ UMa	11 52.2	+53 52	2.44	0.00	A0 V	0.020	+0.2	90	0.094	−12.9		*Phecda*
δ Cen	12 06.8	−50 33	2.59v	−0.15:	*B2 Ve*		−2.7	370	0.042	+09	Var. *R* 2.56–2.62	
ε Crv	08.6	−22 27	3.04	+1.33	K3 III		−0.2	140	0.069	+04.9		
δ Cru	13.5	−58 35	2.81v	−0.23	*B2 IV*		−3.4	570	0.041	+26.4	Var. *R* 2.78–2.84	
δ UMa	13.9	+57 12	3.30	+0.07	A3 V	0.052	+1.9	63	0.106	−12.9		*Megrez*
γ Crv	14.3	−17 22	2.59	−0.10	B8 III		−3.1	450	0.163	−04.2		*Gienah*
α Cru *A*	24.9	−62 56	1.39	−0.25	*B1 IV*		−3.9	370	0.042	*−11.2*	} 5″, *C* 4.90^m 89″	***Acrux***
α Cru *B*	24.9	−62 56	1.86	−0.25	(B3)		−3.4	370	0.042	*−00.6*		
δ Crv *A*	28.3	−16 21	2.97	−0.04	B9.5 V: n	0.018	+0.1	124	0.255	+09	*B* 8.26^m 24″	
γ Cru	29.5	−56 57	1.69	+1.55	*M3 II*		−2.5	220	0.274	+21.3		*Gacrux*
β Crv	32.8	−23 14	2.66	+0.89	G5 III	0.027	+0.1	108	0.059	−07.7		
α Mus	35.4	−68 58	2.70v	−0.20	*B3 IV*		−2.9	430	0.037	+18	Var. *R* 2.66–2.73	
γ Cen *AB*	39.9	−48 48	2.17	+0.00	*A0 IV:*	0.006	−0.5	160	0.197	−07.5	*A* 2.9^m *B* 2.9^m 1″	
γ Vir *AB*	40.1	−01 17	2.76	+0.34	F0 V	0.101	+3.5	32	0.567	−19.7	*A* 3.50^m *B* 3.52^m 4″	
β Mus *AB*	44.4	−67 57	3.06	−0.17:	*B3 V*		−2.1	470	0.041	+42	*A* 3.7^m *B* 4.0^m 1″	
β Cru	46.0	−59 32	1.28	−0.25	*B0 III*		−4.6	490	0.049	+20.0		***Beta Crucis***
ε UMa	52.7	+56 07	1.79	−0.03	A0pv	0.008	+0.2	68	0.113	−09.3	Chromium-europium star	*Alioth*
α CVn *A*	54.6	+38 29	2.90	−0.10	B9.5pv	0.023	+0.1	118	0.238	*−03.3*	Silicon-europium star. *B* 5.61^m 20″	
ε Vir	13 00.7	+11 08	2.86	+0.93	G9 II–III	0.036	+0.6	90	0.274	−14.0		
γ Hya	17.3	−23 01	2.98	+0.92	G8 III	0.021	+0.3	113	0.086	−05.4		
ι Cen	18.9	−36 33	2.76	+0.05	*A2 V*	0.046	+1.1	71	0.351	+00.1		
ζ UMa *A*	22.7	+55 05	2.26	+0.02	A2 V	0.037	+0.1	88	0.127	*−09.0*	*B* 3.94^m 14″ (Alcor, 224″)	*Mizar*
α Vir	23.6	−11 00	0.91v	−0.24	B1 V	0.021	−3.3	220	0.054	*+01.0*	Ecl. *R* 0.91–1.01, 4.0^d	***Spica***
ζ Vir	33.2	−00 27	3.40	+0.10	A3 Vn	0.035	+1.1	93	0.287	−13.2		
ε Cen	38.0	−53 19	2.33	−0.23	*B1 IV*		−3.9	570	0.033	+05.6		
η UMa	46.4	+49 28	1.87	−0.20	B3 V	0.004	−2.1	210	0.123	−10.9		*Alkaid*
ν Cen	47.7	−41 32	3.42	−0.22	B2 IV		−3.4	750	0.037	*+09.0*		
μ Cen	47.8	−42 20	3.12v	−0.13:	B2 V: pne		−2.7	470	0.032	+12.6	Var. *R* 3.08–3.17	
η Boo	53.3	+18 33	2.69	+0.59	G0 IV	0.102	+2.7	32	0.370	*−00.1*		
ζ Cen	53.7	−47 09	2.56	−0.23:	*B2 IV*		−3.4	520	0.076	*+06.5*		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Cen *AB*	14 01.7	−60 13	0.63	−0.23:	*B1 II:*	0.016	−5.2	490	0.035	*−12*	*A* 0.7ᵐ *B* 3.9ᵐ 1″	***Hadar***
π Hya	04.7	−26 32	3.25	+1.13	K2 III	0.039	+1.2	84	0.156	+27.2		
θ Cen	04.9	−36 14	2.04	+1.03	K0 III–IV	0.059	+0.9	55	0.738	+01.3		*Menkent*
α Boo	14.3	+19 20	−0.06	+1.23	K2 IIIp	0.090	−0.3	36	2.284	−05.2		***Arcturus***
γ Boo	30.9	+38 27	3.05	+0.19	A7 III	0.016	+0.2	118	0.186	−35.5		
η Cen	33.6	−42 01	2.39v	−0.21	B1.5 V:ne		−3.0	390	0.049	−00.2	Var. *R* 2.33–2.45	
α Cen *A*	37.6	−60 43	0.01	+0.68	*G2 V*	.751	+4.39	4.3	3.676	−24.6	18″	***Rigil Kentaurus***
α Cen *B*	37.6	−60 43	1.40:	+0.73:	(dK1)		+5.8	4.3		−20.7		
α Lup	40.0	−47 16	2.32	−0.22	B1 V		−3.3	430	0.033	+07.3		
α Cir *AB*	40.1	−64 50	3.18	+0.25	*F0 Vp*	0.049	+1.6	66	0.308	+07.4	Strontium star. *A* 3.19ᵐ *B* 8.61ᵐ 16″	
ε Boo *AB*	43.7	+27 12	2.37	+0.96	K1: III: + A	0.013	+0.0	103	0.051	−16.5	*A* 2.47ᵐ *B* 5.04ᵐ 3″	
α Lib *A*	49.2	−15 52	2.76	+0.15	A3m	0.049	+1.2	66	0.130	−10	*B* 5.15ᵐ 231″	*Zubenelgenubi*
β UMi	50.8	+74 16	2.04	+1.47	K4 III	0.031	−0.5	105	0.033	+16.9		*Kochab*
β Lup	56.6	−43 01	2.69	−0.23	B2 IV		−3.4	540	0.066	−00.3		
κ Cen	57.1	−41 59	3.15	−0.21	B2 V		−2.7	470	0.033	+09.1		
β Boo	15 00.8	+40 30	3.48	+0.95	G8 III	0.022	+0.3	140	0.059	−19.9		
σ Lib	02.3	−25 10	3.31	+1.65	M4 III	0.056	+2.0:	58:	0.089	−04.3		
ζ Lup *A*	10.1	−51 59	3.42	+0.90:	*K0 III*	0.036	+1.2	90	0.135	−09.7	*B* 7.8ᵐ 71″	
δ Boo *A*	14.3	+33 26	3.47	+0.95	G8 III	0.028	+0.3	140	0.148	−12.2	*B* 7.84ᵐ 105″	
β Lib	15.4	−09 16	2.61	−0.11	B8 V	−.012	−0.6	140	0.101	−35.2		
γ TrA	16.1	−68 34	2.94	−0.01	*A0 Vp*	0.005	+0.2	113	0.067	00	Europium star	
δ Lup	19.4	−40 32	3.24	−0.23	B2 IV		−3.4	680	0.032	+02		
γ UMi	20.8	+71 56	3.08	+0.06	A3 II-III	−.005	−1.5	270	0.026	*−03.9*		
ι Dra	24.3	+59 04	3.28	+1.18	K2 III	0.032	+0.8	102	0.012	−11.0		
γ Lup *AB*	33.1	−41 04	2.80	−0.22	B2 Vn		−2.7	570	0.037	+06	*A* 3.5ᵐ *B* 3.7ᵐ 1″	
α CrB	33.4	+26 49	2.23v	−0.02	A0 V	0.043	+0.4	76	0.154	*+01.7*	Ecl. *R* 0.11ᵐ, 17.4ᵈ	*Alphecca*
α Ser	42.8	+06 31	2.65	+1.17	K2 III	0.046	+1.0	71	0.139	+02.9		
β TrA	52.5	−63 20	2.87	+0.28:	*F2 V*	0.078	+2.3	42	0.448	−00.3		
π Sco	57.0	−26 02	2.92	−0.19	B1 V	0.005	−3.3	570	0.034	*−03*		
η Lup *AB*	58.1	−38 19	3.45	−0.23	B2 V		−2.7	570	0.042	+07	*A* 3.47ᵐ *B* 7.70ᵐ 15″	
δ Sco	58.6	−22 32	2.34	−0.13	B0 V		−4.0	590	0.032	−14		

