ASTRONOMICAL PHENOMENA

FOR THE YEAR

2019

Prepared Jointly by
The Nautical Almanac Office
United States Naval Observatory

and

Her Majesty's Nautical Almanac Office
United Kingdom Hydrographic Office

WASHINGTON
U.S. Government Publishing Office

2016

UNITED STATES

Printed in the United States of America
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For sale by the
U.S. Government Publishing Office
Superintendent of Documents
P. O. Box 979050
St. Louis, MO 63197-9000
phone: 1-202-512-1800
order online at https://bookstore.gpo.gov/

UNITED KINGDOM

Available from
HM Nautical Almanac Office
UK Hydrographic Office
Admiralty Way
Taunton
Somerset TA1 2DN
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PREDICTED PERIHELION PASSAGES OF COMETS, 2019

Periodic comet	Perihelion date T	Perihelion distance q(au)	Period P(yr)	Periodic comet	Perihelion date T	Perihelion distance q(au)	Period P(yr)
171P/Spahr	Jan. 13	1·77	6·7	78P/Gehrels	Apr. 2	2·01	7·2
131P/Mueller	Jan. 24	2·42	7·0	209P/LINEAR	June 12	0·97	5·1
123P/West-Hartley	Feb. 5	2·13	7·5	260P/McNaught	Sept. 9	1·42	6·8
29P/Schwassmann-Wachmann	Mar. 7	5·77	14·7	76P/West-Kohoutek-Ikemura	Oct. 26	1·60	6·4

The astronomical data in this booklet are expressed in the scale of universal time (UT); this is also known as Greenwich mean time (GMT) and is the standard time of the Greenwich meridian (0° of longitude). A time in UT may be converted to local mean time by the addition of east longitude (or subtraction of west longitude), where the longitude of the place is expressed in time-measure at the rate of 1 hour for every 15°. The differences between standard times and UT are indicated in the chart on page 22; local clock times may, however, differ from these standard times, especially in summer when clocks are often advanced by 1 hour.

PRINCIPAL PHENOMENA OF SUN AND MOON, 2019

THE SUN

		d	h			d	h	m			d	h	m
Perigee	... Jan.	3	05	Equinoxes	... Mar.	20	21	58	...	... Sept.	23	07	50
Apogee	... July	4	22	Solstices	... June	21	15	54	...	... Dec.	22	04	19

PHASES OF THE MOON

Lunation	New Moon	d	h	m	First Quarter	d	h	m	Full Moon	d	h	m	Last Quarter	d	h	m
1188	Jan.	6	01	28	Jan.	14	06	46	Jan.	21	05	16	Jan.	27	21	10
1189	Feb.	4	21	04	Feb.	12	22	26	Feb.	19	15	54	Feb.	26	11	28
1190	Mar.	6	16	04	Mar.	14	10	27	Mar.	21	01	43	Mar.	28	04	10
1191	Apr.	5	08	50	Apr.	12	19	06	Apr.	19	11	12	Apr.	26	22	18
1192	May	4	22	46	May	12	01	12	May	18	21	11	May	26	16	34
1193	June	3	10	02	June	10	05	59	June	17	08	31	June	25	09	46
1194	July	2	19	16	July	9	10	55	July	16	21	38	July	25	01	18
1195	Aug.	1	03	12	Aug.	7	17	31	Aug.	15	12	29	Aug.	23	14	56
1196	Aug.	30	10	37	Sept.	6	03	10	Sept.	14	04	33	Sept.	22	02	41
1197	Sept.	28	18	26	Oct.	5	16	47	Oct.	13	21	08	Oct.	21	12	39
1198	Oct.	28	03	38	Nov.	4	10	23	Nov.	12	13	34	Nov.	19	21	11
1199	Nov.	26	15	06	Dec.	4	06	58	Dec.	12	05	12	Dec.	19	04	57
1200	Dec.	26	05	13												

