THE OBSERVER'S HANDBOOK FOR 1947

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The Royal Astronomical Society of Canada

C. A. CHANT, EDITOR
F. S. HOGG, ASSISTANT EDITOR
DAVID DUNLAP OBSERVATORY

THIRTY NINTH YEAR OF PUBLICATION

TORONTO
3 WILLCOCKS STREET
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1946

1947 **CALENDAR** **1947**

JANUARY

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

FEBRUARY

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

MARCH

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

APRIL

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

MAY

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

JUNE

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

JULY

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

AUGUST

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

SEPTEMBER

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

OCTOBER

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

NOVEMBER

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

DECEMBER

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

JULIAN DAY CALENDAR, 1947

J.D. 2,432,000 plus the following:

Jan. 1	187	May 1	307	Sept. 1	430
Feb. 1	218	June 1	338	Oct. 1	460
Mar. 1	246	July 1	368	Nov. 1	491
Apr. 1	277	Aug. 1	399	Dec. 1	521

The Julian Day commences at noon.
Thus J.D. 2,432,187 = Jan. 1.5 G.C.T.

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CONTENTS

TABLES IN RECENT OBSERVER'S HANDBOOKS

PRINTED IN CANADA

PREFACE

The HANDBOOK for 1947 is the 39th issue. The chief improvement in it is the inclusion again of Dr. P. M. Millman's portion on *Meteors*.

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

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. It is gratifying to see the HANDBOOK attain so wide a circulation.

David Dunlap Observatory, C. A. CHANT.
Richmond Hill, Ont., October 1946.

ANNIVERSARIES AND FESTIVALS 1947

New Year's Day	Wed.	Jan.	1
Epiphany	Mon.	Jan.	6
Septuagesima Sunday		Feb.	2
Quinquagesima (Shrove Sunday)		Feb.	16
Ash Wednesday		Feb.	19
St. David	Sat.	Mar.	1
St. Patrick	Mon.	Mar.	17
Palm Sunday		Mar.	30
Good Friday		Apr.	4
Easter Sunday		Apr.	6
St. George	Wed.	Apr.	23
Rogation Sunday		May	11
Ascension Day	Thu.	May	15
Empire Day (Victoria Day)	Sat.	May	24
Pentecost (Whit Sunday)		May	25
Birthday of the Queen Mother, Mary (1867)	Mon.	May	26
Trinity Sunday		Jun.	1
Corpus Christi	Thu.	Jun.	5
St. John Baptist (Midsummer Day)	Tue.	Jun.	24
Dominion Day	Tue.	Jul.	1
Birthday of Queen Elizabeth, (1900)	Mon.	Aug.	4
Labour Day	Mon.	Sep.	1
Hebrew New Year (Rosh Hashanah)	Mon.	Sep.	15
St. Michael (Michaelmas Day)	Mon.	Sep.	29
All Saints' Day	Sat.	Nov.	1
Remembrance Day	Tue.	Nov.	11
St. Andrew	Sun.	Nov.	30
First Sunday in Advent		Nov.	30
Ascension of King George VI (1936)	Thu.	Dec.	11
Birthday of King George VI (1895)	Sun.	Dec.	14
Christmas Day	Thu.	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

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

THE CONFIGURATIONS OF JUPITER'S SATELLITES

In the Configurations of Jupiter's Satellites (pages 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*	Cyg	Cygn
Delphinus, *Dolphin*	Del	Dlph
Dorado, *Swordfish*	Dor	Dora
Draco, *Dragon*	Dra	Drac
Equuleus, *Little Horse*	Equ	Equl
Eridanus, *River Eridanus*	Eri	Erid
Fornax, *Furnace*	For	Forn
Gemini, *Twins*	Gem	Gemi
Grus, *Crane*	Gru	Grus
Hercules, (*Kneeling Giant*)	Her	Herc
Horologium, *Clock*	Hor	Horo
Hydra, *Water-snake*	Hya	Hyda
Hydrus, *Sea-serpent*	Hyi	Hydi
Indus, *Indian*	Ind	Indi
Lacerta, *Lizard*	Lac	Lacr
Leo, *Lion*	Leo	Leon
Leo Minor, *Lesser Lion*	LMi	LMin
Lepus, *Hare*	Lep	Leps
Libra, *Scales*	Lib	Libr
Lupus, *Wolf*	Lup	Lupi
Lynx, *Lynx*	Lyn	Lync
Lyra, *Lyre*	Lyr	Lyra
Mensa, *Table* (*Mountain*)	Men	Mens
Microscopium, *Microscope*	Mic	Micr
Monoceros, *Unicorn*	Mon	Mono
Musca, *Fly*	Mus	Musc
Norma, *Square*	Nor	Norm
Octans, *Octant*	Oct	Octn
Ophiuchus, *Serpent-bearer*	Oph	Ophi
Orion, (*Hunter*)	Ori	Orio
Pavo, *Peacock*	Pav	Pavo
Pegasus, (*Winged Horse*)	Peg	Pegs
Perseus, (*Champion*)	Per	Pers
Phoenix, *Phoenix*	Phe	Phoe
Pictor, *Painter*	Pic	Pict
Pisces, *Fishes*	Psc	Pisc
Piscis Australis, *Southern Fish*	PsA	PscA
Puppis, *Poop*	Pup	Pupp
Pyxis, *Compass*	Pyx	Pyxi
Reticulum, *Net*	Ret	Reti
Sagitta, *Arrow*	Sge	Sgte
Sagittarius, *Archer*	Sgr	Sgtr
Scorpius, *Scorpion*	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 = *23h 56m 04.09s* of mean solar time
Mean solar day = *24h 03m 56.56s* of sidereal time
Synodical month = *29d 12h 44m*; sidereal month = *27d 07h 43m*
Tropical year (ordinary) = *365d 05h 48m 46s*
Sidereal year = *365d 06h 09m 10s*
Eclipse year = *346d 14h 53m*

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 ⊕ = 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 ⊕ = 26.2 miles/sec.

Solar Motion

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

The Galactic System

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

Date 1947	Apparent R.A.	Corr. to Sundial	Apparent Dec.
	h m s	m s	° ′
Jan. 1	18 42 21	+03 08	−23 05.4
" 4	18 55 35	+04 33	−22 49.9
" 7	19 08 45	+05 54	−22 30.4
" 10	19 21 52	+07 10	−22 06.8
" 13	19 34 53	+08 22	−21 39.4
" 16	19 47 50	+09 29	−21 08.2
" 19	20 00 40	+10 29	−20 33.3
" 22	20 13 24	+11 24	−19 54.9
" 25	20 26 01	+12 11	−19 13.2
" 28	20 38 31	+12 51	−18 28.3
" 31	20 50 53	+13 24	−17 40.4
Feb. 3	21 03 08	+13 49	−16 49.7
" 6	21 15 16	+14 07	−15 56.3
" 9	21 27 16	+14 18	−15 00.5
" 12	21 39 09	+14 21	−14 02.4
" 15	21 50 55	+14 18	−13 02.2
" 18	22 02 35	+14 08	−12 00.1
" 21	22 14 09	+13 52	−10 56.3
" 24	22 25 37	+13 30	−09 51.0
" 27	22 36 59	+13 03	−08 44.2
Mar. 2	22 48 16	+12 30	−07 36.4
" 5	22 59 28	+11 53	−06 27.6
" 8	23 10 36	+11 11	−05 18.0
" 11	23 21 41	+10 26	−04 07.7
" 14	23 32 42	+09 38	−02 57.0
" 17	23 43 41	+08 47	−01 46.0
" 20	23 54 39	+07 55	−00 34.8
" 23	00 05 35	+07 02	+00 36.3
" 26	00 16 30	+06 07	+01 47.3
" 29	00 27 25	+05 12	+02 57.8
Apr. 1	00 38 20	+04 18	+04 07.8
" 4	00 49 16	+03 24	+05 17.1
" 7	01 00 13	+02 31	+06 25.6
" 10	01 11 11	+01 40	+07 33.1
" 13	01 22 13	+00 51	+08 39.4
" 16	01 33 17	+00 06	+09 44.5
" 19	01 44 24	−00 37	+10 48.1
" 22	01 55 35	−01 15	+11 50.2
" 25	02 06 50	−01 50	+12 50.5
" 28	02 18 08	−02 21	+13 48.8
May 1	02 29 32	−02 47	+14 45.2
" 4	02 41 00	−03 09	+15 39.3
" 7	02 52 32	−03 26	+16 31.0
" 10	03 04 10	−03 38	+17 20.4
" 13	03 15 54	−03 44	+18 07.1
" 16	03 27 42	−03 45	+18 51.1
" 19	03 39 36	−03 41	+19 32.2
" 22	03 51 35	−03 32	+20 10.4
" 25	04 03 38	−03 18	+20 45.4
" 28	04 15 46	−03 00	+21 17.3
" 31	04 27 58	−02 38	+21 45.8
June 3	04 40 14	−02 11	+22 10.9
" 6	04 52 33	−01 42	+22 32.5
" 9	05 04 56	−01 09	+22 50.6
" 12	05 17 20	−00 34	+23 05.1
" 15	05 29 47	+00 03	+23 15.9
" 18	05 42 16	+00 42	+23 23.1
" 21	05 54 45	+01 21	+23 26.5
" 24	06 07 13	+02 00	+23 26.2
" 27	06 19 42	+02 39	+23 22.2
" 30	06 32 08	+03 16	+23 14.5

Date 1947	Apparent R.A.	Corr. to Sundial	Apparent Dec.
	h m s	m s	° ′
July 3	06 44 33	+03 51	+23 03.1
" 6	06 56 55	+04 23	+22 48.1
" 9	07 09 14	+04 53	+22 29.6
" 12	07 21 30	+05 19	+22 07.5
" 15	07 33 42	+05 41	+21 42.1
" 18	07 45 50	+05 59	+21 13.2
" 21	07 57 53	+06 13	+20 41.2
" 24	08 09 51	+06 21	+20 06.0
" 27	08 21 44	+06 24	+19 27.8
" 30	08 33 31	+06 21	+18 46.7
Aug. 2	08 45 12	+06 13	+18 02.8
" 5	08 56 48	+06 00	+17 16.3
" 8	09 08 19	+05 41	+16 27.3
" 11	09 19 45	+05 17	+15 35.8
" 14	09 31 06	+04 48	+14 42.1
" 17	09 42 21	+04 14	+13 46.3
" 20	09 53 33	+03 36	+12 48.5
" 23	10 04 39	+02 53	+11 48.9
" 26	10 15 41	+02 05	+10 47.6
" 29	10 26 40	+01 14	+09 44.8
Sept. 1	10 37 35	+00 20	+08 40.6
" 4	10 48 28	−00 38	+07 35.2
" 7	10 59 18	−01 37	+06 28.7
" 10	11 10 06	−02 38	+05 21.1
" 13	11 20 53	−03 41	+04 12.8
" 16	11 31 40	−04 44	+03 03.7
" 19	11 42 26	−05 48	+01 54.2
" 22	11 53 12	−06 52	+00 44.3
" 25	12 03 58	−07 55	−00 25.8
" 28	12 14 46	−08 57	−01 36.0
Oct. 1	12 25 36	−09 57	−02 46.0
" 4	12 36 28	−10 54	−03 55.8
" 7	12 47 23	−11 49	−05 05.2
" 10	12 58 21	−12 40	−06 14.1
" 13	13 09 24	−13 27	−07 22.2
" 16	13 20 32	−14 09	−08 29.4
" 19	13 31 44	−14 46	−09 35.6
" 22	13 43 02	−15 18	−10 40.5
" 25	13 54 25	−15 44	−11 43.9
" 28	14 05 55	−16 04	−12 45.7
" 31	14 17 32	−16 17	−13 45.7
Nov. 3	14 29 15	−16 23	−14 43.8
" 6	14 41 06	−16 22	−15 39.7
" 9	14 53 04	−16 13	−16 33.4
" 12	15 05 11	−15 57	−17 24.5
" 15	15 17 24	−15 33	−18 12.9
" 18	15 29 46	−15 01	−18 58.5
" 21	15 42 15	−14 22	−19 41.0
" 24	15 54 51	−13 36	−20 20.2
" 27	16 07 33	−12 42	−20 56.1
" 30	16 20 23	−11 43	−21 28.5
Dec. 3	16 33 19	−10 37	−21 57.1
" 6	16 46 20	−09 25	−22 22.1
" 9	16 59 27	−08 08	−22 43.1
" 12	17 12 38	−06 46	−23 00.0
" 15	17 25 52	−05 22	−23 12.9
" 18	17 39 09	−03 54	−23 21.7
" 21	17 52 28	−02 25	−23 26.2
" 24	18 05 47	−00 56	−23 26.4
" 27	18 19 06	+00 34	−23 22.5
" 30	18 32 24	+02 02	−23 14.3

To obtain *local mean* time, apply *corr. to sundial* to *apparent* or *sundial* 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.