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R		
	h m	° ′				″		l.y.	″	km./sec.		
β Sco *AB*	16 03.7	−19 43	2.65	−0.09	B0.5 V	0.004	−3.7	650	0.027	*−06.6*	A 2.78^{m} B 5.04^{m} 1″, C 4.93^{m} 14″	
δ Oph	12.8	−03 36	2.72	+1.59	M1 III	0.029	−0.5	140	0.156	−19.9		
ε Oph	16.7	−04 38	3.22	+0.97	G9 III	0.036	+1.0	90	0.089	−10.3		
σ Sco *A*	19.4	−25 31	2.86v	+0.14	B1 III		−4.4	570	0.030	*−00.4*	β CMa R 2.82–2.90, 0.25^{d}, B 8.49^{m} 20″	
η Dra *A*	23.6	+61 34	2.71	+0.92	G8 III	0.043	+0.9	76	0.062	−14.3	B 8.7^{m} 6″	
α Sco *A*	27.6	−26 22	0.92v	+1.84	M1 Ib+B	0.019	−5.1	520	0.029	−03.2	A 0.86^{m}–1.02^{m} B 5.07^{m} 3″	***Antares***
β Her	28.9	+21 33	2.78	+0.92	G8 III	0.017	+0.3	103	0.105	*−25.5*		
τ Sco	34.0	−28 09	2.85	−0.25	B0 V		−4.0	750	0.030	−00.7		
ζ Oph	35.5	−10 30	2.57	+0.00	O9.5 V	−.007	−4.3	520	0.022	−19		
ζ Her *AB*	40.2	+31 39	2.81	+0.64	G0 IV	0.110	+3.1	30	0.608	*−69.9*	A 2.91^{m} B 5.46^{m} 1″	
η Her	41.9	+38 59	3.46	+0.92	G7 III–IV	0.053	+2.1	62	0.097	+08.3		
α TrA	45.5	−68 59	1.93	+1.43	*K2 III*	0.024	−0.1	82	0.044	−03.6		*Atria*
ε Sco	48.2	−34 15	2.28	+1.16	*K2 III–IV*	0.049	+0.7	66	0.664	−02.5		
μ¹ Sco	49.8	−38 00	2.99v	−0.20	B1.5 V		−3.0	520	0.033	*−25*	Ecl. R 2.99–3.09, 1.4^{d}	
ζ Ara	56.1	−55 56	3.16	+1.61	(gK5)	0.036	+0.9	90	0.042	−06.0		
κ Oph	56.3	+09 26	3.18	+1.15	K2 III	0.026	−0.1	150	0.293	−55.6		
ζ Dra	17 08.7	+65 45	3.20	−0.12	B6 III	0.017	−3.2	620	0.026	−14.1		
η Oph *AB*	08.7	−15 41	2.46	+0.06	A2.5 V	0.047	+1.4	69	0.097	−00.9	A 3.0^{m} B 3.4^{m} 1″	*Sabik*
η Sco	10.0	−43 12	3.33	+0.38	*F2 III*	0.063	+2.3	52	0.293	−28.4		
α Her *AB*	13.3	+14 25	3.10v	+1.41	M5 II	−.007	−2.3	410	0.032	−33.1	A 3.2^{m} ± 0.3 B 5.4^{m} 5″	*Ras-Algethi*
δ Her	13.8	+24 52	3.14	+0.09	A3 IV	0.034	+0.8	96	0.164	−41		
π Her	14.0	+36 50	3.13	+1.43	K3 II	0.020	−2.4	410	0.029	−25.7		
θ Oph	20.2	−24 58	3.29	−0.22	B2 IV		−3.4	710	0.025	−03.6		
β Ara	22.8	−55 30	2.90	+1.45:	*K3 Ib*	0.026	−4.6	1030	0.035	−00.4		
γ Ara *A*	22.9	−56 21	3.32	−0.16	*B1 V*		−3.3	680	0.017	−04	B 10^{m} 18″	
υ Sco	28.7	−37 16	2.71	−0.22	*B2 IV*		−3.4	540	0.039	*+18*		
α Ara	29.5	−49 52	2.95	−0.18:	B2.5 V		−2.4	390	0.083	*−02*		
β Dra *A*	29.7	+52 20	2.77	+0.96	G2 II	0.009	−2.1	310	0.019	−20.0	B 11.49^{m} 4″	
λ Sco	31.6	−37 05	1.60	−0.24	B1 V		−3.3	310	0.031	00		*Shaula*
α Oph	33.5	+12 35	2.09	+0.16	A5 III	0.056	+0.8	58	0.260	+12.7		*Rasalhague*
θ Sco	35.2	−42 59	1.86	+0.39	*F0 Ib*	0.020	−4.6	650	0.012	+01.4		

Star	R.A. 1970	Dec.	*V*	*B−V*	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
κ Sco	17 40.4	−39 01	2.39	−0.21	*B2 IV*		−3.4	470	0.031	−10	
β Oph	42.0	+04 35	2.77	+1.16	K2 III	0.023	−0.1	124	0.160	−12.0	
μ Her *A*	45.3	+27 45	3.42	+0.75	G5 IV	0.108	+3.6	30	0.811	−15.6	*BC* 9.78^m 33″
$ι^1$ Sco	45.5	−40 06	2.99	+0.49	F2 Ia	0.013	−7.1	3400	0.004	*−27.6*	
G Sco	47.7	−37 02	3.21	+1.18	(gK1)	0.032	+0.7	102	0.064	+24.7	
γ Dra	55.9	+51 29	2.21	+1.52	K5 III	0.017	−0.4	108	0.026	−27.6	*Eltanin*
ν Oph	57.4	−09 47	3.32	+1.00	G9 III	0.015	+0.2	140	0.118	+12.4	
γ Sgr	18 03.9	−30 26	2.97	+1.00	*K0 III*	0.018	+0.1	124	0.200	*+22.1*	
η Sgr *A*	15.6	−36 47	3.17	+1.55	*M3 II*	0.038	+1.1:	86:	0.218	+00.5	*B* 10^m 4″
δ Sgr	19.1	−29 50	2.71	+1.39	*K2 III*	0.039	+0.7	84	0.050	−20.0	
η Ser	19.7	−02 54	3.23	+0.94	K0 III–IV	0.054	+1.9	60	0.894	+08.9	
ε Sgr	22.2	−34 24	1.81	−0.02	*B9 IV*	0.015	−1.1	124	0.135	−11	*Kaus Australis*
λ Sgr	26.1	−25 27	2.80	+1.05	*K2 III*	0.046	+1.1	71	0.194	−43.3	
α Lyr	35.9	+38 45	0.04	0.00	A0 V	0.123	+0.5	26.5	0.345	−13.9	***Vega***
φ Sgr	43.8	−27 02	3.20	−0.11	*B8 III*		−3.1	590	0.052	+21.5	
β Lyr *A*	49.0	+33 20	3.38v	−0.05:	Bpe	−.011	−4.6	1300	0.007	*−19.2*	Ecl. *R* 3.38–4.36, 12.9^d, *B* 7.8^m 46″
σ Sgr	53.4	−26 20	2.12	−0.21	B2 V		−2.7	300	0.059	−11	*Nunki*
$ξ^2$ Sgr	55.9	−21 08	3.51	+1.18:	(gK1)	0.006	+0.0	160	0.035	−19.9	
γ Lyr	57.8	+32 39	3.25	−0.05	B9 III	0.011	−2.1	370	0.007	−21.5	
ζ Sgr *AB*	19 00.7	−29 55	2.61	+0.08	*A2 IV*	0.020	+0.1	140	0.020	+22	*A* 3.3^m *B* 3.5^m 1″
ζ Aql *A*	04.0	+13 49	2.99	+0.01	A0 V: nn	0.036	+0.8	90	0.101	−26.3	*B* 12^m 5″
λ Aql	04.7	−04 56	3.44	−0.07	B9: V: n	0.025	−0.1	160	0.092	−14	
τ Sgr	05.1	−27 43	3.30	+1.18	(gK1)	0.038	+1.2	86	0.261	*+45.4*	
π Sgr *ABC*	08.0	−21 04	2.89	+0.35	F2 II–III	0.016	−0.7	250	0.040	−09.8	*A* 3.7^m *B* 3.8^m *C* 6.0^m < 1″
δ Dra	12.5	+67 37	3.06	+1.00	G9 III	0.028	+0.2	124	0.130	+24.8	
δ Aql	24.0	+03 03	3.38	+0.31	F0 IV	0.062	+2.3	53	0.267	*−29.9*	
β Cyg *A*	29.5	+27 54	3.07	+1.12	K3 II: + B:	0.004	−2.4	410	0.009	−24.0	*B* 5.11^m 35″ *Albireo*
δ Cyg *AB*	44.0	+45 04	2.87	−0.03	B9.5 III	0.021	−1.7	270	0.060	−21	*A* 2.91^m *B* 6.44^m 2″
γ Aql	44.8	+10 32	2.67	+1.48	K3 II	0.006	−2.4	340	0.012	−02.1	
α Aql	49.3	+08 47	0.77	+0.22	A7 IV, V	0.198	+2.2	16.5	0.658	−26.3	***Altair***