ECLIPSES AND TRANSIT OF MERCURY

A partial eclipse of the Sun	Jan. 5-6	North eastern China, Mongolia, Japan, eastern Russia, north Micronesia, westernmost Alaska
A total eclipse of the Moon	Jan. 21	Middle East, Africa, Europe, Americas, most of Oceania, easternmost Russia.
A total eclipse of the Sun	Jul. 2	Eastern Oceania, most of South America.
A partial eclipse of the Moon	Jul. 16-17	Australasia, Asia except north east, Africa, Europe except northernmost Scandinavia, most of South America
A transit of Mercury	Nov. 11	Middle East, most of Europe, Africa, southern Greenland, Antarctica, South America, North America (except Alaska), most of Oceania, New Zealand
An annular eclipse of the Sun	Dec. 26	Middle East, North Eastern Africa, Asia except North and Eastern Russia, North and Western Australia, Micronesia, Solomon Islands

For further details see pages 64–88

MOON AT PERIGEE

	d	h		d	h		d	h
Jan.	21	20	June	7	23	Oct.	26	11
Feb.	19	09	July	5	05	Nov.	23	08
Mar.	19	20	Aug.	2	07	Dec.	18	20
Apr.	16	22	Aug.	30	16			
May	13	22	Sept.	28	02			

MOON AT APOGEE

	d	h		d	h		d	h
Jan.	9	04	May	26	13	Oct.	10	18
Feb.	5	09	June	23	08	Nov.	7	09
Mar.	4	11	July	21	00	Dec.	5	04
Apr.	1	00	Aug.	17	11			
Apr.	28	18	Sept.	13	14			

OCCULTATIONS OF PLANETS AND BRIGHT STARS BY THE MOON

Date	d	h	Body	Areas of Visibility
Jan.	31	18	Venus	E. Micronesia, Polynesia (except Hawaii), Galapagos Is., S. Central America, N.W. S. America
Feb.	2	07	Saturn	N. and N.E. Africa, S. and central Europe, Middle East, W. Asia, parts of S. Russia
Feb.	2	20	Pluto	N. Micronesia, Hawaii, Aleutian Is., W. and central North America (except Alaska)
Feb.	6	08	Vesta	Parts of western Russia
Mar.	1	18	Saturn	Most of Micronesia, Northern Polynesia (except Hawaii), Central America, S. North America
Mar.	2	04	Pluto	N.E. Africa, S.W. Europe, Middle East, India, most of S. and E. Asia, most of China, most of Mongolia
Mar.	29	05	Saturn	E. edge of Brazil, southern Africa, Madagascar, S. tip of India, Sri Lanka
Mar.	29	12	Pluto	W. and S. Mexico, Central America, N. half of S. America, Madeira, Cape Verde Is., W. edge of Africa
Apr.	25	14	Saturn	E. Australia, New Zealand, W. South America
Apr.	25	20	Pluto	Sri Lanka, Indonesia, Australia, Melanesia, S.E. Micronesia, N.W. Polynesia
May	2	13	Vesta	Galapagos Is., N. South America, Azores, Cape Verde Is., N.W. Africa, S. Europe
May	19	18	Ceres	Parts of Antarctica
May	22	22	Saturn	S. tip of Africa, parts of E. Antarctica, Kerguelen Is., most of Australia, S. New Zealand
May	23	04	Pluto	Central South America, S. and E. Africa
May	30	22	Vesta	Parts of Indonesia, E. Asia, N.W. Micronesia, Aleutian Is., N.W. North America
June	15	15	Ceres	Central and E. Russia, N.E. Kazakhstan, N. and E. China, Japan
June	19	04	Saturn	Easter Island, S. South America, Antarctic Peninsula, southern Africa
June	19	11	Pluto	Melanesia, N.E. Australia, S. Micronesia, S. Polynesia, Central America, W. South America
July	4	06	Mars	E. tip of Africa, Arabian Peninsula, most of Asia, Micronesia
July	16	07	Saturn	E. Melanesia, S. Polynesia, Easter Island, central South America
July	16	17	Pluto	E. Africa, Madagascar, S. Indonesia, N. and W. Australia, W. Micronesia
Aug.	12	10	Saturn	E. Indonesia, most of Australia, N. New Zealand, Melanesia, Polynesia (except Hawaii)
Aug.	12	22	Pluto	N.E. South America, Ascension Island, central and E. Africa, S. Arabian Peninsula
Sept.	8	14	Saturn	E. Africa, Madagascar, S. Indonesia, W. and N. Australia, W. Micronesia, W. Melanesia
Sept.	9	03	Pluto	Polynesia (except Hawaii), Easter Island, Galapagos Is., N. South America
Oct.	5	21	Saturn	Easter Island, S. South America, South Georgia, Southern Africa