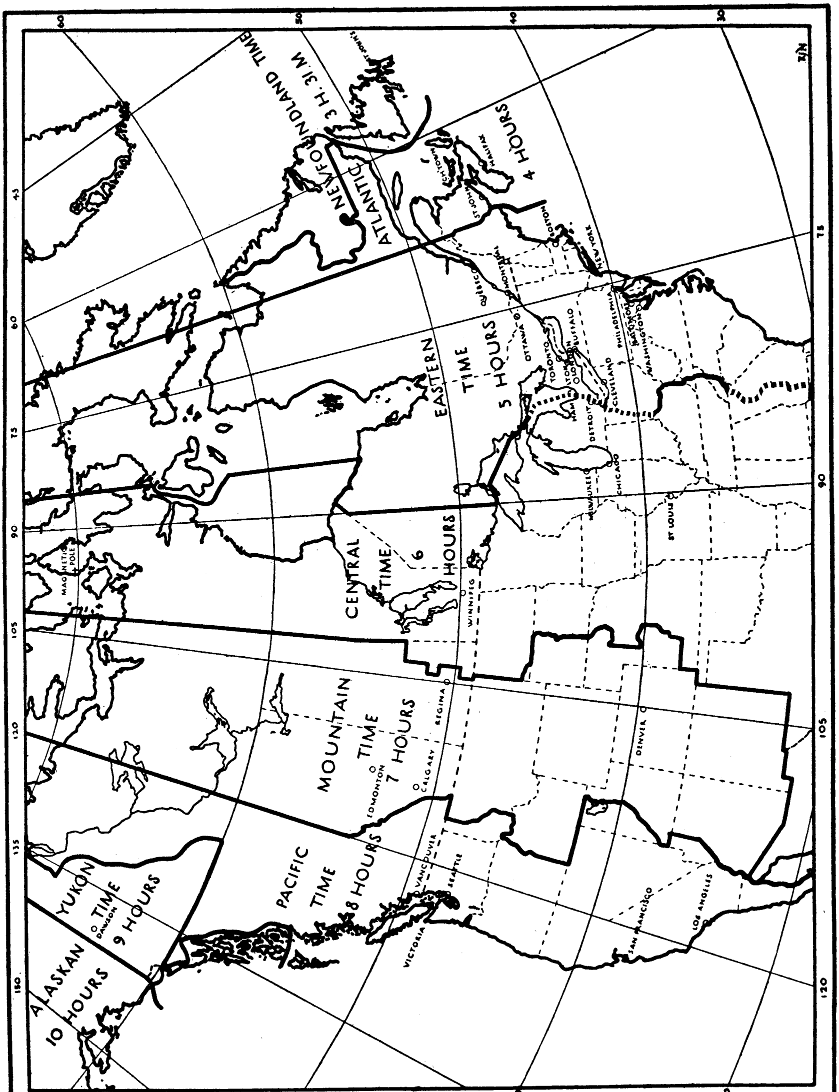
4. *Standard Time*—In everyday life we use still another kind of time. A moment's thought will show that in general two places will not have the same mean time; indeed, difference in longitude between two places is determined from their difference in time. But in travelling it is very inconvenient to 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.	**44°**	min.	**46°**	min.	**50°**	min.
Los Angeles	-7	Brantford	+21	Glace Bay	0	Brandon	+40
		Guelph	+21	Moncton	+19	Kenora	+18
38°		Halifax	+14	Montreal	-6	Medicine Hat	+22
St. Louis	+1	Hamilton	+20	New Glasgow	+11	Moose Jaw	+2
San Francisco	+10	Kingston	+6	North Bay	+18	Port. la Prairie	+33
Washington	+8	Kitchener	+22	Ottawa	+3	Regina	-2
		Milwaukee	-8	Parry Sound	+20	Trail	-9
40°		Minneapolis	+13	Quebec	-15	Vancouver	+12
Baltimore	+6	Orillia	+18	St. John, N.B.	+24	Winnipeg	+28
New York	-4	Oshawa	+15	Sault St. Marie	+37		
Philadelphia	+1	Owen Sound	+24	Sherbrooke	-12	**52°**	
Pittsburgh	+20	Peterborough	+13	Sudbury	+24	Calgary	+36
		St. Catharines	+17	Sydney	+1	Saskatoon	+6
42°		Stratford	+24	Three Rivers	-10		
Boston	-16	Toronto	+18			**54°**	
Buffalo	+15	Woodstock, Ont.	+23	**48°**		Edmonton	+34
Chicago	-10	Yarmouth	+24	Port Arthur	+57	Prince Albert	+1
Cleveland	+26			St. John's, Nfd.	0	Prince Rupert	+41
Detroit	-28	**46°**		Seattle	+9		
London, Ont.	+25	Charlottetown	+13	Timmins	+26	**60°**	
Windsor	+32	Fredericton	+26	Victoria	+13	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° 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
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° 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
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, 1947

(Local Mean Time)

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

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

TIMES OF MOONRISE AND MOONSET, 1947

(Local Mean Time)

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

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

TIMES OF MOONRISE AND MOONSET, 1947

(Local Mean Time)

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

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

TIMES OF MOONRISE AND MOONSET, 1947 (Local Mean Time)

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

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

TIMES OF MOONRISE AND MOONSET, 1947

(Local Mean Time)

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

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

TIMES OF MOONRISE AND MOONSET, 1947

(Local Mean Time)

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

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

THE PLANETS FOR 1947

By C. A. Chant

THE SUN

Mr. DeLisle Garneau reports a notable increase in sun-spots during 1946 over 1945, indicative of an early maximum, probably around the end of 1947 or the beginning of 1948. The most active months to date (Aug. 25, 1946) have been February, March and July. On the northern hemisphere, during the period January to August, 2362 spots were recorded as against 1822 on the southern hemisphere.

MERCURY

Mercury is exceptional in many ways. It is the planet nearest the sun and travels fastest in its orbit, its speed varying from 23 mi. per sec. at aphelion to 35 mi. per sec. at perihelion. 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 the 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. Although its brightness when it is taken as a star is considerable 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 1947

Elong. East—Evening Star			Elong. West—Morning Star		
Date	Distance	Mag.	Date	Distance	Mag.
Feb. 20	18°	− 0.4	Apr. 5	28°	+ 0.5
June 17	25°	+ 0.7	Aug. 3	19°	+ 0.4
Oct. 13	25°	+ 0.2	Nov. 22	20°	− 0.3

The most favourable elongations to observe are: in the evening, Feb. 20; in the morning, Aug. 3, but Nov. 22 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

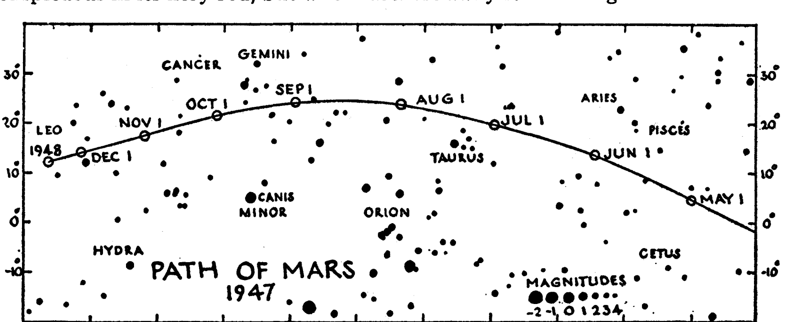
Venus is the next planet in order from the sun. In size and mass it is almost a twin of the earth. Venus being within the earth's orbit, its apparent motion is similar to that of Mercury but much slower and more stately. The orbit of Venus is almost a circle with a radius of 67 million miles, and its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

On Jan. 1, 1947, Venus is a splendid morning star slowly separating from the sun, with which it was in inferior conjunction on Nov. 17, 1946. On Jan. 27 it reaches greatest elongation west, 46° 56′, with stellar magnitude − 4.1, and in the telescope it looks like a half-moon with diameter 25″. It is a morning star all spring and summer, and on Sept. 3 it attains superior conjunction with the sun, at which time its distance from the earth is 93 + 67 or 160 million miles. For the rest of the year Venus is an evening star but not well placed for observation in the northern hemisphere. On May 17 it has a close conjunction with Mars, on July 2 with Uranus and on Nov. 9 with Jupiter. For these, consult the phenomena for the months named (pages 39, 43, 51).

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, which 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. Its mean distance from the sun is 141 million miles and the eccentricity of its orbit is 0.093, and a simple computation shows that its distance from the sun ranges between 128 and 154 million miles. Its distance from the earth varies from 35 to 235 million miles and its brightness changes accordingly. When Mars is nearest it is conspicuous in its fiery red, but when farthest away it is no brighter than Polaris.



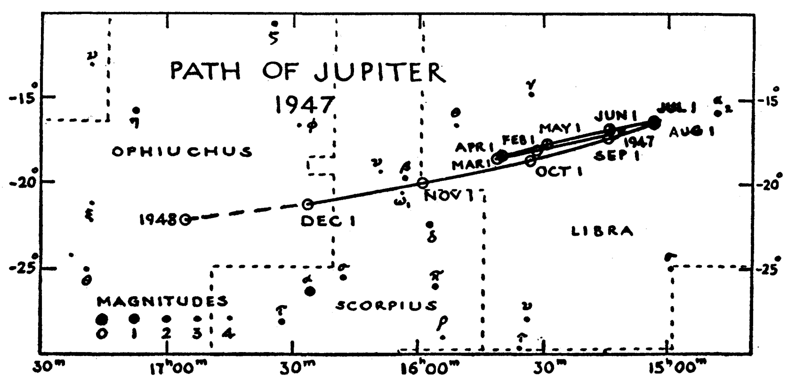
Unlike Venus, its atmosphere is very thin, and features on the solid surface are distinctly visible. Hence its rotation period of 24h. 37m. has been accurately determined.

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 mean value, it may vary by several days. The planet was in opposition on Jan. 13, 1946; the next one comes towards the end of Feb. 1948; consequently there is no opposition during 1947 and Mars will not be well placed for observation during the year. On Jan. 1 it is in R.A. 18h. 48m., Decl. − 23° 51′, in Sagittarius, and it passes near the ecliptic through Capricornus, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, into Leo. 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).

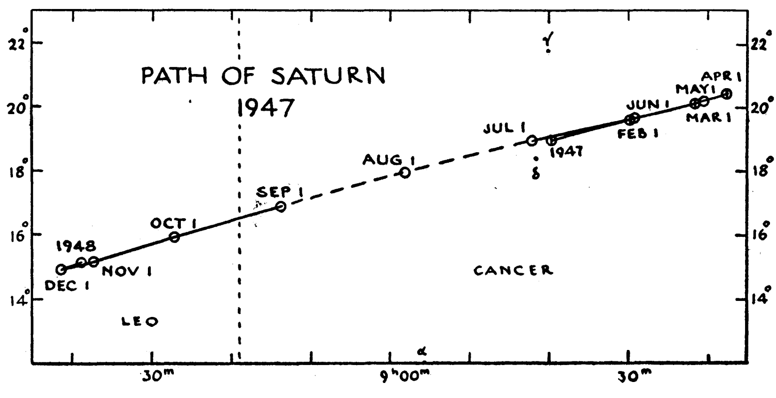
Jupiter is a fine object for the telescope. Many details of the surface as well as the flattening of the planet at the poles, which is undoubtedly due to its short rotation period, are visible. The rapidly varying phenomena of its satellites also provide a continual interest. On Jan. 1 it is a morning star and is on the meridian about 8.30 a.m. Its stellar magnitude is − 1.4. On May 14 it is in opposition with the sun. Its magnitude then is − 2.0, and it rises as the sun sets and is visible all night long. Its distance from the earth at this time is 407 million miles and its equatorial diameter is 45″. Conjunction with the sun occurs on Dec. 1. In the accompanying map that portion of the path when the planet is not well placed for observation is shown by a broken line.



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 of $29\frac{1}{2}$ years the rings appear to open out widest; then they slowly close in until, midway between the maxima, the rings are presented edgewise to the sun or the earth, at which times they are invisible. They were invisible in 1936 and at a maximum in 1944. In 1947 they are slowly closing in but are still quite visible. Their south face is presented now.

The planet is in the constellation Cancer until about Sept. 10 when it passes into Leo. On Jan. 26 it is in opposition to the sun and is visible all night. Its stellar magnitude then is 0.0, slightly brighter than Rigel. On April 23 it is in quadrature with the sun and is on the meridian at sunset. On Aug. 5 it is in conjunction with the sun. On Nov. 15 it is in quadrature, this time 90° west of the sun, and so is on the meridian at sunrise.

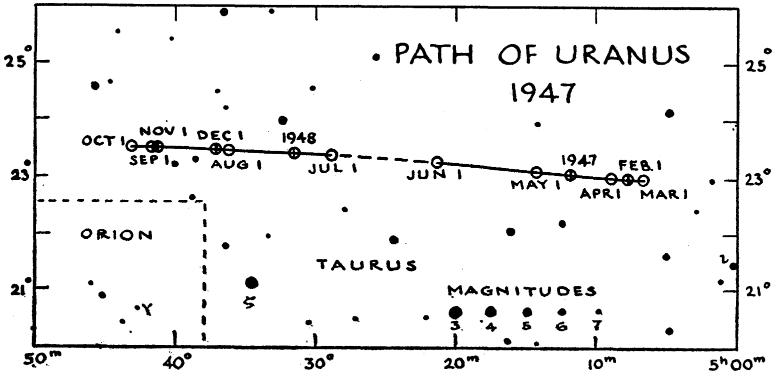


URANUS

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

As shown by the chart, Uranus in 1947 is in the easterly part of Taurus. On Dec. 9, 1946, it was in opposition with the sun. On Mar. 9 it is in quadrature, on June 13 in conjunction, on Sept. 19 in quadrature, and on Dec. 16 in opposition again.

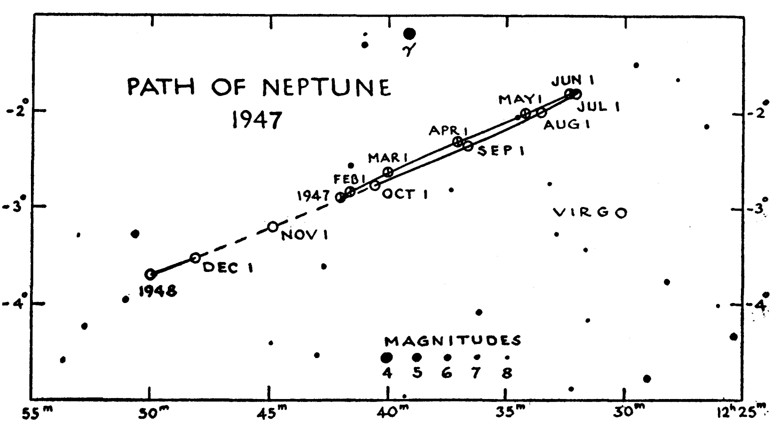
There are interesting references to the earliest observations of Uranus made in America in Edward Ford's "David Rittenhouse" (Philadelphia, 1946).