Star	R.A. 1970	Dec.	V	$B-V$	Type	π	M_V	D	μ	R	
	h m	° ′				″		l.y.	″	km./sec.	
θ Aql	20 09.8	−00 54	3.31	−0.07	B9.5 III	0.008	−1.7	330	0.034	*−27.3*	
β Cap *A*	19.3	−14 53	3.06	+0.76	comp.	0.005	+0.1	130	0.039	−18.9	Type gK0: + late B; *B* 5.97ᵐ 205″
γ Cyg	21.1	+40 09	2.22	+0.66	F8 Ib	−.006	−4.6	750	0.001	−07.5	
α Pav	23.3	−56 50	1.95	−0.20	*B3 IV*		−2.9	310	0.087	*+02.0*	*Peacock*
α Ind	35.5	−47 23	3.11	+1.00	*K0 III*	0.039	+1.1	84	0.082	−01.1	
α Cyg	40.4	+45 10	1.26	+0.09	A2 Ia	−.013	−7.1	1600	0.003	−04.6	**Deneb**
β Pav	42.3	−66 19	3.45	+0.16	*A5 III*	0.026	−0.1	160	0.046	+09.8	
η Cep	44.7	+61 43	3.41	+0.92	K0 IV	0.071	+2.7	46	0.825	−87.3	
ε Cyg	45.0	+33 51	2.46	+1.03	K0 III	0.044	+0.7	74	0.481	*−10.3*	
ζ Cyg	21 11.7	+30 06	3.25:		G8 II	0.021	−2.2	390	0.056	+17.4	
α Cep	17.9	+62 28	2.44	+0.24	A7 IV, V	0.063	+1.4	52	0.156	−10	*Alderamin*
β Cep	28.3	+70 25	3.15v	−0.22v	B2 III	0.005	−4.2	980	0.014	−08.2	β CMa *R* 3.14–3.16, 0.19ᵈ
β Aqr	30.0	−05 43	2.86	+0.82	G0 Ib	0.000	−4.6	1030	0.017	+06.5	
ε Peg *A*	42.7	+09 45	2.31	+1.55	K2 Ib	−.005	−4.6	780	0.025	+04.7	*B* 11ᵐ 82″ *Enif*
δ Cap	45.4	−16 16	2.92v	+0.29	A6m	0.065	+2.0	50	0.392	*−06.3*	Var. *R* 2.88–2.95
γ Gru	52.1	−37 30	3.03	−0.10	*B8 III:*	0.008	−3.1	540	0.102	−02.1	
α Aqr	22 04.2	−00 28	2.96	+0.96	G2 Ib	0.003	−4.6	1080	0.016	+07.5	
α Gru	06.3	−47 07	1.76	−0.14	*B5 V*	0.051	+0.3:	64:	0.194	+11.8	*Al Na'ir*
ζ Cep	09.8	+58 03	3.31	+1.55	K1 Ib	0.019	−4.6	1240	0.015	*−18.4*	
α Tuc	16.4	−60 24	2.87	+1.40	*K3 III–IV*	0.019	+1.5	62	0.079	*+42.2*	
δ Cep *A*	28.1	+58 16	3.96v	+0.66v	F5–G2 Ib	0.005	−4.0	1300	0.012	*−16.8*	Cep. *R* 3.51–4.42, 5.4ᵈ, *B* 6.19ᵐ 41″
ζ Peg	40.0	+10 41	3.40:	−0.08:	B8 V	−.004	−0.6	210	0.077	+07	
β Gru	40.9	−47 02	2.17v	+1.59	*M3 II*	0.003	−2.5	280	0.134	+01.6	Var. *R* 2.11–2.23
η Peg	41.6	+30 04	2.95	+0.85	G8 II: + F?	−.002	−2.2	360	0.027	*+04.3*	
δ Aqr	53.1	−15 59	3.28	+0.08	A3 V	0.039	+1.2	84	0.047	+18.0	
α PsA	56.0	−29 47	1 19	+0.10	A3 V	0.144	+2.0	22.6	0.367	+06.5	**Fomalhaut**
β Peg	23 02.3	+27 55	2.5 v	+1.67	M2 II–III	0.015	−1.5	210	0.234	+08.7	Var. *R* 2.4–2.7 *Scheat*
α Peg	03.3	+15 02	2.50	−0.03	B9.5 III	0.030	−0.1	109	0.071	−03.5	*Markab*
γ Cep	38.1	+77 27	3.20	+1.02	K1 IV	0.064	+2.2	51	0.168	−42.4	

DOUBLE AND MULTIPLE STARS

By Charles E. Worley

Many stars can be separated into two or more components by use of a telescope. The larger the aperture of the telescope, the closer the stars which can be separated under good seeing conditions. With telescopes of moderate size and average optical quality, and for stars which are not unduly faint or of large magnitude difference, the minimum angular separation is given by 4.6/D, where D is the diameter of the telescope's objective in inches.

The following lists contain some interesting examples of double stars. The first list presents pairs whose orbital motions are very slow. Consequently, their angular separations remain relatively fixed and these pairs are suitable for testing the performance of small telescopes. In the second list are pairs of more general interest, including a number of binaries of short period for which the position angles and separations are changing rapidly.

In both lists the columns give, successively; the star designation in two forms; its right ascension and declination for 1970; the combined visual magnitude of the pair and the individual magnitudes; the apparent separation and position angle for 1967.0; and the period, if known.

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

Star		A.D.S.	R.A. 1970		Dec. 1970		Magnitudes			Sep. 1967.0	P.A. 1967.0	P (app.)
			h	m	°	′	comb.	A	B	″	°	years
λ	Cas	434	00	30.1	+54	22	4.9	5.5	5.8	0.6	178	640
α	Psc	1615	02	00.4	+02	37	4.0	4.3	5.3	1.9	290	720
33	Ori	4123	05	29.6	+03	16	5.7	6.0	7.3	1.8	27	—
OΣ	156	5447	06	45.7	+18	14	6.1	6.8	7.0	0.5	254	1,100
Σ	1338	7307	09	19.2	+38	19	5.8	6.5	6.7	1.1	234	220
35	Com	8695	12	51.8	+21	25	5.1*	5.2	7.4	0.9	153	670
Σ	2054	10052	16	23.3	+61	45	5.6	6.0	7.2	1.1	355	—
ϵ^1	Lyr†	11635	18	43.4	+39	39	5.1	5.4	6.5	2.8	358	1,200
ϵ^2	Lyr†	11635	18	43.4	+39	36	4.4	5.1	5.3	2.2	97	600
π	Aql	12962	19	47.4	+11	44	5.6	6.0	6.8	1.4	110	—
σ	Cas	17140	23	57.4	+55	36	5.2	5.4	7.5	3.0	326	—
η	Cas	671	00	47.3	+57	39	3.5*	3.5	7.2	11.3	300	480
Σ	186	1538	01	54.3	+01	42	6.0	6.8	6.8	1.4	53	160
γ	And AB	1630	02	02.0	+42	12	2.1*	2.1	5.4	9.8	64	—
α	C Ma	5423	06	43.9	−16	41	−1.4	−1.4	8.5	10.8	74	50
α	Gem	6175	07	32.7	+31	58	1.6	2.0	2.8	1.9	143	420
ζ	Cnc AB	6650	08	10.4	+17	44	5.0	5.6	5.9	1.1	341	60
ζ	Cnc AC	6650	08	10.4	+17	44	5.2	5.4	7.3	5.6	82	1,150
+42° 1956		KUI	08	58.7	+41	53	3.9	4.1	6.2	0.5	271	22
γ	Leo	7724	10	18.3	+20	00	1.8	2.1	3.4	4.4	122	620
ξ	U Ma AB	8119	11	16.7	+31	42	3.8	4.3	4.8	2.8	130	60
γ	Vir	8630	12	40.1	−01	18	2.8	3.5	3.5	4.7	305	170
Σ	1785	9031	13	47.7	+27	08	7.0	7.6	8.0	3.2	150	155
ζ	Boo	9343	14	39.8	+13	52	3.8	4.5	4.5	1.2	307	125
ξ	Boo	9413	14	50.0	+19	14	4.5	4.7	6.8	7.0	342	150
ζ	Her	10157	16	40.2	+31	39	2.8	2.9	5.5	0.5	322	35
α	Her AB	10418	17	13.3	+14	26	3.1*	3.2	5.4	4.6	108	—
Σ	2173	10598	17	28.8	−01	02	5.3	6.0	6.1	0.8	149	45
70	Oph	11046	18	03.9	+02	32	4.0	4.2	6.0	3.0	71	88
β	648	11871	18	56.0	+32	52	5.2	5.4	7.5	0.7	199	60
4	Aqr	14360	20	49.9	−05	45	6.0	6.4	7.2	1.0	6	150
τ	Cyg	14787	21	13.6	+37	54	3.7	3.8	6.4	0.9	198	50
Σ	3050	17149	23	57.9	+33	34	5.8	6.5	6.7	1.5	290	800