continued on page 14 . . .

GEOCENTRIC PHENOMENA

MERCURY

	d h	d h	d h
Superior conjunction ...	Jan. 30 03	May 21 13	Sept. 4 02
Greatest elongation East	Feb. 27 01 (18°)	June 23 23 (25°)	Oct. 20 04 (25°)
Stationary	Mar. 5 05	July 7 04	Oct. 31 20
Inferior conjunction ...	Mar. 15 02	July 21 13	Nov. 11 15
Stationary	Mar. 27 12	July 31 19	Nov. 20 15
Greatest elongation West	Apr. 11 20 (28°)	Aug. 9 23 (19°)	Nov. 28 11 (20°)

VENUS

	d h		d h
Greatest elongation West	Jan. 6 05 (47°)	Superior conjunction ...	Aug. 14 06

EARTH

	d h		d h m		d h m
Perihelion ...	Jan. 3 05	Equinoxes ...	Mar. 20 21 58	... ...	Sept. 23 07 50
Aphelion ...	July 4 22	Solstices ...	June 21 15 54	... ...	Dec. 22 04 19

SUPERIOR PLANETS

	Conjunction	Stationary	Opposition	Stationary
	d h	d h	d h	d h
Mars	Sept. 2 11	—	—	—
Jupiter	Dec. 27 18 |	Apr. 10 17	June 10 15	Aug. 11 16
Saturn	Jan. 2 06	Apr. 30 02	July 9 17	Sept. 18 06
Uranus	Apr. 22 23	Aug. 12 06	Oct. 28 08 |	Jan. 7 02
Neptune	Mar. 7 01	June 22 04	Sept. 10 07	Nov. 27 20

The vertical bars indicate where the dates for the planet are not in chronological order.

HELIOCENTRIC PHENOMENA

	Aphelion	Perihelion	Descending Node	Greatest Lat. South	Ascending Node	Greatest Lat. North
Mercury	Jan. 12	Feb. 25	Jan. 1	Feb. 1	Feb. 20	Mar. 7
	Apr. 10	May 24	Mar. 30	Apr. 30	May 19	June 3
	July 7	Aug. 20	June 26	July 27	Aug. 15	Aug. 30
	Oct. 3	Nov. 16	Sept. 22	Oct. 23	Nov. 11	Nov. 26
	Dec. 30	—	Dec. 19	—	—	—
Venus	Apr. 18	Aug. 8	Mar. 14	May 10	July 5	Jan. 17
	Nov. 28	—	Oct. 25	Dec. 20	—	Aug. 30
Mars	Aug. 26	—	—	—	Jan. 15	July 18

Jupiter, Saturn, Uranus, Neptune: None in 2019

VISIBILITY OF PLANETS

MERCURY can only be seen low in the east before sunrise, or low in the west after sunset (about the time of beginning or end of civil twilight). It is visible in the mornings between the following approximate dates: January 1 to January 15, March 22 to May 14, July 30 to August 26 and November 18 to December 25. The planet is brighter at the end of each period, (the best conditions in northern latitudes occur from late November to early December and in southern latitudes in mid-April). It is visible in the evenings between the following approximate dates: February 11 to March 8, May 29 to July 13, and September 15 to November 6. The planet is brighter at the beginning of each period, (the best conditions in northern latitudes occur in late February and in southern latitudes in mid-October). Mercury transits the Sun's disk on November 11 at 12h 35m to 18h 04m; the event is visible from westernmost Russia, Middle East, Europe, Africa, South America, North America except the extreme north, most of the Pacific Ocean and New Zealand.

