THE OBSERVER'S HANDBOOK FOR 1948

PUBLISHED BY

The Royal Astronomical Society of Canada

C. A. CHANT, Editor
F. S. HOGG, Assistant Editor
DAVID DUNLAP OBSERVATORY

FORTIETH YEAR OF PUBLICATION

TORONTO
3 Willcocks Street
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1947

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

The Society was incorporated in 1890 as The Astronomical and Physical Society of Toronto, assuming its present name in 1903.

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal and Quebec, P.Q.; Ottawa, Toronto, Hamilton, London and Windsor, Ontario; Winnipeg, Man.; Edmonton, Alta.; Vancouver and Victoria, B.C. As well as over 1100 members of these Canadian Centres, there are nearly 500 members not attached to any Centre, mostly resident in other nations, while some 300 additional institutions or persons are on the regular mailing list for our publications. The Society publishes a monthly "Journal" and a yearly "Observer's Handbook". Single copies of the "Journal" or "Handbook" are 25 cents, postpaid.

Membership is open to anyone interested in astronomy. Annual dues, $2.00; life membership, $25.00. Publications are sent free to all members or may be subscribed for separately. Applications for membership or publications may be made to the General Secretary, 3 Willcocks St., Toronto.

JULIAN DAY CALENDAR, 1948

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

Jan. 1.....2552	May 1.....2673	Sept. 1.....2796
Feb. 1.....2583	Jun. 1.....2704	Oct. 1.....2826
Mar. 1.....2612	July 1.....2734	Nov. 1.....2857
Apr. 1.....2643	Aug. 1.....2765	Dec. 1.....2887

The Julian Day commences at noon. Thus J. D. 2,432,552 = Jan. 1.5 G.C.T.

1948 CALENDAR 1948

JANUARY							FEBRUARY							MARCH							APRIL						
Sun.	..	4	11	18	25		Sun.	1	8	15	22	29		Sun.	..	7	14	21	28		Sun.	..	4	11	18	25	
Mon.	..	5	12	19	26		Mon.	2	9	16	23	....		Mon.	1	8	15	22	29		Mon.	..	5	12	19	26	
Tues.	..	6	13	20	27		Tues.	3	10	17	24	....		Tues.	2	9	16	23	30		Tues.	..	6	13	20	27	
Wed.	..	7	14	21	28		Wed.	4	11	18	25	....		Wed.	3	10	17	24	31		Wed.	..	7	14	21	28	
Thur.	1	8	15	22	29		Thur.	5	12	19	26	....		Thur.	4	11	18	25	....		Thur.	1	8	15	22	29	
Fri.	2	9	16	23	30		Fri.	6	13	20	27	....		Fri.	5	12	19	26	....		Fri.	2	9	16	23	30	
Sat.	3	10	17	24	31		Sat.	7	14	21	28	....		Sat.	6	13	20	27	....		Sat.	3	10	17	24	....	

MAY							JUNE							JULY							AUGUST						
Sun.	2	9	16	23	30		Sun.	..	6	13	20	27		Sun.	..	4	11	18	25		Sun.	1	8	15	22	29	
Mon.	3	10	17	24	31		Mon.	..	7	14	21	28		Mon.	..	5	12	19	26		Mon.	2	9	16	23	30	
Tues.	4	11	18	25	....		Tues.	1	8	15	22	29		Tues.	..	6	13	20	27		Tues.	3	10	17	24	31	
Wed.	5	12	19	26	....		Wed.	2	9	16	23	30		Wed.	..	7	14	21	28		Wed.	4	11	18	25	....	
Thur.	6	13	20	27	....		Thur.	3	10	17	24	....		Thur.	1	8	15	22	29		Thur.	5	12	19	26	....	
Fri.	7	14	21	28	....		Fri.	4	11	18	25	....		Fri.	2	9	16	23	30		Fri.	6	13	20	27	....	
Sat.	1	8	15	22	29	....	Sat.	5	12	19	26	....		Sat.	3	10	17	24	31		Sat.	7	14	21	28	....	

SEPTEMBER							OCTOBER							NOVEMBER							DECEMBER						
Sun.	..	5	12	19	26		Sun.	3	10	17	24	31		Sun.	..	7	14	21	28		Sun.	..	5	12	19	26	
Mon.	..	6	13	20	27		Mon.	4	11	18	25	....		Mon.	1	8	15	22	29		Mon.	..	6	13	20	27	
Tues.	..	7	14	21	28		Tues.	5	12	19	26	....		Tues.	2	9	16	23	30		Tues.	..	7	14	21	28	
Wed.	1	8	15	22	29		Wed.	6	13	20	27	....		Wed.	3	10	17	24	....		Wed.	1	8	15	22	29	
Thur.	2	9	16	23	30		Thur.	7	14	21	28	....		Thur.	4	11	18	25	....		Thur.	2	9	16	23	30	
Fri.	3	10	17	24	....		Fri.	1	8	15	22	29	....	Fri.	5	12	19	26	....		Fri.	3	10	17	24	31	
Sat.	4	11	18	25	....		Sat.	2	9	16	23	30	....	Sat.	6	13	20	27	....		Sat.	4	11	18	25	....	

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List of Air Navigation Stars	1947

PRINTED IN CANADA

PREFACE

The HANDBOOK for 1948 is the 40th issue. During the past decade the circulation of the HANDBOOK has increased from about 1500 to 5500. This year for the first time a number of advertisements have been included, calling the attention of readers to various astronomical accessories. The Officers of the Society greatly appreciate the support which the firms thus represented have rendered to us at this time of financial difficulty.

Four circular star maps 9 inches in diameter at a price of one cent each, and a set of four maps plotted on equatorial co-ordinates at a price of ten cents, are obtainable from the Director of University Extension, University of Toronto, Toronto 5.

Celestial distances given herein are based on the standard value 8".80 for the sun's parallax rather than the more recent value 8".790 as determined by Sir Harold Jones. The predictions of the minima of Algol are based on a period of 2.867318 days by W. M. Smart, and from a minimum at J. D. 2,429,234.6859 observed by J. S. Hall. Observations of three minima by D. W. Rosebrough in November 1945, confirmed the HANDBOOK predictions within about 3 minutes.

Dr. F. S. Hogg, the Assistant Editor, as in recent years, assumed the responsibility of preparing this volume and to him the chief credit of its success is due; but sincere thanks are tendered to all those names mentioned in the book. Our deep indebtedness to the British *Nautical Almanac* and the *American Ephemeris* is thankfully acknowledged.

C. A. CHANT.

David Dunlap Observatory,
Richmond Hill, Ont., November, 1947.

ANNIVERSARIES AND FESTIVALS 1948

New Year's Day	Thu.	Jan. 1
Epiphany	Tue.	Jan. 6
Septuagesima Sunday		Jan. 25
Quinquagesima (Shrove Sunday)		Feb. 8
Ash Wednesday		Feb. 11
St. David	Mon.	Mar. 1
St. Patrick	Wed.	Mar. 17
Palm Sunday		Mar. 21
Good Friday		Mar. 26
Easter Sunday		Mar. 28
St. George	Fri.	Apr. 23
Rogation Sunday		May 2
Ascension Day	Thu.	May 6
Pentecost (Whit Sunday)		May 16
Trinity Sunday		May 23
Empire Day (Victoria Day)	Mon.	May 24
Birthday of the Queen Mother, Mary (1867)	Wed.	May 26
Corpus Christi	Thu.	May 27
St. John Baptist (Midsummer Day)	Thu.	Jun. 24
Dominion Day	Thu.	Jul. 1
Birthday of Queen Elizabeth, (1900)	Wed.	Aug. 4
Labour Day	Mon.	Sep. 6
St. Michael (Michaelmas Day)	Wed.	Sep. 29
Hebrew New Year (Rosh Hashanah)	Mon.	Oct. 4
All Saints' Day	Mon.	Nov. 1
Remembrance Day	Thu.	Nov. 11
First Sunday in Advent		Nov. 28
St. Andrew	Tue.	Nov. 30
Accession of King George VI (1936)	Sat.	Dec. 11
Birthday of King George VI (1895)	Tue.	Dec. 14
Christmas Day	Sat.	Dec. 25

Thanksgiving Day, date set by Proclamation

SYMBOLS AND ABBREVIATIONS

SIGNS OF THE ZODIAC

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

SUN, MOON AND PLANETS

☉ The Sun.	☾ The Moon generally.	♃ Jupiter.
● New Moon.	☿ Mercury.	♄ Saturn.
☽ Full Moon.	♀ Venus.	♅ or ♗ 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 A.R., Right Ascension; δ Declination.
h, m, s, Hours, Minutes, Seconds of Time.
°, ′, ″, Degrees, Minutes, Seconds of Arc.

THE GREEK ALPHABET

A, α,	Alpha.	I, ι,	Iota.	P, ρ,	Rho.
B, β,	Beta.	K, κ,	Kappa.	Σ, σ, ς,	Sigma.
Γ, γ,	Gamma.	Λ, λ,	Lambda.	T, τ,	Tau.
Δ, δ,	Delta.	M, μ,	Mu.	Υ, υ,	Upsilon.
E, ε,	Epsilon.	N, ν,	Nu.	Φ, ϕ,	Phi.
Z, ζ,	Zeta.	Ξ, ξ,	Xi.	X, χ,	Chi.
H, η,	Eta.	O, o,	Omicron.	Ψ, ψ,	Psi.
Θ, θ, ϑ,	Theta.	Π, π,	Pi.	Ω, ω,	Omega.

THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 31, 33, etc.), O represents the disc of the planet, d signifies that the satellite is on the disc, * signifies that the satellite is behind the disc or in the shadow. Configurations are for an inverting telescope.

THE CONSTELLATIONS

Latin and English Names with Abbreviations

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

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

MISCELLANEOUS ASTRONOMICAL DATA

Units of Length

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

Units of Time

Sidereal day = $23^h\ 56^m\ 04.09^s$ of mean solar time
Mean solar day = $24^h\ 03^m\ 56.56^s$ of sidereal time
Synodical month = $29^d\ 12^h\ 44^m$; sidereal month = $27^d\ 07^h\ 43^m$
Tropical year (ordinary) = $365^d\ 05^h\ 48^m\ 46^s$
Sidereal year = $365^d\ 06^h\ 09^m\ 10^s$
Eclipse year = $346^d\ 14^h\ 53^m$

The Earth

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

Earth's Orbital Motion

Solar parallax = 8."80; constant of aberration = 20."47
Annual general precession = 50."26; obliquity of ecliptic = 23° 26′ 50″ (1939)
Orbital velocity = 18.5 miles/sec.; parabolic velocity at $\oplus$ = 26.2 miles/sec

Solar Motion

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

The Galactic System

North pole of galactic plane R.A. $12^h\ 40^m$, Dec. + 28° (1900)
Centre. 325° galactic longitude, = R.A. $17^h\ 24^m$, Dec. −30°
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

Extragalactic Nebulae

Red shift = +530 km./sec./megaparsec = +101 miles /sec./million l.y.

Radiation Constants

Velocity of light = 299,774 km./sec. = 186,271 miles/sec.
Solar constant = 1.93 gram calories/square cm./minute
Light ratio for one magnitude = 2.512; log ratio = 0.4000
Radiation from a star of zero apparent magnitude = 3×10^{-6} meter candles
Total energy emitted by a star of zero absolute magnitude = 5×10^{25} horsepower

Miscellaneous

Constant of gravitation, G = 6.670×10^{-8} c.g.s. units
Mass of the electron, m = 9.035×10^{-28} gm.; mass of the proton = 1.662×10^{-24} gm.
Planck's constant, h = 6.55×10^{-27} erg. sec.
Loschmidt's number = 2.705×10^{19} molecules/cu. cm. of gas at N.T.P.
Absolute temperature = $T°\ K = T°C + 273° = 5/9\ (T°\ F + 459°)$
1 radian = 57°.2958 = 3437′.75 = 206,265″
π = 3.141,592,653,6
No. of square degrees in the sky = 41,253

1948 EPHEMERIS OF THE SUN AT 0h GREENWICH CIVIL TIME

Date 1948	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.	Date 1948	Apparent R.A.	Corr. to Sun-dial	Apparent Dec.
	h m s	m s	° ′		h m s	m s	° ′
Jan. 1	18 41 15	+03 00	−23 06.5	July 2	06 43 32	+03 47	+23 04.2
" 4	18 54 30	+04 25	−22 51.4	" 5	06 55 55	+04 20	+22 49.5
" 7	19 07 41	+05 46	−22 32.2	" 8	07 08 15	+04 50	+22 31.3
" 10	19 20 48	+07 04	−22 08.9	" 11	07 20 31	+05 17	+22 09.5
" 13	19 33 51	+08 17	−21 41.8	" 14	07 32 44	+05 40	+21 44.3
" 16	19 46 48	+09 24	−21 10.8	" 17	07 44 52	+05 58	+21 15.7
" 19	19 59 39	+10 25	−20 36.2	" 20	07 56 54	+06 11	+20 43.9
" 22	20 12 23	+11 20	−19 58.1	" 23	08 08 52	+06 20	+20 09.0
" 25	20 25 00	+12 07	−19 16.7	" 26	08 20 45	+06 23	+19 31.1
" 28	20 37 30	+12 48	−18 32.1	" 29	08 32 33	+06 21	+18 50.2
" 31	20 49 53	+13 21	−17 44.5				
				Aug. 1	08 44 15	+06 14	+18 06.5
Feb. 3	21 02 09	+13 47	−16 54.0	" 4	08 55 52	+06 01	+17 20.2
" 6	21 14 17	+14 06	−16 00.8	" 7	09 07 24	+05 43	+16 31.3
" 9	21 26 18	+14 17	−15 05.1	" 10	09 18 50	+05 20	+15 40.0
" 12	21 38 12	+14 22	−14 07.2	" 13	09 30 11	+04 51	+14 46.5
" 15	21 50 00	+14 19	−13 07.1	" 16	09 41 27	+04 17	+13 50.9
" 18	22 01 40	+14 10	−12 05.2	" 19	09 52 38	+03 38	+12 53.3
" 21	22 13 14	+13 54	−11 01.5	" 22	10 03 45	+02 55	+11 53.9
" 24	22 24 42	+13 32	−09 56.3	" 25	10 14 47	+02 08	+10 52.7
" 27	22 36 04	+13 05	−08 49.7	" 28	10 25 46	+01 18	+09 50.1
				" 31	10 36 42	+00 24	+08 45.9
Mar. 1	22 47 21	+12 32	−07 42.0				
" 4	22 58 34	+11 55	−06 33.2	Sept. 3	10 47 35	−00 33	+07 40.5
" 7	23 09 42	+11 14	−05 23.6	" 6	10 58 26	−01 32	+06 34.0
" 10	23 20 48	+10 30	−04 13.4	" 9	11 09 15	−02 33	+05 26.5
" 13	23 31 50	+09 42	−03 02.6	" 12	11 20 02	−03 35	+04 18.2
" 16	23 42 49	+08 52	−01 51.6	" 15	11 30 48	−04 39	+03 09.3
" 19	23 53 47	+08 00	−00 40.5	" 18	11 41 33	−05 43	+01 59.8
" 22	00 04 43	+07 06	+00 30.7	" 21	11 52 19	−06 47	+00 50.0
" 25	00 15 37	+06 11	+01 41.6	" 24	12 03 05	−07 50	−00 20.1
" 28	00 26 32	+05 16	+02 52.1	" 27	12 13 53	−08 52	−01 30.3
" 31	00 37 27	+04 21	+04 02.1	" 30	12 24 43	−09 52	−02 40.4
Apr. 3	00 48 23	+03 28	+05 11.5	Oct. 3	12 35 35	−10 50	−03 50.3
" 6	00 59 20	+02 35	+06 20.1	" 6	12 46 30	−11 44	−04 59.7
" 9	01 10 19	+01 44	+07 27.8	" 9	12 57 29	−12 35	−06 08.7
" 12	01 21 20	+00 56	+08 34.2	" 12	13 08 31	−13 23	−07 16.8
" 15	01 32 24	+00 10	+09 39.4	" 15	13 19 38	−14 06	−08 24.1
" 18	01 43 31	−00 33	+10 43.2	" 18	13 30 49	−14 44	−09 30.3
" 21	01 54 41	−01 12	+11 45.3	" 21	13 42 06	−15 16	−10 35.2
" 24	02 05 55	−01 48	+12 45.7	" 24	13 53 29	−15 43	−11 38.8
" 27	02 17 13	−02 19	+13 44.2	" 27	14 04 59	−16 03	−12 40.8
" 30	02 28 36	−02 46	+14 40.6	" 30	14 16 35	−16 17	−13 41.0
May 3	02 40 03	−03 08	+15 35.0	Nov. 2	14 28 19	−16 23	−14 39.3
" 6	02 51 36	−03 25	+16 27.0	" 5	14 40 09	−16 22	−15 35.4
" 9	03 03 14	−03 37	+17 16.5	" 8	14 52 07	−16 14	−16 29.2
" 12	03 14 57	−03 43	+18 03.5	" 11	15 04 12	−15 58	−17 20.5
" 15	03 26 45	−03 45	+18 47.7	" 14	15 16 25	−15 35	−18 09.2
" 18	03 38 38	−03 42	+19 29.1	" 17	15 28 46	−15 04	−18 54.9
" 21	03 50 36	−03 33	+20 07.4	" 20	15 41 14	−14 26	−19 37.6
" 24	04 02 39	−03 20	+20 42.7	" 23	15 53 49	−13 40	−20 17.2
" 27	04 14 46	−03 03	+21 14.8	" 26	16 06 31	−12 47	−20 53.3
" 30	04 26 58	−02 41	+21 43.6	" 29	16 19 21	−11 48	−21 26.0
June 2	04 39 14	−02 15	+22 09.0	Dec. 2	16 32 17	−10 41	−21 55.0
" 5	04 51 33	−01 45	+22 30.9	" 5	16 45 18	−09 30	−22 20.3
" 8	05 03 56	−01 12	+22 49.3	" 8	16 58 24	−08 13	−22 41.6
" 11	05 16 21	−00 37	+23 04.1	" 11	17 11 35	−06 52	−22 58.9
" 14	05 28 48	+00 00	+23 15.2	" 14	17 24 49	−05 28	−23 12.1
" 17	05 41 15	+00 39	+23 22.7	" 17	17 38 05	−04 02	−23 21.1
" 20	05 53 44	+01 17	+23 26.4	" 20	17 51 23	−02 33	−23 26.0
" 23	06 06 12	+01 56	+23 26.4	" 23	18 04 42	−01 03	−23 26.6
" 26	06 18 40	+02 34	+23 22.7	" 26	18 18 02	+00 26	−23 23.0
" 29	06 31 07	+03 12	+23 15.3	" 29	18 31 20	+01 55	−23 15.2

To obtain *local mean* time, apply *corr. to sun-dial* to *apparent* or *sun-dial* time.

SOLAR AND SIDEREAL TIME

In practical astronomy three different kinds of time are used, while in ordinary life we use a fourth.

1. *Apparent Time*—By apparent noon is meant the moment when the sun is on the meridian, and apparent time is measured by the distance in degrees that the sun is east or west of the meridian. Apparent time is given by the sun-dial.

2. *Mean Time*—The interval between apparent noon on two successive days is not constant, and a clock cannot be constructed to keep apparent time. For this reason *mean time* is used. The length of a mean day is the average of all the apparent days throughout the year. The *real sun* moves about the ecliptic in one year; an imaginary *mean sun* is considered as moving uniformly around the celestial equator in one year. The difference between the times that the real sun and the mean sun cross the meridian is the *equation of time.* Or, in general, *Apparent Time—Mean Time = Equation of Time.* This is the same as *Correction to Sun-dial* on page 7, with the sign reversed.

3. *Sidereal Time*—This is time as determined from the stars. It is sidereal noon when the Vernal Equinox or First of Aries is on the meridian. In accurate time-keeping the moment when a star is on the meridian is observed and the corresponding mean time is then computed with the assistance of the Nautical Almanac. When a telescope is mounted equatorially the position of a body in the sky is located by means of the sidereal time.