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

THE NEAREST STARS

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

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

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

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

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

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

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

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

*Deceased

THE NEAREST STARS

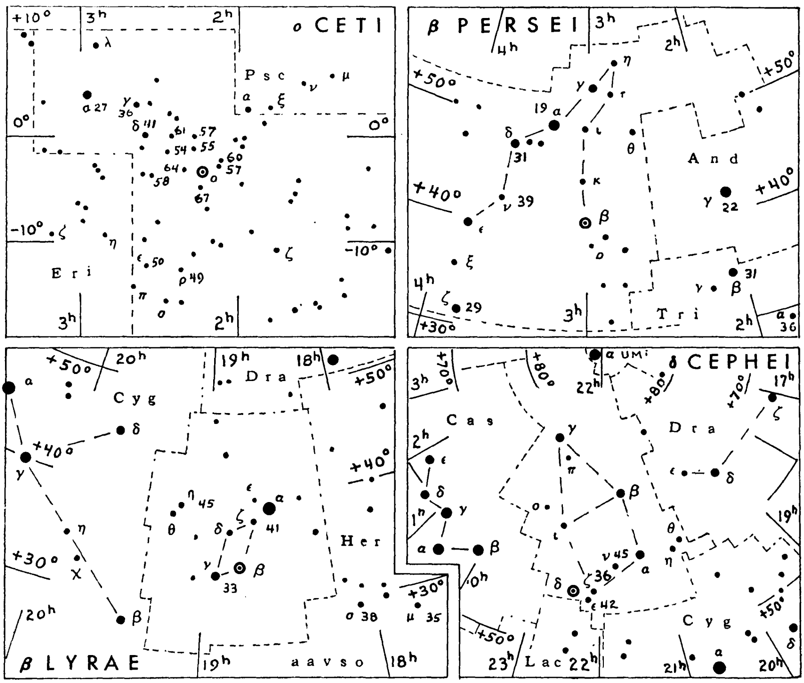
Star	1970				Sp.	π	D	μ	W	m	L
	α		δ								
	h	m	°	′		″	l.y.	″	km./sec.		
Sun					G2					-26.9	1.0
α Cen A	14	37	−60	43	G2	0.751	4.3	3.68	34	0.0	1.0
B					K1					1.4	0.28
C	14	27	−62	33	M5*e*					11	0.000052
Barnard's *	17	56	+ 4	36	M5	.545	6.0	10.30	141	9.5	0.00040
Wolf 359	10	55	+ 7	13	M6*e*	.421	7.7	4.84	56	13.5	0.000017
Luy. 726-8A	1	37	−18	07	M6*e*	.410	7.9	3.35	48	12.5	0.00004
B					M6*e*					13.0	0.00003
Lal. 21185*	11	02	+36	10	M2	.398	8.2	4.78	103	7.5	0.0048
Sirius A	6	44	−16	41	A1	.375	8.7	1.32	18	−1.4	23.
B					*wd*					7.1	0.008
Ross 154	18	48	−23	51	M5*e*	.351	9.3	0.67	10	10.6	0.00036
Ross 248	23	40	+44	01	M6*e*	.316	10.3	1.58	84	12.2	0.00010
ε Eri	3	32	− 9	34	K2	.303	10.8	0.97	21	3.8	0.25
Ross 128	11	46	+ 1	01	M5	.298	10.9	1.40	26	11.1	0.00030
61 Cyg* A	21	06	+38	36	K6	.293	11.1	5.22	106	5.6	0.052
B					M0					6.3	0.028
Luy. 789-6	22	37	−15	31	M6	.292	11.2	3.27	80	12.2	0.00012
Procyon A	7	38	+ 5	18	F5	.288	11.3	1.25	20	0.4	5.8
B					*wd*					10.8	0.00044
ε Ind	22	02	−56	55	K5	.285	11.4	4.67	87	4.7	0.12
Σ 2398 A	18	42	+59	35	M4	.280	11.6	2.29	38	8.9	0.0028
B					M4					9.7	0.0013
Groom. 34 A	0	17	+43	51	M2*e*	.278	11.7	2.91	51	8.1	0.0058
B					M4*e*					10.9	0.00044
τ Ceti	1	43	−16	06	G8	.275	11.8	1.92	37	3.5	0.36
Lac. 9352	23	04	−36	02	M2	.273	11.9	6.87	118	7.2	0.013
BD +5°1668	7	26	+ 5	28	M4	.263	12.4	3.73	72	10.1	0.0010
Lacaille 8760	21	15	−39	00	M1	.255	12.8	3.46	68	6.6	0.028
Kapteyn's	5	11	−45	00	M0	.251	13.0	8.79	275	9.2	0.0025
Kruger 60 A	22	27	+57	33	M4	.249	13.1	0.87	29	9.9	0.0013
B					M5*e*					11.4	0.00033
Ross 614 A	6	28	− 2	48	M5*e*	.248	13.1	0.97	30	10.9	0.00052
B					?					14.8	0.000016
BD−12°4523	16	29	−12	35	M5	.244	13.4	1.24	27	10.0	0.0013
van Maanen's	0	47	+ 5	16	*wd*F	.236	13.8	2.98	64	12.3	0.00016
Wolf 424 A	12	32	+ 9	12	M6*e*	.223	14.6	1.87	40	12.6	0.00014
B					M6*e*					12.6	0.00014
Groom. 1618	10	09	+49	36	K5	.222	14.7	1.45	41	6.8	0.030
CD−37°15492	0	03	−37	30	M3	.219	14.9	6.09	134	8.6	0.0058
CD−46°11540	17	27	−46	53	M4	.213	15.3	1.15		9.7	0.0023
BD+20°2465*	10	18	+20	01	M4*e*	.211	15.4	0.49	15	9.5	0.0028
CD−44°11909	17	36	−44	17	M5	.209	15.6	1.14		11.2	0.00058
CD−49°13515	21	31	−49	08	M3	.209	15.6	0.78		9	0.0044
AOe 17415-6	17	37	+68	22	M3	.206	15.8	1.31	34	9.1	0.0040
Ross 780	22	51	−14	25	M5	.206	15.8	1.12	28	10.2	0.0014
Lal. 25372	13	44	+15	04	M2	.205	15.9	2.30	55	8.6	0.0063
CC 658	11	44	−64	39	*wd*	.203	16.0	2.69		11	0.0008
o² Eri A	4	14	− 7	42	K0	.200	16.3	4.08	105	4.5	0.30
B					*wd*A					9.2	0.0040
C					M5*e*					11.0	0.0008
70 Oph A	18	04	+ 2	31	K1	.199	16.4	1.13	28	4.2	0.40
B					K5					5.9	0.083
Altair	19	49	+ 8	47	A7	.198	16.5	0.66	31	0.8	8.3
BD+43°4305	22	46	+44	11	M5*e*	.198	16.5	0.84	20	10.2	0.0016
AC 79°3888	11	45	+78	50	M4	0.196	16.6	0.87	121	11.0	0.0008

*Star has an unseen component.

VARIABLE STARS

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

In the tables the first column, the Harvard designation of the star, gives the 1900 position: the first four figures give the hours and minutes of R.A., the last two figures give the Dec. in degrees, italicised for southern declinations. The column headed *Max.* gives the mean maximum magnitude. The *Period* is in days. The *Epoch* gives the predicted date of the *earliest* maximum occurring this year; by adding the period to this epoch other dates of maximum may be found. The list of long-period variables has been prepared by the American Association of Variable Star Observers and includes the variables with maxima brighter than mag. 8.0, and north of Dec. −20°. These variables may reach maximum two or three weeks before or after the listed epoch and may remain at maximum for several weeks. The second table contains stars which are representative of other types of variable. The data are taken from "The General Catalogue of Variable Stars" by Kukarkin and Parenago and for eclipsing binaries from *Rocznik Astronomiczny Obserwatorium Krakowskiego,* 1966, International Supplement.