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 1947 Neptune is still in the constellation Virgo. It is in opposition with the sun on March 30. 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. 4.



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. Its position in 1947 at opposition on Feb. 1 is R.A. 9h. 7.3m. Decl. $+23° 45'$. This position was courteously supplied by the Director of the *American Ephemeris.*

ECLIPSES, 1947

In 1947 there will be only *three* eclipses, two of the sun and one of the moon.

I. *A Total Eclipse of the Sun,* May 20, 1947, invisible in North America. The path of totality crosses South America, through Chile, Argentina, Paraguay and Brazil, and across the Atlantic. In Africa it crosses Liberia, French West Africa, the Gold Coast, Nigeria, French Equatorial Africa and the Congo, ending at sunset in Kenya. It will appear as a partial eclipse from most of South America and Africa. The duration of totality will reach about four minutes in Brazil, and nearly five minutes in Liberia.

Circumstances of the Eclipse

	Greenwich Civil Time	Longitude	Latitude
Eclipse begins	May 20d 11h 10.8m	66° 42′ W	29° 44′ S
Central eclipse begins	12 09.4	77 46 W	36 30 S
Central eclipse at local app. noon	13 35.1	24 40 W	1 58 S
Central eclipse ends	15 25.3	36 58 E	2 12 S
Eclipse ends	16 23.9	24 51 E	4 46 N

II. *A Partial Eclipse of the Moon,* June 3, 1947, invisible in Canada. At maximum, in the Eastern Hemisphere, only one-fortieth of the moon's diameter will be obscured.

III. *An Annular Eclipse of the Sun.* November 12, 1947, invisible in eastern Canada, visible as a partial eclipse in western Canada. The central path of the eclipse lies mostly in the Pacific, ending in South America. In western British Columbia about a quarter of the sun's diameter will be eclipsed at maximum. There the eclipse will last from about 10 a.m. until noon, P.S.T.

THE SKY MONTH BY MONTH

By J. F. Heard

THE SKY FOR JANUARY, 1947

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 42m to 20h 55m and its Decl. changes from 23° 05′ S. to 17° 24′ S. The equation of time changes steadily from − 3m 08s to − 13m 33s. The earth is in perihelion, or nearest the sun, on January 3. 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. 19h 22m, Decl. 23° 50′ S. and transits at 11.50. It is too close to the sun for observation, being in superior conjunction on the 23rd.

Venus on the 15th is in R.A. 16h 27m, Decl. 17° 37′ S. and transits at 08.53. It is a brilliant morning star all month with magnitude brighter than − 4. It rises in the south-east several hours before sunrise. It should be seen fairly easily in the daytime by looking about 30° above the southern horizon about 9 o'clock. In the telescope about half the surface will appear illuminated.

Mars on the 15th is in R.A. 19h 35m, Decl. 22° 37′ S. and transits at 12.00. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 15h 22m, Decl. 17° 28′ S. and transits at 07.46. It is in Libra, rising several hours after midnight and being about on the meridian at sunrise. At about sunrise on the 16th it is occulted by the moon (see p. 56). Its magnitude at this time is − 1.4. 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. 08h 36m, Decl. 19° 15′ N. and transits at 01.00. It rises about an hour after sunset and is visible for the rest of the night. It is in opposition on the 26th. It is now at its brightest with magnitude zero, and its rings are presented at an angle of about 19° to the line of sight. The planet is retrograding during the next few months.

Uranus on the 15th is in R.A. 05h 10m, Decl. 23° 02′ N. and transits at 21.31.

Neptune on the 15th is in R.A. 12h 42m, Decl. 02° 53′ S. and transits at 05.06.

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

ASTRONOMICAL PHENOMENA MONTH BY MONTH

By Ruth J. Northcott

JANUARY

75th Meridian Civil Time

d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 6h 30m
Wed. 1	20		□♆⊙		42O13
Thu. 2			....	07 29	41O23
Fri. 3			Quadrantid meteors		
	11		♀ in Perihelion		43O12
	21		⊕ in Perihelion. Dist. from ⊙, 91,342,000 mi.		
Sat. 4			....		432O*
Sun. 5	4	46	☌♅☾ ♅ 0° 35′ S.	04 18	4321O
Mon. 6	3		☌♂⊙		43O12
	9		Moon in Perigee. Dist. from ⊕, 222,000 mi. ...		
	23	47	🌕 Full Moon		
Tue. 7	7		☿ in Aphelion		1O423
Wed. 8	7	18	☌♄☾ ♄ 3° 48′ S.	01 07	2O143
Thu. 9			....		1O234
Fri. 10			....	21 56	3O124
Sat. 11			....		32O4*
Sun. 12	20	18	☌♆☾ ♆ 3° 19′ S.		321O4
Mon. 13	1		♆ Stationary in R.A.	18 45	3O124
	21	56	☾ Last Quarter		
Tue. 14			....		1O234
Wed. 15			....		2O413
Thu. 16	8	25	☌♃☾ ♃ 0° 38′ S.	15 35	41O3*
Fri. 17	22	04	☌♀☾ ♀ 4° 04′ N.		d4O12
Sat. 18	7		☌☿♂ ☿ 0° 57′ S.		4321O
Sun. 19	0		Moon in Apogee. Dist. from ⊕, 252,300 mi. ...	12 24	d432O
Mon. 20			....		43O12
Tue. 21	18	04	☌♂☾ ♂ 2° 44′ N.		41O23
Wed. 22	1	02	☌☿☾ ☿ 1° 54′ N.	09 13	42O13
	3	34	🌑 New Moon		
Thu. 23	4		☌☿⊙ Superior		41O3*
Fri. 24			....		O3412
Sat. 25	9		♀ Greatest Hel. Lat. N.	06 03	312O4
Sun. 26	1		☍♄⊙ Dist. from ⊕, 754,100,000 mi. ...		32O14
Mon. 27	15		☿ Greatest Hel. Lat. S.		3O24*
	22		♀ Greatest elongation W., 46° 56′		
Tue. 28			....	02 52	1O324
Wed. 29	19	07	☽ First Quarter		2O134
Thu. 30			....	23 41	12O34
Fri. 31			....		O3124

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

THE SKY FOR FEBRUARY, 1947

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 55m to 22h 45m and its Decl. changes from 17° 24′ S. to 07° 59′ S. The equation of time changes from − 13m 33s to a maximum of − 14m 21s on the 12th and then to − 12m 42s 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 53m, Decl. 07° 21′ S. and transits at 13.17. It moves into the evening sky and by the 20th it is at greatest eastern elongation. Around that time it may be glimpsed about 10° above the south-western horizon at sunset. On the 26th it reaches a stationary point in R.A. and thereafter retrogrades, or moves westward among the stars.

Venus on the 15th is in R.A. 18h 41m, Decl. 20° 35′ S. and transits at 09.04. It is a morning star all month but it is approaching the sun and by the end of the month it is only about 15° above the south-eastern horizon at sunrise. Its magnitude is about − 4 and it appears rather more than half illuminated when seen in a telescope.

Mars on the 15th is in R.A. 21h 15m, Decl. 17° 03′ S. and transits at 11.38. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 15h 37m, Decl. 18° 19′ S. and transits at 05.59. It rises shortly after midnight just before Antares. It is in quadrature on the 15th. There is a close conjunction of Jupiter and the moon on the night of the 12th-13th. 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. 08h 25m, Decl. 19° 54′ N. and transits at 22.44. It is well up in the east at sunset and is visible nearly all night.

Uranus on the 15th is in R.A. 05h 07m, Decl. 22° 59′ N. and transits at 19.26.

Neptune on the 15th is in R.A. 12h 41m, Decl. 02° 45′ S. and transits at 03.03.

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

FEBRUARY

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 5h 30m
Sat.	1	13	02	☌ ♅ ☾ ♅ 0° 39′ S.		d3104
Sun.	2			....	20 30	32401
Mon.	3	18		Moon in Perigee. Dist. from ⊕, 224,400 mi.		43102
Tue.	4	15	07	☌ ♄ ☾ ♄ 3° 36′ S.		d402*
Wed.	5	10	50	Full Moon	17 20	42013
Thu.	6			....		42103
Fri.	7			....		40132
Sat.	8			....	14 09	41302
Sun.	9	5	22	☌ ♆ ☾ ♆ 3° 03′ S.		32401
Mon.	10			....		31024
Tue.	11			....	10 58	30124
Wed.	12	16	58	☾ Last Quarter		2034*
		22	44	☌ ♃ ☾ ♃ 0° 01′ S.		
Thu.	13			....		21034
Fri.	14			....	07 48	01234
Sat.	15	16		Moon in Apogee. Dist. from ⊕, 251,700 mi.		13024
		16		☿ in ☊		
		19		□ ♃ ☉		
Sun.	16	17	58	☌ ♀ ☾ ♀ 5° 09′ N.		32014
Mon.	17			....	04 37	3104*
Tue.	18			....		34012
Wed.	19	20	31	☌ ♂ ☾ ♂ 3° 50′ N.		4203*
Thu.	20	7		☿ in Perihelion	01 26	42103
		21	00	New Moon		
		22		☿ Greatest elongation E., 18° 07′		
Fri.	21			....		40123
Sat.	22	3	59	☌ ☿ ☾ ☿ 7° 02′ N.	22 16	41302
Sun.	23			....		43201
Mon.	24	19		♅ Stationary in R.A.		4310*
Tue.	25			....	19 05	43012
Wed.	26	23		☿ Stationary in R.A.		41203
Thu.	27			....		d2043
Fri.	28	4	12	☽ First Quarter	15 54	01234
		19	23	☌ ♅ ☾ ♅ 0° 52′ S.		

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

THE SKY FOR MARCH, 1947

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 45m to 00h 38m and its Decl. changes from 07° 59′ S. to 04° 08′ N. On the 21st at 06.13 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. The equation of time changes steadily from − 12m 42s to − 4m 18s. 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. 22h 49m, Decl. 04° 36′ S. and transits at 11.18. It is poorly placed for observation, being in inferior conjunction on the 8th. Later in the month it moves into the morning sky but is not high enough at sunrise to be observed easily. On the 21st it resumes direct, or eastward, motion among the stars.

Venus on the 15th is in R.A. 20h 54m, Decl. 16° 54′ S. and transits at 09.28. It is a morning star and can be seen low in the south-east at sunrise. Its magnitude is about − 3.6 and its disc is about 70% illuminated.

Mars on the 15th is in R.A. 22h 41m, Decl. 09° 33′ S, and transits at 11.13. It is too close to the sun for observation.

Jupiter on the 15th is in R.A. 15h 42m, Decl. 18° 31′ S. and transits at 04.14. It rises just before midnight in the south-east and is about 10° north of and preceding Antares. On the 14th it is stationary in R.A. and begins to retrograde or move westward 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. 08h 19m, Decl. 20° 17′ N. and transits at 20.48. It is high in the eastern sky at sunset, about in line with Castor and Pollux (to the south-east of them), and remains up most of the night.

Uranus on the 15th is in R.A. 05h 07m, Decl. 22° 59′ N. and transits at 17.37.

Neptune on the 15th is in R.A. 12h 39m, Decl. 02° 29′ S. and transits at 01.11.

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

MARCH

75th Meridian Civil Time

d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 4h 00m
Sat. 1			. . . .		10324
Sun. 2	6		♂ Greatest Hel. Lat. S.		32014
	13		☿ Greatest Hel. Lat. N.		
Mon. 3	15		Moon in Perigee. Dist. from ⊕, 227,800 mi. . . .	12 44	31204
	21	15	☌ ♄ ☾ ♄ 3° 35′ S.		
Tue. 4			. . . .		30124
Wed. 5			. . . .		10234
Thu. 6	22	15	○ Full Moon.	09 33	20143
Fri. 7			. . . .		4023*
Sat. 8	14	30	☌ ♆ ☾ ♆ 2° 53′ S.		41032
	17		☌ ☿ ☉ Inferior.		
Sun. 9	1		□ ♅ ☉.	06 22	43201
Mon. 10			. . . .		43210
Tue. 11			. . . .		43012
Wed. 12	9	56	☌ ♃ ☾ ♃ 0° 27′ N.	03 12	41032
Thu. 13			. . . .		42013
Fri. 14	10		♃ Stationary in R.A.		41023
	13	28	☾ Last Quarter.		
Sat. 15	12		Moon in Apogee. Dist. from ⊕, 251,200 mi. . . .	00 01	d4032
Sun. 16	12		☌ ☿ ♂ ☿ 3° 40′ N.		32014
Mon. 17			. . . .	20 50	32104
Tue. 18	20	08	☌ ♀ ☾ ♀ 5° 12′ N.		30124
Wed. 19			. . . .		1024*
Thu. 20	14	41	☌ ☿ ☾ ☿ 6° 49′ N.	17 39	20134
	23	13	☌ ♂ ☾ ♂ 4° 15′ N.		
Fri. 21	3		☿ Stationary in R.A.		1034*
	6	13	☉ enters ♈, Spring commences. Long. of ☉, 0°.		
Sat. 22	10		♀ in ♉.		01324
	11	34	● New Moon.		
Sun. 23			. . . .	14 29	32014
Mon. 24			. . . .		32410
Tue. 25			. . . .		43012
Wed. 26	0		☿ in ♉.	11 18	4102*
Thu. 27	12		♂ in Perihelion.		42013
Fri. 28	1	29	☌ ♅ ☾ ♅ 1° 10′ S.		41203
Sat. 29	8		Moon in Perigee. Dist. from ⊕, 230,000 mi. . . .	08 07	40132
	11	15	☽ First Quarter.		
Sun. 30	19		☍ ♆ ☉ Dist. from ⊕, 2,721,000,000 mi. . .		4320*
Mon. 31	02	16	☌ ♄ ☾ ♄ 3° 44′ S.		32410

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

THE SKY FOR APRIL, 1947

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 38m to 02h 30m and its Decl. changes from 04° 08′ N. to 14° 45′ N. The equation of time changes from − 4m 18s to + 2m 47s, being zero on the 15th. That is, the apparent sun changes from being behind the mean sun to being ahead of the mean sun. 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. 23h 58m, Decl. 03° 00′ S. and transits at 10.30. On the 5th it is at greatest elongation west but at sunrise it is less than 10° above the eastern horizon and not easily seen. For the rest of the month it approaches the sun.