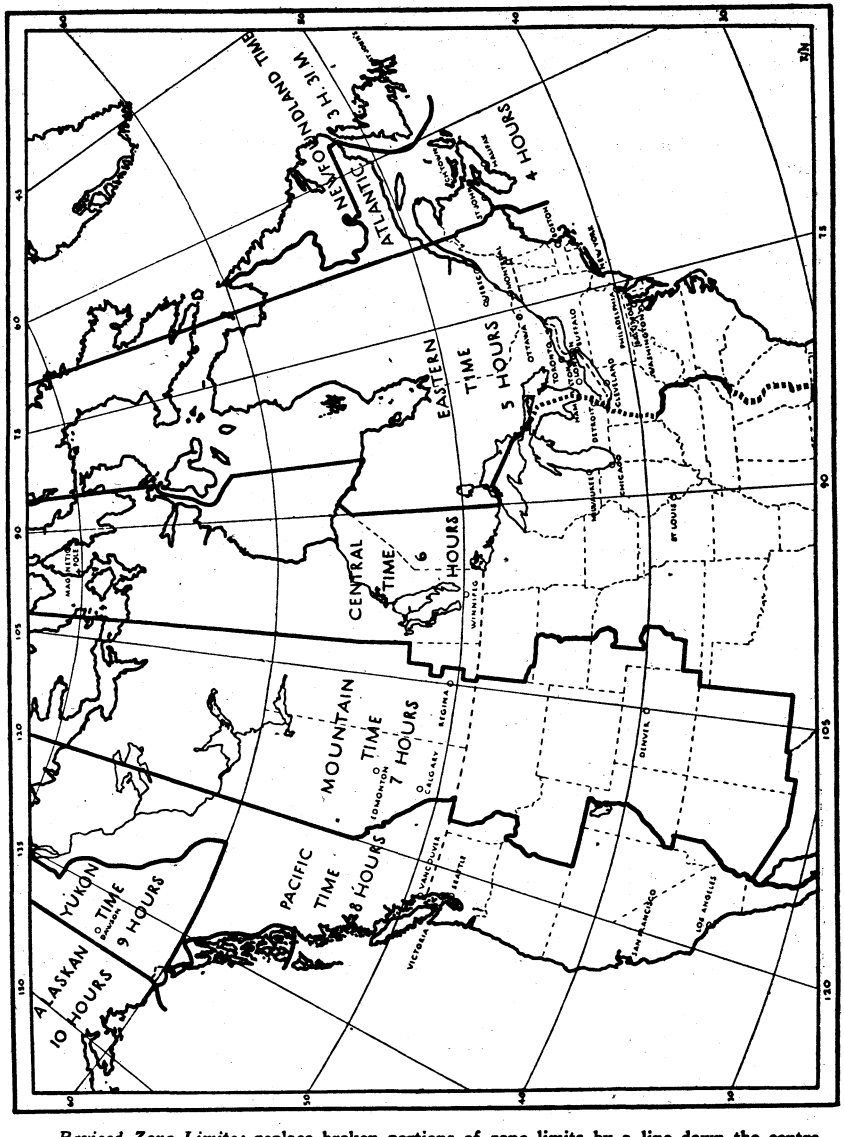
4. *Standard Time*—In everyday life we use still another kind of time. A moment's thought will show that in general two places will not have the same mean time; indeed, difference in longitude between two places is determined from their difference in time. But in travelling it is very inconvenient to have the time varying from station to station. For the purpose of facilitating transportation the system of *Standard Time* was introduced in 1883. Within a certain belt approximately 15° wide, all the clocks show the same time, and in passing from one belt to the next the hands of the clock are moved forward or backward one hour.

In Canada we have six standard time belts, as follows;—60th meridian or Atlantic Time, 4h. slower than Greenwich; 75th meridian or Eastern Time, 5h.; 90th meridian or Central Time, 6h.; 105th meridian or Mountain Time, 7h.; 120th meridian or Pacific Time, 8h.; and 135th meridian or Yukon Time, 9h. slower than Greenwich.

The boundaries of the time belts are shown on the map on page 9.

Daylight Saving Time is the standard time of the next zone eastward. It is adopted in many places between certain specified dates during the summer.

MAP OF STANDARD TIME ZONES



Revised Zone Limits: replace broken portions of zone limits by a line down the centre of Lake Michigan, thence along northern and eastern borders of Indiana; also along northern and western borders of Georgia.

TIMES OF SUNRISE AND SUNSET

In the tables on pages 11 to 16 are given the times of sunrise and sunset for places in latitudes 36°, 40°, 44°, 46°, 48°, 50° and 52°. The times are given in Local Mean Time, and in the table below are given corrections to change from Local Mean to Standard Time for the cities and towns named.

How the Tables are Constructed

The time of sunrise and sunset at a given place, in local mean time, varies from day to day, and depends principally upon the declination of the sun. Variations in the equation of time, the apparent diameter of the sun and atmospheric refraction at the points of sunrise and sunset also affect the final result. These quantities, as well as the solar declination, do not have precisely the same values on corresponding days from year to year, and so the table gives only approximately average values. The times are for the rising and setting of the upper limb of the sun, and are corrected for refraction. It must also be remembered that these times are computed for the sea horizon, which is only approximately realised on land surfaces, and is generally widely departed from in hilly and mountainous localities. The greater or less elevation of the point of view above the ground must also be considered, to get exact results.

The Standard Times for Any Station

In order to find the time of sunrise and sunset for any place on any day, first 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 time of sunrise and sunset for the proper latitude, on the desired day, and apply the correction to get the Standard Time.

34°	min.
Los Angeles	− 7
38°	
St. Louis	+ 1
San Francisco	+10
Washington	+ 8
40°	
Baltimore	+ 6
New York	− 4
Philadelphia	+ 1
Pittsburgh	+20
42°	
Boston	−16
Buffalo	+15
Chicago	−10
Cleveland	+26
Detroit	−28
London, Ont.	+25
Windsor	+32

44°	min.
Brantford	+21
Guelph	+21
Halifax	+14
Hamilton	+20
Kingston	+ 6
Kitchener	+22
Milwaukee	− 8
Minneapolis	+13
Orillia	+18
Oshawa	+15
Owen Sound	+24
Peterborough	+13
St. Catharines	+17
Stratford	+24
Toronto	+18
Woodstock, Ont.	+23
Yarmouth	+24
46°	
Charlottetown	+13
Fredericton	+26

46°	min.
Glace Bay	0
Moncton	+19
Montreal	− 6
New Glasgow	+11
North Bay	+18
Ottawa	+ 3
Parry Sound	+20
Quebec	−15
St. John, N.B.	+24
Sault St. Marie	+37
Sherbrooke	−12
Sudbury	+24
Sydney	+ 1
Three Rivers	−10
48°	
Port Arthur	+57
St. John's, Nfd.	0
Seattle	+ 9
Timmins	+26
Victoria	+13

50°	m n.
Brandon	+40
Kenora	+18
Medicine Hat	+22
Moose Jaw	+ 2
Port. la Prairie	+33
Regina	− 2
Trail	− 9
Vancouver	+12
Winnipeg	+28
52°	
Calgary	+36
Saskatoon	+ 6
54°	
Edmonton	+34
Prince Albert	+ 1
Prince Rupert	+41
60°	
Dawson	+18

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

In the above list Owen Sound is under "44°", and the correction is + 24 min. On page 11 the time of sunrise on February 12 for latitude 44° is 7.05; add 24 min. and we get 7.29 (Eastern Standard Time). Regina is under "50°", and the correction is —2 min. From the table the time is 7.17 and subtracting 2 min. we get the time of sunrise 7.15 (Mountain Standard Time).

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

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

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

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

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

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

BEGINNING OF MORNING AND ENDING OF EVENING TWILIGHT

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

TIMES OF MOONRISE AND MOONSET, 1948

(Local Mean Time)

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

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

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

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

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

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

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

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

TIMES OF MOONRISE AND MOONSET, 1948

(Local Mean Time)

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

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

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

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

THE PLANETS FOR 1948

By C. A. CHANT

THE SUN

The current sun-spot cycle has produced the most and largest sun-spots ever observed. That of March 1947, and the corresponding group of April 1947 were in each case the largest on record. The maximum of the cycle may be occurring about the beginning of 1948. For the whole of the year 1948 far above average spottedness of the sun may be expected.

MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and it travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. With the exception of Pluto, its orbit has the greatest eccentricity and the greatest inclination to the ecliptic. It receives from the sun most light and heat per square mile of its surface, the amount on the average being 6.7 times that received by the earth. Again excepting Pluto, whose size and mass are still uncertain, Mercury's size and mass are the smallest; but its period of rotation on its axis is believed to be longest of all.

Mercury's period of revolution is 88 days, and as its orbit is well within that of the earth, 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 1948

Elong. East—Evening Star			Elong. West—Morning Star		
Date	Distance	Mag.	Date	Distance	Mag.
Feb. 4	18°	− 0.4	Mar. 17	28°	+ 0.5
May 28	23°	+ 0.7	July 16	21°	+ 0.6
Sept. 25	26°	+ 0.3	Nov. 4	19°	− 0.3

The most favourable elongations to observe are: in the evening, Feb. 4; in the morning, July 16, but Nov. 4 will also be possible. At these times Mercury is about 80 million miles from the earth and in a telescope looks like a half-moon about 7″ in diameter.

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 that of Mercury but much slower and more stately. The orbit of Venus. is almost a circle with a radius of 67 million miles, and its orbital speed is 22 mi. per sec.

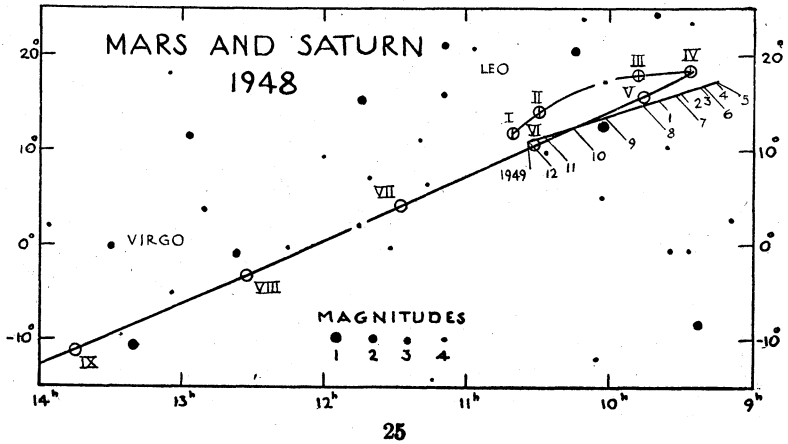
On Jan. 1, 1948, Venus is an evening star, appearing low in the south-west at sunset, and is not in good position for observers in the northern hemisphere. It was in superior conjunction with the sun on Sept. 3, 1947, and is slowly separating from it. The planet reaches greatest elongation east, 45° 46′, on April 14, at which time it is in Decl. + 25°. In the telescope it looks like a half-moon with diameter 24″. On May 18 it attains greatest brilliancy, at which time its Decl. is + 27° and its stellar magnitude is − 4.2. Quickly it moves in towards the sun, and it reaches inferior conjunction on June 24. It is then only 93−67 or 26 million miles from the earth. After this it is a morning star but it will be too close to the sun to be conveniently observed for about a month. On July 31 it attains greatest brilliancy, mag. − 4.2; and on Sept. 2 it reaches greatest elongation west, 45° 56′. It remains a fine morning star for the rest of the year.

On June 30 Venus and Mercury are in close conjunction, only 58′ apart, but they are too near the sun to be observed.

With the exception of the sun and moon, Venus is the brightest object in the sky. Its brilliance is largely due to the dense clouds which cover the surface of the planet. They reflect well the sun's light; but they also prevent the astronomer from detecting any solid object on the surface of the body. If such could be observed it would enable him to determine the planet's rotation period. It is probably around 30 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 with these two numbers shows that its distance from the sun ranges between 128 and 154 million miles. Its



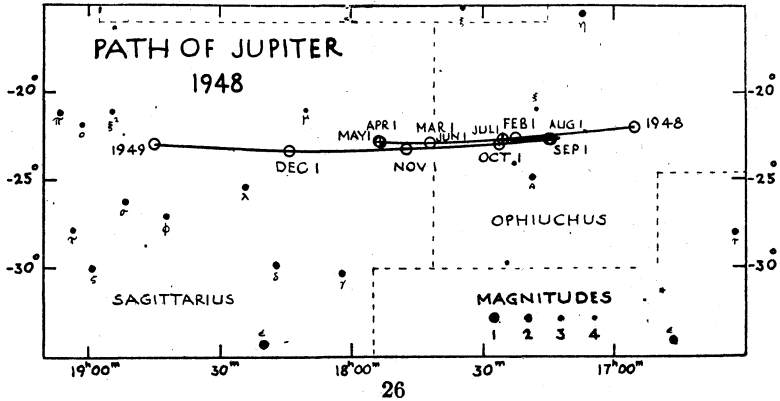
distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris. Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Utilizing them its rotation period of 24h. 37m. has been accurately determined.

The sidereal, or true mechanical, period of revolution of Mars is 687 days; and the synodic period (for example, the interval from one opposition to the next one) is 780 days. This is the average value; it may vary from 764 to 810 days. The planet was in opposition on Jan. 13, 1946; the next one is on Feb. 17, 1948, at 11 a.m. (E.S.T.). Four hours later it is nearest the earth, the distance between the two bodies being 63,000,000 miles. This is not a close opposition as the distance at close oppositions may be less than 35,000,000 miles. At opposition this year the planet is about 5° north of the bright white star Regulus, mag. 1.3. The stellar magnitude of Mars then is − 1.0, and it is fiery red. On Feb. 19 it is 26′ from the star Eta Leonis, of mag. 3.6. The planet reaches a stationary point on March 30, after which it moves east through Leo and Virgo. See the accompanying map.

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 11 satellites, two of them discovered in 1938 (see p. 59). Not so long ago it was generally believed that the planet was still cooling down from its original high temperature, but from actual measurements of the radiation from it to the earth it has been deduced that the surface is at about − 200° F. The spectroscope shows that its atmosphere is largely ammonia and methane (marsh-gas).

Jupiter is a fine object for the telescope. Many details of the surface as well as the flattening of the planet at the poles, which is undoubtedly due to its short rotation period, are visible. The rapidly varying phenomena of its satellites also provide a continual interest. On Jan. 1 it is a morning star and is on the meridian about 10.15 a.m. Its stellar magnitude is − 1.3. On June 15 it is in opposition with the sun. Its magnitude then is − 2.2, and it rises as the sun sets and is visible all night long. Its distance from the earth at this time is about 396 million



miles and its equatorial diameter is 46". Conjunction with the sun occurs about Jan. 4, 1949. The accompanying map shows the path of the planet in Ophiuchus and Sagittarius.

SATURN

Saturn was the outermost planet known until modern times. In size it is a good second to Jupiter. In addition to its family of nine satellites, this planet has a unique system of rings, and it is one of the finest of celestial objects in a good telescope. The plane of the rings makes an angle of 27° with the plane of the planet's orbit, and twice during the planet's revolution period of 29½ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. They were invisible in 1936 and at a maximum in 1944. In 1948 they are slowly closing in but are still quite visible. Their south face is presented now.

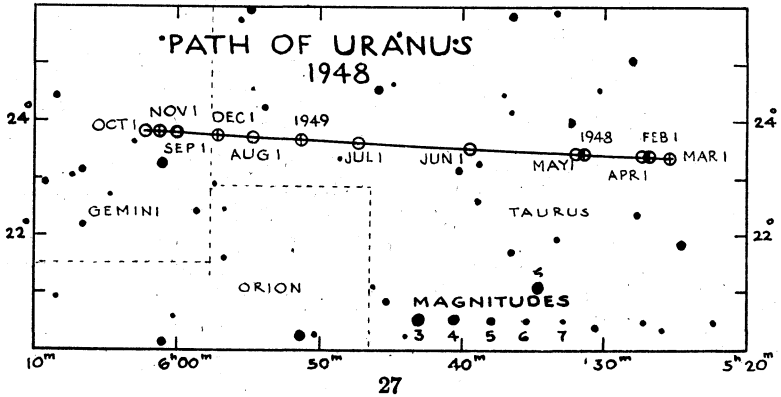
The planet is in the constellation Leo (see map of Mars and Saturn). On Feb. 8 it is in opposition to the sun and is visible all night. Its stellar magnitude then is 0.1, slightly brighter than Rigel. On May 6 it is in quadrature with the sun and is on the meridian at sunset. On Aug. 19 it is in conjunction with the sun. On Nov. 28 it is in quadrature, this time 90° west of the sun, and so is on the meridian at sunrise.

URANUS

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

As shown by the chart, Uranus in 1948 is in Taurus and Gemini. On Dec. 16, 1947, it was in opposition with the sun. On Mar. 12 it is in quadrature, on June 17 in conjunction, on Sept. 23 in quadrature, and on Dec. 20 in opposition again.

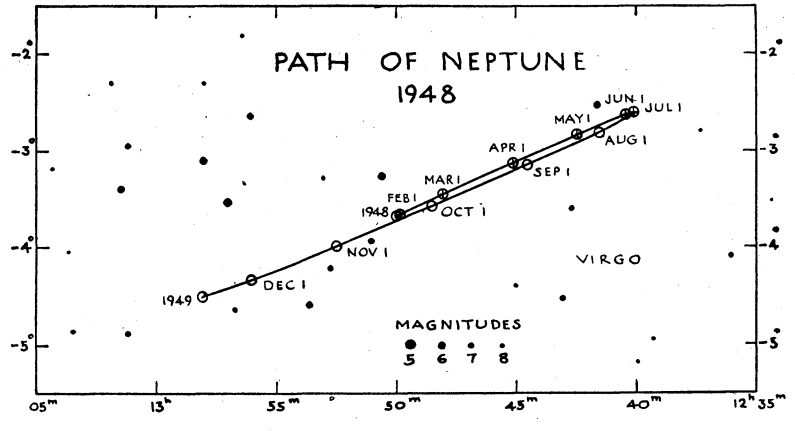
There are interesting references to the earliest observations of Uranus made in America in Edward Ford's "David Rittenhouse" (Philadelphia, 1946).



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. This discovery was a crowning demonstration of the correctness of Newton's law of gravitation. It caused a sensation at the time. The planet's distance from the sun is 2800 million miles and its period of revolution is 165 years. Its single satellite was discovered in 1846, soon after the planet.

During 1948 Neptune is still in the constellation Virgo. It is in opposition with the sun on April 1. Its stellar magnitude then is + 7.7 and hence it is too faint for the naked eye. In the telescope it shows a greenish tint and a diameter of 2″.5. It is in conjunction with the sun on Oct. 5.



PLUTO

Pluto, the most distant known planet, was discovered at the Lowell Observatory in 1930, following prolonged mathematical calculations and observations by photography. Its mean distance from the sun is 3666 million miles and its revolution period is 248 years. It appears as a 15th mag. star in the constellation Cancer.

OPPOSITION—EPHEMERIS OF PLUTO, 1947-48
Equator and Equinox 1950.0

0^h *G.C.T.*	*R.A.* h m	*Dec.*	0^h *G.C.T.*	*R.A.* h m	*Dec.*
Nov. 21	9 18.9	+ 23° 10′	Feb. 9	9 13.8	+ 23° 48′
Dec. 1	9 18.8	+ 23° 13′	Feb. 19	9 12.9	+ 23° 52′
Dec. 11	9 18.5	+ 23° 17′	Feb. 29	9 11.9	+ 23° 56′
Dec. 21	9 18.0	+ 23° 22′	Mar. 10	9 11.1	+ 23° 59′
Dec. 31	9 17.3	+ 23° 27′	Mar. 20	9 10.4	+ 24° 02′
Jan. 10	9 16.6	+ 23° 32′	Mar. 30	9 09.9	+ 24° 03′
Jan. 20	9 15.7	+ 23° 38′	Apr. 9	9 09.5	+ 24° 04′
Jan. 30	9 14.8	+ 23° 43′	Apr. 19	9 09.2	+ 24° 03′

Its position in 1948 at opposition on February 5 is R.A. 9 h. 42 m. Dec. 23° 46′. The information given in the table was courteously supplied by Dr. G. M. Clemence, Director of the United States Nautical Almanac Office.

ECLIPSES, 1948

In 1948 there will be only *three* eclipses, two of the sun and one of the moon.

I. *A Partial Eclipse of the Moon*, April 23, 1948, invisible from most of Canada; visible from extreme western and northwestern regions of North America, from much of the Pacific Ocean, Asia and Australia. This eclipse is of very small magnitude; at maximum less than three per cent. of the moon's diameter is covered by the earth's umbra. Greenwich Civil Time of mid-eclipse is 13h 38.8m.

II. *An Annular Eclipse of the Sun*, May 8-9, 1948, visible as a partial eclipse from only the northern and western parts of Canada and Alaska. The central path crosses the Indian Ocean, Burma, Thailand, Indo-China, eastern China, Korea, Sea of Japan and the northern Pacific Ocean. From British Columbia and parts of Alberta, Yukon and the Northwest Territories the sun will appear partially eclipsed shortly before sunset. Computations show that, at its closest (over the Sea of Japan) the vertex of the shadow cone will be only 5 miles from the earth; thus there is a possibility that the eclipse might be briefly total at this point.

Circumstances of the Eclipse

	Greenwich Civil Time	Longitude	Latitude
Eclipse begins	May 8d 23h 39.9m	96° 00′ E	6° 04′ S
Central eclipse begins	9 0 44.7	77 08 E	2 33 N
Central eclipse at local app. noon	9 2 43.8	138 08 E	43 57 N
Central eclipse ends	9 4 06.3	135 10 W	43 40 N
Eclipse ends	9 5 11.0	155 52 W	35 22 N

III. *A Total Eclipse of the Sun*, November 1, 1948, invisible from North America. The path of totality starts at sunrise in Central Africa, but lies mostly in the Indian and Antarctic Oceans. The eclipse will be partial from much of Africa, Australia and New Zealand. The maximum duration of totality is less than two minutes, in the southern Indian Ocean.

Circumstances of the Eclipse

	Greenwich Civil Time	Longitude	Latitude
Eclipse begins	Nov. 1d 3h 19.0m	39° 01′ E	10° 56′ N
Central eclipse begins	1 4 19.3	22 03 E	3 42 N
Central eclipse at local app. noon	1 6 15.7	81 58 E	37 21 S
Central eclipse ends	1 7 38.2	165 27 E	43 23 S
Eclipse ends	1 8 38.6	147 10 E	36 19 S

THE SKY MONTH BY MONTH

By J. F. Heard

THE SKY FOR JANUARY, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 41m to 20h 54m and its Decl. changes from 23° 07′ S. to 17° 28′ S. The equation of time changes from − 3m 00s to − 13m 30s. The earth is in perihelion or nearest the sun on the 2nd. For changes in the length of the day, see p. 11.

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. 18.

Mercury on the 15th is in R.A. 20h 15m, Decl. 22° 00′ S. and transits at 12.44. It is in superior conjunction on the 3rd and moves into the evening sky but is too close to the sun most of the month for easy observation. (See February.)

Venus on the 15th is in R.A. 21h 56m, Decl. 14° 21′ S. and transits at 14.23. It is an evening star this month, to be seen fairly low in the south-west at sunset. Its stellar magnitude at this time is − 3.4 and its disk is about 85% illuminated.