LONG-PERIOD VARIABLE STARS

Variable	Max. m	Per d	Epoch 1967	Variable	Max. m	Per d	Epoch 1967
001755 T Cas	7.8	445	June 26	143227 R Boo	7.2	223	Apr. 29
001838 R And	7.0	409	Nov. 25	151731 S CrB	7.3	361	Mar. 13
021143 W And	7.4	397	Mar. 20	154639 V CrB	7.5	358	Jan. 1
0214*03* o Cet	3.4	332	Oct. 18	154615 R Ser	6.9	357	Jan. 1
0228*13* U Cet	7.5	235	Mar. 9	160625 RU Her	8.0	484	Apr. 9
023133 R Tri	6.2	266	Apr. 12	162119 U Her	7.5	406	June 20
043065 T Cam	8.0	374	Nov. 5	1621*12* V Oph	7.5	298	Aug. 18
0455*14* R Lep	6.8	432	Jan. 17	163266 R Dra	7.6	245	Apr. 23
050953 R Aur	7.7	459	...	164715 S Her	7.6	307	Feb. 11
054920 U Ori	6.3	372	June 28	1702*15* R Oph	7.9	302	Sept. 1
0617*02* V Mon	7.0	335	Mar. 16	171723 RS Her	7.9	219	June 13
065355 R Lyn	7.9	379	Jan. 1	180531 T Her	8.0	165	Feb. 17
070122a R Gem	7.1	370	May 2	181136 W Lyr	7.9	196	Feb. 16
070310 R CMi	8.0	338	June 2	183308 X Oph	6.8	334	Jan. 1
072708 S CMi	7.5	332	Feb. 28	190108 R Aql	6.1	300	June 28
081112 R Cnc	6.8	362	Feb. 5	1910*17* T Sgr	8.0	392	Sept. 30
081617 V Cnc	7.9	272	July 5	1910*19* R Sgr	6.3	269	Apr. 6
084803 S Hya	7.8	257	May 18	193449 R Cyg	7.5	426	...
0850*08* T Hya	7.8	288	Mar. 15	194048 RT Cyg	7.3	190	May 27
093934 R LMi	7.1	372	Jan. 2	194632 χ Cyg	5.2	407	June 17
094211 R Leo	5.8	313	Jan. 17	200938 RS Cyg	7.2	418	Oct. 31
103769 R UMa	7.5	302	Apr. 1	201647 U Cyg	7.2	465	Jan. 9
1214*18* R Crv	7.5	317	Apr. 26	2044*05* T Aqr	7.7	202	Jan. 23
122001 SS Vir	6.8	355	Apr. 22	210868 T Cep	6.0	390	Jan. 28
123160 T UMa	7.7	257	Sept. 6	213753 RU Cyg	8.0	234	Apr. 6
123307 R Vir	6.9	146	Mar. 12	230110 R Peg	7.8	378	Nov. 1
123961 S UMa	7.8	226	June 22	230759 V Cas	7.9	228	Jan. 12
131546 V CVn	6.8	192	Jan. 3	231508 S Peg	8.0	319	Feb. 27
1327*06* S Vir	7.0	378	Oct. 19	2338*15* R Aqr	6.5	387	June 28
134440 R CVn	7.7	328	May 26	235350 R Cas	7.0	431	Oct. 6
142584 R Cam	7.9	270	June 8	2357*15* W Cet	7.6	351	May 17
142539 V Boo	7.9	258	May 19				

OTHER TYPES OF VARIABLE STARS

Variable	Max. m	Min. m	Type	Sp. Cl.	Period d	Epoch 1967 E.S.T.
005381 U Cep	6.7	9.8	Ecl	B8+gG2	2.49295	Jan. 2.42*
0258*38* ρ Per	3.3	4.0	Semi R	M4	33–55, 1100	
030140 β Per	2.1	3.3	Ecl	B8+G	2.86731	Jan. 3.27*
035512 λ Tau	3.5	4.0	Ecl	B3	3.952952	Jan. 2.08*
060822 η Gem	3.1	3.9	Semi R	M3	233.4	. . .
061907 T Mon	6.4	8.0	δ Cep	F7–K1	27.0205	Jan. 23.17
065820 ζ Gem	4.4	5.2	δ Cep	F7–G3	10.15172	Jan. 1.65
154428 R Cr B	5.8	14.8	R Cr B	cFpep		
171014 α Her	3.0	4.0	Semi R	M5	50–130, 6 yrs.	
1842*05* R Sct	6.3	8.6	RVTau	G0e-K0p	144	
184633 β Lyr	3.4	4.3	Ecl	B8	12.931163	Jan. 5.44*
192242 RR Lyr	6.9	8.0	RR Lyr	A2–F1	0.5668223	Jan. 1.13
194700 η Aql	4.1	5.2	δ Cep	F6–G4	7.176641	Jan. 2.67
222557 δ Cep	4.1	5.2	δ Cep	F5–G2	5.366341	Jan. 3.13

*Minimum

STAR CLUSTERS

By T. Schmidt-Kaler

The star clusters for this list have been selected to include those most conspicuous. Two types of clusters can be recognized: open (or galactic), and globular. Globulars appear as highly symmetrical agglomerations of very large numbers of stars, distributed throughout the galactic halo but concentrated toward the centre of the Galaxy. Their colour-magnitude diagrams are typical for the old stellar population II. Open clusters appear usually as irregular aggregates of stars, sometimes barely distinguished from random fluctuations of the general field. They are concentrated to the galactic disk, with colour-magnitude diagrams typical for the stellar population I of the normal stars of the solar neighbourhood.

The first table includes all well-defined open clusters with diameters greater than 40′ or integrated magnitudes brighter than 5.0, as well as the richest clusters and some of special interest. *NGC* indicates the serial number of the cluster in Dreyer's *New General Catalogue of Clusters and Nebulae*, *M*, its number in Messier's catalogue, α and δ denote right ascension and declination, *P*, the apparent integrated photographic magnitude according to Collinder (1931), *D*, the apparent diameter in minutes of arc according to Trumpler (1930) when possible, in one case from Collinder; *m*, the photographic magnitude of the fifth-brightest star according to Shapley (1933) when possible or from new data, in italics; *r*, the distance of the cluster in kpcs (1 kpc = 3263 light-years), as a mean from the values given by Johnson, Hoag *et al.* (1961), and by Becker (1963/64), in a few cases from other sources, with values in italics from Trumpler; *Sp*, the earliest spectral type of cluster stars as determined from three-colour photometry, or from spectral types in italics. The spectral type also indicates the age of the cluster, expressed in millions of years, thus: O5 = 0.5; b0 = 5; b5 = 50; a0 = 300; a5 = 1000; f0 = 3000; f5 = 10,000.

The second table includes all globular clusters with a total apparent photographic magnitude brighter than 7.6. The first three columns are as in the first table, followed by *B*, the total photographic magnitude; *D*, the apparent diameter in minutes of arc containing 90 per cent of the stars, and in italics, total diameters from miscellaneous sources; *Sp*, the integrated spectral type; *m*, the mean blue magnitude of the 25 brightest stars (excluding the five brightest); *N*, the number of known variables; *r*, the distance in kpcs (absolute magnitude of RR Lyrae variables taken as $M_B = +0.5$); *V*, the radial velocity in km/sec. The data are taken from a compilation by Arp (1965); in case no data were available there, various other sources have been used, especially H. S. Hogg's Bibliography (1963).

Open Clusters

NGC	α 1970 δ		P	D	m	r	Sp	Remarks
	h m	° ′						
188	00 41.0	+85 11	9.3	14	14.6	1.55	f5	oldest known
752	01 56.0	+37 32	6.6	45	9.6	0.38	f0	
869	02 16.9	+57 01	4.3	30	9.5	2.26	b0	h Per
884	02 20.3	+56 59	4.4	30	9.5	2.41	b0	χ Per, M supergiants
Perseus	03 20	+48 30	2.3	240	5	0.17	b3	moving cl., α Per
Pleiades	03 45.3	+24 02	1.6	120	4.2	0.125	b7	M45, best known
Hyades	04 18	+15 34	0.8	400	*1.5*	0.040	a2	moving cl. in Tau*
1912	05 26.6	+35 49	7.0	18	9.7	1.37	b8	
1976/80	05 33.9	−05 57	2.5	50	*5.5*	0.42	O5	Trapezium, very young
2099	05 50.4	+32 32	6.2	24	9.7	1.28	b8	M37
2168	06 07.0	+24 21	5.6	29	9.0	0.87	b5	M35
2232	06 25.0	−04 44	4.1	*20*	*7*	*0.49*	*b3*	
2244	06 30.8	+04 53	5.2	27	*8.0*	1.65	O5	Rosette, very young
2264	06 39.4	+09 55	4.1	30	*8.0*	0.73	O9	S Mon
2287	06 45.8	−20 42	5.0	32	*8.8*	0.67	b3	M41
2362	07 17.6	−24 53	3.8	7	9.4	1.53	b0	τ CMa

*Basic for distance determination.