Venus on the 15th is in R.A. 23h 17m, Decl. 05° 54′ S. and transits at 09.49. It is a morning star visible low in the south-east at sunrise. Its magnitude is about − 3.4 and its disc is about 80% illuminated.

Mars on the 15th is in R.A. 00h 10m, Decl. 00° 01 N. and transits at 10.40. It is too close to the sun for easy observation.

Jupiter on the 15th is in R.A. 15h 36m, Decl. 18° 07′ S. and transits at 02.06. It rises about two hours before midnight and is prominent in the southern sky the rest of the night. It has now brightened to magnitude − 2 and will remain at this maximum brightness for the next few months. On the night of the 8th it rises very close to the moon. 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. 08h 18m, Decl. 20° 21′ N. and transits at 18.45. It is about on the meridian at sunset and sets about midnight. It resumes direct, or eastward, motion among the stars on the 3rd and it is in quadrature with the sun on the 23rd.

Uranus on the 15th is in R.A. 05h 11m, Decl. 23° 04′ N. and transits at 15.39.

Neptune on the 15th is in R.A. 12h 36m, Decl. 02° 09′ S. and transits at 23.02.

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

APRIL

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 2h 30m
Tue.	1			....	04 56	30412
Wed.	2			....		13024
Thu.	3	13		♄ Stationary in R.A....................		20134
Fri.	4	22	11	☌♆☾ ♆ 2° 53′ S..................	01 46	12034
Sat.	5	6		☿ Greatest elongation W., 27° 48′.........		01234
		7		☿ in Aphelion..........................		
		10	28	Full Moon..............................		
Sun.	6			....	22 35	13024
Mon.	7			....		d3204
Tue.	8	16	47	☌♃☾ ♃ 0° 36′ N.................		30124
Wed.	9			....	19 24	31042
Thu.	10			....		42013
Fri.	11			....		42103
Sat.	12	8		Moon in Apogee. Dist from ⊕, 251,200 mi....	16 13	40123
Sun.	13	9	23	☾ Last Quarter.........................		41032
Mon.	14			....		43201
Tue.	15			....	13 02	4302*
Wed.	16			....		43102
Thu.	17			....		24031
Fri.	18	0	37	☌♀☾ ♀ 3° 57′ N.................	09 51	21043
Sat.	19	0	54	☌☿☾ ☿ 1° 59′ N.................		01234
		1	56	☌♂☾ ♂ 3° 46′ N.................		
		18		☌☿♂ ☿ 1° 49′ S.................		
Sun.	20	23	19	New Moon...............................		10324
Mon.	21			Lyrid meteors..........................	06 40	32014
Tue.	22			....		304**
Wed.	23	2		□♄☉....................................		31024
Thu.	24	6		Moon in Perigee. Dist. from ⊕, 227,800 mi....	03 29	20314
		9	33	☌♅☾ ♅ 1° 24′ S.................		
Fri.	25	15		☿ Greatest Hel. Lat. S.................		21043
		20		♀ in Aphelion..........................		
Sat.	26			....		40123
Sun.	27	8	23	☌♄☾ ♄ 3° 55′ S.................	00 19	41032
		17	18	☽ First Quarter.......		
Mon.	28			....		42301
Tue.	29			....	21 08	43120
Wed.	30			....		d4302

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

THE SKY FOR MAY, 1947

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 30m to 04h 32m and its Decl. changes from 14° 45′ N. to 21° 55′ N. The equation of time is small all month, changing from + 2m 47s to a maximum of + 3m 46s on the 15th and then to + 2m 29s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 03h 19m, Decl. 18° 21′ N. and transits at 11.55. It is in superior conjunction on the 15th and thereafter rapidly assumes a favourable position in the evening sky. By the end of the month it is about 14° above the western horizon at sunset.

Venus on the 15th is in R.A. 01h 31m, Decl. 07° 39′ N. and transits at 10.04. It is a morning star visible low in the east just before sunrise. Its magnitude has faded to − 3.3 and, seen in a telescope, it is only slightly gibbous.

Mars on the 15th is in R.A. 01h 35m, Decl. 09° 04′ N. and transits at 10.07. It is beginning to be observable as a morning star, rising about two hours before the sun and being about 12° up in the east at sunrise. It is difficult to spot at this time, however, since its magnitude is fainter than 1.5.

Jupiter on the 15th is in R.A. 15h 22m, Decl. 17° 17′ S. and transits at 23.49. It rises at about sunset and is in the sky all night. Opposition is on the 14th. There is a close conjunction with the moon on the night of the 5th-6th. 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. 08h 24m, Decl. 20° 03′ N. and transits at 16.53. It is well to the west of the meridian at sunset and sets before midnight.

Uranus on the 15th is in R.A. 05h 17m, Decl. 23° 11′ N. and transits at 13.47.

Neptune on the 15th is in R.A. 12h 33m, Decl. 01° 53′ S. and transits at 21.01.

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

MAY

75th Meridian Civil Time

d		h	m		Min. of Algol h m	Config. of Jupiter's Sat. 0h 45m
Thu.	1			....		d4O**
Fri.	2	3	51	☌♆☾ ♆ 3° 00′ S..................	17 57	42103
Sat.	3			....		40213
Sun.	4			Eta Aquarid meteors........................		14023
		23	53	○ Full Moon............................		
Mon.	5	19	09	☌♃☾ ♃ 0° 24′ N..................	14 46	23014
Tue.	6			....		31204
Wed.	7			....		30124
Thu.	8			....	11 35	3024*
Fri.	9			....		21034
Sat.	10	2		Moon in Apogee. Dist. from ⊕, 251,600 mi....		O2134
Sun.	11			....	08 24	10324
Mon.	12			....		23041
Tue.	13	3	08	☾ Last Quarter..........................		3421O
Wed.	14	3		☍♃☉ Dist. from ⊕, 407,300,000 mi....	05 13	43012
		15		☿ in ☊................................		
Thu.	15	17		☌☿☉ Superior.....................		43102
Fri.	16			....		d4203
Sat.	17	7		☌♀♂ ♀ 1° 01′ S..................	02 02	4013*
Sun.	18	3	46	☌♂☾ ♂ 2° 27′ N..................		41023
		4	30	☌♀☾ ♀ 1° 25′ N..................		
		7		♀ Greatest Hel. Lat. S..................		
Mon.	19	6		☿ in Perihelion..........................	22 51	42301
Tue.	20			Total eclipse of ☉, see p. 29..................		3241O
		8	44	● New Moon............................		
		19	17	☌☿☾ ☿ 0° 49′ N..................		
Wed.	21	20	26	☌♅☾ ♅ 1° 33′ S..................		30412
Thu.	22	2		Moon in Perigee. Dist. from ☉, 224,600 mi....	19 39	31024
Fri.	23			....		2O134
Sat.	24	17	38	☌♄☾ ♄ 4° 03′ S..................		O34**
Sun.	25			....	16 28	10234
Mon.	26	23	35	☽ First Quarter..........................		d2O14
Tue.	27			....		321O4
Wed.	28	11		☌☿♅ ☿ 1° 50′ N..................	13 17	3O124
Thu.	29	8	33	☌♆☾ ♆ 3° 05′ S..................		314O2
		13		☿ Greatest Hel. Lat. N..................		
Fri.	30			....		42O13
Sat.	31			....	10 06	42O3*

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

THE SKY FOR JUNE, 1947

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 32m to 06h 36m and its Decl. changes from 21° 55′ N. to 23° 27′ N. at the solstice on the 22nd and then to 23° 11′ N. at the end of the month. The equation of time changes from + 2m 29s to zero on the 14th and then to − 3m 28s at the end of the month. For changes in the length of the day, see p. 13.

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

Mercury on the 15th is in R.A. 07h 17m, Decl. 23° 35′ N. and transits at 13.48. Most of this month it is well placed for observation in the evening sky. Until about the 22nd it is some 15° above the western horizon at sunset. Its greatest eastern elongation is on the 17th; at that time it is only a few degrees south of Castor and Pollux and outshines them slightly, being of stellar magnitude 0.6. On the 30th it is stationary in R.A. and begins to move westward among the stars.

Venus on the 15th is in R.A. 03h 58m, Decl. 19° 19′ N. and transits at 10.29. It is a morning star visible low in the east at sunrise.

Mars on the 15th is in R.A. 03h 04m, Decl. 16° 49′ N. and transits at 09.34. It rises with the Pleiades, about 10° further to the south in azimuth, a couple of hours before the sun. At sunrise it is about 20° above the eastern horizon. On the night of the 15th-16th there is a close conjunction with the moon.

Jupiter on the 15th is in R.A. 15h 08m, Decl. 16° 27′ S.and transits at 21.33. It is well up in the south-east at sunset and remains visible most of the night. There are close conjunctions with the moon on the nights of the 1st-2nd and the 28th-29th. 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. 08h 35m, Decl. 19° 24′ N. and transits at 15.02. It is well to the west at sunset and sets about three hours later.

Uranus on the 15th is in R.A. 05h 25m, Decl. 23° 19′ N. and transits at 11.53.

Neptune on the 15th is in R.A. 12h 32m, Decl. 01° 47′ S. and transits at 18.58.

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

JUNE

75th Meridian Civil Time

	d	h	m		Min. of Algol h	m	Config. of Jupiter's Sat. 23h 30m
Sun.	1	19	05	☌ ♃ ☾ ♃ 0° 01′ N..................			d4O31
Mon.	2			....			4321O
Tue.	3			Partial eclipse of ☾, see p. 29...............	06	55	43O21
		14	27	○ Full Moon...........................			
Wed.	4			....			431O2
Thu.	5			....			24O31
Fri.	6	16		Moon in Apogee. Dist. from ⊕, 252, 200 mi....	03	44	21O43
Sat.	7			....			O1234
Sun.	8			....			dO134
Mon.	9			....	00	33	231O4
Tue.	10			....			3O214
Wed.	11	17	58	☾ Last Quarter.......................	21	21	31O24
Thu.	12			....			2O14*
Fri.	13	14		☌ ♅ ☉..			21O43
Sat.	14			....	18	10	4O123
Sun.	15			....			4O23*
Mon.	16	3	26	☌ ♂ ☾ ♂ 0° 44′ N..................			4231O
Tue.	17	4	40	☌ ♀ ☾ ♀ 1° 16′ S..................	14	59	43O1*
		6		☿ Greatest elongation E., 24° 41′..........			
Wed.	18	9	19	☌ ♅ ☾ ♅ 1° 41′ S..................			431O2
		16	26	● New Moon..........................			
Thu.	19	9		Moon in Perigee. Dist. from ⊕, 222,500 mi....			42O1*
Fri.	20	5		♆ Stationary in R.A....................	11	48	421O3
		8	37	☌ ☿ ☾ ☿ 3° 43′ S..................			
Sat.	21	6	28	☌ ♄ ☾ ♄ 4° 07′ S..................			4O123
		23		☿ in ☋.....................................			
Sun.	22	1	19	☉ enters ♋, Summer commences. Long. of ☉, 90°			1O423
Mon.	23			....	08	36	d23O4
Tue.	24			....			3O14*
Wed.	25	7	25	☽ First Quarter........................			
		14	11	☌ ♆ ☾ ♆ 3° 01′ S..................			31O24
Thu.	26			....	05	25	23O14
Fri.	27			....			21O34
Sat.	28	20	11	☌ ♃ ☾ ♃ 0° 15′ S..................			O1234
Sun.	29			....	02	14	1O234
Mon.	30	12		☿ Stationary in R.A....................			d23O4
		12		□ ♆ ☉..			

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

THE SKY FOR JULY, 1947

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 36m to 08h 41m and its Decl. changes from 23° 11′ N. to 18° 18′ N. The equation of time changes steadily from − 3m 28s to − 6m 17s. On the 5th 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. 07h 29m, Decl. 16° 56′ N. and transits at 11.57. Until the end of the month it is poorly placed for observation and is in inferior conjuction on the 14th, thereafter becoming a morning star. By the end of the month it is about 12° above the eastern horizon at sunrise, about 10° south of Castor and Pollux and about the same brightness. On the 25th it resumes direct, or eastward, motion among the stars.

Venus on the 15th is in R.A. 06h 34m, Decl. 23° 16′ N. and transits at 11.07. It is still a morning star visible low in the east at sunrise but by the end of the month it is only 7° above the horizon at sunrise.

Mars on the 15th is in R.A. 04h 32m, Decl. 21° 45′ N. and transits at 09.04. It is in the morning sky and can easily be located by the fact that it is about 5° north of Aldebaran and only a little fainter.