Mars on the 15th is in R.A. 10h 42m, Decl. 12° 22′ N. and transits at 3.07. It is easily located a few degrees east of Regulus, rising a few hours after sunset. It is a little fainter than Regulus at the beginning of the month and surpasses it by the end of the month. This increase in brightness will be interesting to watch. On the 9th it is stationary in R.A. and begins to move westward among the stars. About midnight on the 27th-28th there is an occulation of Mars by the moon visible in parts of Canada. (See also Saturn on this page.)

Jupiter on the 15th is in R.A. 17h 08m, Decl. 22° 23′ S. and transits at 9.33. It rises in the south-east a couple of hours before the sun and is about 18° above the horizon at sunrise. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 36m, Decl. 15° 33′ N. and transits at 2.01. It rises just before Mars and is a few degrees west of Regulus, whereas Mars is a few degrees east of it. It is a little fainter than Regulus and Mars and not so red as they. These three objects will be interesting to watch in relation to one another early this year.

Uranus on the 15th is in R.A. 05h 29m, Decl. 23° 25′ N. and transits at 21.51.

Neptune on the 15th is in R.A. 12h 50m, Decl. 03° 43′ S. and transits at 5.15.

Pluto—For information in regard to this planet, see p. 28.

By Ruth J. Northcott

JANUARY

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 7h 45m
Thu.	1			.....	11 04	12043
Fri.	2	1		⊕ in Perihelion. Dist. from ☉, 91,340,000 mi.		24013
Sat.	3			Quadrantid meteors.....		
		6	13	☾ Last Quarter.....		d4102
		6	36	☌♆☾ ♆ 1° 55′ S.....		
		8		☌☿☉ Superior.....		
Sun.	4	5		□♆☉	07 53	43012
Mon.	5			.....		43210
Tue.	6			.....		43201
Wed.	7			.....	04 42	4032*
Thu.	8	8	56	☌♃☾ ♃ 2° 42′ N.....		41023
Fri.	9	12		♂ Stationary in R.A.....		42013
Sat.	10			.....	01 31	14032
Sun.	11	2	44	● New Moon.....		30142
		12	56	☌☿☾ ☿ 2° 28′ N.....		
Mon.	12			.....	22 20	32104
Tue.	13	1		Moon in Apogee. Dist. from ⊕, 252,600 mi....		32014
		23	25	☌♀☾ ♀ 3° 35′ N.....		
Wed.	14	12		☿ Greatest Hel. Lat. S.....		10324
Thu.	15	11		♆ Stationary in R.A.....	19 10	d0234
Fri.	16			.....		20134
Sat.	17			.....		10234
Sun.	18			.....	15 59	30412
Mon.	19	6	32	◑ First Quarter.....		31240
Tue.	20			.....		43201
Wed.	21			.....	12 48	41032
Thu.	22			.....		40123
Fri.	23	6	40	☌♇☾ ♇ 2° 32′ S.....		4203*
Sat.	24			.....	09 38	4103*
Sun.	25			.....		43012
Mon.	26	2	11	○ Full Moon.....		34120
		6		Moon in Perigee. Dist from ⊕, 221,500 mi....		
		23	39	☌♄☾ ♄ 4° 01′ S.....		
Tue.	27			.....	06 27	32401
Wed.	28	0	34	☌♂☾ ♂ 0° 39′ S.....		1024*
		12		♂ Greatest Hel. Lat. N.....		
Thu.	29			.....		01234
Fri.	30	14	18	☌♆☾ ♆ 1° 37′ S.....	03 16	2034*
Sat.	31			.....		21034

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR FEBRUARY, 1948

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

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

The Sun—During February the sun's R.A. increases from 20h 54m to 22h 47m and its Decl. changes from 17° 28′ S. to 07° 42′ S. The equation of time changes from − 13m 30s to a maximum of 14m 22s on the 13th and then to − 12m 32s at the end of the month. For changes in the length of the day, see p. 11.

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. 18.

Mercury on the 15th is in R.A. 22h 24m, Decl. 06° 41′ S. and transits at 12.43. On the 4th it is at greatest eastern elongation and for a week or so before and after this time it is quite well placed for observation, being about 15° above the south-western horizon at sunset. On the 10th it is stationary in R.A. and by the 19th it has moved westward to be in inferior conjunction and then becomes a morning star but poorly placed for observation.

Venus on the 15th is in R.A. 00h 15m, Decl. 01° 04′ N. and transits at 14.40. It is an evening star and its position for observing is improving. At mid-month it is about 32° above the south-western horizon at sunset and it sets about 3 hours after the sun.

Mars on the 15th is in R.A. 10h 11m, Decl. 16° 03′ N. and transits at 0.34. It rises just after sunset and during the month it moves westward, approaching Regulus and passing it to the north on the 18th. It reaches its greatest brilliance (− 1.0) about the middle of the month; opposition to the sun and closest approach to the earth are on the 17th. In parts of Canada it is occulted by the moon on the evening of the 23rd. (See also Saturn on this page.)

Jupiter on the 15th is in R.A. 17h 33m, Decl. 22° 47′ S. and transits at 7.55. 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. 54.

Saturn on the 15th is in R.A. 09h 26m, Decl. 16° 23′ N. and transits at 23.46. It remains just west of Mars and Regulus this month and is fainter than either of them. It is in opposition on the 8th.

Uranus on the 15th is in R.A. 05h 26m, Decl. 23° 22′ N. and transits at 19.46.

Neptune on the 15th is in R.A. 12h 49m, Decl. 03° 35′ S. and transits at 3.12.

Pluto—For information in regard to this planet, see p. 28.

FEBRUARY

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 6h 45m
Sun.	1	19	31	☾ Last Quarter		30124
Mon.	2	13		☿ in ♌	00 06	d3104
Tue.	3					32014
Wed.	4	11		☿ Greatest elongation E., 18° 17′	20 55	13024
Thu.	5	1	08	☌ ♃ ☾ ♃ 3° 16′ N		40123
Fri.	6					42103
Sat.	7	4		☿ in Perihelion	17 44	42013
Sun.	8	21		☍ ♄ ☉ Dist. from ⊕, 760,700,000 mi.		43012
Mon.	9	1		Moon in Apogee. Dist. from ⊕, 252,700 mi.		43102
		22	02	● New Moon		
Tue.	10	8		☿ Stationary in R.A.	14 33	43201
Wed.	11	1	07	☌ ☿ ☾ ☿ 7° 34′ N		43102
Thu.	12					40132
Fri.	13	7	03	☌ ♀ ☾ ♀ 3° 22′ N	11 23	21043
Sat.	14					20143
Sun.	15					0324*
Mon.	16				08 12	31024
Tue.	17	10		☿ Greatest Hel. Lat. N.		32014
		11		☍ ♂ ☉ Dist. from ⊕, 62,950,000 mi.		
		15		♂ nearest ⊕		
		20	55	☽ First Quarter		
Wed.	18					3104*
Thu.	19	15	07	☌ ♁ ☾ ♁ 2° 44′ S	05 01	03124
		22		☌ ☿ ☉ Inferior		
Fri.	20					12043
Sat.	21					20413
Sun.	22				01 51	41032
Mon.	23	6		♀ in ♌		d4302
		7	45	☌ ♄ ☾ , ♄ 3° 58′ S		
		19		Moon in Perigee. Dist. from ⊕, 222,200 mi.		
		20	51	☌ ♂ ☾ ♂ 0° 34′ S		
Tue.	24	12	16	♍ Full Moon	22 40	43201
Wed.	25					4310*
Thu.	26	23	43	☌ ♆ ☾ ♆ 1° 24′ S		40312
Fri.	27				19 29	41203
Sat.	28					42013
Sun.	29	9		♁ Stationary in R.A.		41023

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR MARCH, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 47m to 00h 41m and its Decl. changes from 07° 42′ S. to 04° 25′ N. The equation of time changes from − 12m 32s to − 4m 03s. On the 20th at 11.57 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. 12.

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. 19.

Mercury on the 15th is in R.A. 21h 57m, Decl. 13° 04′ S. and transits at 10.27. It is a morning star all month and is at greatest western elongation on the 17th. But this elongation is unfavourable, the planet being only about 9° above the south-eastern horizon at sunrise.

Venus on the 15th is in R.A. 02h 19m, Decl. 15° 24′ N. and transits at 14.49. It is an evening star, still better placed than in February, being seen in the west at sunset and setting about 4 hours later.

Mars on the 15th is in R.A. 09h 33m, Decl. 18° 39′ N. and transits at 21.57. Now a few degrees north-west of Regulus it is well up at sunset. By the end of the month it has become fainter than Regulus again (magnitude − 0.1). On the 30th it is stationary in R.A. and resumes eastward motion among the stars. (See also Saturn on this page.)

Jupiter on the 15th is in R.A. 17h 49m, Decl. 22° 54′ S. and transits at 6.17. It rises just after midnight and is to be seen low in the south for the rest of the night. Quadrature is on the 18th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 18m, Decl. 17° 02′ N. and transits at 21.44. It is just a few degrees west of Mars and nearly a magnitude fainter. Since the beginning of the year it has been retrograding, i.e. moving westward among the stars.

Uranus on the 15th is in R.A. 05h 26m, Decl. 23° 22′ N. and transits at 17.52.

Neptune on the 15th is in R.A. 12h 47m, Decl. 03° 19′ S. and transits at 1.16.

Pluto—For information in regard to this planet, see p. 28.

MARCH

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 5h 30m
Mon.	1			.....	16 19	30412
Tue.	2	11	35	☾ Last Quarter.....		3204*
Wed.	3	2		☿ Stationary in R.A.....		32104
		15	37	☌♃☾ ♃ 3° 47′ N.....		
Thu.	4			.....	13 08	30124
Fri.	5	0		☌ in Aphelion.....		10234
Sat.	6			.....		20134
Sun.	7	9		Moon in Apogee. Dist from ⊕, 252,400 mi....	09 57	10234
Mon.	8	4	47	☌☿☾ ☿ 6° 09′ N.....		30124
Tue.	9			.....		3204*
Wed.	10	16	15	● New Moon.....	06 46	d3420
Thu.	11	21		☿ in ♉.....		4012*
Fri.	12	15		□♁☉.....		41023
Sat.	13			.....	03 36	42013
Sun.	14	9	57	☌♀☾ ♀ 2° 17′ N.....		41023
Mon.	15			.....		43012
Tue.	16			.....	00 25	43210
Wed.	17	15		☿ Greatest elongation W., 27° 41′.....		d3240
		21	59	☌♁☾ ♁ 2° 38′ S.....		
Thu.	18	5		□♃☉.....	21 14	30124
		7	27	☽ First Quarter.....		
Fri.	19			.....		10234
Sat.	20	11	57	☉ enters ♈, Spring commences. Long. of ☉, 0°.		20134
Sun.	21	14	43	☌♄☾ ♄ 4° 05′ S.....	18 04	1034*
		19	16	☌♂☾ ♂ 1° 38′ S.....		
Mon.	22	4		☿ in Aphelion.....		d0124
Tue.	23	3		Moon in Perigee. Dist from ⊕, 224,600 mi....		31204
Wed.	24	22	10	☻ Full Moon.....	14 53	32014
Thu.	25	9	29	☌♆☾ ♆ 1° 21′ S.....		3024*
Fri.	26			.....		14032
Sat.	27	20		♀ in Perihelion.....	11 42	42013
Sun.	28			.....		4103*
Mon.	29			.....		40312
Tue.	30	10		☌ Stationary in R.A.....	08 31	43120
Wed.	31	3	54	☌♃☾ ♃ 4° 08′ N.....		43201

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR APRIL, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 00h 41m to 02h 32m and its Decl. changes from 04° 25′ N. to 14° 59′ N. The equation of time changes from − 4m 03s to + 2m 54s, being zero on the 15th; that is, the apparent sun changes from being east of the mean sun to being west of it. For changes in the length of the day, see p. 12.

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. 19. There is a partial eclipse of the moon, not visible in North America, on April 23. (See p. 29.)

Mercury on the 15th is in R.A. 00h 41m, Decl. 02° 08′ N. and transits at 11.11. It is too close to the sun all month for observation, being in superior conjunction on the 29th.

Venus on the 15th is in R.A. 04h 34m, Decl. 25° 25′ N. and transits at 15.02. It is at its best this month as an evening star, being at greatest eastern elongation on the 14th. At that time it is about 5° north of Aldebaran and sets a good four hours after the sun. Its stellar magnitude has increased to − 4.0 and its disk is now only about half illuminated.

Mars on the 15th is in R.A. 09h 32m, Decl. 17° 26′ N. and transits at 19.56. It is still a few degrees north-west of Regulus and is nearly to the meridian at sunset, setting shortly after midnight. Swinging away from the earth in its orbit, it is now fading quite rapidly and is down to magnitude + 0.5 by the end of the month. (See also Saturn on this page.)

Jupiter on the 15th is in R.A. 17h 55m, Decl. 22° 56′ S. and transits at 4.22. It rises about at midnight and is to be seen low in the south during the rest of the night. On the 15th it is stationary in R.A. and begins to move westward among the stars. For the configurations of Jupiter's satellites see opposite page, and for the eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 14m, Decl. 17° 18′ N. and transits at 19.38. It remains a few degrees west of Mars and by the end of the month is the same brightness as Mars. On the 17th it is stationary in R.A. and begins to move eastward.

Uranus on the 15th is in R.A. 05h 29m, Decl. 23° 25′ N. and transits at 15.54.

Neptune on the 15th is in R.A. 12h 44m, Decl. 02° 59′ S. and transits at 23.07.

Pluto—For information in regard to this planet, see p. 28.

APRIL

75th Meridian Civil Time

	d	h	m		Min. of Algol	Config. of Jupiter's Sat. 4h 00m
					h m	
Thu.	1	5	25	☾ Last Quarter		43102
		6		♂♆☉ Dist. from ⊕, 2,721,000,000 mi.		
Fri.	2				05 20	d4032
Sat.	3					24013
Sun.	4	1		Moon in Apogee. Dist. from ⊕, 251,800 mi.		21043
Mon.	5				02 10	03124
Tue.	6					31024
Wed.	7	12	54	☌☿☾ ☿ 1° 30′ N.	22 59	32014
Thu.	8					31024
Fri.	9	8	16	● New Moon		0124*
Sat.	10				19 48	2034*
Sun.	11	12		☿ Greatest Hel. Lat. S.		21043
Mon.	12					40132
Tue.	13	3	09	☌♀☾ ♀ 1° 08′ N.	16 37	43102
Wed.	14	4	39	☌♎☾ ♎ 3° 10′ S.		43201
		23		♀ Greatest elongation E., 45° 46′		
Thu.	15	3		♃ Stationary in R.A.		4310*
Fri.	16	14	42	☽ First Quarter	13 26	43012
Sat.	17	2		♄ Stationary in R.A.		4203*
		20	40	☌♄☾ ♄ 4° 13′ S.		
Sun.	18	4	50	☌♂☾ ♂ 2° 52′ S.		d4203
		18		♀ Greatest Hel. Lat. N.		
Mon.	19	20		Moon in Perigee. Dist. from ⊕, 228,000 mi.	10 15	40123
Tue.	20					13402
Wed.	21			Lyrid meteors		32014
		17	50	☌♆☾ ♆ 1° 26′ S.		
Thu.	22				07 04	3104*
Fri.	23			Partial eclipse of ☾, see p. 29		30124
		8	28	☍ Full Moon		
Sat.	24					12034
Sun.	25				03 54	d2034
Mon.	26					01234
Tue.	27	12	57	☌♃☾ ♃ 4° 14′ N.		13024
Wed.	28				00 43	32041
Thu.	29	0		☌☿☉ Superior		34120
		6		☌♀♎ ♀ 3° 45′ N.		
Fri.	30	12		☿ in ♌	21 32	43012
		23	48	☾ Last Quarter		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR MAY, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 02h 32m to 04h 35m and its Decl. changes from 14° 59′ N. to 22° 01′ N. The equation of time changes from + 2m 54s to a maximum of + 3m 45s on the 14th and then to + 2m 24s at the end of the month. There is an annular eclipse of the sun, visible as a partial eclipse in the north-west corner of North America, on the 8th-9th. (see p. 29). For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 04h 37m, Decl. 24° 11′ N. and transits at 13.09. From the middle of the month till the end it is very well placed for observation as an evening star in the west just after sunset. On the 28th when it is at greatest eastern elongation it is about 19° above the horizon just north of west at sunset. There is a close conjunction with the moon on the evening of the 9th.

Venus on the 15th is in R.A. 06h 23m, Decl. 27° 09′ N. and transits at 14.51. It is a splendid evening star this month, quite high in the west at sunset. On the 18th it is at greatest brilliancy (stellar magnitude − 4.2) and it appears distinctly crescent-shaped in a telescope.

Mars on the 15th is in R.A. 10h 05m, Decl. 13° 36′ N. and transits at 18.32. It is slightly west of the meridian at sunset and sets about midnight. It is now moving eastward and it will be interesting to watch it approach Regulus and pass about a degree to the north of it on the night of the 15th. By the end of the month it has faded to magnitude + 1.0. Quadrature is on the 22nd. (See also Saturn on this page.)

Jupiter on the 15th is in R.A. 17h 50m, Decl. 22° 56′ S. and transits at 2.18. It rises a couple of hours before midnight and is to be seen low in the south during the remainder of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 17m, Decl. 17° 04′ N. and transits at 17.43. It is west of Mars by a few degrees and this separation is increasing by virtue of Mars' more rapid eastward motion. It is now a little brighter than Mars (mag. + 0.6). Quadrature is on the 6th.

Uranus on the 15th is in R.A. 05h 35m, Decl. 23° 29′ N. and transits at 14.02.

Neptune on the 15th is in R.A. 12h 41m, Decl. 02° 44′ S. and transits at 21.06.

Pluto—For information in regard to this planet, see p. 28.

MAY

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 2h 30m
Sat.	1	20		Moon in Apogee. Dist. from ⊕, 251,200 mi....		d4103
Sun.	2			.....		42013
Mon.	3			.....	18 21	4023*
Tue.	4			Eta Aquarid meteors.....		d4102
Wed.	5	3		☿ in Perihelion.....		43201
Thu.	6	13		□♄☉.....	15 10	34210
Fri.	7			.....		30412
Sat.	8	21	30	● New Moon.....		10234
				Annular eclipse of ☉, see p. 29.....		
Sun.	9	21	38	☌☿☾ ☿ 0° 04′ S.....	11 59	20134
Mon.	10			.....		10234
Tue.	11	12	55	☌♁☾ ♁ 3° 16′ S.....		d0324
Wed.	12	4	33	☌♀☾ ♀ 0° 08′ S.....	08 48	32014
Thu.	13			.....		32104
Fri.	14			.....		30124
Sat.	15	3	14	☌♄☾ ♄ 4° 15′ S.....	05 37	10432
		10		☿ Greatest Hel. Lat. N.....		
		11		Moon in Perigee. Dist. from ⊕, 229,800 mi....		
		19	55	◑ First Quarter.....		
Sun.	16	0	15	☌☌☾ ☌ 3° 42′ S.....		24013
Mon.	17			.....		4103*
Tue.	18	4		♀ Greatest brilliancy.....	02 26	40132
Wed.	19	0	06	☌♆☾ ♆ 1° 30′S.....		4320*
Thu.	20			.....	23 15	43210
Fri.	21			.....		43012
Sat.	22	17		□☌☉.....		41032
		19	37	☍ Full Moon.....		
Sun.	23	20		☌☿♁ ☿ 2° 06′ N.....	20 04	24013
Mon.	24	17	57	☌⚳☾ ⚳ 4° 03′ N.....		1043*
Tue.	25			.....		01324
Wed.	26			.....	16 52	3204*
Thu.	27			.....		32104
Fri.	28	20		☿ Greatest elongation E., 23° 05′.....		30124
Sat.	29	15		Moon in Apogee. Dist. from ⊕, 251,200 mi....	13 41	1024*
Sun.	30	17	43	☾ Last Quarter.....		20134
Mon.	31			.....		12043

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR JUNE, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 04h 35m to 06h 39m and its Decl. changes from 22° 01′ N. to 23° 27′ N. at the solstice on the 21st and then to 23° 08′ N. at the end of the month. The equation of time changes from + 2m 24s to − 3m 35s, being zero on the 11th, that is, the apparent sun changes from being west of the mean sun to being east of it. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 06h 29m, Decl. 21° 24′ N. and transits at 12.53. Early in the month it is well placed as an evening star (see May) but by the 15th it is only about 9° above the western horizon at sunset and so not easily seen. It is stationary in R.A. on the 11th and is in inferior conjunction on the 23rd, moving into the morning sky.

Venus on the 15th is in R.A. 06h 36m, Decl. 22° 58′ N. and transits at 12.59. It is stationary in R.A. on the 2nd and thereafter begins to move westward among the stars and to approach the sun increasingly rapidly. It starts the month as a reasonably high evening star 22° above the western horizon at sunset and by the 24th it is in inferior conjunction and no longer to be seen.

Mars on the 15th is in R.A. 10h 57m, Decl. 07° 47′ N. and transits at 17.22. It is well past the meridian at sunset and sets before midnight, being a few degrees south-east of Regulus.

Jupiter on the 15th is in R.A. 17h 34m, Decl. 22° 52′ S. and transits at 0.01 and 23.56. It is about on the meridian at midnight and sets just about at sunrise. Opposition is on the 15th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 26m, Decl. 16° 23′ N. and transits at 15.50. It still makes with Mars and Regulus an interesting group, Saturn to the west of Regulus, Mars to the east, both planets a magnitude fainter than the star.

Uranus on the 15th is in R.A. 05h 43m, Decl. 23° 33′ N. and transits at 12.08.

Neptune on the 15th is in R.A. 12h 40m, Decl. 02° 37′ S. and transits at 19.03.

Pluto—For information in regard to this planet, see p. 28.