NGC	α 1970 δ		P	D	m	r	Sp	Remarks
	h m	° ′						
2422	07 34.2	−14 26	4.3	30	9.8	0.48	b4	
2437	07 40.4	−14 45	6.6	27	10.8	1.66	b3	M46
2451	07 44.3	−37 54	3.7	37	6	*0.29*	*b3*	
2516	07 57.8	−60 49	3.3	50	10.1	0.37	b9	
2546	08 11.4	−37 33	5.0	45	7	0.74	b0	
2632	08 38.4	+20 06	3.9	90	7.5	0.158	a5	Praesepe, M44
IC2391	08 39.4	−52 57	2.6	45	3.5	0.15	b3	
IC2395	08 40.1	−48 05	4.6	20	10.1	0.90	b2	
2682	08 48.8	+11 56	7.4	18	10.8	0.83	f2	M67, old cl.
3114	10 01.7	−59 58	4.5	37	7	0.85	b6	
IC2602	10 42.2	−64 14	1.6	65	6	0.16	b2	θ Car
Tr 16	10 44.0	−59 33	6.7	10	10	1.95	b0	η Car and nebula
3532	11 05.1	−58 30	3.4	55	8.1	0.42	b9	
3766	11 34.7	−61 27	4.4	12	8.1	1.63	b0	
Coma	12 23.6	+26 16	2.9	300	5.5	0.08	a2	Very sparse cl.
4755	12 51.8	−60 10	5.2	12	7	1.34	b3	κ Cru, "jewel box"
6067	16 10.9	−54 08	6.5	16	10.9	2.10	b3	G and K supergiants
6231	16 51.9	−41 45	8.5	16	7.5	1.82	O5	O supergiants, WR-stars
Tr24	16 54.9	−40 37	8.5	60	*7.3*	*0.58*	*O5*	
6405	17 38.1	−32 12	4.6	26	8.3	0.57	b4	M6
IC4665	17 45.2	+05 44	5.4	50	7	0.33	b5	
6475	17 51.9	−34 48	3.3	50	7.4	0.24	b8	M7
6494	17 55.1	−19 01	5.9	27	10.2	0.55	b9	M23
6523	18 01.3	−24 23	5.2	45	7	1.47	O5	M8, Lagoon neb. and very young cl. NGC6530
6611	18 17.2	−13 48	6.6	8	10.6	1.90	O5	M16, nebula
IC4725	18 29.9	−19 16	6.2	35	9.3	0.60	b3	M25, Cepheid, U Sgr
IC4756	18 37.8	+05 25	5.4	50	8.5	*0.41*	*b9*	
6705	18 49.5	−06 19	6.8	12.5	12	1.72	b8	M11, very rich cl.
Me1227	20 06.7	−79 25	5.2	60	*9*	*0.24*	*b9*	
IC1396	21 38.0	+57 22	5.1	60	*8.5*	*0.73*	*O6*	Tr 37
7790	23 56.9	+61	7.1	4.5	11.7	3.39	b4	3 Ceph: CEa, CEb, CF Cas

Globular Clusters

NGC	M	α 1970 δ		B	D	Sp	m	N	r	V
		h m	° ′							
104	47 Tuc	00 22.6	−72 14	4.35	*44*	G3	13.54	11	5	−24
1851		05 13.0	−40 03	7.72:	*11.5*	F7		3	14.0	+309
2808		09 11.3	−64 44	7.4	*18.8*	F8	15.09	4	9.1	+101
5139	ω Cen	13 25.0	−47 09	4.5	*65.4*	F7	13.01	165	5.2	+230
5272	3	13 40.8	+28 32	6.86	9.3	F7	14.35	189	10.6	−153
5904	5	15 17.0	+02 12	6.69	10.7	F6	14.07	97	8.1	+49
6121	4	16 21.8	−26 27	7.05	22.6	*G0*	13.21	43	4.3	+65
6205	13	16 40.6	+36 31	6.43	12.9	F6	13.85	10	6.3	−241
6218	12	16 45.6	−01 54	7.58	21.5	F8	14.07	1	7.4	−16
6254	10	16 55.5	−04 04	7.26	16.2	G1	14.17	3	6.2	+71
6341	92	17 16.2	+43 11	6.94	12.3	F1	13.96	16	7.9	−118
6397		17 38.4	−53 40	6.9	*19*	F5	12.71	3	2.9	+11
6541		18 05.8	−43 45	7.5	*23.2*	F6	13.45	1	4.0	−148
6656	22	18 34.5	−23 57	6.15	26.2	F7	13.73	24	3.0	−144
6723		18 57.6	−36 40	7.37	11.7	G4	14.32	19	7.4	−3
6752		19 08.2	−60 02	6.8	*41.9*	F6	13.36	1	5.3	−39
6809	55	19 38.2	−31 00	6.72	21.1	F5	13.68	6	6.0	+170
7078	15	21 28.6	+12 02	6.96	9.4	F2	14.44	103	10.5	−107
7089	2	21 31.9	−00 58	6.94	6.8	F4	14.77	22	12.3	−5

GALACTIC NEBULAE

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

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

EXTERNAL GALAXIES

By S. van den Bergh

Among the hundreds of thousands of systems far beyond our own Galaxy relatively few are readily seen in small telescopes. The first list contains the brightest galaxies. The first four columns give the catalogue numbers and position. In the column *Type*, *E* indicates elliptical, *I*, irregular, and *Sa*, *Sb*, *Sc*, spiral galaxies, in which the arms are more open going from *a* to *c*. Roman numerals I, II, III, IV, and V refer to supergiant, bright giant, giant, subgiant and dwarf galaxies respectively; *p* means "peculiar". The remaining columns give the apparent photographic magnitude, the angular dimensions and the distance in millions of light-years.

The second list contains the nearest galaxies and includes the photographic distance modulus $(m - M)_{pg}$, and the absolute photographic magnitude, M_{pg}.

The Brightest Galaxies

NGC or name	M	α 1970	δ	Type	m_{pg}	Dimensions	Distance millions of l.y.
		h m	° ′			′ ′	
55		00 13.5	−39 23	Sc or Ir	7.9	30×5	7.5
205		00 38.7	+41 32	E6p	8.89	12×6	2.1
221	32	00 41.1	+40 43	E2	9.06	3.4×2.9	2.1
224	31	00 41.1	+41 07	Sb I–II	4.33	163×42	2.1
247		00 45.6	−20 54	S IV	9.47	21×8.4	7.5
253		00 46.1	−25 27	Scp	7.0:	22×4.6	7.5
SMC		00 51.7	−72 59	Ir IV or IV–V	2.86	216×216	0.2
300		00 53.5	−37 51	Sc III–IV	8.66	22×16.5	7.5
598	33	01 32.2	+30 30	Sc II–III	6.19	61×42	2.4
Fornax		02 38.3	−34 39	dE	9.1:	50×35	0.4
LMC		05 23.8	−69 47	Ir or Sc III–IV	0.86	432×432	0.2
2403		07 33.9	+65 40	Sc III	8.80	22×12	6.5
2903		09 30.4	+21 39	Sb I–II	9.48	16×6.8	19.0
3031	81	09 53.1	+69 12	Sb I–II	7.85	25×12	6.5
3034	82	09 53.6	+69 50	Scp:	9.20	10×1.5	6.5
4258		12 17.5	+47 28	Sbp	8.90	19×7	14.0
4472	49	12 28.3	+08 09	E4	9.33	9.8×6.6	37.0
4594	104	12 38.3	−11 28	Sb	9.18	7.9×4.7	37.0
4736	94	12 49.5	+41 16	Sbp II:	8.91	13×12	14.0
4826	64	12 55.3	+21 51	?	9.27	10×3.8	12.0:
4945		13 03.5	−49 19	Sb III	8.0	20×4	—
5055	63	13 14.4	+42 11	Sb II	9.26	8.0×3.0	14.0
5128		13 23.6	−42 51	E0p	7.87	23×20	—
5194	51	13 28.6	+47 21	Sc I	8.88	11×6.5	14.0
5236	83	13 35.4	−29 43	Sc I–II	7.0:	13×12	8.0:
5457	101	14 02.1	+54 29	Sc I	8.20	23×21	14.0
6822		19 43.2	−14 50	Ir IV–V	9.21	20×10	1.7

The Nearest Galaxies

Name	NGC	α 1970 h	m	δ °	′	m_{pg}	$(m-M)_{pg}$	M_{pg}	Type	Dist. thous. of l.y.
M31	224	00	41.1	+41	07	4.33	24.65	−20.3	Sb I–II	2,100
Galaxy		—		—		—	—	?	Sb or Sc	—
M33	598	01	32.2	+30	30	6.19	24.70	−18.5	ScII–III	2,400
LMC		05	23.8	−69	47	0.86	18.65	−17.8	Ir or SBc III–IV	160
SMC		00	51.7	−72	59	2.86	19.05	−16.2	Ir IV or IV–V	190
NGC	205	00	38.7	+41	32	8.89	24.65	−15.8	E6p	2,100
M32	221	00	41.1	+40	43	9.06	24.65	−15.6	E2	2,100
NGC	6822	19	43.2	−14	50	9.21	24.55	−15.3	Ir IV-V	1,700
NGC	185	00	37.2	+48	11	10.29	24.65	−14.4	E0	2,100
IC1613		01	03.5	+01	58	10.00	24.40	−14.4	Ir V	2,400
NGC	147	00	31.5	+48	11	10.57	24.65	−14.1	dE4	2,100
Fornax		02	38.3	−34	39	9.1:	20.6:	−12:	dE	430:
Leo I		10	06.9	+12	27	11.27	21.8:	−10:	dE	750:
Sculptor		00	58.4	−33	52	10.5	19.70	−9.2	dE	280
Leo II		11	11.9	+22	19	12.85	21.8:	−9:	dE	750:
Draco		17	19.7	+57	57	—	19.50	?	dE	260
Ursa Minor		15	08.4	+67	13	—	19.40	?	dE	250