Jupiter on the 15th is in R.A. 15h 02m, Decl. 16° 11′ S. and transits at 19.30. It is about on the meridian at sunset and sets about midnight. On the 16th it resumes direct, or eastward, motion among the stars. On the night of the 25th-26th there is a close conjunction with the moon. 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. 08h 49m, Decl. 18° 31′ N. and transits at 13.19. It is now difficult to locate, being very low in the west at sunset and setting within an hour after.

Uranus on the 15th is in R.A. 05h 33m, Decl. 23° 24′ N. and transits at 10.02.

Neptune on the 15th is in R.A, 12h 32m, Decl. 01° 52′ S. and transits at 17.01.

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

JULY

75th Meridian Civil Time

d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 22h 45m
Tue. 1				23 02	3420*
Wed. 2	6		☿ in Aphelion		43102
	15		☌ ♀ ♅ ♀ 0° 34′ S.		
Thu. 3	5	38	○ Full Moon		43201
	22		Moon in Apogee. Dist. from ⊕, 252,500 mi.		
Fri. 4				19 51	42103
Sat. 5	5		⊕ in Aphelion. Dist. from ☉, 94,451,000 mi.		40213
Sun. 6					41023
Mon. 7				16 40	42301
Tue. 8					3420*
Wed. 9					31042
Thu. 10				13 28	d3014
Fri. 11	5	54	☾ Last Quarter		21034
Sat. 12					02134
Sun. 13	13		♀ in ♌	10 17	10234
Mon. 14	13		☌ ☿ ☉ Inferior		20314
	23	56	☌ ♂ ☾ ♂ 0° 56′ S.		
Tue. 15	22	26	☌ ♅ ☾ ♅ 1° 51′ S.		32104
Wed. 16	4		♃ Stationary in R.A.	07 06	d3024
Thu. 17	0	40	☌ ♀ ☾ ♀ 3° 05′ S.		34012
	13	18	☌ ☿ ☾ ☿ 8° 45′ S.		
	18		Moon in Perigee. Dist. from ⊕, 222,000 mi.		
	23	15	● New Moon		
Fri. 18	21	50	☌ ♄ ☾ ♄ 4° 10′ S.		42103
Sat. 19				03 54	4013*
Sun. 20					41023
Mon. 21					42031
Tue. 22	4		☌ ☿ ♀ ☿ 4° 55′ S.	00 43	43210
	14		☿ Greatest Hel. Lat. S.		
	22	10	☌ ♆ ☾ ♆ 2° 50′ S.		
Wed. 23					43012
Thu. 24	17	54	☽ First Quarter	21 32	4302*
Fri. 25	3		☿ Stationary in R.A.		2410*
Sat. 26	1	41	☌ ♃ ☾ ♃ 0° 13′ S.		0143*
Sun. 27	13		♂ in ♌	18 20	10234
Mon. 28			Delta Aquarid meteors		20314
Tue. 29					32104
Wed. 30				15 09	30124
Thu. 31	1		Moon in Apogee. Dist. from ⊕, 252,400 mi.		3024*

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

THE SKY FOR AUGUST, 1947

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 41m to 10h 38m and its Decl. changes from 18° 18′ N. to 08° 41′ N. The equation of time changes from − 6m 17s to 0m − 20s. 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. 08h 39m, Decl. 19° 16′ N. and transits at 11.12. It is at greatest western elongation on the 3rd and for the first half of the month it can be seen in the morning sky 12° to 14° above the western horizon at sunrise with stellar magnitude about zero, outshining Castor and Pollux, which are some 10° above it. Later in the month it approaches the sun and is in superior conjunction on the 28th.

Venus on the 15th is in R.A. 09h 15m, Decl. 17° 08′ N. and transits at 11.46. It is still a morning star but too close to the sun for easy observation.

Mars on the 15th is in R.A. 06h 03m, Decl. 23° 42′ N. and transits at 08.32. It rises some four hours before the sun and will be found about midway between Aldebaran and the twins at mid-month. Its magnitude is 1.5.

Jupiter on the 15th is in R.A. 15h 07m, Decl. 16° 40′ S. and transits at 17.34. It is well past the meridian at sunset and sets before midnight. It is in quadrature on the 12th. On the evening of the 22nd it is close to the moon. 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. 09h 05m, Decl. 17° 28′ N. and transits at 11.33. It is too close to the sun to see, being in conjunction on the 5th.

Uranus on the 15th is in R.A. 05h 39m, Decl. 23° 29′ N. and transits at 08.07.

Neptune on the 15th is in R.A. 12h 35m, Decl. 02° 08′ S. and transits at 15.01.

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

AUGUST

75th Meridian Civil Time

	d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 21h 15m
Fri.	1	20	50	○ Full Moon........................		d2O4*
Sat.	2			....	11 57	2O143
Sun.	3	15		☿ Greatest elongation W., 19° 21′..........		14O23
Mon.	4			....		42O13
Tue.	5	13		☌ ♄ ☉	08 46	4213O
		21		☌ ♂ ⛢ ♂ 0° 01′ N..................		
Wed.	6			....		43O21
Thu.	7			....		431O2
Fri.	8			....	05 34	423O1
Sat.	9	15	22	☾ Last Quarter........................		42O3*
Sun.	10	15		☿ in ☊..		41O23
Mon.	11			....	02 23	4O213
Tue.	12			Perseid meteors........................		213O4
		4		□ ♃ ☉..		
		9	52	☌ ⛢ ☾ ⛢ 2° 06′ S..................		
		14		☌ ♀ ♄ ♀ 0° 20′ N..................		
		16	47	☌ ♂ ☾ ♂ 2° 19′ S..................		
Wed.	13			....	23 12	3O214
Thu.	14			....		31O24
Fri.	15	3		Moon in Perigee. Dist. from ⊕, 223,300 mi....		23O14
		5	09	☌ ☿ ☾ ☿ 3° 54′ S..................		
		6		☿ in Perihelion........................		
		13	56	☌ ♄ ☾ ♄ 4° 14′ S..................		
		19	31	☌ ♀ ☾ ♀ 3° 56′ S..................		
Sat.	16	3		♀ in Perihelion........................	20 00	2O34*
		6	12	● New Moon........................		
Sun.	17			....		1O234
Mon.	18	8		☌ ☿ ♄ ☿ 0° 35′ N..................		O2134
Tue.	19	8	38	☌ ♆ ☾ ♆ 2° 35′ S..................	16 49	213O4
Wed.	20			....		34O1*
Thu.	21			....		341O2
Fri.	22	12	47	☌ ♃ ☾ ♃ 0° 07′ N..................	13 37	432O1
Sat.	23	7	40	☽ First Quarter........................		421O3
Sun.	24			....		d4O23
Mon.	25	12		☿ Greatest Hel. Lat. N..................	10 26	4O123
Tue.	26	15		☌ ☿ ♀ ☿ 0° 28′ N..................		421O3
Wed.	27	11		Moon in Apogee. Dist. from ⊕, 251,900 mi....		342O1
Thu.	28	22		☌ ☿ ☉ Superior........................	07 14	31O42
Fri.	29			....		32O14
Sat.	30			....		21O34
Sun.	31	11	34	○ Full Moon........................	04 03	O1234

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

THE SKY FOR SEPTEMBER, 1947

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 38m to 12h 26m and its Decl. changes from 08° 41′ N. to zero at the autumnal equinox on the 23rd (at 16.29 E.S.T.) and then to 02° 46′ S. at the end of the month. The equation of time changes from − 20s to zero on the 2nd and then to + 9m 57s at the end of the month. For changes in the length of the day, see p. 15.

The Moon—For its phases, perigee and apogee times and distances, and its conjunctions with the planets, see opposite page. Times of moonrise and moonset are given on p. 22. The full moon of September 30th is Harvest Moon.

Mercury on the 15th is in R.A. 12h 20m, Decl. 01° 43′ S. and transits at 12.49. All month it is poorly placed for observation, being very low in the west at sunset.

Venus on the 15th is in R.A. 11h 42m, Decl. 03° 30′ N. and transits at 12.10. It is in superior conjunction on the 3rd and is too close to the sun all month for observation.

Mars on the 15th is in R.A. 07h 29m, Decl. 22° 37′ N.and transits at 07.55. It rises about two hours after midnight and at mid-month is about 5° south of the twins and about the same brightness.

Jupiter on the 15th is in R.A. 15h 22m, Decl. 17° 46′ S. and transits at 15.47. It is low in the south-west at sunset and sets a few hours later. There is an unusual shift of the four bright satellites from all on one side on the evening of the 13th to all on the other side on the 14th. 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. 09h 20m, Decl. 16° 23′ N. and transits at 09.46. It rises a little north of east about two hours before the sun. It follows Mars by about 20° and precedes Regulus by about 10° and is brighter than either.

Uranus on the 15th is in R.A. 05h 43m, Decl. 23° 31′ N. and transits at 06.09.

Neptune on the 15th is in R.A. 12h 38m, Decl. 02° 32′ S. and transits at 13.03.

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

d	h	m	SEPTEMBER 75th Meridian Civil Time	Min. of Algol h m	Config. of Jupiter's Sat. 20h 00m
Mon. 1			....		0234*
Tue. 2			....		21034
Wed. 3	9		☌ ♀ ☉ Superior..........................	00 51	32014
Thu. 4			....		31024
Fri. 5			....	21 40	d3041
Sat. 6			....		24103
Sun. 7	1		♀ Greatest Hel. Lat. N..................		40213
	22	57	☾ Last Quarter...........................		
Mon. 8	18	25	☌ ♅ ☾ ♅ 2° 24′ S..................	18 29	41023
Tue. 9			....		d4203
Wed. 10	5	58	☌ ♂ ☾ ♂ 3° 19′ S.................		43201
Thu. 11			....	15 17	43102
Fri. 12	4	46	☌ ♄ ☾ ♄ 4° 22′ S.................		43021
	6		Moon in Perigee. Dist. from ⊕, 226,000 mi....		
Sat. 13			....		24130
Sun. 14	14	28	● New Moon..........................	12 06	02413
	17	33	☌ ♀ ☾ ♀ 3° 23′ S.................		
Mon. 15	13	31	☌ ☿ ☾ ☿ 3° 57′ S.................		10243
	20	23	☌ ♆ ☾ ♆ 2° 23′ S.................		
Tue. 16			....		20134
Wed. 17	22		☿ in ☋..................................	08 54	2304*
Thu. 18	4		☌ ☿ ♆ ☿ 1° 38′ S.................		31024
Fri. 19	4	44	☌ ♃ ☾ ♃ 0° 37′ N.................		30214
	17		□ ♅ ☉....................................		
Sat. 20			....	05 43	21304
Sun. 21			....		0134*
Mon. 22	0	42	☽ First Quarter.........................		10423
Tue. 23	16	29	☉ enters ♎, Autumn commences. Long. of ☉, 180°	02 32	42013
Wed. 24	2		Moon in Apogee. Dist. from ⊕, 251,400 mi....		4230*
Thu. 25			....		43102
Fri. 26			....	23 20	43012
Sat. 27	16		☌ ♀ ♆ ♀ 0° 18′ S.................		42310
Sun. 28	5		☿ in Aphelion...........................	20 09	42031
Mon. 29			....		41023
Tue. 30	1	41	○ Full Moon.............................		42013

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

THE SKY FOR OCTOBER, 1947

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 26m to 14h 21m and its Decl. changes from 02° 46′ S. to 14° 05′ S. The equation of time changes steadily from + 9m 57s to + 16m 20s. 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 October 29th is Hunter's Moon.

Mercury on the 15th is in R.A. 14h 49m, Decl. 19° 22′ S. and transits at 13.18. Although it reaches greatest eastern elongation on the 13th it is no good for observation because of the way the ecliptic "hugs" the horizon at sunset at this season. On the 25th it commences retrograde motion.

Venus on the 15th is in R.A. 13h 59m, Decl. 11° 25′ S. and transits at 12.29. It is too close to the sun all month for observation.

Mars on the 15th is in R.A. 08h 42m, Decl. 19° 31′ N. and transits at 07.10. It rises shortly after midnight and is nearly to the meridian at sunrise. At mid-month it is about half-way between the twins and Regulus, Saturn being between Mars and Regulus.

Jupiter on the 15th is in R.A. 15h 44m, Decl. 19° 07′ S. and transits at 14.11. It is well down in the south-west at sunset and sets about an hour 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. 09h 32m, Decl. 15° 31′ N. and transits at 08.00. It rises about an hour after midnight and is located about half-way between Mars and Regulus, outshining them both with magnitude 0.7.

Uranus on the 15th is in R.A. 05h 43m, Decl. 23° 31′ N. and transits at 04.11.

Neptune on the 15th is in R.A. 12h 43m, Decl. 02° 58′ S. and transits at 11.09.