JUNE

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 0h 45m
Tue.	1				10 30	40132
Wed.	2	13		☿ Stationary in R.A.		d4310
Thu.	3					43201
Fri.	4				07 19	4302*
Sat.	5					41302
Sun.	6					42013
Mon.	7	7	55	● New Moon	04 08	41203
		20		☿ in ♉		
		23	31	☌☊☾ ☊ 3° 20′ S.		
Tue.	8	17	50	☌☿☾ ☿ 4° 23′ S.		40123
		23	24	☌♀☾ ♀ 3° 19′ S.		
Wed.	9					13402
Thu.	10	14		Moon in Perigee. Dist. from ⊕, 227,600 mi.	00 56	32014
Fri.	11	2		☿ Stationary in R.A.		3024*
		12	18	☌♄☾ ♄ 4° 10′ S.		
Sat.	12				21 45	31024
Sun.	13	2	45	☌☌☾ ☌ 3° 55′ S.		20134
		20		♀ in ♉		
Mon.	14	0	40	☽ First Quarter		21034
Tue.	15	2		☍☋☉ Dist. from ⊕, 395,800,000 mi.	18 34	01234
		5	15	☌♆☾ ♆ 1° 26′ S.		
Wed.	16					d1024
Thu.	17	10		☌☊☉		32041
Fri.	18	3		☿ in Aphelion	15 23	3410*
Sat.	19					d4302
Sun.	20	19	31	☌☋☾ ☋ 3° 45′ N.		42013
Mon.	21	7	11	☉ enters ♋, Summer commences. Long. of ☉, 90°	12 12	42103
		7	54	☍ Full Moon		
		19		♆ Stationary in R.A.		
Tue.	22					40123
Wed.	23	22		☌☿☉ Inferior		41032
Thu.	24	9		☌♀☉ Inferior	09 00	43201
Fri.	25					34120
Sat.	26	8		Moon in Apogee. Dist. from ⊕, 251,700 mi.		30142
Sun.	27				05 49	20134
Mon.	28					21034
Tue.	29	10	23	☾ Last Quarter		01234
Wed.	30	14		☌☿♀ ☿ 0° 58′ S.	02 38	10324

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR JULY, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 06h 39m to 08h 44m and its Decl. changes from 23° 08′ N. to 18° 07′ N. The equation of time changes from − 3m 35s to a maximum of − 6m 23s on the 26th and then to − 6m 14s at the end of the month. On the 4th the earth is in aphelion or farthest from the sun. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 06h 09m, Decl. 20° 32′ N and transits at 10.38. It is a morning star all this month, reaching greatest western elongation on the 16th when it will appear about 14° above the horizon just a little north of east at sunrise. By the end of the month it is too close to the sun for easy observation.

Venus on the 15th is in R.A. 05h 38m, Decl. 17° 59′ N. and transits at 10.04. Having passed to the west of the sun it is now a morning star. By the 15th it is rising 2 hours ahead of the sun and is up about 17° in the eastern sky by sunrise. On this same day it is stationary in R.A. and resumes eastward motion among the stars. By the 31st it is at greatest brilliancy again (− 4.2) and all this time near inferior conjunction it is distinctly crescent shaped.

Mars on the 15th is in R.A. 11h 56m, Decl. 00° 55′ N. and transits at 16.23. Now about half-way between Regulus and Spica, it is well down in the south-west at sunset and sets a few hours later. It is now at magnitude + 1.3.

Jupiter on the 15th is in R.A. 17h 19m, Decl. 22° 45′ S. and transits at 21.44. It is well up in the south-east at sunset and is to be seen low in the south for most of the night. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 38m, Decl. 15° 23′ N. and transits at 14.04. West of Regulus by a few degrees and well down towards the western horizon at sunset, it is to be seen only for a short while in the evening sky.

Uranus on the 15th is in R.A. 05h 51m, Decl. 23° 36′ N. and transits at 10.17.

Neptune on the 15th is in R.A. 12h 41m, Decl. 02° 41′ S. and transits at 17.06.

Pluto—For information in regard to this planet, see p. 28.

JULY

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 23h 15m
Thu.	1			.....		31204
Fri.	2	1		□♆☉.....	23 26	30124
Sat.	3			.....		d140*
Sun.	4	12		⊕ in Aphelion. Dist. from ☉, 94,456,000 mi...		d4203
		12		☌♀♁ ♀ 4° 32′ S.....		
Mon.	5	8		☿ Stationary in R.A.....	20 15	40123
		11	07	☌♀☾ ♀ 8° 05′ S.....		
		11	52	☌♁☾ ♁ 3° 26′ S.....		
		13	27	☌☿☾ ☿ 8° 07′ S.....		
Tue.	6	16	09	● New Moon.....		41032
Wed.	7			.....		43201
Thu.	8	9		Moon in Perigee. Dist. from ⊕, 224,500 mi....	17 04	43120
		11		☿ Greatest Hel. Lat. S.....		
Fri.	9	0	39	☌♄☾ ♄ 4° 01′ S.....		43012
Sat.	10			.....		4102*
Sun.	11	10	51	☌♂☾ ♂ 3° 27′ S.....	13 52	d2403
Mon.	12	11	17	☌♆☾ ♆ 1° 13′ S.....		01243
Tue.	13	6	30	◑ First Quarter.....		10324
Wed.	14			.....	10 41	23014
Thu.	15	23		♀ Stationary in R.A.....		32104
Fri.	16	3		☿ Greatest elongation W., 20° 33′.....		30124
Sat.	17	20	11	☌⚳☾ ⚳ 3° 33′ N.....	07 30	13024
Sun.	18	9		♀ in Aphelion.....		20134
Mon.	19			.....		043**
Tue.	20	21	31	○ Full Moon.....	04 18	41032
Wed.	21			.....		42301
Thu.	22			.....		43210
Fri.	23	22		Moon in Apogee. Dist. from ⊕, 252,200 mi....	01 07	43012
Sat.	24			.....		41302
Sun.	25			.....	21 55	42013
Mon.	26			.....		42103
Tue.	27	12		☿ in ♌.....		41023
Wed.	28			Delta Aquarid meteors.....	18 44	23041
Thu.	29	1	11	☾ Last Quarter.....		32104
Fri.	30			.....		30214
Sat.	31	3		♀ Greatest brilliancy.....	15 33	31024
		11		☌♀♁ ♀ 5° 27′ S.....		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR AUGUST, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 08h 44m to 10h 40m and its Decl. changes from 18° 21′ N. to 08° 24′ N. The equation of time changes from − 6m 14s to − 0m 05s. For changes in the length of the day, see p. 14.

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

Mercury on the 15th is in R.A. 09h 53m, Decl. 14° 43′ N. and transits at 12.22. It is poorly placed all month for observation, being in inferior conjunction on the 11th.

Venus on the 15th is in R.A. 06h 33m, Decl. 18° 50′ N. and transits at 9.00. It is a good morning star all month, rising several hours before the sun.

Mars on the 15th is in R.A. 13h 04m, Decl. 06° 51′ S. and transits at 15.30. It is now low in the south-west at sunset and sets within a couple of hours. Moving eastward it approaches and passes Spica a few degrees to the north on the 22nd.

Jupiter on the 15th is in R.A. 17h 13m, Decl. 22° 43′ S. and transits at 19.35. It is nearly on the meridian at sunset and sets about midnight. On the 15th it is stationary in R.A. and resumes direct or eastward motion among the stars. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 54.

Saturn on the 15th is in R.A. 09h 53m, Decl. 14° 08′ N. and transits at 12.17. It is no longer to be seen, being in conjunction with the sun on the 19th.

Uranus on the 15th is in R.A. 05h 58m, Decl. 23° 37′ N. and transits at 8.22.

Neptune on the 15th is in R.A. 12h 43m, Decl. 02° 57′ S. and transits at 15.06.

Pluto—For information in regard to this planet, see p. 28.

AUGUST

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 21h 45m
Sun.	1	3		☿ in Perihelion		20134
Mon.	2	0	28	☌♁☾ ♁ 3° 38′ S		21034
		1	39	☌♀☾ ♀ 9° 03′ S		
Tue.	3				12 21	01234
Wed.	4	8	09	☌☿☾ ☿ 3° 48′ S		d034*
		23	13	● New Moon		
Thu.	5	1		☌♂Ψ ♂ 1° 32′ S		32104
		15		Moon in Perigee. Dist. from ⊕, 222,400 mi.		
		15	45	☌♄☾ ♄ 3° 52′ S		
Fri.	6				09 10	34021
Sat.	7					43102
Sun.	8	19	44	☌Ψ☾ Ψ 0° 56′ S		42031
		23	46	☌♂☾ ♂ 2° 19′ S		
Mon.	9	16		♀ Greatest Hel. Lat. S	05 58	42103
Tue.	10					40123
Wed.	11	9		☿ Greatest Hel. Lat. N		41023
		14	40	☽ First Quarter		
		15		☌☿⊙ Superior		
Thu.	12			Perseid meteors	02 47	42310
Fri.	13	5		♂ in ♉		3401*
		23	24	☌♃☾ ♃ 3° 35′ N		
Sat.	14	19		☌☿♄ ☿ 0° 34′ N	23 35	31042
Sun.	15	22		♃ Stationary in R.A.		2014*
Mon.	16					21034
Tue.	17				20 24	01234
Wed.	18					10234
Thu.	19	1		☌♄⊙		d2304
		12	32	○ Full Moon		
Fri.	20	4		Moon in Apogee. Dist. from ⊕, 252,600 mi.	17 13	3014*
Sat.	21					31024
Sun.	22					2041*
Mon.	23				14 01	42103
Tue.	24					40123
Wed.	25					41023
Thu.	26				10 50	42301
Fri.	27	13	46	☾ Last Quarter		4320*
Sat.	28					43102
Sun.	29	11	31	☌♁☾ ♁ 3° 53′ S	07 38	42301
Mon.	30	22	15	☌♀☾ ♀ 7° 58′ S		21403
Tue.	31					02413

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR SEPTEMBER, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 40m to 12h 28m and its Decl. changes from 08° 24′ N. to 03° 04′ S. The equation of time changes from − 0m 05s to + 10m 12s, the apparent sun passing to the west of the mean sun on the 1st. On the 22nd, at 22.22 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. 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. The full moon of September 18th is the Harvest Moon.

Mercury on the 15th is in R.A. 12h 58m, Decl. 07° 45′ S. and transits at 13.23. It is poorly placed all month, being only about 6° above the western horizon at sunset at the time of greatest elongation on the 25th.

Venus on the 15th is in R.A. 08h 34m, Decl. 17° 02′ N. and transits at 8.59. It is a splendid morning star all month, rising several hours before the sun and standing about 40° above the eastern horizon at sunrise. Greatest western elongation is on the 2nd.

Mars on the 15th is in R.A. 14h 20m, Decl. 14° 26′ S. and transits at 14.44. It may still be seen for an hour or so after sunset very low in the south-west. During the afternoon of the 6th an occultation of Mars by the moon will occur for parts of Canada.

Jupiter on the 15th is in R.A. 17h 19m, Decl. 22° 55′ S. and transits at 17.40. It is past the meridian at sunset and sets before midnight. It is in quadrature on the 13th. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

Saturn on the 15th is in R.A. 10h 08m, Decl. 12° 50′ N. and transits at 10.31. It is very close to Regulus (within a degree on the 11th) and may be seen very low on the eastern horizon just before sunrise.

Uranus on the 15th is in R.A. 06h 02m, Decl. 23° 38′ N. and transits at 6.24.

Neptune on the 15th is in R.A. 12h 46m, Decl. 03° 20′ S. and transits at 13.08.

Pluto—For information in regard to this planet, see p. 28.

SEPTEMBER

75h Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 20h 15m
Wed.	1			.....	04 27	10234
Thu.	2	8	04	☌♄ ☾ ♄ 3° 46′S.....		23014
		23		☿ Greatest elongation W., 45° 56′.....		
Fri.	3	1		Moon in Perigee. Dist. from ⊕, 222,000 mi....		32104
		6	21	● New Moon.....		
		19		☿ in ♉.....		
Sat.	4	13	09	☌☿ ☾ ☿ 3° 22′ S.....	01 15	d3024
Sun.	5	6	50	☌♆ ☾ ♆ 0° 41′ S.....		d3014
Mon.	6	16	51	☌♂ ☾ ♂ 0° 44′ S.....	22 04	21034
Tue.	7			.....		02143
Wed.	8			.....		14023
Thu.	9			.....	18 53	42301
Fri.	10	2	05	☽ First Quarter.....		43210
		7	34	☌♃ ☾ ♃ 3° 47′ N.....		
Sat.	11			.....		43012
Sun.	12	9		☌☿ ♆ ☿ 2° 53′ S.....	15 41	4302*
Mon.	13	0		□♃☉.....		42103
Tue.	14	2		☿ in Aphelion.....		4013*
Wed.	15			.....	12 30	41023
Thu.	16	6		Moon in Apogee. Dist. from ⊕, 252,400 mi....		24031
Fri.	17			.....		32104
Sat.	18	4	43	♍ Full Moon. Harvest Moon.....	09 18	30124
Sun.	19			.....		3024*
Mon.	20			.....		21034
Tue.	21			.....	06 07	0134*
Wed.	22	22	22	☉ enters ♎, Autumn commences. Long.of ☉, 180°		10234
Thu.	23	11		□♇☉.....		20314
Fri.	24			.....	02 56	32104
Sat.	25	5		☿ Greatest elongation E., 26° 09′.....		34012
		19	41	☌♇ ☾ ♇ 4° 06′ S.....		
Sun.	26	0	07	☾ Last Quarter.....	23 44	43102
Mon.	27			.....		d4203
Tue.	28			.....		42013
Wed.	29	8	04	☌♀ ☾ ♀ 5° 46′S.....	20 33	41023
		23	35	☌♄ ☾ ♄ 3° 41′ S.....		
Thu.	30			.....		24013

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR OCTOBER, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 28m to 14h 24m and its Decl. changes from 03° 04′ S. to 14° 20′ S. The equation of time changes from + 10m 12s to + 16m 22s. For changes in the length of 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 page 22. The full moon of October 17th is the Hunter's Moon.

Mercury on the 15th is in R.A. 13h 56m, Decl. 14° 46′ S. and transits at 12.17. In the first part of the month it is poorly placed but after inferior conjunction on the 19th it moves into the morning sky and rapidly becomes more favourable for observation. By the end of the month it is about 16° above the eastern horizon at sunrise.

Venus on the 15th is in R.A. 10h 46m, Decl. 8° 33′ N. and transits at 9.13. It is a good morning star all month rising several hours before the sun. On the 6th it passes within about half a degree of Regulus.

Mars on the 15th is in R.A. 15h 44m, Decl. 20° 29′ S. and transits at 14.09. It is very nearly set at sunset but might still be glimpsed for a while near Antares.

Jupiter on the 15th is in R.A. 17h 35m, Decl. 23° 12′ S. and transits at 15.58. It is well past the meridian 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. 55.

Saturn on the 15th is in R.A. 10h 21m, Decl. 11° 43′ N. and transits at 8.45. It rises a few hours before the sun and is a few degrees east of Regulus.

Uranus on the 15th is in R.A. 06h 02m, Decl. 23° 38′ N. and transits at 4.27.

Neptune on the 15th is in R.A. 12h 50m, Decl. 03° 46′ S. and transits at 11.14.

Pluto—For information in regard to this planet, see p. 28.

	d	h	m	OCTOBER 75th Meridian Civil Time	Min. of Algol h m	Config. of Jupiter's Sat. 19h 00m
Fri.	1	11		Moon in Perigee. Dist. from ⊕, 223,300 mi....		42310
Sat.	2	14	42	● New Moon.....	17 22	34021
		19	21	☌♆☾ ♆ 0° 33′ S.....		
Sun.	3			.....		31402
Mon.	4	5	33	☌☿☾ ☿ 3° 51′ S.....		23014
		10		☿ Greatest Hel. Lat. S.....		
		23		♀ in ♌.....		
Tue.	5	13	13	☌♂☾ ♂ 0° 58′ N.....	14 10	2304*
		21		☌♆☉.....		
Wed.	6	5		♁ Stationary in R.A.....		10234
Thu.	7	21	08	☌♃☾ ♃ 4° 05′ N.....		02134
		23		☿ Stationary in R.A.....		
Fri.	8	15		☌♀♄ ♀ 1° 08′ S.....	10 59	21304
Sat.	9	17	10	☽ First Quarter.....		3014*
Sun.	10			.....		31024
Mon.	11			.....	07 48	23014
Tue.	12			.....		24103
Wed.	13	16		Moon in Apogee. Dist. from ⊕, 251,900 mi....		d4023
Thu.	14			.....	04 36	40123
Fri.	15			.....		42130
Sat.	16			.....		4301*
Sun.	17	21	23	○ Full Moon. Hunter's Moon.....	01 24	43102
Mon.	18			.....		43201
Tue.	19	19		☌☿☉ Inferior.....	22 14	42103
Wed.	20			.....		01423
Thu.	21			.....		0243*
Fri.	22			Orionid meteors.....	19 03	d2104
Sat.	23	1	09	☌♁☾ ♁ 4° 10′ S.....		32014
		11		☿ in ♌.....		
Sun.	24			.....		31024
Mon.	25	8	41	☾ Last Quarter.....	15 51	32014
Tue.	26			.....		21034
Wed.	27	12	21	☌♄☾ ♄ 3° 33′ S.....		01243
Thu.	28	2		☿ in Perihelion.....	12 39	0423*
		7		☿ Stationary in R.A.....		
Fri.	29	2	02	☌♀☾ ♀ 2° 10′ S.....		24103
		15		Moon in Perigee. Dist. from ⊕, 226,200 mi....		
Sat.	30	7	16	☌♆☾ ♆ 0° 28′ S.....		43201
		18	33	☌☿☾ ☿ 0° 31′ N.....		
Sun.	31			.....	09 29	43102

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR NOVEMBER, 1948

Positions of the sun and planets are given for 0h Greenwich Civil 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 24m to 16h 28m and its Decl. changes from 14° 20′ S. to 21° 46′ S. The equation of time changes from + 16m 22s to a maximum of + 16m 23s on the 3rd and then to + 11m 04s at the end of the month. There is a total eclipse of the sun, not visible in North America, on the 1st. (See page 29.) For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 14h 22m, Decl. 12° 13′ S. and transits at 10.47. Early in the month it is well placed as a morning star about 16° above the eastern horizon at sunrise. Greatest western elongation is on the 4th. At mid-month it is still good but by the end of the month it is too close to the sun.

Venus on the 15th is in R.A. 13h 04m, Decl. 04° 49′ S. and transits at 9.28. It is still a good morning star though not so high now. On the 20th it passes a few degrees north of Spica.

Mars on the 15th is in R.A. 17h 21m, Decl. 24° 04′ S. and transits at 13.44. It is too low in the south-west at sunset for easy observation.

Jupiter on the 15th is in R.A. 18h 00m, Decl. 23° 23′ S. and transits at 14.21. It is well past the meridian 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. 55.

Saturn on the 15th is in R.A. 10h 31m, Decl. 10° 55′ N. and transits at 6.53. It rises about midnight and is only a few degrees east of Regulus. On the 28th it is in quadrature.

Uranus on the 15th is in R.A. 06h 00m, Decl. 23° 39′ N. and transits at 2.22.

Neptune on the 15th is in R.A. 12h 54m, Decl. 04° 10′ S. and transits at 9.16.

Pluto—For information in regard to this planet, see p. 28.

NOVEMBER

75th Meridian Civil Time

	d	h	m		Min. of Algol	Config. of Jupiter's Sat. 17h 45m
					h m	
Mon.	1	1	02	● New Moon		d4301
				Total eclipse of ☉, see p. 29		
Tue.	2					4210*
Wed.	3	11	54	☌♂☾ ♂ 2° 26′ N	06 18	4O213
Thu.	4	14		☿ Greatest elongation W., 18° 51′		41O23
		14	54	☌♃☾ ♃ 4° 19′ N		
Fri.	5					42O13
Sat.	6				03 07	32O4*
Sun.	7	8		☿ Greatest Hel. Lat. N.		31O24
		17		☿ in Perihelion		
Mon.	8	11	46	☽ First Quarter	23 56	3O214
Tue.	9					2104*
Wed.	10	10		Moon in Apogee. Dist. from ⊕, 251,400 mi.		O134*
Thu.	11				20 44	1O234
Fri.	12	16		☌☿♀♆ ♀ 0° 18′ N		2O134
Sat.	13					2304*
Sun.	14				17 33	31042
Mon.	15			Leonid meteors		34012
Tue.	16	13	31	○ Full Moon		42130
Wed.	17				14 22	42013
Thu.	18					41O23
Fri.	19	5	48	☌♁☾ ♁ 4° 05′ S		42013
Sat.	20				11 11	42130
Sun.	21					d4302
Mon.	22					34012
Tue.	23	16	22	☾ Last Quarter	08 00	23104
		21	26	☌♄☾ ♄ 3° 18′ S		
Wed.	24					2O134
Thu.	25	20		Moon in Perigee. Dist. from ⊕, 229,500 mi.		1O234
Fri.	26	16	48	☌♆☾ ♆ 0° 19′ S	04 49	2O134
Sat.	27					d2104
Sun.	28	0		□♄☉		3O124
		1	01	☌♀☾ ♀ 1° 52′ N		
Mon.	29	11		☿ Greatest Hel. Lat. N.	01 38	3O24*
Tue.	30	1	31	☌☿☾ ☿ 2° 29′ N		32104
		13	44	● New Moon		
		19		☿ in ♉		

Explanation of symbols and abbreviations on p. 4, of time on p. 8.

THE SKY FOR DECEMBER, 1948

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

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

The Sun—During December the sun's R.A. increases from 16h 28m to 18h 45m and its Decl. changes from 21° 46′ S. to 23° 27′ S. at the solstice on the 21st and then to 23° 04′ S. at the end of the month. The equation of time changes from + 11m 04s to zero on the 25th then to − 3m 22s at the end of the month. For changes in the length of the day, see p. 16.