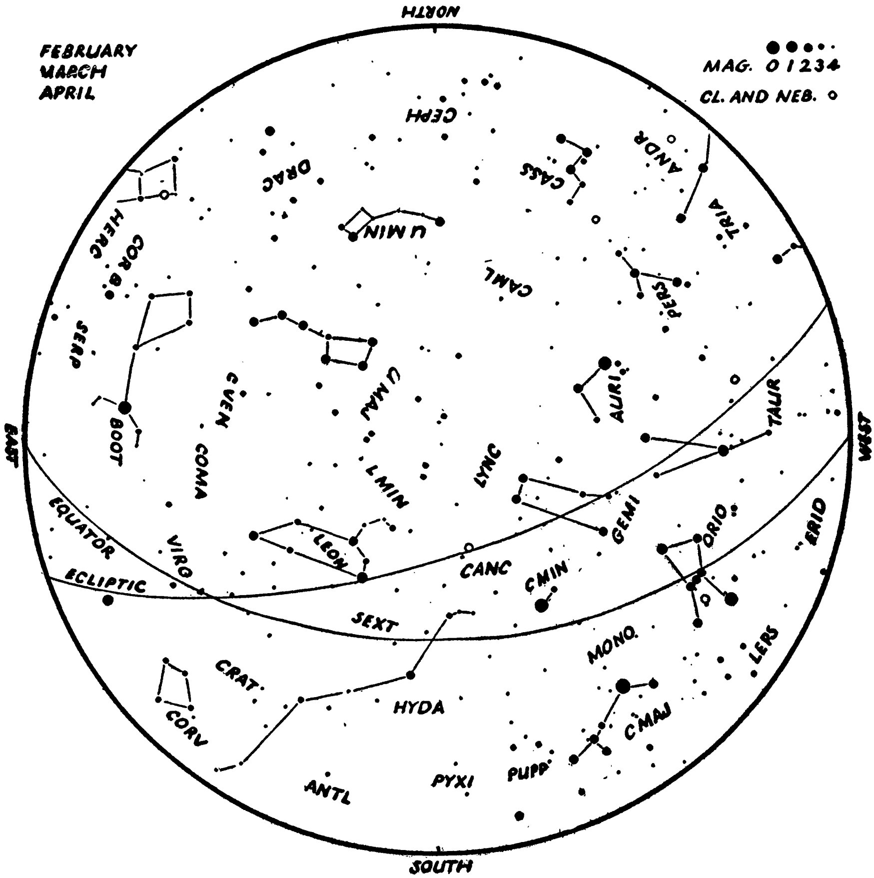
RADIO SOURCES

By John Galt

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

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

STAR MAP I

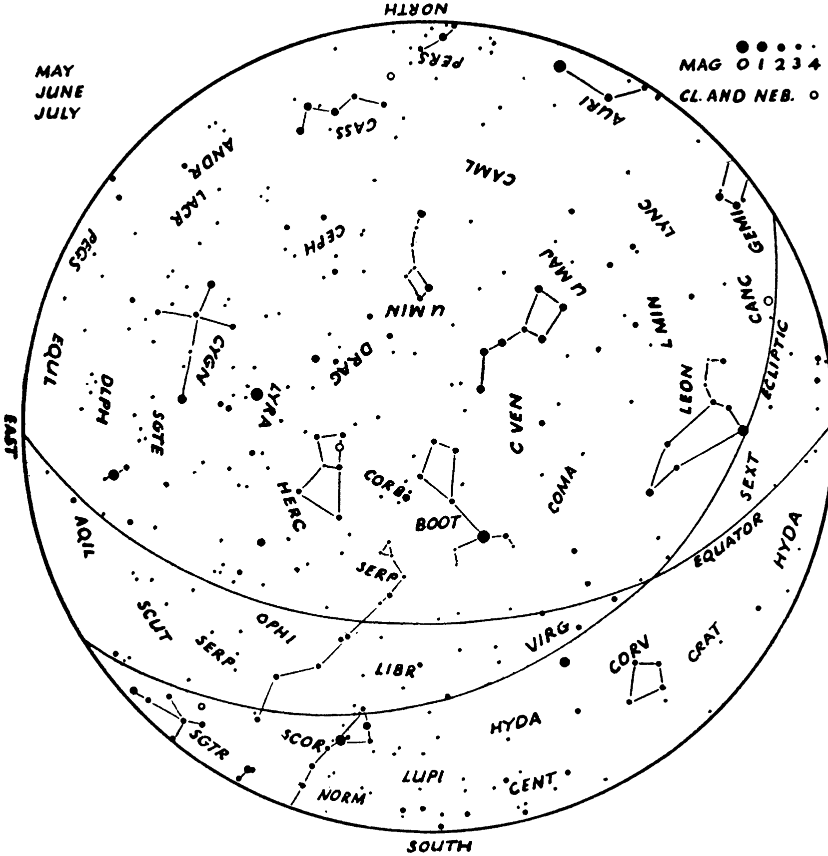


The above map represents the evening sky at

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

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

STAR MAP 2

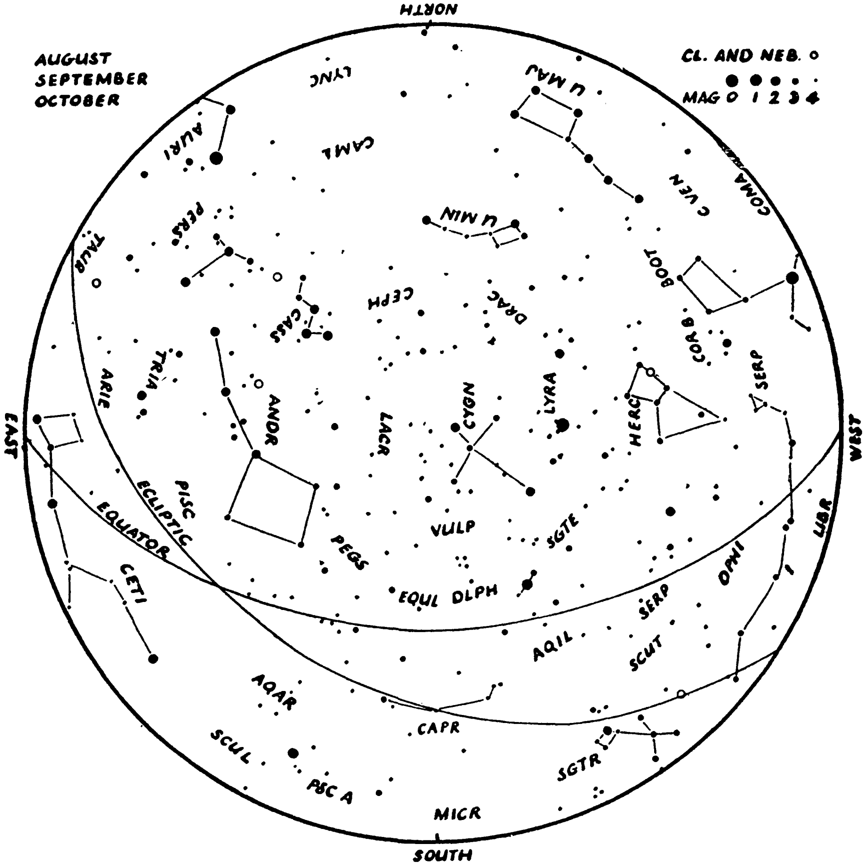


The above map represents the evening sky at

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

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

STAR MAP 3