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

	d	h	m	OCTOBER 75th Meridian Civil Time	Min. of Algol h m	Config. of Jupiter's Sat. 18h 30m
Wed.	1			....	16 58	21034
Thu.	2	11		♅ Stationary in R.A.		30124
Fri.	3			....		3024*
Sat.	4	10		☌♆☉	13 46	32104
Sun.	5			....		20314
Mon.	6	0	20	☌♅☾ ♅ 2° 37′ S.		10234
Tue.	7	5	29	☾ Last Quarter	10 35	02134
Wed.	8	15	36	☌♂☾ ♂ 3° 49′ S.		21034
Thu.	9	13		Moon in Perigee. Dist. from ⊕, 229,100 mi....		30421
		16	48	☌♄☾ ♄ 4° 31′ S.		
Fri.	10			....	07 24	3402*
Sat.	11			....		43210
Sun.	12			....		4201*
Mon.	13	7	39	☌♆☾ ♆ 2° 18′ S.	04 12	41023
		18		☿ Greatest elongation E., 25° 02′.		
Tue.	14	1	10	● New Moon		40213
		21	19	☌♀☾ ♀ 1° 21′ S.		
Wed.	15	22	53	☌☿☾ ☿ 3° 57′ S.		42103
Thu.	16	23	41	☌♃☾ ♃ 1° 10′ N.	01 01	4301*
Fri.	17			....		34102
Sat.	18	13		☿ Greatest Hel. Lat. S.	21 50	d3204
Sun.	19			....		2014*
Mon.	20			....		10234
Tue.	21	20	11	☽ First Quarter	18 39	02134
		22		Moon in Apogee. Dist. from ⊕, 251,200 mi....		
Wed.	22			Orionid meteors		21034
Thu.	23			....		32014
Fri.	24			....	15 27	31024
Sat.	25	17		☿ Stationary in R.A.		32014
Sun.	26			....		2340*
Mon.	27			....	12 16	41023
Tue.	28			....		40123
Wed.	29	5		☌☿♀ ☿ 2° 42′ S.		42103
		15	07	○ Full Moon		
Thu.	30			....	09 05	42301
Fri.	31			....		43102

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

THE SKY FOR NOVEMBER, 1947

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 21m to 16h 25m and its Decl. changes from 14° 05′ S. to 21° 38′ S. The equation of time changes from + 16m 20s to a maximum of + 16m 24s on the 4th and then to + 11m 21s at the end of the month. A partial eclipse of the sun will be visible in Western Canada on the 12th (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 16m, Decl. 11° 22′ S. and transits at 10.40. Inferior conjunction is on the 5th and thereafter the planet becomes a morning star and rapidly assumes a favourable position. By the 22nd it is at greatest western elongation and stands about 19° above the south-eastern horizon at sunrise with magnitude − 0.3. At sunrise on the 11th Mercury will be seen a few degrees below the moon.

Venus on the 15th is in R.A. 16h 35m, Decl. 22° 33′ S. and transits at 13.03 It is an evening star but not too easily seen until the end of the month when it is about 10° above the south-western horizon at sunset. On the evening of the 9th and thereabouts Venus and Jupiter may be seen in the very early evening close together low in the south-west.

Mars on the 15th is in R.A. 09h 45m, Decl. 15° 32′ N. and transits at 06.11. It rises about midnight and during the month makes an interesting and close configuration with Saturn and Regulus. At first they are lined up with about equal spacing: Mars, Saturn, Regulus (from west to east), Saturn brightest, Mars reddest, Regulus faintest. By the 11th Mars has approached Saturn and passes within a degree north of it; by the 28th it has approached Regulus and passes within 2° north of it.

Jupiter on the 15th is in R.A. 16h 11m, Decl. 20° 30′ S. and transits at 12.36. It is almost too low in the south-west at sunset to be glimpsed, especially later in the month. It approaches very close to Venus on the 9th. 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. 09h 40m, Decl. 15° 00′ N. and transits at 06.05. It rises just before midnight and is visible all night. See the note on Mars.

Uranus on the 15th is in R.A. 05h 40m, Decl. 23° 30′ N. and transits at 02.06.

Neptune on the 15th is in R.A. 12h 46m, Decl. 03° 22′ S. and transits at 09.11.

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

NOVEMBER

75th Meridian Civil Time

d	h	m		Min. of Algol h m	Config. of Jupiter's Sat. 17h 15m
Sat. 1			....		d4301
Sun. 2	3		♀ in ☋	05 54	42310
	5	33	☌ ♅ ☾ ♅ 2° 42′ S.		
Mon. 3	9		Moon in Perigee. Dist. from ⊕, 229,400 mi....		d4023
Tue. 4			....		01423
Wed. 5	12	03	☾ Last Quarter	02 43	21034
	18		☌ ☿ ☉ Inferior		
	21	37	☌ ♂ ☾ ♂ 3° 44′ S.		
Thu. 6	1	40	☌ ♄ ☾ ♄ 4° 34′ S.		20314
	14		☿ in ☊		
Fri. 7			....	23 32	31024
Sat. 8			....		30214
Sun. 9	9		☌ ♀ ♃ ♀ 0° 56′ S.		23104
	16	58	☌ ♆ ☾ ♆ 2° 15′ S.		
Mon. 10			Taurid meteors	20 20	
Tue. 11	5		☿ in Perihelion		
	13		☌ ♂ ♄ ♂ 0° 55′ N.		
	14	46	☌ ☿ ☾ ☿ 0° 02′ S.		
Wed. 12			Annular eclipse of ☉, see p. 29		
	15	01	● New Moon		
Thu. 13	19	39	☌ ♃ ☾ ♃ 1° 41′ N.	17 09	
Fri. 14	5	25	☌ ♀ ☾ ♀ 1° 00′ N.		
	13		☿ Stationary in R.A.		
Sat. 15	9		□ ♄ ☉		
Sun. 16			Leonid meteors	13 58	
Mon. 17	14		□ ♂ ☉		
Tue. 18	18		Moon in Apogee. Dist. from ⊕, 251,500 mi....		
Wed. 19			....	10 47	
Thu. 20	16	44	☽ First Quarter		
Fri. 21	11		☿ Greatest Hel. Lat. N.		
Sat. 22	6		☿ Greatest elongation W., 19° 44′	07 36	
Sun. 23			....		
Mon. 24			....		
Tue. 25			....	04 25	
Wed. 26			....		
Thu. 27			....		
Fri. 28	3	45	○ Full Moon	01 14	
Sat. 29	12	16	☌ ♅ ☾ ♅ 2° 37′ S.		
Sun. 30	13		Moon in Perigee. Dist. from ⊕, 226,100 mi....	22 03	

Explanation of symbols and abbreviations on p. 4, of time on p. 8. Jupiter being near the sun, phenomena of the satellites are not given from November 10 to December 31.

THE SKY FOR DECEMBER, 1947

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 25m to 18h 41m and its Decl. changes from 21° 38′ S. to 23° 27′ S. at the solstice on the 22nd and then to 23° 07′ S. at the end of the month. The equation of time changes from + 11m 21s to zero on the 25th and then to − 3m 00s 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. 16h 39m, Decl. 22° 08′ S. and transits at 11.10. For the first few days of the month it can be seen low in the south-eastern sky just before sunrise, then it approaches the sun too close for observation.

Venus on the 15th is in R.A. 19h 18m, Decl. 23° 48′ S. and transits at 13.48. It is an evening star, appearing low in the south-west at sunset. It has a fairly close conjunction with the moon on the 14th.

Mars on the 15th is in R.A. 10h 28m, Decl. 12° 32′ N. and transits at 04.56. It rises somewhat before midnight and can be located just a few degrees east of Regulus. It has now brightened considerably and is zero magnitude at the end of the month, now surpassing Saturn which is a few degrees west of Regulus.

Jupiter on the 15th is in R.A. 16h 40m, Decl. 21° 36′ S. and transits at 11.07. It is too close to the sun (conjunction is on the 1st) to be seen. 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. 09h 41m, Decl. 15° 01′ N. and transits at 04.08. It rises somewhat before midnight and is a few degrees west of Regulus, Mars being about an equal distance east of Regulus at mid-month. At the beginning of the month Saturn and Mars are about equal brightness but Mars is brightening faster and outshines Saturn by about half a magnitude at the end of the month.

Uranus on the 15th is in R.A. 05h 35m, Decl. 23° 28′ N. and transits at 00.03 and at 23.59.

Neptune on the 15th is in R.A. 12h 49m, Decl. 03° 38′ S. and transits at 07.16.

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

DECEMBER

75th Meridian Civil Time

d	h	m		Min. of Algol h m
Mon. 1	5		☌♃☉	
Tue. 2			. . . .	
Wed. 3	8	36	☌♄☾ ♄ 4° 28′ S.	18 52
	23	09	☌♂☾ ♂ 3° 01′ S.	
Thu. 4	19	55	☾ Last Quarter	
	22		♄ Stationary in R.A.	
Fri. 5			. . . .	
Sat. 6	12		♀ in Aphelion	15 41
Sun. 7	0	08	☌♆☾ ♆ 2° 09′ S.	
Mon. 8			. . . .	
Tue. 9			. . . .	12 30
Wed. 10			. . . .	
Thu. 11	5	48	☌☿☾ ☿ 1° 38′ N.	
	15	02	☌♃☾ ♃ 2° 10′ N.	
Fri. 12			Geminid meteors	09 19
	7	53	● New Moon	
Sat. 13			. . . .	
Sun. 14	14	34	☌♀☾ ♀ 2° 42′ N.	
	21		☌☿♃ ☿ 0° 34′ S.	
	22		☿ in ☊	
Mon. 15			. . . .	06 09
Tue. 16	13		Moon in Apogee. Dist. from ⊕, 252,200 mi. . . .	
	17		☍♅☉ Dist. from ⊕, 1681,000,000 mi. . .	
Wed. 17			. . . .	
Thu. 18			. . . .	02 58
Fri. 19			. . . .	
Sat. 20	12	43	☽ First Quarter	23 47
Sun. 21			. . . .	
Mon. 22	11	43	☉ enters ♑, Winter commences. Long. of ☉, 270°	
Tue. 23			. . . .	20 36
Wed. 24			. . . .	
Thu. 25	4		☿ in Aphelion	
Fri. 26	21	07	☌♅☾ ♅ 2° 31′ S.	17 25
Sat. 27	15	27	○ Full Moon	
Sun. 28	18		Moon in Perigee. Dist. from ⊕, 223,000 mi. . . .	
	23		♀ Greatest Hel. Lat. S.	
Mon. 29			. . . .	14 14
Tue. 30	15	38	☌♄☾ ♄ 4° 14′ S.	
Wed. 31	17	34	☌♂☾ ♂ 1° 47′S.	

Explanation of symbols and abbreviations on p. 4, of time on p. 8.
Jupiter being near the sun, phenomena of the satellites are not given from November 10 to December 31.

PHENOMENA OF JUPITER'S SATELLITES, 1947

By Charles E. Apgar, Westfield, New Jersey

JANUARY

d	h	m	Sat.	Phen.
3	06	25	I	SI
4	06	53	I	OR
5	04	00	I	Te
6	06	56	III	ED
7	05	32	II	SI
9	04	15	II	OR
11	05	38	I	ED
12	03	49	I	TI
12	04	55	I	Se
12	05	58	I	Te
17	05	21	III	TI
19	04	40	I	SI
	05	46	I	TI
	06	49	I	Se
20	05	17	I	OR
23	04	48	II	ED
24	04	50	III	SI
	06	50	III	Se
25	04	46	II	Te
26	06	33	I	SI
27	03	53	I	ED
28	03	10	I	Se
	04	20	I	Te

FEBRUARY

d	h	m	Sat.	Phen.
1	02	32	II	SI
	04	56	II	TI
	05	03	II	Se
3	05	46	I	ED
4	02	55	I	SI
	03	45	III	OD
	04	07	I	TI
	05	03	I	Se
	05	39	III	OR
	06	15	I	Te
5	03	36	I	OR
8	05	06	II	SI
10	04	16	II	OR
11	02	42	III	ED
	04	44	III	ER
	04	48	I	SI
	06	02	I	TI
12	02	07	I	ED
	05	30	I	OR
13	02	38	I	Te
17	01	49	II	ED
19	01	51	II	Te
	09	00	I	ED
20	02	23	I	TI
	03	18	I	Se
	04	32	I	Te
21	01	52	I	OR
22	01	45	III	TI
	03	32	III	Te
24	04	24	II	ED
26	01	57	II	TI
	02	00	II	Se
	04	22	II	Te
	05	53	I	ED
27	03	03	I	SI
	04	16	I	TI
	05	12	I	Se
28	03	43	I	OR

MARCH

d	h	m	Sat.	Phen.
1	00	52	I	Te
	02	37	III	Se
	05	39	III	TI

March—cont'd

d	h	m	Sat.	Phen.
5	02	03	II	SI
	04	26	II	TI
	04	33	II	Se
6	04	56	I	SI
7	01	12	II	OR
	02	14	I	ED
	05	34	I	OR
8	00	35	I	TI
	01	33	I	Se
	02	43	I	Te
	04	35	III	SI
12	01	03	III	OR
	04	36	II	SI
14	03	41	II	OR
	04	07	I	ED
15	01	18	I	SI
	02	25	I	TI
	03	27	I	Se
	04	33	I	Te
16	01	51	I	OR
19	00	30	III	ER
	03	00	III	OD
	04	43	III	OR
21	01	28	II	ED
22	03	11	I	SI
	04	14	I	TI
	05	20	I	Se
23	00	28	I	ED
	00	55	II	Te
	03	39	I	OR
	23	49	I	Se
24	00	49	I	Te
26	02	25	III	ED
	04	28	III	ER
28	04	04	II	ED
29	05	04	I	SI
	22	59	II	SI
30	00	52	II	TI
	01	29	II	Se
	02	22	I	ED
	03	16	II	Te
	05	26	I	OR
	23	33	I	SI
31	00	29	I	TI
	01	42	I	Se
	02	37	I	Te
	23	53	I	OR

APRIL

d	h	m	Sat.	Phen.
5	22	25	III	Se
	23	56	III	TI
6	01	32	II	SI
	01	34	III	Te
	03	12	II	TI
	04	02	II	Se
	04	15	I	ED
7	01	27	I	SI
	02	16	I	TI
	03	36	I	Se
	04	24	I	Te
	22	43	I	ED
8	00	05	II	OR
	01	39	I	OR
	22	50	I	Te
13	00	22	III	SI
	02	23	III	Se
	03	23	III	TI
	04	05	II	SI
	05	00	III	Te