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

Mercury on the 15th is in R.A. 17h 34m, Decl. 24° 44′ S. and transits at 12.02. It is poorly placed all month. Superior conjunction is on the 12th.

Venus on the 15th is in R.A. 15h 26m, Decl. 17° 05′ S. and transits at 9.52. It is still a morning star but has risen only about 20° above the south-eastern horizon at sunrise. As for brilliance and illumination, it finishes the year about as it started, magnitude − 3.4 and illuminated portion about 87%.

Mars on the 15th is in R.A. 19h 01m, Decl. 23° 47′ S. and transits at 13.26. It is too low in the south-west at sunset for easy observation.

Jupiter on the 15th is in R.A. 18h 28m, Decl. 23° 16′ S. and transits at 12.52. It is too near the sun for easy observation most of the month. For the configurations of Jupiter's satellites see opposite page, and for their eclipses, etc., see p. 55.

Saturn on the 15th is in R.A. 10h 34m, Decl. 10° 41′ N. and transits at 4.58. Still only a few degrees east of Regulus, it rises well before midnight and is to be seen for the rest of the night.

Uranus on the 15th is in R.A. 05h 55m, Decl. 23° 39′ N. and transits at 0.20.

Neptune on the 15th is in R.A. 12h 57m, Decl. 04° 26′ S. and transits at 7.21.

Pluto—For information in regard to this planet, see p. 29.

			DECEMBER 75th Meridian Civil Time	Min. of Algol	Config. of Jupiter's Sat. 17h 15m
d	h	m		h m	
Wed. 1	3		☌☌♃ ♂ 1° 03′ S.	22 27	24013
Thu. 2	10	47	☌♃☾ ♃ 4° 29′ N.		41023
	12	08	☌☌☾ ♂ 3° 28′ N.		
Fri. 3					40213
Sat. 4				19 16	42103
Sun. 5					
Mon. 6					
Tue. 7				16 05	
Wed. 8	6		Moon in Apogee. Dist. from ⊕, 251,200 mi.		
	8	57	☽ First Quarter		
Thu. 9					
Fri. 10				12 54	
Sat. 11	1		☿ in Aphelion		
Sun. 12	15		☌☿☉ Superior		
			Geminid meteors		
Mon. 13				10 44	
Tue. 14					
Wed. 15					
Thu. 16	4	11	☍ Full Moon	06 33	
	11	50	☌♁☾ ♁ 3° 58′ S.		
Fri. 17	16		♄ Stationary in R.A.		
Sat. 18					
Sun. 19				03 22	
Mon. 20	7		☍♁☉ Dist. from ⊕, 1,675,000,000 mi.		
	12		Moon in Perigee. Dist. from ⊕, 229,100 mi.		
Tue. 21	3	51	☌♄☾ ♄ 2° 57′ S.		
	17	34	☉ enters ♑, Winter commences. Long. of ☉, 270°		
Wed. 22				00 11	
Thu. 23	0	12	☾ Last Quarter		
	18		☌☿♃ ☿ 2° 01′ S.		
	23	41	☌♆☾ ♆ 0° 02′ S.		
Fri. 24				21 00	
Sat. 25					
Sun. 26	8		♃ in ♉		
Mon. 27				17 49	
Tue. 28	1	20	☌♀☾ 4° 18′ N.		
Wed. 29					
Thu. 30	4	44	● New Moon	14 38	
	6	41	☌♃☾ ♃ 4° 39′N.		
Fri. 31	1	38	☌☿☾ ☿ 2° 46′ N.		
	9		☿ Greatest Hel. Lat. S.		
	13	42	☌☌☾ ♂ 3° 58′ N.		

Jupiter being near sun, phenomena of the satellites are not given after Dec. 4th.

PHENOMENA OF JUPITER'S SATELLITES, 1948

By CHARLES E. APGAR, Westfield, New Jersey

JANUARY

d	h	m	Sat.	Phen.
1	06	36	II	Se
7	06	38	I	ED
8	06	01	I	Se
	06	38	I	Te
	06	40	II	SI
15	05	44	I	SI
	06	27	I	TI
16	05	58	I	OR
24	05	07	I	Te
	06	12	II	ED
26	05	30	II	Te
28	05	21	III	ED
31	04	55	I	TI
	06	09	I	Se

FEBRUARY

d	h	m	Sat.	Phen.
2	05	43	II	TI
	06	18	II	Se
7	05	52	I	SI
8	06	03	III	Te
	06	25	I	OR
9	06	21	II	SI
11	05	17	II	OR
15	05	04	I	ED
	05	46	III	Se
16	04	24	I	Se
	05	31	I	Te
23	04	07	I	SI
	05	16	I	TI
	06	17	I	Se
24	04	49	I	OR
25	05	43	II	ED
26	04	42	III	OR
27	03	22	II	Se
	05	48	II	Te

MARCH

d	h	m	Sat.	Phen.
1	06	00	I	SI
2	03	19	I	ED
3	03	52	I	Te
4	03	45	III	ER
5	03	25	II	SI
	05	55	II	TI
	05	57	II	Se
9	05	12	I	ED
10	03	36	I	TI
	04	32	I	Se
	05	47	I	Te
11	03	09	I	OR
	05	07	III	ED
14	06	14	II	OR
15	02	49	III	Te
17	04	15	I	SI
	05	30	I	TI
18	05	03	I	OR
19	02	09	I	Te
21	02	42	II	ED
22	04	07	III	TI
23	02	56	II	Te
25	03	27	I	ED
26	01	51	I	TI
	02	47	I	Se
	04	02	I	Te
28	05	16	II	ED
29	02	59	III	SI
30	02	57	II	TI
	02	59	II	Se

APRIL

d	h	m	Sat.	Phen.
1	05	21	I	ED
2	02	29	I	SI
	03	43	I	TI
	04	40	I	Se
3	03	16	I	OR
6	03	01	II	SI
8	02	09	II	OR
9	01	47	III	OD
	04	23	I	SI
	04	32	III	OR
10	01	42	I	ED
	05	06	I	OR
11	01	02	I	Se
	02	13	I	Te
15	04	37	II	OR
16	00	54	III	ED
	03	36	III	ER
17	03	36	I	ED
18	00	44	I	SI
	01	51	I	TI
	02	56	I	Se
	04	03	I	Te
19	01	23	I	OR
22	02	18	II	ED
23	23	59	II	Se
24	02	04	II	Te
25	02	38	I	SI
	03	39	I	TI
	23	57	I	ED
26	03	11	I	OR
27	00	18	I	Te
	01	36	III	Te

MAY

d	h	m	Sat.	Phen.
1	00	00	II	SI
	01	54	II	TI
	02	33	II	Se
	04	26	II	Te
2	04	31	I	SI
3	01	51	I	ED
	23	54	I	TI
4	01	12	I	Se
	01	29	III	Se
	02	06	I	Te
	02	25	III	TI
	23	25	I	OR
8	02	34	II	SI
	04	14	II	TI
10	01	00	II	OR
	03	44	I	ED
11	00	53	I	SI
	01	40	I	TI
	02	44	III	SI
	03	05	I	Se
	03	52	I	Te
12	01	11	I	OR
14	22	24	III	OR
16	23	22	II	ED
17	03	09	II	OR
18	02	47	I	SI
	03	26	I	TI
	22	13	II	Te
19	00	06	I	ED
	02	56	I	OR
	23	28	I	Se
20	00	04	I	Te
22	01	47	III	OR
24	01	58	II	ED

May—cont'd

d	h	m	Sat.	Phen.
25	21	56	II	TI
	23	33	II	Se
26	00	29	II	Te
	01	59	I	ED
	23	09	I	SI
	23	37	I	TI
27	01	22	I	Se
	01	49	I	Te
	23	06	I	OR
29	00	41	III	ED

JUNE

d	h	m	Sat.	Phen.
1	23	33	II	SI
2	00	11	II	TI
	02	07	II	Se
	02	43	II	Te
	03	53	I	ED
3	01	03	I	SI
	01	21	I	TI
	03	16	I	Se
	03	34	I	Te
	21	02	II	OR
	22	22	I	ED
4	00	50	I	OR
	21	45	I	Se
	22	00	I	Te
8	21	25	III	Se
	22	01	III	Te
9	02	06	II	SI
	02	24	II	TI
10	02	58	I	SI
	03	05	I	TI
	20	29	II	ED
	23	18	II	OR
11	00	15	I	ED
	02	34	I	OR
	21	26	I	SI
	21	31	I	TI
	23	40	I	Se
	23	44	I	Te
12	21	00	I	OR
15	22	32	III	TI
	22	35	III	SI
16	01	16	III	Te
	01	24	III	Se
17	22	58	II	OD
18	01	43	II	ER
	02	05	I	OD
	23	15	I	TI
	23	21	I	SI
19	01	28	I	Te
	01	34	I	Se
	20	18	II	Te
	20	31	I	OD
	20	32	II	Se
	22	50	I	ER
23	01	49	III	TI
	02	34	III	SI
25	01	14	II	OD
	03	49	I	OD
26	00	59	I	TI
	01	15	I	SI
	03	12	I	Te
	20	32	II	SI
	22	15	I	OD
	22	32	II	Te
	23	06	II	Se
27	00	45	I	ER

June—cont'd

d	h	m	Sat.	Phen.
	21	38	I	Te
	21	57	I	Se

JULY

d	h	m	Sat.	Phen.
3	02	44	I	TI
	22	13	II	TI
	23	06	II	SI
	23	26	III	ER
	23	59	I	OD
4	00	46	II	Te
	01	41	II	Se
	02	38	I	ER
	21	10	I	TI
	21	39	I	SI
	23	23	I	Te
	23	52	I	Se
5	20	16	II	ER
	21	07	I	ER
10	22	07	III	OD
11	00	29	II	TI
	01	40	II	SI
	01	44	I	OD
	22	56	I	TI
	23	34	I	SI
12	01	09	I	Te
	01	47	I	Se
	20	10	I	OD
	22	54	II	ER
	23	02	I	ER
13	20	16	I	Se
18	01	31	III	OD
19	00	43	I	TI
	01	29	I	SI
	21	18	II	OD
	21	56	I	OD
20	00	56	I	ER
	01	32	II	ER
	21	22	I	Te
	22	11	I	Se
21	20	07	II	Se
	21	25	III	Se
26	23	40	II	OD
	23	43	I	OD
27	20	57	I	TI
	21	53	I	SI
	23	10	I	Te
28	00	06	I	Se
	20	07	II	SI
	20	50	II	Te
	21	19	I	ER
	21	32	III	Te
	22	30	III	SI
	22	42	II	Se

AUGUST

d	h	m	Sat.	Phen.
3	22	46	I	TI
	23	48	I	SI
4	19	59	I	OD
	20	39	II	TI
	22	19	III	TI
	22	41	II	SI
	23	12	II	Te
	23	14	I	ER
5	20	30	I	Se
6	20	07	II	ER
11	21	48	I	OD
	23	03	II	TI

August—cont'd

d	h	m	Sat	Phen.
12	20	12	I	SI
	21	17	I	Te
	22	25	I	Se
13	19	38	I	ER
	22	45	II	ER
15	20	28	III	ED
	23	27	III	ER
19	20	55	I	TI
	22	08	I	SI
	23	08	I	Te
20	20	15	II	OD
	21	33	I	ER
22	19	31	III	OD
	19	44	II	Se
	22	23	III	OR
26	22	48	I	TI
27	19	59	I	OD
	22	47	II	OD
28	19	29	I	Te
	20	45	I	Se
29	19	44	II	SI
	19	49	II	Te
	22	19	II	Se

SEPTEMBER

d	h	m	Sat.	Phen.
2	21	28	III	Se
3	21	52	I	OD
4	19	10	I	TI
	20	27	I	SI
	21	23	I	Te
5	19	47	II	TI
	19	51	I	ER
	22	19	II	SI
	22	21	II	Te
7	19	57	II	ER
9	20	10	III	Te
11	21	05	I	TI
12	21	46	I	ER
13	19	05	I	Se
16	21	17	III	TI
19	20	10	I	OD
20	18	47	I	SI
	19	29	III	ER
	19	43	I	Te
	21	00	I	Se
21	19	56	II	OD
23	19	24	II	Se
27	19	27	I	TI

September—cont'd

d	h	m	Sat.	Phen.
	20	26	III	ED
	20	42	I	SI
28	20	05	I	ER
30	19	23	II	SI
	19	32	II	Te

OCTOBER

d	h	m	Sat.	Phen.
4	19	29	III	OD
5	18	33	I	OD
6	19	20	I	Se
7	19	38	II	TI
9	19	46	II	ER
13	19	02	I	SI
	20	06	I	Te
14	18	24	I	ER
15	18	28	III	SI
20	19	52	I	TI
22	18	12	III	TI
25	19	07	II	Se
28	19	00	I	OD
29	18	36	I	Te

NOVEMBER

d	h	m	Sat.	Phen.
1	19	05	II	SI
5	18	22	I	TI
6	18	38	I	ER
13	17	13	I	OD
14	17	54	I	Se
17	17	59	II	OD
20	17	35	III	Se
21	17	34	I	SI
26	17	41	II	Te

DECEMBER

d	h	m	Sat.	Phen.
3	17	51	II	TI

Jupiter being near the Sun, phenomena of the Satellites are not given from December 5 to December 31.

E—eclipse, O—occultation, T—transit, S—shadow, D—disappearance, R—reappearance, I—ingress, e—egress; 75th Meridian Civil Time. (For other times see p. 8)

LUNAR OCCULTATIONS

Prepared by J. F. HEARD

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 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, adapted from the 1948 Nautical Almanac, give the times of immersion or emersion or both for occultations of stars of magnitude 4.5 or brighter visible at Toronto and at Montreal and also at Vancouver and Calgary, at night. Emersions at the bright limb of the moon are given only in the case of stars brighter than magnitude 3.5. 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 than 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 in the table is the position angle of the point of contact on the moon's disk reckoned from the north point towards the east.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1948

Date	Star	Mag.	I or E	Age of Moon	Toronto				Montreal			
					E.S.T.	a	b	P	E.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 27	Mars	−0.7	I	16.9	Graze	.....	.....	...	23 51.1	−0.6	−2.9	173
28	Mars	−0.7	E	16.9	Graze	.....	.....	...	00 31.4	−2.2	+2.4	245
Feb. 23	Mars	−0.9	I	14.0	19 38.8	−0.9	−2.3	167	19 40.7	−0.9	−1.5	159
23	Mars	−0.9	E	14.0	20 10.8	−0.7	+3.7	231	20 21.6	−1.0	+2.7	241
July 31	A Tau	4.5	I	24.5	01 31.2	+0.3	+1.6	55	01 32.7	+0.2	+1.7	58
31	A Tau	4.5	E	24.5	02 25.1	−0.1	+1.5	259	02 29.2	−0.3	+1.6	255
Sep. 6	Mars*	1.5	I	3.4	16 59.0	−2.6	−0.2	66	17 15.0	.....	.....	49
6	Mars*	1.5	E	3.4	17 42.6	−0.5	−2.7	358	17 39.2	.....	.....	12
Nov. 19	136 Tau	4.5	I	18.1	02 10.9	.....	.....	11	No. occ.	.....	.....	...
19	136 Tau	4.5	E	18.1	02 34.1	.....	.....	338	No. occ.	.....	.....	...

*Daytime occultation.

LUNAR OCCULTATIONS VISIBLE AT VANCOUVER AND CALGARY, 1948

Date	Star	Mag.	I or E	Age of Moon	Vancouver				Calgary			
					P.S.T.	a	b	P	M.S.T.	a	b	P
				d	h m	m	m	°	h m	m	m	°
Jan. 27	Mars	−0.7	I	16.9	20 13.0	−0.3	−0.4	151	21 15.5	−0.4	−0.4	151
27	Mars	−0.7	E	16.9	20 53.8	−0.1	+2.2	249	21 58.9	−0.4	+2.2	252
Feb. 3	δ Sco	2.5	I	23.2	04 43.4	+0.1	−0.9	165	05 45.2	−0.6	−0.2	147
3	δ Sco	2.5	E	23.2	05 32.0	−2.1	+1.6	247	06 51.4	−1.8	+0.6	265
27	θ Vir	4.4	I	17.4	05 54.3	−1.5	−1.0	67	Sun	.....	.....	...
Sep. 6	Mars*	1.5	I	3.4	12 40.7	−0.8	+0.1	129	13 50.0	−1.2	+0.3	113
6	Mars*	1.5	E	3.4	13 53.2	−1.2	−0.1	302	22 02.6	−1.0	−0.7	318

*Daytime occultation.

METEORS AND METEORITES

By Peter M. Millman

A meteor or "shooting star" appears when one of the larger particles comprising the dust of space happens to encounter the earth's atmosphere at high velocity. In general the particle is completely vapourized high in the upper atmosphere but occasionally it is large enough so that a portion reaches the earth's surface, and this solid lump of iron or stone is known as a meteorite. The study of meteors and meteorites contributes a large amount of valuable information concerning the nature and origin of the universe and there are many intriguing problems in this field awaiting solution. The amateur can do work of lasting value here, as the large and very expensive instrumental equipment required for most astronomical research is not needed for the study of meteors.

For any given observation point there is no way of predicting in advance just where the next meteor will appear, in other words, it is chiefly a matter of chance whether it appears north, south, east, west, or directly overhead. Taking an overall average for the whole year and all parts of the night a single observer with an unobstructed view of the sky will see 10 meteors per hour on a clear

moonless night. This statement must be qualified by the fact that meteors are roughly twice as numerous during the second half of the night as they are during the first, and their rate of appearance is approximately doubled for the second half of the year as compared with the first six months. There is also a great variation in meteor frequency from one night to the next. The observed meteors range in brightness all the way from those only visible in fairly large telescopes up to great fireballs exceeding the full moon in luminosity. The frequency of meteors increases approximately in inverse proportion to their brightness.

In addition to the stray so-called "sporadic" meteors which appear on any night of the year, there are various swarms of meteors, each swarm moving along in its particular lliptical orbit about the sun. In most cases these meteor orbits are found to correspond closely with those of certain comets. When the earth encounters such a swarm of meteors the apparent paths, when projected backwards in the sky, all seem to meet in a point, a result of perspective. This point indicates the direction from which the meteors are coming and is called the "radiant". The meteor shower is commonly called after the constellation in which the radiant is located. The best known meteor showers are listed in the accompanying table which has been compiled from various sources. Of these showers the Perseids and Geminids are the most consistent. Some, such as the Leonids, Giacobinids, and Bielids, have provided spectacular displays in certain years and in others have been almost or totally absent. The Bielids have scarcely been observed at all since the 19th century; the Giacobinids were first observed in 1933. The hourly number listed in the table is the approximate number of meteors which are likely to be seen in one hour by a single observer on a clear moonless night at the shower maximum in a normal year.

Amateur cooperation assists greatly in the scientific study of meteors. Visual observations may be divided into two types:

(a) *Systematic programs.* These may be carried out either by a single observer or by groups of observers. In this case the sky is observed continuously for a period of time and the numbers of meteors seen, their brightness, colour, position, and other characteristics recorded. Plotting the observations on a star map is more important when the program is carried out in cooperation with another party observing some distance away.

(b) *The chance observation of a bright meteor or fireball.* Any meteor markedly brighter than Jupiter (mag. −2) should be carefully recorded and the observation forwarded to some observatory where meteor records are being kept. In this case it is very important to note the position of the meteor in the sky, as well as all other features observed. Information equally important, but often forgotten, is the exact time and date of the phenomenon and an accurate description of where the observer was situated, given within 100 yds. if possible.

Skilled visual or photographic observations from two or more stations make possible the computation of meteor heights. Most meteors are visible in the range from 40 to 80 miles above the earth's surface and move with velocities ranging from 20 to 60 miles per second.

Continued on page 79.