VENUS is a brilliant object in the morning sky from the beginning of the year until the second week of July when it becomes too close to the Sun for observation. It reappears in the second half of September in the evening sky where it stays until the end of the year. Venus is in conjunction with Mercury on October 30, with Jupiter on January 22 and November 24 and with Saturn on February 18 and December 11.

MARS is visible as a reddish object in Pisces in the evening sky at the beginning of the year. Its eastward elongation decreases as it moves through Aries from mid-February, Taurus from late March (passing 7° N of Aldebaran on April 16), into Gemini from mid-May (passing 6° S of Pollux on June 23) and into Cancer in late June. It becomes too close to the Sun for observation in mid-July. It reappears in the morning sky during the third week of October in Virgo (passing 3° N of Spica on November 8) and then moves into Libra early in December, where it remains for the rest of the year. Mars is in conjunction with Mercury on June 18 and July 7.

JUPITER is visible in the morning sky in Ophiuchus at the beginning of the year. Its westward elongation increases and from mid-March it can be seen for more than half the night. It is at opposition on June 10 when it is visible throughout the night. By early September it can only be seen in the evening sky. It moves into Sagittarius in mid-November and from mid-December becomes too close to the Sun for observation. Jupiter is in conjunction with Venus on January 22 and November 24.

SATURN is too close to the Sun for observation from the beginning of the year until the third week of January when it rises just before sunrise in Sagittarius, in which constellation it remains throughout the year. Its westward elongation increases and in mid-April it becomes visible for more than half the night. It is at opposition on July 9 when it can be seen throughout the night. From early October until late December it can only be seen in the evening sky and then becomes too close to the Sun for observation for the remainder of the year. Saturn is in conjunction with Venus on February 18 and December 11.

URANUS is visible at the beginning of the year in Pisces and by mid-January can only be seen in the evening sky, moving into Aries in early February. In early April it becomes too close to the Sun for observation. It reappears in mid-May in the morning sky and is at opposition on October 28. Its eastward elongation then gradually decreases but can be seen for more than half the night for the remainder of the year.

NEPTUNE is visible at the beginning of the year in the evening sky in Aquarius and remains in this constellation throughout the year. In mid-February it becomes too close to the Sun for observation and reappears in late March in the morning sky. Neptune is at opposition on September 10 and from early December can only be seen in the evening sky.

DO NOT CONFUSE (1) Venus with Jupiter in late January and late November, with Saturn in mid-February and mid-December and with Mercury in mid-April, late September and late October to early November; on all occasions Venus is the brighter object. (2) Mercury with Mars from mid-June to mid-July when Mercury is the brighter object.

VISIBILITY OF PLANETS IN MORNING AND EVENING TWILIGHT

	Morning		Evening	
Venus	January 1	– July 8	September 20	– December 31
Mars			January 1	– July 18
	October 17	– December 31		
Jupiter	January 1	– June 10	June 10	– December 15
Saturn	January 19	– July 9	July 9	– December 27

VISIBILITY OF PLANETS

The planet diagram on page 9 shows, in graphical form for any date during the year, the local mean times of meridian passage of the Sun, of the five planets, Mercury, Venus, Mars, Jupiter and Saturn, and of every 2^h of right ascension. Intermediate lines, corresponding to particular stars, may be drawn in by the user if desired. The diagram is intended to provide a general picture of the availability of planets and stars for observation during the year.

On each side of the line marking the time of meridian passage of the Sun, a band 45^m wide is shaded to indicate that planets and most stars crossing the meridian within 45^m of the Sun are generally too close to the Sun for observation.