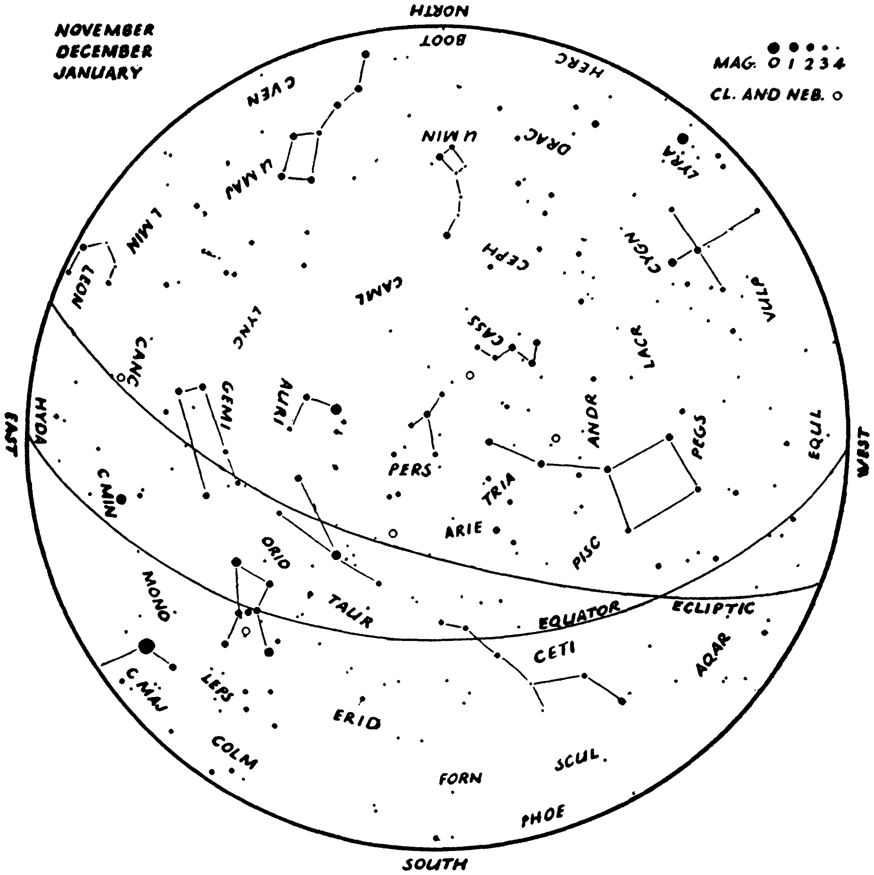


The above map represents the evening sky at

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

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

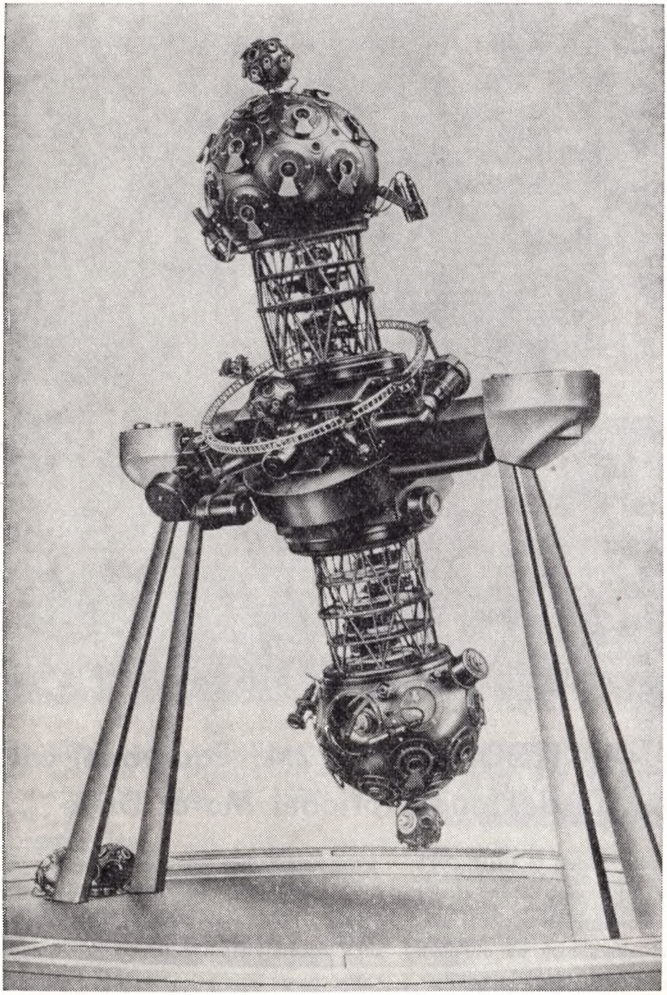
STAR MAP 4

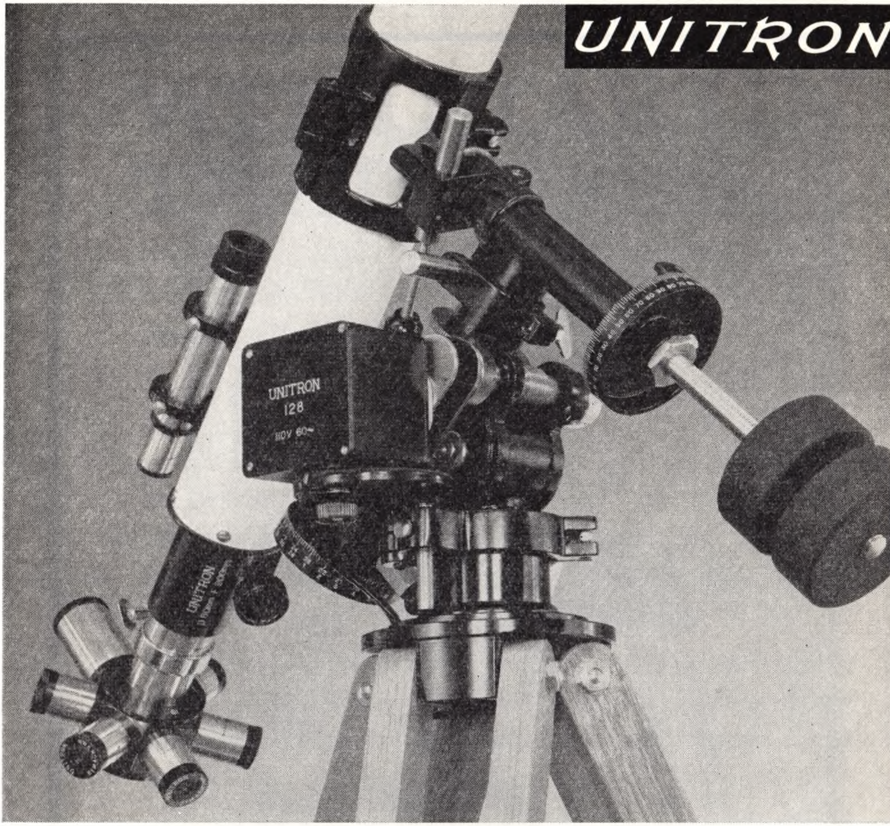


The above map represents the evening sky at

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

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





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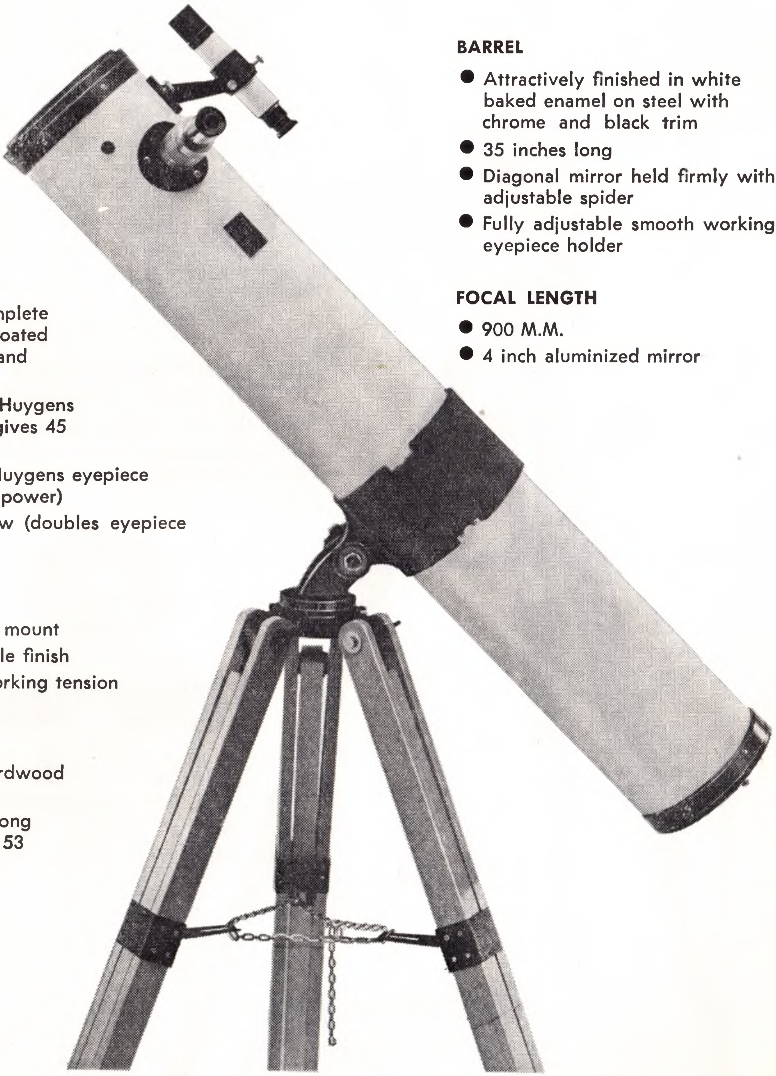

UNITRON'S 6" Refractor on left, 4" on right

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