PRINCIPAL ELEMENTS OF THE SOLAR SYSTEM

ORBITAL ELEMENTS (Jan. 1, 12^h, 1945)

Planet	Mean Distance from Sun (a) ⊕ =1	Mean Distance from Sun (a) millions of miles	Period (P)	Eccentricity (e)	Inclination (i)	Long. of Node (☊)	Long. of Perihelion (π)	Mean Long. of Planet
					°	°	°	°
Mercury	.387	36.0	88.0days	.206	7.0	47.6	76.5	120.5
Venus	.723	67.2	224.7	.007	3.4	76.1	130.7	36.0
Earth	1.000	92.9	365.3	.017	....	.....	101.9	99.8
Mars	1.524	141.5	687.0	.093	1.9	49.1	334.9	267.4
Jupiter	5.203	483.3	11.86yrs.	.048	1.3	99.8	13.3	164.4
Saturn	9.54	886.	29.46	.056	2.5	113.1	91.8	97.1
Uranus	19.19	1783.	84.0	.047	0.8	73.7	169.7	76.8
Neptune	30.07	2793.	164.8	.009	1.8	131.1	44.1	184.0
Pluto	39.46	3666.	247.7	.249	17.1	109.5	223.4	158.3

PHYSICAL ELEMENTS

Object	Symbol	Mean Diameter miles	Mass ⊕ =1	Density water =1	Axial Rotation	Mean Surface Gravity ⊕ =1	Albedo Bond's	Magnitude at Opposition or Elongation
Sun	☉	864,000	332,000	1.4	$24^d.7$ (equatorial)	27.9		− 26.7
Moon	☾	2,160	.0123	3.3	$27^d\ 7.7^h$	.16	.07	− 12.6
Mercury	☿	3,010	.056	3.8	88^d	.27	.07	0±
Venus	♀	7,580	.82	4.9	30^d ?	.85	.59	− 4±
Earth	⊕	7,918	1.00	5.5	$23^h\ 56^m$	1.00	.29	
Mars	♂	4,220	.108	4.0	$24^h\ 37^m$	.38	.15	− 2±
Jupiter	♃	87,000	318.	1.3	$9^h\ 50^m$±	2.6	.56?	− 2±
Saturn	♄	72,000	95.	.7	10^h15^m±	1.2	.63?	0±
Uranus	♅	31,000	14.6	1.3	$10^h.8$±	.9	.63?	+ 5.7
Neptune	♆	33,000	17.2	1.3	16^h ?	1.0	.73?	+ 7.6
Pluto	♇	4,000?	.8 ?					+ 14

SATELLITES OF THE SOLAR SYSTEM

Name	Stellar Mag.	Mean Dist. from Planet			Revolution Period			Diameter Miles	Discoverer
		"	*	Miles	d	h	m		
SATELLITE OF THE EARTH									
Moon	−12.6	530		238,857	27	07	43	2160	
SATELLITES OF MARS									
Phobos	12	8		5,800	0	07	39	10?	Hall, 1877
Deimos	13	21		14,600	1	06	18	5?	Hall, 1877
SATELLITES OF JUPITER									
V	13	48		112,600	0	11	57	100?	Barnard, 1892
Io	5	112		261,800	1	18	28	2300	Galileo, 1610
Europa	6	178		416,600	3	13	14	2000	Galileo, 1610
Ganymede	5	284		664,200	7	03	43	3200	Galileo, 1610
Callisto	6	499		1,169,000	16	16	32	3200	Galileo, 1610
VI	14	3037		7,114,000	250	16		100?	Perrine, 1904
VII	16	3113		7,292,000	260	01		40?	Perrine, 1905
X	18	3116		7,300,000	260			15?	Nicholson, 1938
XI	18	5990		14,000,000	692			15?	Nicholson, 1938
VIII	16	6240		14,600,000	739			40?	Melotte, 1908
IX	17	6360		14,900,000	758			20?	Nicholson, 1914
SATELLITES OF SATURN									
Mimas	12	27		115,000	0	22	37	400?	W. Herschel, 1789
Enceladus	12	34		148,000	1	08	53	500?	W. Herschel, 1789
Tethys	11	43		183,000	1	21	18	800?	G. Cassini, 1684
Dione	11	55		234,000	2*	17	41	700?	G. Cassini, 1684
Rhea	10	76		327,000	4	12	25	1100?	G. Cassini, 1672
Titan	8	177		759,000	15	22	41	2600?	Huygens, 1655
Hyperion	13	214		920,000	21	06	38	300?	G. Bond, 1848
Iapetus	11	515		2,210,000	79	07	56	1000?	G. Cassini, 1671
Phoebe	14	1870		8,034,000	550			200?	W. Pickering, 1898
SATELLITES OF URANUS									
Ariel	16	14		119,000	2	12	29	600?	Lassell, 1851
Umbriel	16	19		166,000	4	03	28	400?	Lassell, 1851
Titania	14	32		272,000	8	16	56	1000?	W. Herschel, 1787
Oberon	14	42		364,000	13	11	07	900?	W. Herschel, 1787
SATELLITE OF NEPTUNE									
Triton	13	16		220,000	5	21	03	3000?	Lassell, 1846

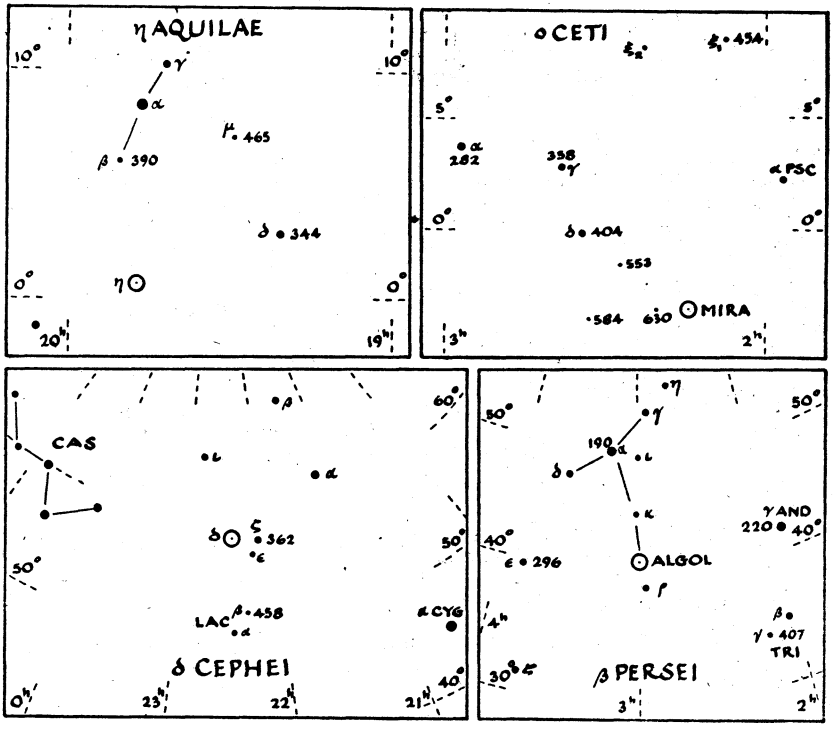
*As seen from the sun.

Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV, respectively, in order of distance from the planet.

VARIABLE STARS

Much pleasure may be derived from the estimation of the brightness of 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. These magnitudes are given as magnitudes, tenths and hundredths, with the decimal point omitted. Thus a star 362 is of magnitude 3.62. To determine the brightness of the variable at any time, carefully estimate the brightness as some fraction of the interval between two comparison stars, one brighter and one fainter than the variable. The result may then be expressed in magnitudes and tenths. Record the magnitude 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. Such studies of naked-eye estimates of brightness will at once reveal the differences in variation between the different kinds of variable. For each short period variable the observations made on any one cycle may be carried forward one, two or any number of periods to form a combined light curve.

For the two cepheids, good mean curves may be readily found by observing the variables once a night on as many nights as possible. For Algol, which changes rapidly for a few hours before and after minimum, estimates should be made at quarter or half hour intervals around the times of minimum as tabulated on pages 31-53. Mira may be observed for a couple of months as it rises from the naked-eye limit to 2nd or 3rd magnitude maximum and fades again.



REPRESENTATIVE BRIGHT VARIABLE STARS

Name	Design.	Max.	Min.	Sp.	Period	Type	Date	Discoverer
η Aql	194700	3.7	4.4	G4	7.17652	Cep	1784	Pigott
N Aql	184300	-0.2	10.9	Q	Irr.	Nova	1918	Bower
ϵ Aur	045443	3.3	4.1	F5p	9833.	Ecl	1821	Fritsch
δ Cep	222557	3.6	4.3	G0	5.36640	Cep	1784	Goodricke
U Cep	005381	6.8	9.2	A0	2.49293	Ecl	1880	W. Ceraski
o Cet[1]	0214*o3*	2.0	10.1	M5e	331.8	LPV	1596	Fabricius
RR Cet	012700	8.4	9.0	F0	0.55304	Clus	1906	Oppolzer
R CrB	154428	5.8	13.8	cG0e	Irr.	RCrB	1795	Pigott
χ Cyg	194632	4.2	14.0	M7e	412.9	LPV	1686	Kirch
P Cyg	201437a	3.5	6.0	B1qk	Irr.	Nova	1600	Blaeu
SS Cyg	213843	8.1	12.0	Pec.	Irr.	SSCyg	1896	Wells
XX Cyg	200158	11.4	12.1	A	0.13486	Clus	1904	L. Ceraski
ζ Gem	065820	3.7	4.1	cG1	10.15353	Cep	1847	Schmidt
η Gem	060822	3.3	4.2	M2	235.58	LPV	1865	Schmodt
R Gem	070122a	6.5	14.3	Se	370.1	LPV	1848	Hind
U Gem	074922	8.8	13.8	Pec.	Irr.	SSCyg	1855	Hind
α Her	171014	3.1	3.9	M5	Irr.	SemiR	1795	W. Herschel
R Hya	1324*22*	3.5	10.1	M7e	414.7	LPV	1670	Montanari
R Leo	094211	5.0	10.5	M7e	310.3	LPV	1782	Koch
β Lyr	184633	3.4	4.3	B5e	12.92504	Ecl	1784	Goodricke
RR Lyr	192242	7.2	8.0	A5	0.56685	Clus	1901	Fleming
α Ori[2]	054907	0.2	1.2	M2	2070. Irr.	SemiR	1840	J. Herschel
U Ori	054920	5.4	12.2	M7e	376.9	LPV	1885	Gore
β Per[3]	030140	2.3	3.5	B8	2.86731	Ecl	1669	Montanari
ρ Per	025838	3.3	4.1	M4	Irr.	Irr.	18	54Schmidt
R Sge	200916	8.6	10.4	cG7	70.84	SemiR	1859	Baxendell
R Sct	1842*o5*	4.5	9.0	K5e	141.5	SemiR	1795	Pigott
λ Tau	035512	3.8	4.1	B3	3.95294	Ecl	1848	Baxendell
RV Tau	044126	9.4	12.5	K0	78.60	SemiR	1905	L. Ceraski
SU Tau	054319	9.5	15.4	G0e	Irr.	RCrB	1908	Cannon
α UMi[4]	012288	2.3	2.4	cF7	3.96858	Cep	1911	Hertzsprung
N Her	180445	1.5	14.0	Q	Irr.	Nova	1934	Prentice
N Lac	221255	2.2	—	Q	Irr.	Nova	1936	Peltier

[1]oCet (Mira); [2]αOri (Betelgeuse); [3]βPer (Algol); [4]αUMi (Polaris).

The designation (Harvard) gives the 1900 position of the variable; here the first two figures give the hours, and the next two figures the minutes of R.A., while the last two figures give the declination in degrees, italicised for southern declinations. Thus the position of the fourth star of the list, δ Cep (*22*2557) is R.A. 22h 25m, Dec. + 57°. The period is in days and decimals of a day. The type is based on the classification of Gaposchkin and Gaposchkin's comprehensive text-book, *Variable Stars*. The abbreviations here used are: Ecl, Eclipsing Binaries; LPV, Long Period Variables; Semi R, Semiregular; Cep, Cepheids; Clus, cluster type; Nova; SS Cyg and R Cr B, irregular variables of which SS Cygni and R Coronae Borealis are prototypes; and Irr, other irregular variables.

DOUBLE AND MULTIPLE STARS

A number of the stars which appear as single to the unaided eye may be separated into two or more components by field glasses or a small telescope. Such objects are spoken of as *double* or *multiple stars*. With larger telescopes pairs which are still closer together may be resolved, and it is found that, up to the limits of modern telescopes, over ten per cent. of all the stars down to the ninth magnitude are members of double stars.

The possibility of resolving a double star of any given separation depends on the diameter of the telescope objective. Dawes' simple formula for this relation is $d'' = 4.5/A$, where d is the separation, in seconds of arc, of a double star that can be just resolved, and A is the diameter of the objective in inches. Thus a one-inch telescope should resolve a double star with a distance of 4″.5 between its components, while a ten-inch telescope should resolve a pair 0″.45 apart. It should be noted that this applies only to stars of comparable brightness. If one star is markedly brighter than its companion, the glare from the brighter makes it impossible to separate stars as close as the formula indicates. This formula may be applied to the observation of double stars to test the quality of the seeing and telescope.

It is obvious that a star may appear double in one of two ways. If the components are at quite different distances from the observer, and merely appear close together in the sky the stars form an *optical* double. If, however, they are in the same region of space, and have common proper motion, or orbital motion about one another, they form a *physical* double. An examination of the probability of stars being situated sufficiently close together in the sky to appear as double shows immediately that almost all double stars must be physical rather than optical.

Double stars which show orbital motion are of great astrophysical importance, in that a careful determination of their elliptical orbits and parallaxes furnishes a measure of the gravitational attraction between the two components, and hence the mass of the system.

In the case of many unresolvable close doubles, the orbital motion may be determined by means of the spectroscope. In still other doubles, the observer is situated in the orbital plane of the binary, and the orbital motion is shown by the fluctuations in light due to the periodic eclipsing of the components. Such doubles are designated as *spectroscopic* binaries and *eclipsing* variables.

The accompanying table provides a list of double stars, selected on account of their brightness, suitability for small telescopes, or particular astrophysical interest. The data are taken chiefly from Aitken's *New General Catalogue of Double Stars*, and from the Yale *Catalogue of Bright Stars*. Successive columns give the star, its 1950 equatorial coordinates, the magnitudes and spectral classes of its components, their separation, in seconds of arc, and the approximate distance of the double star in light years. The last column gives, for binary stars of well determined orbits, the period in years, and the mean separation of the components in astronomical units. For stars sufficiently bright to show colour differences in the telescope used, the spectral classes furnish an indication of the colour. Thus O and B stars are bluish white, A and F white, G yellow, K orange and M stars reddish.

A good reference work in the historical, general, and mathematical study of double stars is Aitken's *The Binary Stars*.

REPRESENTATIVE DOUBLE STARS

Star	α 1950 h m	δ ° ′	Mag. and Spect.	d ″	D L.Y.	Remarks
π And	00 34.2	+33 27	4.4B3; 8.5	36	470	†
η Cas	00 46.0	+57 33	3.6F8; 7.2M0	8	18	526y; 66AU
α UMi	01 48.8	+89 02	var. F8; 8.8	19	470	Polaris
γ Ari	01 50.8	+19 03	4.8A0; 4.8A0	8.3	150	
α Pis	01 59.4	+02 31	5.2A2; 4.3A2	2.4	130	††
γ And	02 00.8	+42 05	2.3K0; 5.4A0; 6.6	10, 0.7	410	56y; 23AU
6 Tri	02 09.5	+30 04	5.4G4; 7.0F3	3.6	330	††
η Per	02 47.0	+55 41	3.9K0; 8.5	28	540	
32 Eri	03 51.8	−03 06	5.0A; 6.3G5	6.7	300	
β Ori	05 12.1	−08 15	0.3B8; 7.0	9	540	†
θ Ori	05 32.8	−05 25	5.4;6.8; 6.8; 7.9; O	13, 17	540	Trapezium
β Mon	06 26.4	−07 00	4.7B2; 5.2; 5.6	7, 25	470	†
12 Lyn	06 41.8	+59 30	5.3A2; 6.2; 7.4	1.7, 8	180	†
α CMa	06 43.0	−16 39	−1.6A0; 8.5F	11	9	50y; 20AU
δ Gem	07 17.1	+22 05	3.5F0; 8.0M0	6.8	58	†
α Gem	07 31.4	+32 00	2.0A0; 2.8A0; 9M10	4, 70	47	340y; 79AU
ζ Cnc	08 09.3	+17 48	5.6G0; 6.0; 6.2	1, 5	78	60y; 21AU
γ Leo	10 17.2	+20 06	2.6K0; 3.8G5	4	160	400y
ξ UMa	11 15.5	+31 48	4.4G0; 4.9G0	2	25	††60y; 20AU
ι Leo	11 21.3	+10 48	4.1F3; 6.8F3	2	69	
γ Vir	12 39.1	−01 10	3.6F0; 3.7F0	6	34	171y; 42AU
α CVn	12 53.7	+38 35	2.9A0; 5.4A0	20	140	††
ζ UMa	13 21.9	+55 11	2.4A2; 4.0A2	14	78	††
π Boo	14 38.4	+16 38	4.9A0; 5.1A0	6	360	†
ε Boo	14 42.8	+27 17	2.7K0; 5.1A0	3	220	
ξ Boo	14 49.1	+19 18	4.8G5; 6.7	3	22	151y; 31AU
δ Ser	15 32.4	+10 42	4.2F0; 5.2F0	4	170	
ξ Sco	16 01.6	−11 14	5.1F3; 4.8; 7G7	1, 7	84	44.7y; 19AU
α Her	17 12.4	+14 27	var.M5; 5.4G	5	540	†
δ Her	17 13.0	+24 54	3.2A0; 8.1G2	11	100	† Optical
ε Lyr	18 42.7	+39 37	5.1, 6.0A3; 5.1, 5.4A5	3, 2	200	Pairs 207″
β Cyg	19 28.7	+27 51	3.2K0; 5.4B9	34	410	†
α Cap	20 14.9	−12 40	3.8G5; 4.6G0	376		Optical
γ Del	20 44.3	+15 57	4.5G5; 5.5F8	10	110	
61 Cyg	21 04.6	+38 30	5.6K5; 6.3K5	23	11	
β Cep	21 28.1	+70 20	var.B1; 8.0A3	14	540	†
ζ Aqr	22 26.2	−00 17	4.4F2; 4.6F1	3	140	
δ Cep	22 27.3	+58 10	var.G0; 7.5A0	41	650	
8 Lac	22 33.6	+39 23	5.8B3; 6.5B5	22	1100	†
σ Cas	23 56.5	+55 29	5.1B2; 7.2B3	3	820	

† or ††, one, or two of the components are themselves very close visual double or, more generally, spectroscopic binaries.

THE BRIGHTEST STARS†

Their Magnitudes, Types, Proper Motions, Distances and Radial Velocities

The accompanying table contains the principal facts regarding 259 stars brighter than apparent magnitude 3.51 which it is thought may be of interest to our amateur members. The various columns should be self-explanatory but some comments may be in order.

The first column gives the name of the star and if it is preceded by the sign || such means that the star is a visual double and the combined magnitude is entered in the fourth column. Besides the 48 thus indicated there are 12 others on the list with faint companions but for these it is not thought that there is any physical connection. In the case of the 20 stars variable in light this fourth column shows their maximum and minimum magnitudes. The 19 first magnitude stars are set up in bold face type.

In the fifth column are given the types as revised at various observatories—principally at our own, but omitting the *s* and *n* designations descriptive of the line character. The annual proper motion follows in the next column and this may not necessarily be correct to the third decimal place.

The parallaxes are taken from the Yale Catalogue of Stellar Parallaxes 1935, the mean of the trigonometric and spectroscopic being adopted. The few negative trigonometric parallaxes were adjusted by Dyson's tables before being combined with the spectroscopic. The distance is given also in light years in the eighth column as to the lay mind that seems a fitting unit. The absolute magnitudes in the ninth column are the magnitudes the stars would have if all were at a uniform distance of 32.6 light years ($\pi = 0.''1$). At that distance the sun would appear as a star of magnitude 4.8.

The radial velocities in the last column have been taken from Vol 18 of the Lick Publications. An asterisk * following the velocity means that such is variable. In these cases the velocity of the system, if known, is given; otherwise a mean velocity for the observations to date is set down.

Of the 259 stars or star systems here listed 146 are south and 113 north of the equator. This is to be expected from the fact that the northern half of the sky includes less of the Milky Way than the southern.

The number in each spectral class, apart from the one marked peculiar, is as follows: O, 3: B, 74; A, 55; F, 22; G, 43, K 42 and M, 19. The B-stars are intrinsically luminous and appear in this list out of all proportion to their total number. The stars in Classes A and K are by far the most numerous but the revision of types throws many originally labelled K back into the G group.

From the last column we see that 98 velocities are starred, indicating that 38 per cent of the bright stars, or at least one in every three, are binary in character. For visual binaries the proportion has usually been listed as one in nine. Our list shows one in six but it is only natural to expect that we would observe a higher proportion among the nearby stars, such as these are on the average.

Other relationships can be established from the list if our amateur members care to study it.

†This feature of the HANDBOOK, first appearing in the 1925 edition, was prepared and frequently revised by the late Dr. W. E. Harper (1878-1940).