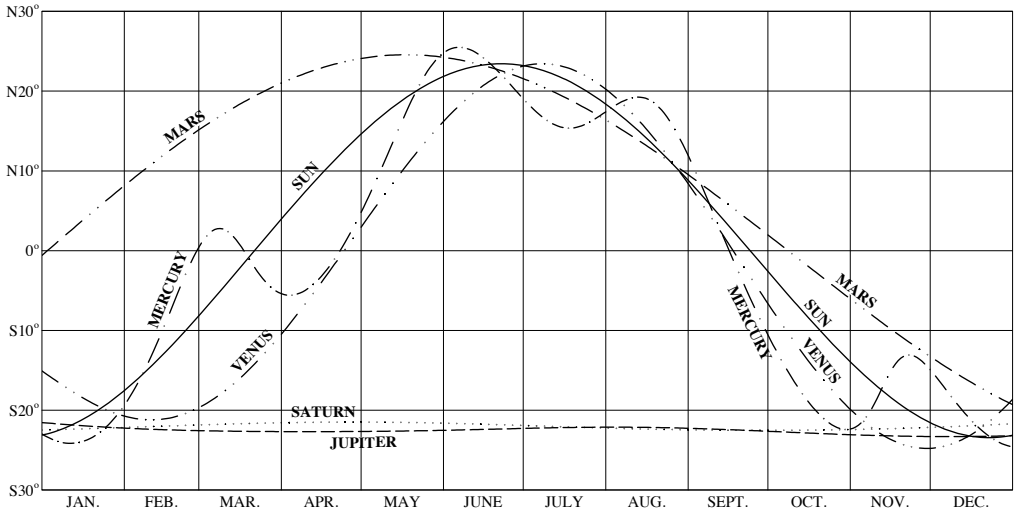
For any date the diagram provides immediately the local mean time of meridian passage of the Sun, planets and stars, and thus the following information:

a) whether a planet or star is too close to the Sun for observation;
b) visibility of a planet or star in the morning or evening;
c) location of a planet or star during twilight;
d) proximity of planets to stars or other planets.