April—cont'd

d	h	m	Sat.	Phen.
14	03	20	I	SI
	04	01	I	TI
	22	34	II	ED
15	00	36	I	ED
	02	25	II	OR
	03	24	I	OR
	21	49	I	SI
	22	28	I	TI
	23	59	I	Se
16	00	36	I	Te
	21	50	I	OR
20	04	20	III	SI
22	01	10	II	ED
	02	29	I	ED
	04	43	II	OR
	23	42	I	SI
23	00	13	I	TI
	01	53	I	Se
	02	21	I	Te
	22	01	III	OR
	22	25	II	Se
	23	18	II	Te
	23	35	I	OR
29	03	47	II	ED
	04	23	I	ED
30	01	36	I	SI
	01	57	I	TI
	03	47	I	Se
	04	06	I	Te
	22	12	III	ED
	22	28	II	SI
	22	51	I	ED
	23	07	II	TI

MAY

d	h	m	Sat.	Phen.
1	00	58	II	Se
	01	19	I	OR
	01	20	III	OR
	01	32	II	Te
	22	15	I	Se
	22	32	I	Te
7	03	31	I	SI
	03	41	I	TI
8	00	45	I	ED
	01	02	II	SI
	01	21	II	TI
	02	10	III	ED
	03	02	I	OR
	03	32	II	Se
	03	46	II	Te
	21	59	I	SI
	22	07	I	TI
9	00	09	I	Se
	00	16	I	Te
	21	28	I	OR
	22	24	II	OR
15	02	38	I	OD
	03	34	II	TI
	03	35	II	SI
	23	51	I	TI
	23	54	I	SI
16	02	00	I	Te
	02	04	I	Se
	21	04	I	OD
	22	12	II	OD
	23	16	I	ER
17	00	50	II	ER
	20	26	I	Te
	20	32	I	Se

May—cont'd

d	h	m	Sat.	Phen.
18	19	55	III	TI
	20	11	III	SI
	21	36	III	Te
	22	15	III	Se
23	01	36	I	TI
	01	48	I	SI
	03	45	I	Te
	22	47	I	OD
24	00	27	II	OD
	01	10	I	ER
	03	27	II	ER
	20	02	I	TI
	20	17	I	SI
	22	11	I	Te
	22	27	I	Se
25	21	21	II	Te
	21	56	II	Se
	23	11	III	TI
26	00	10	III	SI
	00	55	III	Te
	02	15	III	Se
30	03	20	I	TI
31	00	31	I	OD
	02	44	II	OD
	03	04	I	ER
	21	46	I	TI
	22	11	I	SI
	23	56	I	Te

JUNE

d	h	m	Sat.	Phen.
1	00	22	I	Se
	21	09	II	TI
	21	33	I	ER
	22	00	II	SI
	23	36	II	Te
2	00	30	II	Se
	02	29	III	TI
5	20	09	III	ER
7	02	16	I	OD
	23	32	I	TI
8	00	06	I	SI
	01	41	I	Te
	02	16	I	Se
	20	42	I	OD
	23	25	II	TI
	23	27	I	ER
9	00	34	II	SI
	01	52	II	Te
	20	08	I	Te
10	22	00	II	ER
12	21	16	III	OR
	22	01	III	ED
13	00	07	III	ER
15	01	18	I	TI
	02	01	I	SI
	22	28	I	OD
16	01	21	I	ER
	01	42	II	TI
	20	30	I	SI
	21	54	I	Te
	22	40	I	Se
17	20	31	II	OD
18	00	37	II	ER
19	22	48	III	OD
20	00	44	III	OR
23	00	15	I	OD
	21	32	I	TI
	22	25	I	SI
	23	42	I	Te

June—cont'd

d	h	m	Sat.	Phen.
24	00	34	I	Se
	21	44	I	ER
	22	52	II	OD
26	21	30	II	Se
30	22	10	III	Se
	23	21	I	TI

JULY

d	h	m	Sat.	Phen
1	00	20	I	SI
	20	30	I	OD
	23	39	I	ER
2	20	58	I	Se
3	21	35	II	SI
	22	03	II	Te
4	00	05	II	Se
7	21	46	III	Te
8	00	03	III	SI
	22	19	I	OD
9	20	43	I	SI
	21	47	I	Te
	22	53	I	Se
10	21	58	II	TI
11	00	10	II	SI

July—cont'd

d	h	m	Sat.	Phen.
11	00	28	II	Te
12	21	46	II	ER
14	23	23	III	TI
16	00	09	I	OD
	21	29	I	TI
	22	39	I	SI
	23	38	I	Te
17	21	57	I	ER
18	20	05	III	ER
23	23	21	I	TI
24	20	28	I	OD
25	19	58	I	Te
	21	12	I	Se
	21	54	III	ED
26	21	56	II	OD
28	21	08	II	Se
31	22	21	I	OD

AUGUST

d	h	m	Sat.	Phen.
1	20	43	III	OD
	20	58	I	SI
	21	52	I	Te
	22	56	III	OR

August—cont'd

d	h	m	Sat.	Phen.
2	20	16	I	ER
4	21	13	II	Te
	21	15	II	SI
8	21	36	I	TI
9	22	11	I	ER
11	21	17	II	TI
12	19	59	III	SI
	22	08	III	Se
13	21	31	II	ER
16	20	38	I	OD
17	20	10	I	Te
	21	26	I	Se
19	21	03	III	Te
24	19	57	I	TI
	21	12	I	SI
25	20	30	I	ER
29	20	50	II	Se
30	20	03	III	ER

SEPTEMBER

d	h	m	Sat.	Phen.
2	19	44	I	Se
6	19	18	III	OR
9	19	30	I	SI

September—cont'd

d	h	m	Sat.	Phen.
9	20	31	I	Te
21	19	09	II	OD
24	19	26	I	OD
25	18	59	I	Te
30	18	42	II	Te

OCTOBER

d	h	m	Sat.	Phen.
2	18	48	I	TI
3	19	03	I	ER
7	18	56	II	TI
9	18	15	II	ER
11	18	16	I	Se
18	18	01	I	SI

NOVEMBER

d	h	m	Sat.	Phen.
1	17	50	II	SI

Jupiter being near the Sun, phenomena of the Satellites are not given from November 10 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 1947 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 disc reckoned from the north point towards the east.

LUNAR OCCULTATIONS VISIBLE AT TORONTO AND MONTREAL, 1947

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			°	h m			°
Jan. 16	JUPITER	−1.4	I	24.0	07 50.5	−2.9	+0.7	73	08 10.2	.....	.....	56
16	JUPITER	−1.4	E	24.0	08 53.1	−1.0	−2.2	344	08 53.1	.....	.....	357
Feb. 2	ε Gem	3.2	I	11.8	23 30.8	−1.5	−1.4	111	23 36.8	−1.3	−1.2	101
3	ε Gem	3.2	E	11.8	00 40.3	−1.4	−0.5	258	00 46.0	−1.1	−1.1	269
3	κ Gem	3.7	I	12.7	20 20.8	−1.3	+0.4	108	20 29.7	−1.4	+0.4	104
7	ν Vir	4.2	I	16.9	23 25.6	−1.0	+0.6	109	23 33.5	−1.2	+0.9	98
8	ν Vir	4.2	E	16.9	00 35.2	−1.1	−0.6	312	00 39.8	−1.0	−1.1	325
Sep. 27	τ Aqr	4.2	I	13.2	18 54.2	−0.9	+2.5	24	19 04.1	−0.9	+2.3	22
Oct. 4	τ Tau	4.3	I	20.4	Low	.....	.....	...	21 13.5	+0.2	+1.3	82
4	τ Tau	4.3	E	20.4	22 03.9	+0.2	+1.6	242	22 05.9	+0.1	+1.7	239
10	η Leo	3.6	I	25.7	05 31.4	−1.0	+0.4	114	Sun	.....	.....	...
20	τ Sgr	3.4	E	6.6	Sun	.....	.....	...	17 04.0	−1.9	+0.9	222
31	κ Tau	4.4	I	17.9	20 56.0	0.0	+1.7	62	20 59.9	−0.2	+1.7	66
31	κ Tau	4.4	E	17.9	21 54.7	−0.5	+1.6	252	22 00.8	−0.6	+1.7	243
Dec. 25	κ Tau	4.4	I	13.4	16 53.4	+0.1	+1.7	59	16 56.2	0.0	+1.7	62
31	η Leo	3.6	I	18.8	00 37.4	−1.1	+0.7	103	00 46.0	−1.3	+1.0	93
31	η Leo	3.6	E	18.8	01 47.5	−1.4	−0.5	304	01 53.8	−1.3	−1.0	315

LUNAR OCCULTATIONS VISIBLE AT VANCOUVER AND CALGARY, 1947

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			°	h m			°
Jan. 16	JUPITER	−1.4	I	24.0	Low	.....	.....	...	04 57.6	−0.7	+0.9	110
16	JUPITER	−1.4	E	24.0	05 01.9	−0.9	+0.7	293	06 11.0	−0.9	+0.2	308
Feb. 2	ε Gem	3.2	I	11.8	19 23.6	−1.0	+1.3	81	20 35.3	−1.2	+1.0	83
2	ε Gem	3.2	E	11.8	20 33.0	−1.4	+0.7	269	21 46.4	−1.4	+0.3	270
3	κ Gem	3.7	I	12.7	17 09.7	+0.4	+2.2	47	18 10.6	+0.1	+2.2	55
7	ν Vir	4.2	E	16.9	Low	.....	.....	...	22 08.7	−0.3	−0.1	321
Mar. 3	κ Gem	3.7	I	10.4	03 57.4	.....	.....	29	No occn.	.....	.....	...
Apr. 1	η Leo	3.6	I	10.5	Sun	.....	.....	...	19 22.5	−1.3	+3.2	58
May 23	κ Gem	3.7	I	3.7	22 13.4	+0.6	−2.1	148	23 05.6	+0.5	−1.7	136
Aug. 4	τ Aqr	4.2	I	17.3	03 55.2	−1.5	−0.7	81	Sun	.....	.....	...
Oct. 10	η Leo	3.6	I	25.7	Low	.....	.....	...	03 25.8	+0.1	+2.0	74
10	η Leo	3.6	E	25.7	03 09.9	−0.3	0.0	321	04 13.7	−0.5	0.0	319
31	κ Tau	4.4	E	17.9	Low	.....	.....	...	19 52.1	−0.2	+0.9	305
Dec. 18	τ Aqr	4.2	I	6.6	18 12.9	−1.3	+0.2	59	19 24.4	−1.3	−0.5	70
30	η Leo	3.6	I	18.8	21 27.8	+0.3	+2.3	62	22 29.4	+0.1	+2.4	64
30	η Leo	3.6	E	18.8	22 07.5	−0.5	−0.5	331	23 11.9	−0.6	−0.6	331

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.

Continued on page 80.

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	$10^h 15^m$±	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

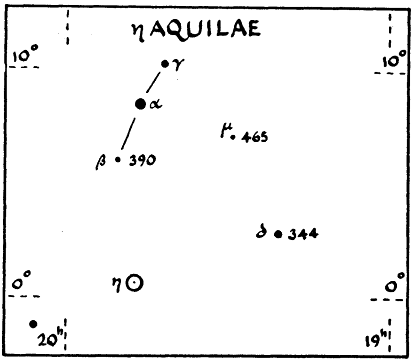
*As seen from the sun.

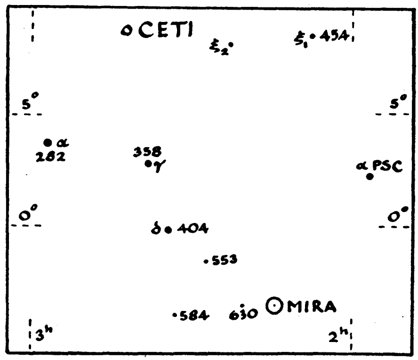
Satellites Io, Europa, Ganymede, Callisto are usually denoted I, II, III, IV, respectively, in order of distance from the planet.

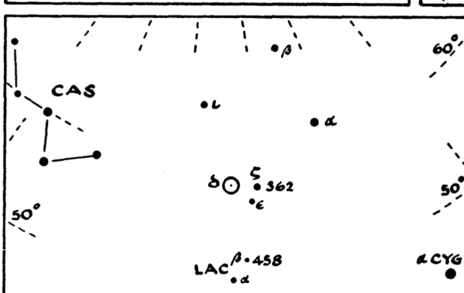
VARIABLE STARS

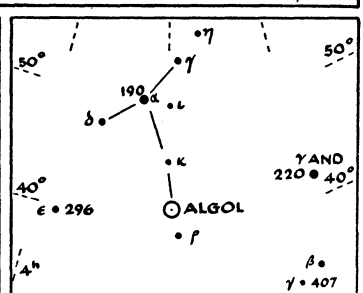
Much pleasure may be derived from the estimation of the brightness of variable stars. Maps of the fields of four bright variable stars are given below. In each case the magnitudes of several suitable comparison stars are given. These magnitudes are given as magnitudes, tenths and hundredths, with the 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.









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*03*	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*05*	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 (222557) 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

By Frank S. Hogg

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	δ	Mag. and Spect.	d	D	Remarks
	h m	° ′		″	L.Y.	
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.

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†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 46.9 m; Dec. + 89° 01′ (1947)

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^2 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 Hyda.......	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
μ¹ 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
‖α¹ 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
ι¹ 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*
||β¹ 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.[illegible]*
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		h Per	02 15.5	+56 55	Op	30	7			4,300
884		χ Per	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		ω Cen	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.