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
α Andr.....	0 6	+28 49	2.2	A1	.217	.034	96	−0.1	−13.0*
β Cass.....	6	+58 52	2.4	F2	.561	.080	41	1.9	+11.4
γ Pegs	11	+14 54	2.9	B2	.015	.005	652	−3.6	+ 5.0*
β Hydi.....	23	−77 32	2.9	G0	2.243	.162	21	4 0	+22.8
α Phoe.....	24	−42 35	2.4	G5	.448	.040	81	0.4	+74.6*
δ Andr.....	37	+30 35	3.5	K3	.167	.026	125	0.6	− 7.1*
α Cass.....	38	+56 16	2.2–2.8	G8	.062	.018	181	−1.5	− 3.8
β Ceti.....	41	−18 16	2.2	G7	.233	.052	63	0.8	+13.1
‖γ Cass.....	54	+60 27	2.2	B0e	.031	.035	93	−0.1	− 6.8
‖β Phoe.....	1 04	−46 59	3.4	G4	.043	.020	163	−0.1	− 1.2
β Andr.....	07	+35 21	2.4	M0	.219	.041	79	0.5	+ 0.1
δ Cass.....	23	+59 59	2.8–2.9	A3	.308	.050	65	1.3	+ 6.8
γ Phoe.....	26	−43 34	3.4	M1	.223	.008	407	−2.1	+25.7*
α Erid.....	36	−57 29	0.6	B9	.093	.046	71	−1.1	+19.
‖α U. Min.....	49	+89 02	2.3–2.4	F7	.043	.008	407	−3.4	−17.4*
ε Cass.....	51	+63 25	3.4	B5	.043	.011	296	−1.4	− 8.1
β Arie.....	52	+20 34	2.7	A3	.150	.066	49	1.8	− 0.6*
α Hydi.....	57	−61 49	3.0	A7	.255	.080	41	2.5	+ 7.0*
‖γ Andr.....	2 01	+42 05	2.3	K0	.073	.020	163	−1.2	−11.7
α Arie.....	04	+23 14	2.2	K2	.242	.045	72	0 5	−14.3
β Tria.....	07	+34 45	3.1	A6	.161	.029	112	0.4	+10.4*
‖ο Ceti.....	17	− 3 12	1.7–9.6	M6e	.239	.013	251	−2.7	+57.8*
‖θ Erid.....	56	−40 30	3.4	A2	.068	.032	102	0.9	+11.9*
α Ceti.....	3 00	+ 3 54	2.8	M1	.080	.018	181	−0.9	−25.7
γ Pers.....	01	+53 19	3.1	F9	.012	.017	192	−0.7	+ 1.0*
ρ Pers.....	02	+38 39	3.3–4.1	M6	.176	.024	136	0.3	+28.2
β Pers.....	05	+40 46	2.1–3.2	B8	011	.033	99	−0.3	+ 5.7*
α Pers.....	21	+49 41	1.9	F4	.041	.017	192	−2.0	− 2.4
δ Pers.....	39	+47 38	3.1	B5	.047	.012	272	−1.5	−10. *
‖η Taur.....	45	+23 57	3.0	B5p	.053	.014	233	−1.3	+10.3
γ Hydi.....	48	−74 24	3.2	M3	.124	.008	407	−2.3	+16.0
ζ Pers.....	51	+31 44	2.9	B1	.023	.008	407	−2.6	+20.9
‖ε Pers.....	54	+39 52	3.0	B2	.041	.006	543	−3.1	− 6 *
γ Erid.....	56	−13 39	3.2	M0	.133	.012	272	−1.6	+61.7
λ Taur.....	58	+12 21	3.8–4.2	B3	.015	.008	407	−2.2	+13.0*
α Reti.....	4 14	−62 36	3.4	G5	.070	.016	204	−0.6	+35.6

α U. Min., *Polaris:* RA. 1h 47.5 m; Dec. + 89° 01′ (1948)

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
α **Taur**.....	4 33	+16 24	1.1	K8	.205	.060	54	0.0	+54.1
α Dora.....	33	−55 09	3.5	A0p	.....	.. .	.....	.....	+25.6
π^3 Orio.....	47	+ 6 52	3.3	F5	.474	.124	26	3.8	+24.6
ι Auri.....	54	+33 05	2.9	K4	.030	.020	163	−0.6	+17.6
ε Auri.....	58	+43 45	3.1-3.8	F2	.015	006	543	−2.7	−4.1 *
η Auri.....	5 03	+41 10	3.3	B3	.082	013	251	−1.1	+ 7.8
ε Leps.....	03	−22 26	3.3	K5	.074	.016	204	−0.7	+ 1.0
β Erid.....	05	− 5 09	2.9	A1	.117	.055	59	1.6	− 7
μ Leps.....	11	−16 16	3.3	A0p	.053	.020	163	−0.2	+27.7
‖β **Orio**.....	12	− 8 15	0.3	B8p	.005	.006	543	−5.8	+23.6*
‖α **Auri**.....	13	+45 57	0.2	G1	.439	.078	42	−0.3	+30.2
‖η Orio.....	22	− 2 26	3.4	B0	.009	.006	543	−2.7	+19.5*
γ Orio.....	22	+ 6 18	1.7	B2	.019	.015	217	−2.4	+18.0
β Taur.....	23	+28 34	1.8	B8	.180	.028	116	−1.0	+ 8.0
β Leps.....	26	−20 48	3.0	G2	.095	.018	181	−0.7	−13.5
‖δ Orio.....	29	− 0 20	2.4-2.5	B0	.006	.007	466	−3.4	+19.9*
α Leps.....	31	−17 51	2.7	F6	.006	.012	272	−2.1	+24.7
ι Orio.....	33	− 5 56	2.9	O8	.007	.021	155	−0.5	+21.5*
ε Orio.....	34	− 1 14	1.8	B0	.004	.008	407	−3.7	+25.8
ζ Taur.....	35	+21 07	3.0	B3e	.028	.010	326	−2.0	+16.4*
‖ζ Orio.....	38	− 1 58	1.8	B0	.012	.011	296	−3.0	+18.8
α Colm.....	38	−34 06	2.8	B8	.036	.022	148	−0.6	+34.6
κ Orio.....	45	− 9 41	2.2	B0	.009	.006	543	−3.9	+20.1
β Colm.....	49	−35 47	3.2	K0	.397	.026	125	0.3	+89.4
α **Orio**.....	52	+ 7 24	0.5-1.1	M2	.032	.012	272	−4.1	+21.0*
β Auri.....	56	+44 57	2.1-2.2	A0p	.046	.052	63	0.7	−18.1*
‖θ Auri.....	56	+37 13	2.7	A1	.106	.029	112	0.0	+28.6
η Gemi.....	6 12	+22 31	3.2-4.2	M2	.062	.014	233	−1.1	+21.4*
ζ C Maj.....	18	−30 02	3.1	B3	.012	.013	251	−0.7	+33.1*
μ Gemi.....	20	+22 32	3.2	M3	.129	.016	204	−0.8	+54.8
β C Maj.....	20	−17 56	2.0	B1	.003	.014	233	−2.3	+34.4*
α **Cari**.....	23	−52 40	−0.9	F0	.022	.005	652	−7.4	+20.5
γ Gemi.....	35	+16 27	1.9	A2	.066	.050	65	0.4	−11.3*
ν Pupp.....	36	−43 09	3.2	B8	.021	.023	148	0.0	+28.2*
ε Gemi.....	41	+25 12	3.2	G9	.020	.009	362	−2.0	+ 9.9
ξ Gemi.....	42	+12 57	3.4	F5	.230	.054	60	2.1	+25.1
‖α **C Maj**.....	43	−16 39	−1.6	A2	1.315	.386	8	1.3	− 7.5*
α Pict.....	48	−61 53	3.3	A5	.271	.....	.....	.....	+20.6

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
τ Pupp.	6 49	−50 33	2.8	G8	.091	.025	130	−0.2	+36.4*
‖ϵ C Maj.	57	−28 54	1.6	B1	.005	.010	326	−3.4	+27.4
ζ Gemi.	7 01	+20 39	3.7–4.3	G0p	.007	.005	652	−2.8	+ 6.7*
o^2 C Maj.	01	−23 45	3.1	B5p	.006	.007	466	−2.7	+48.6
δ C Maj.	06	−26 19	2.0	G4p	.003	.006	543	−4.1	+34.3*
L^2 Pupp.	12	−44 33	3.4–6.2	M5e	.332	.018	181	−0.3	+53.0
π Pupp.	15	−37 00	2.7	K5	.004	.018	181	−1.0	+15.8
η C Maj.	22	−29 12	2.4	B5p	.007	.012	272	−2.2	+40.4
β C Min.	24	+ 8 23	3.1	B8	.063	.022	148	−0.2	+23 *
σ Pupp.	28	−43 12	3.3	M0	.191	.016	204	−0.7	+88.1*
α_1 Gemi.	31	+32 00	2.0	A2	.201	.074	44	1.4	+ 6.0*
α_2 Gemi.	31	+32 00	2.8	A0	.209	.074	44	2.2	− 1.2*
‖α C Min.	37	+5 21	0.5	F5	1.242	.316	10	3.0	− 3.0*
β Gemi.	42	+28 09	1.2	G9	.623	.105	31	1.3	+ 3.3
ξ Pupp.	47	−24 44	3.5	K1	.004	.006	543	−2.6	+ 3.7*
ζ Pupp.	8 02	−39 52	2.3	O8	.032	.004	815	−4.7	−24.
ρ Pupp.	05	−24 10	2.9	F6	.097	.025	130	−0.1	+46.6
‖γ Velr.	08	−47 12	2.2	OW9	.002	.....	.....	.....	+ 3.5
‖ϵ Cari.	21	−59 21	1.7	K0	.030	.010	326	−3.3	+11.5
o U Maj.	26	+60 53	3.5	G2	.166	.014	233	−0.8	+19.8
‖δ Velr.	43	−54 32	2.0	A0	.093	.030	109	−0.6	+ 2.2
‖ϵ Hyda.	44	+ 6 36	3.5	F9	.193	.012	272	−1.1	+36.8*
ζ Hyda.	53	+ 6 08	3.3	G7	.101	.026	125	0.3	+22.6
‖ι U Maj.	56	+48 14	3.1	A4	.500	.060	54	2.0	+12.6
λ Velr.	9 06	−43 14	2.2	K4	.024	.016	204	−1.8	+18.4
β Cari.	13	−69 31	1.8	A0	.192	.....	.....	.....	− 5.
ι Cari.	16	−59 04	2.2	F0	.023	.....	.....	.....	+13.3
α Lync.	18	+34 36	3.3	K8	.214	.022	148	0.0	+37.4
κ Velr.	21	−54 48	2.6	B3	.017	.017	192	−1.2	+21.7*
α Hyda.	25	− 8 26	2.2	K4	.036	.018	181	−1.5	− 4.4
θ U Maj.	30	+51 54	3.3	F7	1.096	.072	45	2.6	+15.8
N Velr.	30	−56 49	3.4–4.2	K5	.038	.022	148	0.1	−13.9
ϵ Leon.	43	+24 00	3.1	G0	.045	.009	362	−2.1	+ 5.1
‖υ Cari.	46	−64 50	3.1	F0	.019	.....	.....	.....	+13.6
α Leon.	10 06	+12 13	1.3	B6	.244	.046	71	−0.4	+ 2.6
q Cari.	15	−61 05	3.4	K5	.043	.014	233	−0.9	+ 8.6

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′				″	″		km./sec.
‖γ Leo	10 17	+20 06	2.3	G8	.347	.024	136	−0.8	−36.8
μ U Maj	19	+41 45	3.2	K4	.082	.031	105	0.7	−20.3*
θ Cari	41	−64 08	3.0	B0	.022	.007	466	−2.8	+24. *
η Cari	43	−59 25	1.0–7.4	Pec	.007	.....	.....	.....	−25.0
‖μ Velr	45	−49 09	2.8	G5	.079	.033	99	0.4	+ 6.9
ν Hyda	47	−15 56	3.3	K3	.218	.020	163	−0.2	− 1.0
β U Maj	59	+56 39	2.4	A3	.089	.045	72	0.7	−12.1*
α U Maj	11 01	+62 01	2.0	G5	.137	.036	91	−0.2	− 8.6*
ψ U Maj	07	+44 46	3.2	K0	.067	.035	93	0.9	− 3.6
δ Leon	11	+20 47	2.6	A2	.208	.058	56	1.4	−23.2
θ Leon	12	+15 42	3.4	A2	.103	.025	130	0.4	+ 7.8
λ Cent	33	−62 45	3.3	B9	.045	.031	105	0.8	+ 7.9
β Leon	47	+14 51	2.2	A2	.507	.084	39	1.8	− 2.3
γ U Maj	51	+53 58	2.5	A0	.095	.035	93	0.2	−11.1
δ Cent	12 06	−50 27	2.9	B3e	.040	.015	217	−1.2	+ 9.
ε Corv	08	−22 30	3.2	K2	.063	.024	136	0.1	+ 4.9
δ Cruc	12	−58 28	3.1	B3	.045	.017	192	−0.7	+26.4
δ U Maj	13	+57 19	3.4	A0	.113	.050	65	1.9	−12.
γ Corv	13	−17 16	2.8	B8	.159	.024	136	−0.3	− 4.2*
α^1 Cruc	24	−62 49	1.6	B1	.048	.022	148	−1.7	−12.2*
α^2 Cruc	24	−62 49	2.1	B3	.048	.022	148	−1.2	+ 0.3*
‖δ Corv	27	−16 14	3.1	A0	.249	.026	125	0.2	+ 8.7
γ Cruc	28	−56 50	1.5	M4	.270	.....	.....	.....	+21.3
β Corv	32	−23 07	2.8	G5	.059	.027	121	0.0	− 7.7
α Musc	34	−68 52	2.9	B5	.040	.015	217	−1.2	+18.
‖γ Cent	39	−48 41	2.4	A0	.200	.032	102	−0.1	− 7.5
‖γ Virg	39	− 1 10	2.9	F0	.561	.080	41	2.4	−19.6
‖β Musc	43	−67 50	3.3	B3	.039	.011	296	−1.5	+42. *
β Cruc	45	−59 25	1.5	B1	.054	.007	466	−4.3	−20. *
ε U Maj	52	+56 14	1.7	A2	.117	.067	49	0.8	−11.9*
‖α^3 C. Ven	54	+38 35	2.8	A1	.233	.030	109	0.2	− 3.5
ε Virg	13 00	+11 14	3.0	G6	.270	.037	88	0.8	−14.0
γ Hyda	16	−22 54	3.3	G7	.085	.028	116	0.5	− 5.4
ι Cent	18	−36 27	2.9	A2	.351	.049	67	1.4	+ 0.1
‖ζ^1 U. Maj	22	+55 11	2.4	A2p	.131	.042	78	0.5	− 9.9*
α Virg	23	−10 54	1.2	B2	.051	.018	181	−2.5	+ 1.6*
ζ Virg	32	− 0 20	3.4	A2	.285	.038	86	1.3	−13.1

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
ϵ Cent.....	13 37	−53 13	2.6	B2	.039	.012	272	−2.0	− 5.6
η U. Maj.....	46	+49 34	1.9	B3	.116	.015	217	−2.2	−10.9
μ Cent	47	−42 13	3.3	B3e	.026	.009	362	−1.9	+12.6
ζ Cent.....	52	−47 02	3.1	B3	.080	.013	251	−1.3	*
η Boot.....	52	+18 39	2.8	G1	.370	.100	33	2.8	− 0.2*
β Cent.....	14 00	−60 08	0.9	B3	.039	.026	125	−2.0	−12. *
π Hydae.....	04	−26 26	3.5	K3	.164	.037	88	1.3	+27.2
θ Cent.....	04	−36 07	2.3	G8	.745	.056	58	1.0	+ 1.3
α Boot.....	13	+19 26	0.2	K0	2.287	.102	32	0.2	− 5.1
γ Boot.....	30	+38 32	3.0	A3	.182	.063	52	2.0	−35.5
η Cent.....	32	−41 56	2.6	B3	.046	.012	272	−2.0	− 0.2*
‖**α Cent**.....	36	−60 38	0.1	G0	3.682	.768	4	4.5	−22.2*
α Circ.....	38	−64 46	3.4	F0	.308	.063	52	2.4	+ 7.4
α Lupi.....	39	−46 10	2.9	B2	.033	.009	362	−2.3	+ 7.3*
‖ϵ Boot.....	43	+27 17	2.7	G8	.045	.019	172	−0.9	−16.4
‖α^2 Libr.....	48	−15 47	2.9	F1	.128	.056	58	1.6	−10. *
β U. Min.....	51	+74 22	2.2	K4	.028	.030	109	−0.4	+16.9
β Lupi.....	55	−42 56	2.8	B3	.067	.012	272	−1.8	− 0.3*
κ Cent.....	56	−41 54	3.4	B2	.034	.011	296	−1.4	+ 9.1*
σ Libr.....	15 01	−25 05	3.4	M4	.091	.020	163	−0.1	− 4.3
ζ Lupi.....	09	−51 55	3.5	G5	.125	.027	121	0.7	− 9.7
γ Tr. Au.....	14	−68 30	3.1	A0	.064	.....	.....	.....	0.
β Libr.....	14	− 9 12	2.7	B8	.100	.015	217	−1.4	−37. *
δ Lupi.....	18	−40 28	3.4	B3	.031	.012	272	−1.2	+ 1.6
γ U. Min.....	21	+72 01	3.1	A2	.016	.022	148	−0.2	− 3.9*
ι Drac.....	24	+59 08	3.5	K3	.010	.030	109	0.9	−11.1
‖γ Lupi.....	32	−41 00	3.0	B3	.038	.013	251	−1.4	+ 6.
α Cor. B.....	33	+26 53	2.3	A0	.160	.054	60	1.0	+ 1.0*
α Serp.....	42	+ 6 35	2.8	K3	.142	.043	76	1.0	+ 3.0
β Tr. Au.....	51	−63 17	3.0	F0	.436	.096	34	2.9	− 0.3
π Scor.....	56	−25 58	3.0	B3	.037	.012	272	−1.6	− 3.0*
δ Scor.....	57	−22 29	2.5	B1	.039	.011	296	−2.3	−16. *
‖β Scor.....	16 03	−19 40	2.8	B3	.029	.016	204	−1.2	− 9.3*
δ Ophi.....	12	− 3 34	3.3	K8	.159	.030	109	0.7	−19.8
ϵ Ophi.....	16	− 4 34	3.3	G9	.088	.031	105	0.8	−10.3
‖σ Scor.....	18	−25 28	3.1	B1	.033	.009	362	−2.1	− 0.4*
‖η Drac.....	23	+61 38	2.9	G5	.062	.038	86	0.8	−14.3

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	°			″	″			km./sec.
‖α Scor.....	16 26	−26 19	1.2	M1	.032	.019	172	−2.4	− 3.2*
β Herc.....	28	+21 36	2.8	G4	.104	.020	163	−0.7	−25.8*
τ Scor.....	33	−28 07	2.9	B1	.037	.009	362	−2.3	+ 0.6
ζ Ophi.....	34	−10 28	2.7	B0	.023	.008	407	−2.8	−19. *
‖ζ Herc.....	39	+31 42	3.0	G0	.601	.105	31	3.1	−70.8*
α Tr. Au.....	43	−68 56	1.9	K5	.031	.025	130	−1.1	− 3.7
ε Scor.....	47	−34 12	2.4	G9	.665	.038	86	0.3	− 2.5
μ^1 Scor.....	48	−37 58	3.1	B3p	.030	.011	296	−1.7	*
ζ Arae.....	54	−55 55	3.1	K5	.046	.028	116	0.3	− 6.0
κ Ophi.....	55	+ 9 27	3.1-4.0	K3	.290	.042	78	1.2	−55.6
‖η Ophi.....	17 08	−15 40	2.6	A2	.095	.047	69	1.0	− 1.0
η Scor.....	08	−43 11	3.4	A7	.294	.066	49	2.5	−28.4
ζ Drac.....	09	+65 47	3.2	B8	.023	.028	116	0.4	−14.1
‖α^1 Herc.....	12	+14 27	3.1-3.9	M7	.030	.008	407	−2.4	−32.5
δ Herc.....	13	+24 54	3.2	A2	.164	.036	91	1.0	−39. *
π Herc.....	13	+36 52	3.4	K3	.021	.018	181	−0.3	−25.7
θ Ophi.....	19	−24 57	3.4	B2	.031	.008	407	−2.1	− 3.6
β Arae.....	21	−55 29	2.8	K1	.036	.023	142	−0.4	− 0.4
υ Scor.....	27	−37 15	2.8	B3	.042	.010	326	−2.2	+18. *
α Arae.....	28	−49 50	3.0	B3e	.090	.015	217	−1.1	− 2.2
β Drac.....	29	+52 20	3.0	G0	.012	.007	466	−2.8	−20.1
λ Scor.....	30	−37 04	1.7	B2	.036	.016	204	−2.3	0. *
α Ophi.....	33	+12 35	2.1	A0	.264	.060	54	1.0	+15. *
θ Scor.....	34	−42 58	2.0	F0	.012	.024	136	−1.1	+ 1.4
κ Scor.....	39	−39 00	2.5	B3	.028	.009	362	−2.7	−10. *
β Ophi.....	41	+ 4 35	2.9	K2	.157	.030	109	0.3	−11.9
ι^1 Scor.....	44	−40 06	3.1	F8	.004	.008	407	−2.4	−27.6*
‖μ Herc.....	44	+27 45	3.5	G5	.817	.114	28	3.8	−16.1
G Scor.....	46	−37 02	3.2	K2	.069	.029	112	0.5	+24.7
ν Ophi.....	56	− 9 46	3.5	G7	.118	.022	148	0.2	+12.4
γ Drac.....	55	+51 30	2.4	K5	.026	.026	125	−0.5	−27.8
γ Sgtr.....	18 03	−30 26	3.1	K0	.202	.030	109	0.5	+22.3*
η Sgtr.....	14	−36 47	3.2	M4	.216	.030	109	0.6	+ 0.5
δ Sgtr.....	18	−29 51	2.8	K4	.052	.033	99	0.4	−20.0
η Serp.....	19	− 2 55	3.4	G9	.898	.050	65	1.9	+ 8.9
ε Sgtr.....	21	−34 25	2.0	A0	.139	.020	163	−1.5	−10.8
λ Sgtr.....	25	−25 27	2.9	K1	.196	.036	91	0.7	−43.3
α Lyra.....	35	+38 44	0.1	A1	.348	.140	23	0.8	−13.8