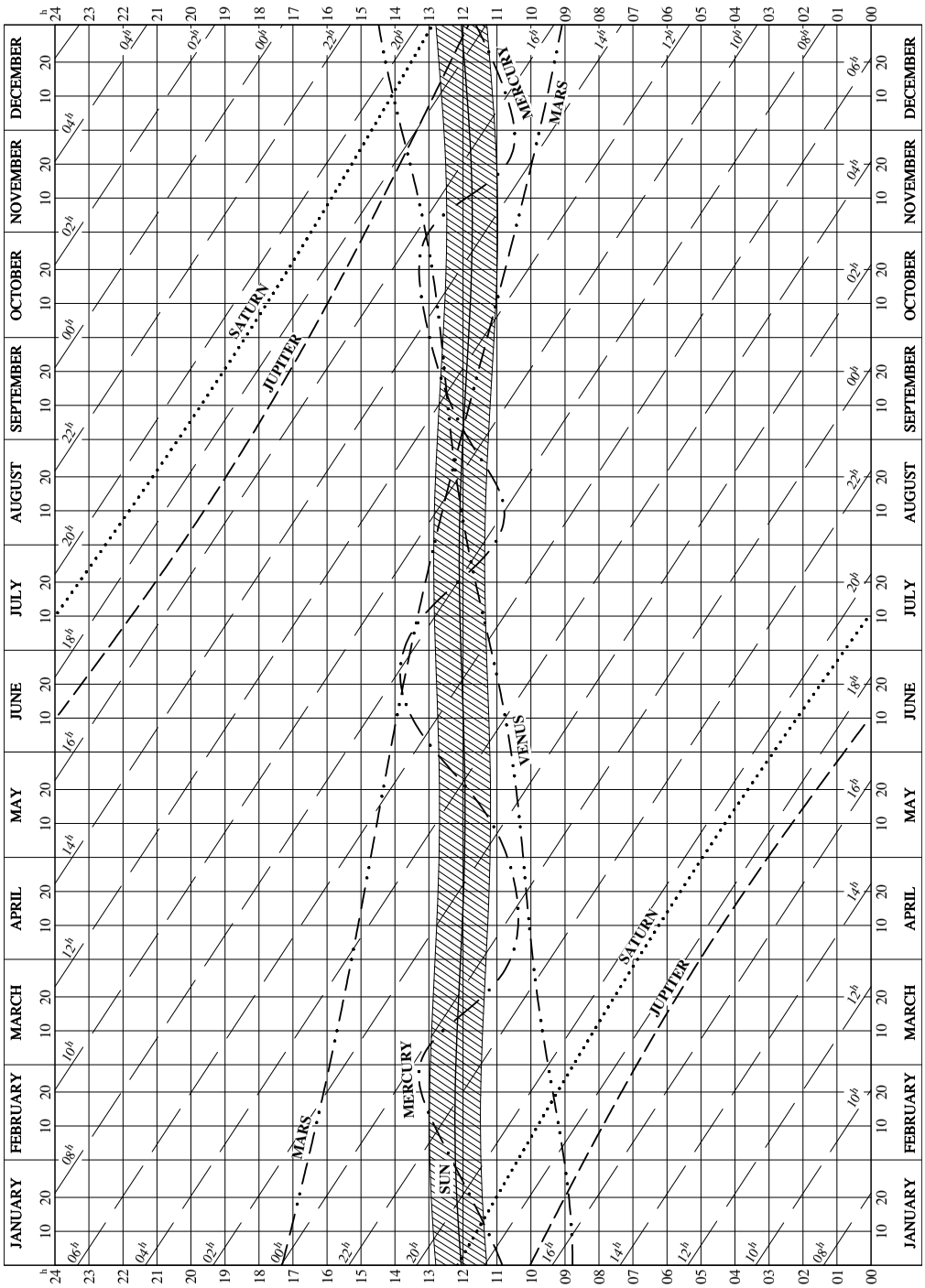
When the meridian passage of a body occurs at midnight, it is close to opposition to the Sun and is visible all night, and may be observed in both morning and evening twilights. As the time of meridian passage decreases, the body ceases to be observable in the morning, but its altitude above the eastern horizon during evening twilight gradually increases until it is on the meridian at evening twilight. From then onwards the body is observable above the western horizon, its altitude at evening twilight gradually decreasing, until it becomes too close to the Sun for observation. When it again becomes visible, it is seen in the morning twilight, low in the east. Its altitude at morning twilight gradually increases until meridian passage occurs at the time of morning twilight, then as the time of meridian passage decreases to 0^h, the body is observable in the west in the morning twilight with a gradually decreasing altitude, until it once again reaches opposition.

Notes on the visibility of the planets are given on page 7. Further information on the visibility of planets may be obtained from the diagram below which shows, in graphical form for any date during the year, the declinations of the bodies plotted on the planet diagram on page 9.