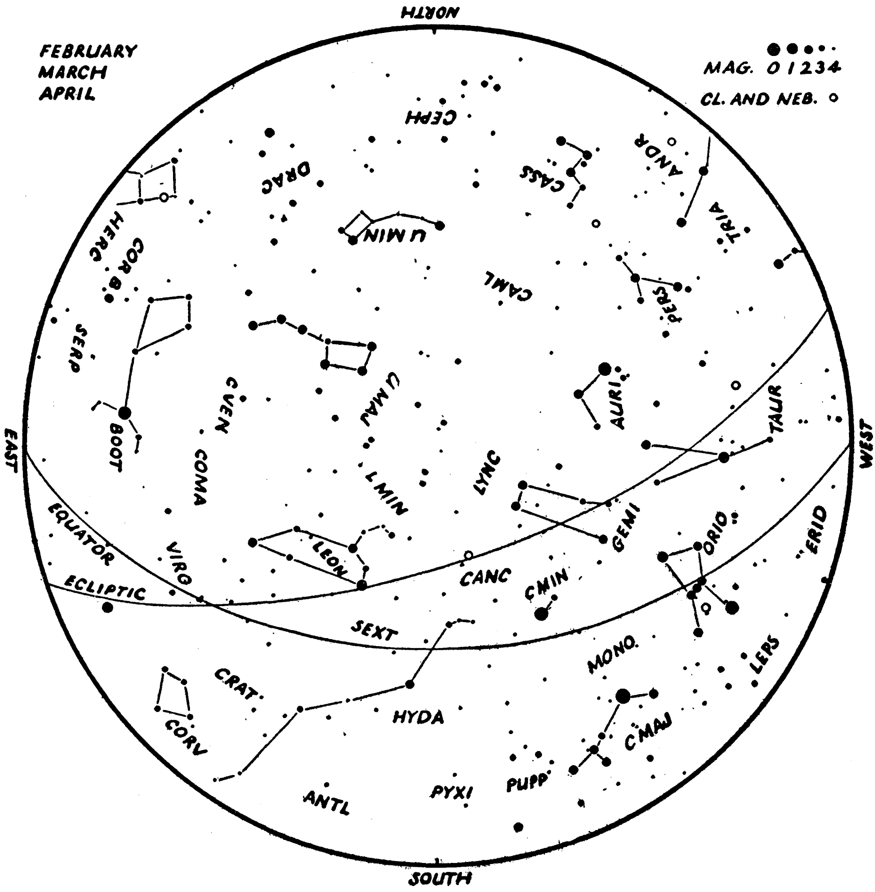
N.G.C.	M	Con	α 1950 h m	δ ° ′	Cl	Size ′	m n	m *	Dist. l.y.	Name
650	76	Per	01 38.3	+51 20	Pl	1.5	11	17	15,000	
1952	1	Tau	05 31.5	+21 59	Pl	6	11	16	10,000	Crab
1976	42	Ori	05 32.5	−05 25	Dif	30			1,800	Orion
B33		Ori	05 38.0	−02 29	Drk	4			300	Horsehead
2261		Mon	06 36.4	+08 47	Dif	2				Hubble's var
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

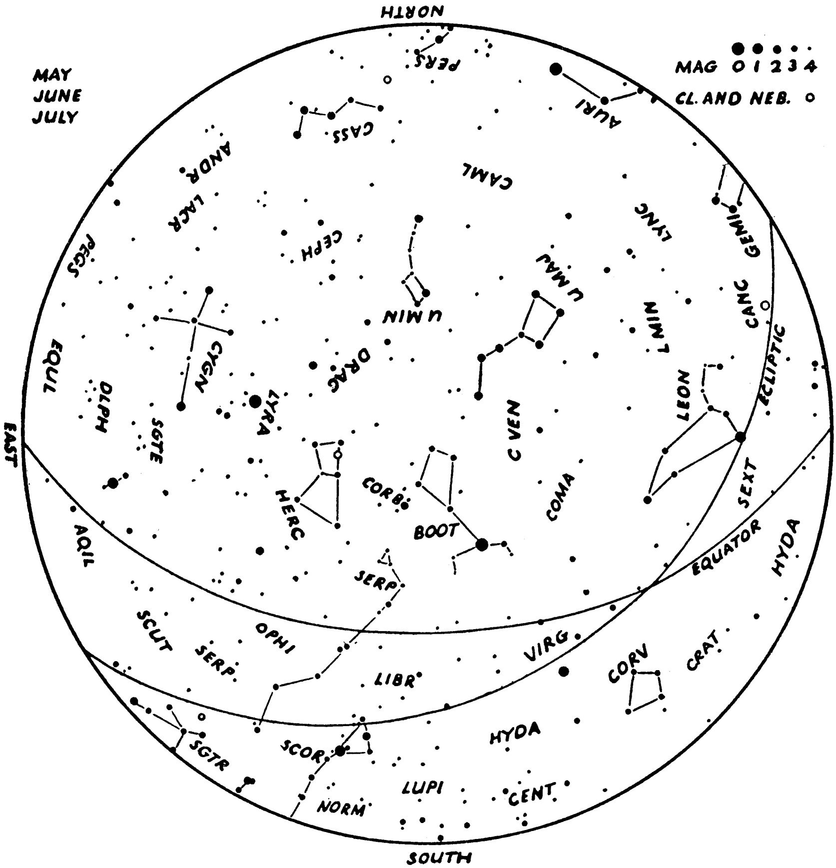


The above map represents the evening sky at

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.

STAR MAP 2

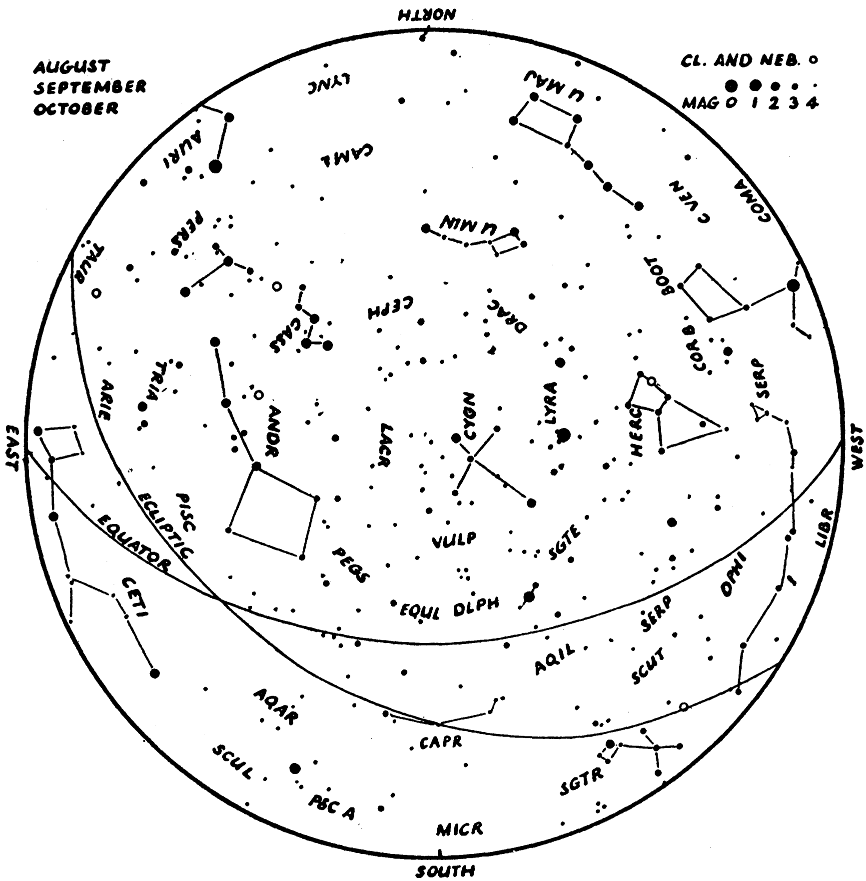


The above map represents the evening sky at

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

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

STAR MAP 3

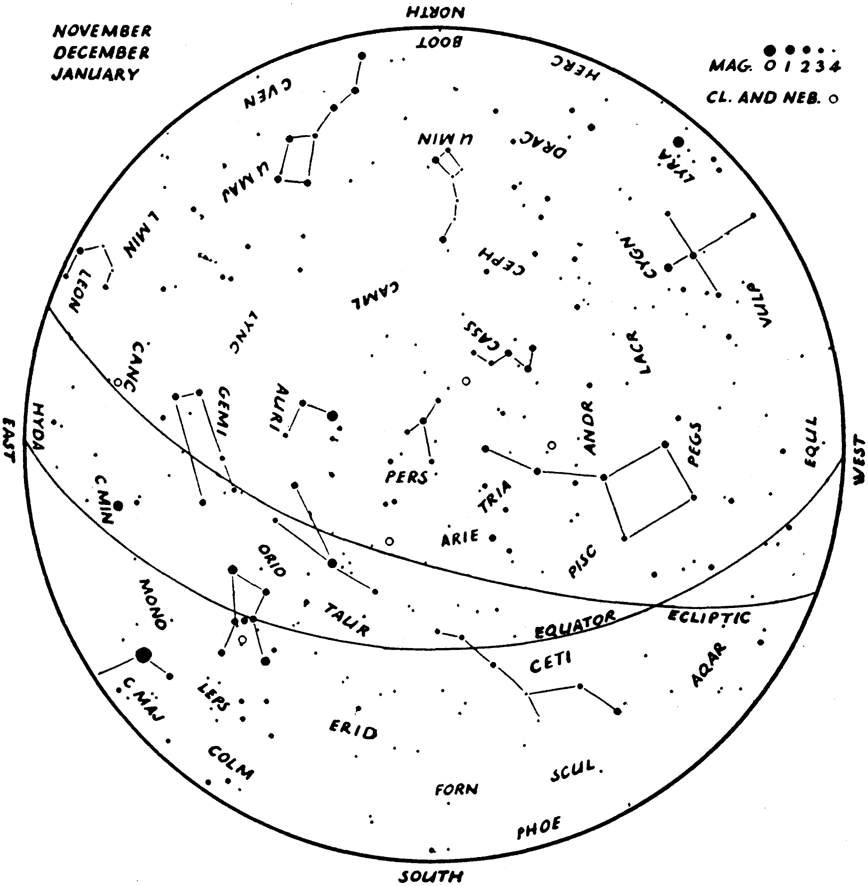


The above map represents the evening sky at

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

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

STAR MAP 4



The above map represents the evening sky at

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

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

CHIEF STARS USED IN AERIAL NAVIGATION

No.	Name	Pronunciation	Constell. Name	Mag.	R.A. 1950 h m	Dec. ° ′	SHA 1946 ° ′
1	Achernar	ā′ker-när	α Erid	0.6	01 36	S 57 29	336 05
2	Acrux	ă′krŭks	α Cruc	1.1	12 24	S 62 49	174 06
3	Aldebaran	ăl-dĕb′ä-răn	α Taur	1.1	04 33	N 16 25	291 48
4	Alpheratz	ăl-fē′răts	α Andr	2.2	00 06	N 28 49	358 36
5	Altair	ăl-tä′ĭr	α Aqil	0.9	19 48	N 08 44	62 58
6	Antares	ăn-ta′rēz	α Scor	1.2	16 26	S 26 20	113 29
7	Arcturus	ärk-tū′rŭs	α Boot	0.2	14 13	N 19 26	146 42
8	Betelgeuse	bĕt-ĕl-gûz′	α Orio	0.8*	05 52	N 07 24	271 56
9	Canopus	ka-nō′-pûs	α Cari	−0.9	06 23	S 52 40	264 19
10	Capella	kä-pĕl′ä	α Auri	0.2	05 13	N 45 57	281 50
11	Deneb	dĕn′ĕb	α Cygn	1.3	20 40	N 45 06	50 06
12	Dubhe	dōōb′hĕ	α U Maj	2.0	11 01	N 62 01	194 54
13	Fomalhaut	fō′măl-hôt	α Psc A	1.3	22 55	S 29 53	16 20
14	Peacock	pē′kŏk	α Pavo	2.1	20 22	S 56 54	54 39
15	Pollux	pŏl′ŭks	β Gemi	1.2	07 42	N 28 09	244 30
16	Procyon	prō′sĭ-ŏn	α C Min	0.5	07 37	N 05 21	245 53
17	Regulus	rĕg′ū-lūs	α Leon	1.3	10 06	N 12 13	208 38
18	Rigel	rī′gĕl, rī′jĕl	β Orio	0.3	05 12	S 08 15	282 01
19	Rigil Kent.	r. kĕn-tô′rŭs	α Cent	0.1	14 36	S 60 38	141 01
20	Sirius	sĭr′ĭ-ŭs	α C Maj	−1.6	06 43	S 16 38	259 18
21	Spica	spī′kä	α Virg	1.2	13 23	S 10 54	159 25
22	Vega	vē′gä	α Lyra	0.1	18 35	N 38 44	81 13
30	Denebola	dĕn-ĕb′ō-lä	β Leon	2.2	11 46	N 14 51	183 26
39	Benetnasch	bĕ-nĕt′nash	η U Maj	1.9	13 46	N 49 34	153 39
47	Polaris	pō-lā′rĭs	α U Min	2.3	01 49	N 89 02	333 26

*No. 8. Magnitude varies from 0.5 to 1.1

No. 47. Polaris: 194 position given on page 65.

Abbreviations: 1, Achar; 3, Aldeban; 4, Alphaz; 13, Fomalt; 19, Rikent; 39, Benesch.

Pronunciation Key

ā as in fate	ē as in we	ī as in ice	ō as in go	ū as in unite
ă " fat	ĕ " met	ĭ " ill	ŏ " odd	ŭ " up
ä " arm	ë " water	ōō " food	ô " orb	û " urn

Continued from page 57.

METEORS AND METEORITES

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.

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

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1890-1947

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