Star	R.A. 1950	Decl. 1950	Mag.	Type	Ann. Proper Motion	Parallax	Distance in Light Years	Abs. Mag.	Rad. Vel.
	h m	° ′			″	″			km./sec.
ϕ Sgtr	18 43	−27 03	3.3	B8	.150	.015	217	−0.8	+21.5*
‖β Lyra	48	+33 18	3.4–4.1	B2p	.011	.006	543	−2.7	−19.0*
σ Sgtr	52	−26 22	2.1	B3	.067	.021	155	−1.3	−10.7
γ Lyra	57	+32 37	3.3	B9p	.008	.016	204	−0.7	−21.5*
‖ζ Sgtr	59	−29 57	2.7	A2	.019	.035	93	0.4	+22.1
ζ Aqil	19 03	+13 47	3.0	A0	.103	.038	86	0.9	−25. *
τ Sgtr	04	−27 45	3.4	K0	.268	.036	91	1,2	+45.4*
π Sgtr	07	−21 06	3.0	F2	.041	.017	192	−0.8	− 9.8
δ Drac	13	+67 34	3.2	G8	.135	.028	116	0.4	+24.8
δ Aqil	23	+ 3 01	3.4	A3	.267	.052	63	2.0	−32.3*
‖β^1 Cygn	29	+27 51	3.2	K0	.010	.010	326	−1.8	−23.9*
‖δ Cygn	43	+45 00	3.0	A1	.067	.023	116	0.2	−20.
γ Agil	44	+10 29	2.8	K3	.018	.018	181	−0.9	− 2.0
α Aqil	48	+ 8 44	0.9	A2	.659	.184	18	2.2	−26.1
θ Aqil	20 09	− 0 58	3.4	A0	.035	.018	181	−0.3	−28.6*
‖β Capr	18	−14 56	3.2	F8	.042	.022	148	−0.1	−19.0*
γ Cygn	20	+40 06	2.3	F8	.006	.008	407	−3.2	− 7.6
α Pavo	22	−56 54	2.1	B3	.087	.014	233	−2.2	+ 1.8*
α Indi	34	−47 28	3.2	G2	.072	.034	96	0.9	− 1.1
α Cygn	40	+45 06	1.3	A2p	.004	.002	1630	−7.2	− 6.3*
ϵ Cygn	44	+33 47	2.6	G7	.485	.040	81	0.6	−10.5*
ζ Cygn	21 11	+30 01	3.4	G6	.061	.018	181	−0.3	+16.9*
α Ceph	17	+62 22	2.6	A2	.163	.076	43	2.0	− 8.
β Ceph	28	+70 20	3.3–3.4	B1	.013	.006	543	−2.8	− 7.2
β Aqar	29	− 5 48	3.1	G1	.020	.008	407	−2.4	+ 6.7
ϵ Pegs	42	+ 9 39	2.5	K2	.028	.014	233	−1.8	+ 5.2
δ Capr	44	−16 21	3.0	A3	.395	.062	53	2.0	− 6.4*
γ Grus	51	−37 36	3.2	B8	.114	.020	163	−0.3	− 2.1
α Aqar	22 03	− 0 34	3.2	G0	.019	.006	543	−2.9	+ 7.6
α Grus	05	−47 12	2.2	B5	.202	.036	91	0.0	+11.8
α Tucn	15	−60 31	2.9	K5	.088	.019	172	−0.7	+42.2*
β Grus	40	−47 09	2.2	M6	.131	.010	326	−2.8	+ 1.6
η Pegs	41	+29 58	3.1	G1	.039	.016	204	−0.9	+ 4.4*
α Psc. A	55	−29 53	1.3	A3	.367	.118	28	1.7	+ 6.5
β Pegs	23 01	+27 49	2.6	M3	.235	.020	163	−0.9	+ 8.6
α Pegs	02	+14 56	2.6	A0	.077	.033	99	0.2	− 4. *
γ Ceph	37	+77 21	3.4	K1	.167	.062	53	2.4	−42.0

STAR CLUSTERS

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

N.G.C.	M	Con.	α 1950 h m	δ ° ′	Cl.	Diam. ′	Mag. B.S.	No.	Int. mag.	Dist. l.y
869		hPer	02 15.5	+56 55	Op	30	7			4,300
884		χPer	02 18.9	+56 53	Op	30	7			4,300
1039	34	Per	02 38.3	+42 35	Op	30	9	80		1,500
Pleiades	45	Tau	03 44.5	+23 58	Op	120	4.2	250		490
Hyades		Tau	04 17	+15 30	Op	400	4.0	100		120
1912	38	Aur	05 25.3	+35 48	Op	18	9.7	100		2,800
2099	37	Aur	05 49.0	+32 33	Op	24	9.7	150		2,700
2168	35	Gem	06 05.7	+24 21	Op	29	9.0	120		2,700
2287	41	C Ma	06 44.9	−20 42	Op	32	9	50		1,300
2632	44	Cnc	08 37.2	+20 10	Op	90	6.5	350		490
5139		ωCen	13 23.7	−47 03	Gl	23	12.9		3	22,000
5272	3	C Vn	13 39.9	+28 38	Gl	10	14.2		4.5	40,000
5904	5	Ser	15 15.9	+02 16	Gl	13	14.0		3.6	35,000
6121	4	Scr	16 20.5	−26 24	Gl	14	13.9		5.2	24,000
6205	13	Her	16 39.9	+36 33	Gl	10	13.8		4.0	34,000
6218	12	Oph	16 44.6	−01 51	Gl	9	14.0		6.0	36,000
6254	10	Oph	16 54.5	−04 02	Gl	8	14.1		5.4	36,000
6341	92	Her	17 15.6	+43 12	Gl	8	13.9		5.1	36,000
6494	23	Sgr	17 54.0	−19 01	Op	27	10.2	120		2,200
6611	16	Ser	18 16.0	−13 48	Op	8	10.6	55		6,700
6656	22	Sgr	18 33.3	−23 57	Gl	17	12.9		3.6	22,000
7078	15	Peg	21 27.6	+11 57	Gl	7	14.3		5 2	43,000
7089	2	Aqr	21 30.9	−01 04	Gl	8	14.6		5.0	45,000
7092	39	Cyg	21 30.5	+48 13	Op	32	6.5	25		1,000
7654	52	Cas	23 22.0	+61 19	Op	13	11.0	120		4,400

GALACTIC NEBULAE

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

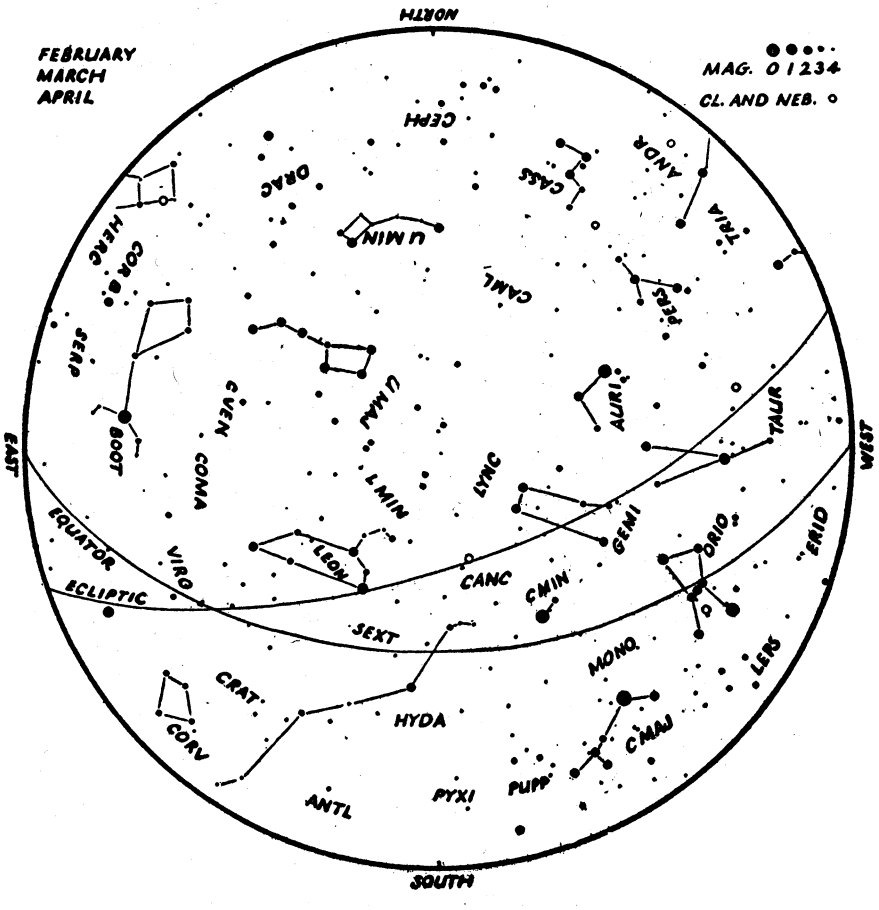
N.G.C.	M	Con	α 1950 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 38.3	+51 20	Pl	1.5	11	17	15,000	
1952	1	Tau	05 31.5	+21 59	Pl	6	11	16	10,000	Crab
1976	42	Ori	05 32.5	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.0	−02 29	Drk	4			300	Horsehead
2261		Mon	06 36.4	+08 47	Dif	2				Hubble's var
2392		Gem	07 26.2	+21 02	Pl	0.3	8	10	2,800	
2440		Pup	07 39.6	−18 05	Pl	0.9	11	16	8,600	
3587	97	UMa	11 11.8	+55 17	Pl	3.3	11	14	12,000	Owl
		Cru	12 48	−63	Drk	300			300	Coalsack
6210		Her	16 42.4	+23 54	Pl	0.3	10	12	5,600	
B72		Oph	17 20.5	−23 36	Drk	20			400	S nebula
6514	20	Sgr	17 59.3	−23 02	Dif	24			3,200	Trifid
B86		Sgr	17 59.9	−27 52	Drk	5				
6523	8	Sgr	18 00.6	−24 23	Dif	50			3,600	Lagoon
6543		Dra	17 58.6	+66 38	Pl	0.4	9	11	3,500	
6572		Oph	18 10.2	+06 50	Pl	0.2	9	12	4,000	
B92		Sgr	18 12.7	−18 15	Drk	15				
6618	17	Sgr	18 18.0	−16 12	Dif	26			3,000	Horseshoe
6720	57	Lyr	18 52.0	+32 58	Pl	1.4	9	14	5,400	Ring
6826		Cyg	19 43.5	+50 24	Pl	0.4	9	11	3,400	
6853	27	Vul	19 57.4	+22 35	Pl	8	8	13	3,400	Dumb-bell
6960		Cyg	20 43.6	+30 32	Dif	60				Network
7000		Cyg	20 57.0	+44 07	Dif	100				N. America
7009		Aqr	21 01.4	−11 34	Pl	0.5	8	12	3,000	
7662		And	23 23.4	+42 12	Pl	0.3	9	13	3,900	

EXTRA-GALACTIC NEBULAE

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

N.G.C.	M	Con	α 1950 h m	δ ° ′	Cl	Dimens. ′ ′	Mag.	Distance l.y.	Vel. km/sec
221	32	And	00 39.9	+40 36	E	3×3	8.8	800,000	− 185
224	31	And	00 40.0	+41 00	Sb	160×40	5.0	800,000	− 220
SMC		Tuc	00 53	−72 38	I	220×220	1.5	100,000	+ 170
598	33	Tri	01 31.0	+30 24	Sc	60×40	7.0	700,000	− 70
LMC		Dor	05 21	−69 27	I	430×530	0.5	90,000	+ 280
3031	81	UMa	09 51.5	+69 18	Sb	16×10	8.3	2,400,000	− 30
3034	82	UMa	09 51.8	+69 58	I	7× 2	9.0	2,600,000	+ 290
3368	96	Leo	10 44.1	+12 05	Sa	7× 4	10.0	5,700,000	+ 940
3623	65	Leo	11 16.3	+13 22	Sb	8× 2	9.9	5,000,000	+ 800
3627	66	Leo	11 17.6	+13 16	Sb	8× 2	9.1	4,300,000	+ 650
4258		CVn	12 16.5	+47 34	Sb	20× 6	8.7	4,600,000	+ 500
4374	84	Vir	12 22.5	+13 09	E	3× 2	9.9	6,000,000	+1050
4382	85	Com	12 22.9	+18 28	E	4× 2	10.0	3,700,000	+ 500
4472	49	Vir	12 27.2	+08 16	E	5× 4	10.1	5,700,000	+ 850
4565		Com	12 33.9	+26 16	Sb	15× 1	11.0	7,600,000	+1100
4594		Vir	12 37.4	−11 20	Sa	7× 2	9.2	7,200,000	+1140
4649	60	Vir	12 41.1	+11 50	E	4× 3	9.5	7,500,000	+1090
4736	94	CVn	12 48.6	+41 24	Sb	5× 4	8.4	3,000,000	+ 290
4826	64	Com	12 54.3	+21 57	Sb	8× 4	9.2	1,300,000	+ 150
5005		CVn	13 08.6	+37 20	Sc	5× 2	11.1	6,600,000	+ 900
5055	63	CVn	13 13.6	+42 18	Sb	8× 3	9.6	3,600,000	+ 450
5194	51	CVn	13 27.8	+47 27	Sc	12× 6	7.4	3,000,000	+ 250
5236	83	Hya	13 34.2	−29 36	Sc	10× 8	8	2,900,000	+ 500
6822		Sgr.	19 42.4	−14 53	I	20×10	11	1,000,000	− 150
7331		Peg	22 34.8	+33 59	Sb	9× 2	10.4	5,200,000	+ 500

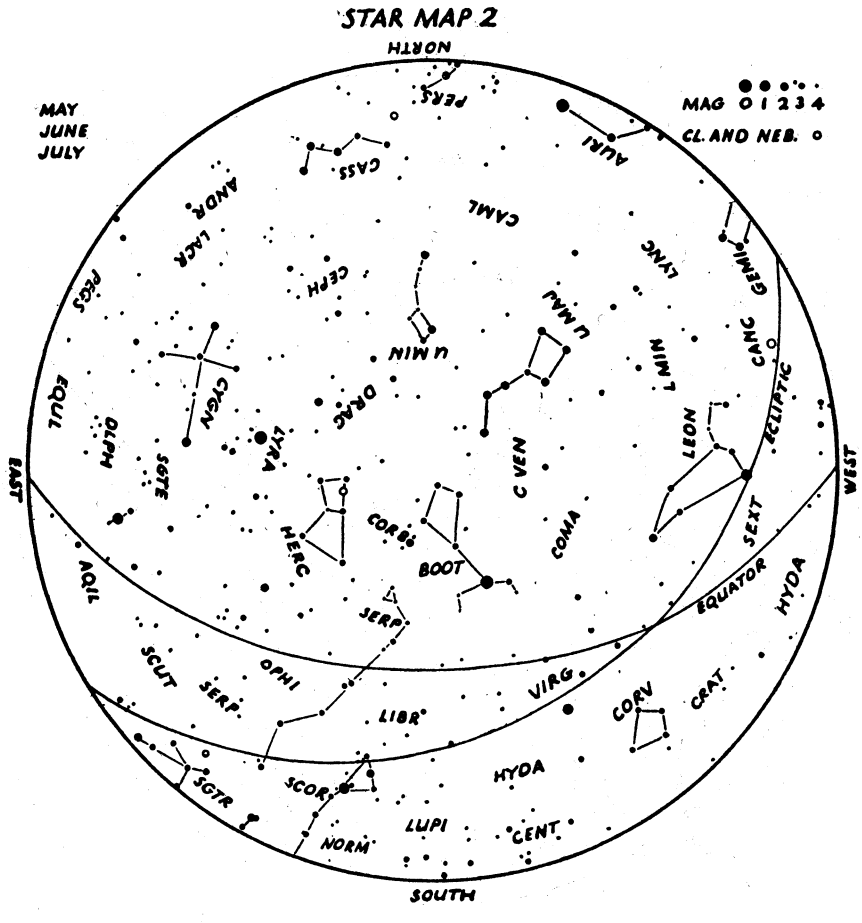
STAR MAP I



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.

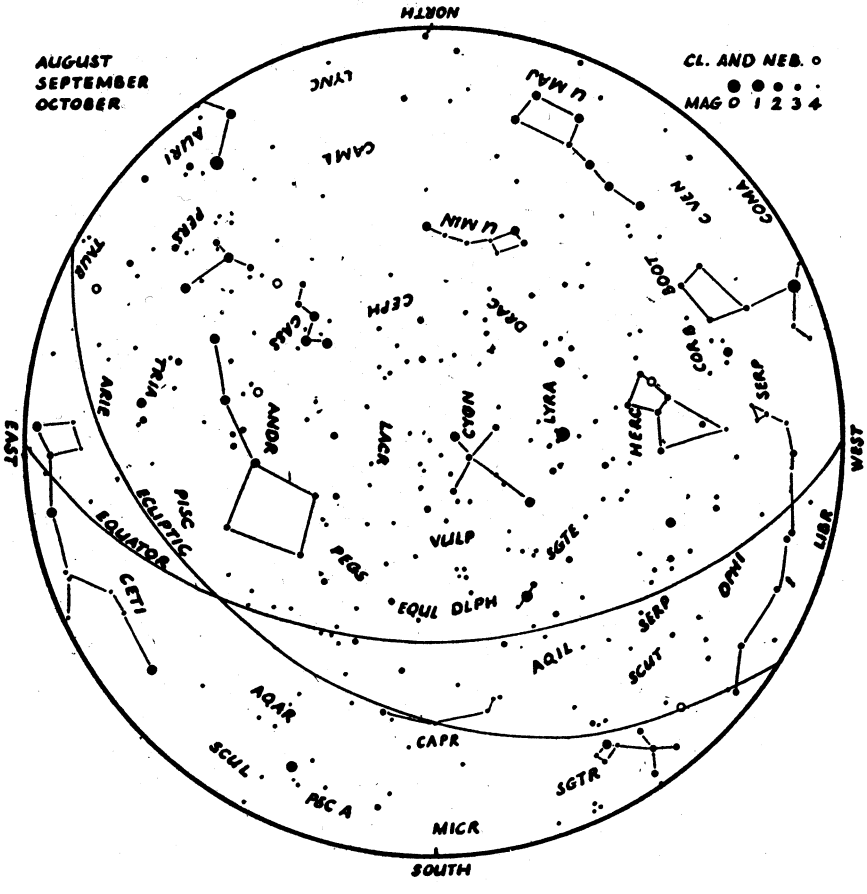


The above map represents the evening sky at

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

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

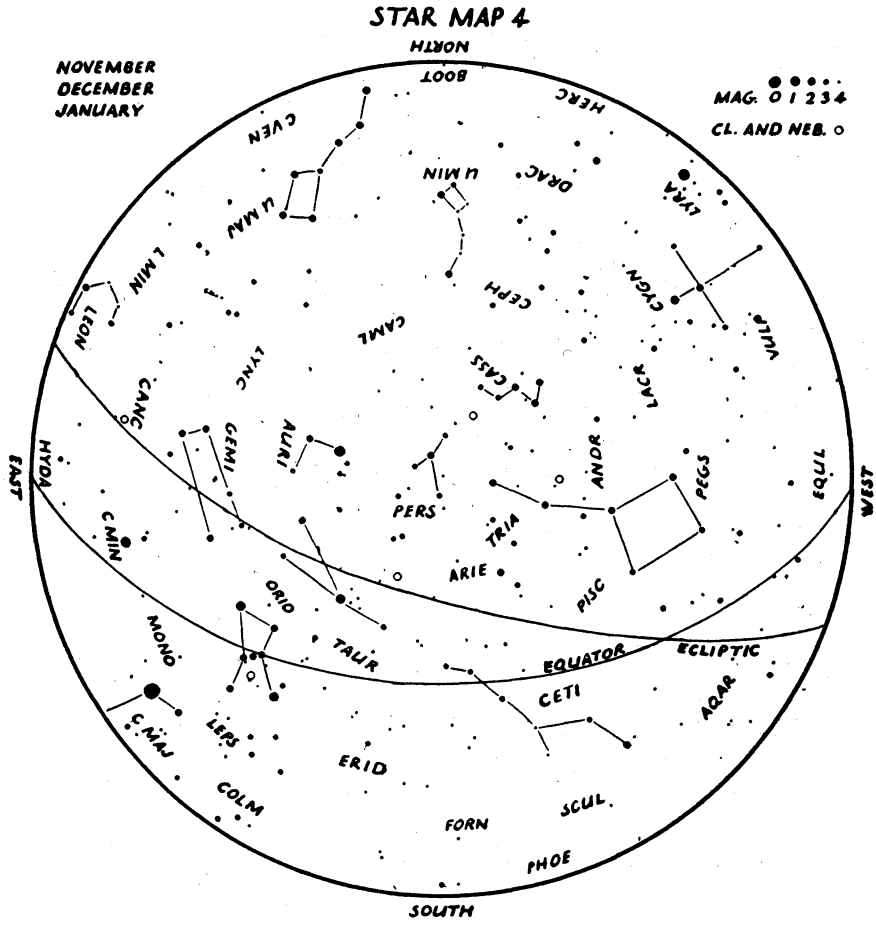
STAR MAP 3



The above map represents the evening sky at

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

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



The above map represents the evening sky at

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

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

Continued from page 57.

METEORS AND METEORITES

Many common terrestrial stones have mistakenly been thought to have a meteoric origin, and any supposed meteorite should be investigated carefully. Contrary to popular belief, meteorites do not contain valuable minerals in quantities sufficient to make them of commercial interest, but they have a definite scientific value. Meteorites are of two main types, iron and stone. The irons have specific gravity ranging from 7 to 8 and are amost entirely composed of metallic nickel-iron. The stones have a specific gravity ranging from 2 to 4 or greater and, with very few exceptions, contain metallic inclusions that are revealed on grinding or filing the specimen. A freshly fallen meteorite is covered by a smooth black fusion crust but oxidation removes this where the object has lain in the ground for any length of time. Any object whose history and structure indicate that it is of meteoric origin should be submitted to some authority for further study.

A more detailed discussion of both visual and photographic observations of meteors will be found in "General Instructions for Meteor Observing." Meteor observations for the United States may be sent to the American Meteor Society, Flower Observatory, Upper Darby, Pa.; those for Canada to the writer at the Dominion Observatory, Ottawa, Ont.

PRINCIPAL METEOR SHOWERS FOR THE NORTHERN HEMISPHERE

Shower	Approx. Radiant		Current Maximum Date	Spectacular Displays	Hourly Number (all meteors)	Duration (in days)	Abbreviations (for use in observing records)
	α	δ					
Quadrantids....	232°	+52°	Jan. 3		20	4	Q
Lyrids.....	280	+37	Apr. 21		10	4	Y
Eta Aquarids...	336	− 1	May 4		10	8	E
Delta Aquarids .	340	−17	July 28		20	12	D
Perseids.....	47	+57	Aug. 12		50	25	P
Giacobinids.....	267	+55	Oct. 9	1933, 1946		1	J
Orionids.....	96	+15	Oct. 22		20	14	O
Taurids.....	56	+16	Nov. 10?			30	T
Leonids.....	152	+22	Nov. 16	1799, 1833, 1866, 1867	20	14	L
Bielids.....	25	+45	Nov. 27	1872, 1885			B
Geminids.....	110	+33	Dec. 12		30	14	G

TABLE OF PRECESSION FOR 50 YEARS

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