DECLINATION OF SUN AND PLANETS, 2019



LOCAL MEAN TIME OF MERIDIAN PASSAGE



ELONGATIONS AND MAGNITUDES OF PLANETS AT 0^h UT

Date	Mercury		Venus	
	Elong.	Mag.	Elong.	Mag.
	°		°	
Jan. −3	W. 18	−0·4	W. 47	−4·7
2	W. 16	−0·4	W. 47	−4·6
7	W. 14	−0·5	W. 47	−4·6
12	W. 11	−0·6	W. 47	−4·5
17	W. 8	−0·8	W. 47	−4·5
22	W. 6	−1·0	W. 46	−4·4
27	W. 3	−1·3	W. 46	−4·4
Feb. 1	E. 2	−1·5	W. 45	−4·3
6	E. 5	−1·4	W. 45	−4·3
11	E. 9	−1·2	W. 44	−4·2
16	E. 13	−1·1	W. 43	−4·2
21	E. 16	−1·0	W. 42	−4·2
26	E. 18	−0·6	W. 41	−4·1
Mar. 3	E. 17	+0·3	W. 41	−4·1
8	E. 13	+2·0	W. 40	−4·1
13	E. 5	+4·8	W. 39	−4·0
18	W. 6	+4·6	W. 38	−4·0
23	W. 15	+2·5	W. 37	−4·0
28	W. 21	+1·4	W. 36	−4·0
Apr. 2	W. 25	+0·7	W. 35	−3·9
7	W. 27	+0·4	W. 33	−3·9
12	W. 28	+0·2	W. 32	−3·9
17	W. 27	+0·1	W. 31	−3·9
22	W. 26	0·0	W. 30	−3·9
27	W. 23	−0·2	W. 29	−3·9
May 2	W. 20	−0·4	W. 28	−3·8
7	W. 16	−0·7	W. 26	−3·8
12	W. 11	−1·1	W. 25	−3·8
17	W. 5	−1·7	W. 24	−3·8
22	E. 1	−2·4	W. 23	−3·8
27	E. 7	−1·7	W. 21	−3·8
June 1	E. 12	−1·1	W. 20	−3·8
6	E. 17	−0·7	W. 19	−3·8
11	E. 21	−0·4	W. 17	−3·8
16	E. 24	−0·1	W. 16	−3·8
21	E. 25	+0·2	W. 15	−3·8
26	E. 25	+0·6	W. 13	−3·8
July 1	E. 24	+1·0	W. 12	−3·9

Date	Mercury		Venus	
	Elong.	Mag.	Elong.	Mag.
	°		°	
July 1	E. 24	+1·0	W. 12	−3·9
6	E. 21	+1·6	W. 11	−3·9
11	E. 16	+2·6	W. 9	−3·9
16	E. 10	+4·0	W. 8	−3·9
21	E. 5	+5·4	W. 7	−3·9
26	W. 9	+4·2	W. 5	−3·9
31	W. 14	+2·3	W. 4	−3·9
Aug. 5	W. 18	+0·9	W. 3	−4·0
10	W. 19	0·0	W. 2	−4·0
15	W. 18	−0·7	E. 1	·
20	W. 15	−1·1	E. 2	−4·0
25	W. 10	−1·4	E. 3	−4·0
30	W. 5	−1·7	E. 5	−3·9
Sept. 4	W. 2	−1·9	E. 6	−3·9
9	E. 5	−1·4	E. 7	−3·9
14	E. 9	−0·9	E. 8	−3·9
19	E. 12	−0·6	E. 10	−3·9
24	E. 15	−0·4	E. 11	−3·9
29	E. 18	−0·2	E. 12	−3·9
Oct. 4	E. 20	−0·2	E. 14	−3·9
9	E. 22	−0·1	E. 15	−3·9
14	E. 24	−0·1	E. 16	−3·8
19	E. 25	−0·1	E. 17	−3·8
24	E. 24	−0·1	E. 19	−3·8
29	E. 22	+0·1	E. 20	−3·8
Nov. 3	E. 17	+1·0	E. 21	−3·8
8	E. 8	+3·3	E. 22	−3·8
13	W. 3	·	E. 24	−3·8
18	W. 13	+1·3	E. 25	−3·9
23	W. 19	−0·1	E. 26	−3·9
28	W. 20	−0·6	E. 27	−3·9
Dec. 3	W. 19	−0·6	E. 28	−3·9
8	W. 18	−0·6	E. 29	−3·9
13	W. 15	−0·6	E. 30	−3·9
18	W. 13	−0·6	E. 31	−3·9
23	W. 10	−0·7	E. 33	−3·9
28	W. 8	−0·8	E. 34	−3·9
33	W. 5	−1·0	E. 35	−4·0

SELECTED DWARF AND MINOR PLANETS

	Conjunction	Stationary	Opposition	Stationary
Ceres	—	Apr. 8	May 28	July 19
Pallas	Dec. 3	Mar. 5	Apr. 10	June 3
Juno	Aug. 22	—	—	—
Vesta	Mar. 7	Sept. 25	Nov. 12	—
Pluto	Jan. 11	Apr. 25	July 14	Oct. 2

ELONGATIONS AND MAGNITUDES OF PLANETS AT 0^h UT

Date		Mars		Jupiter		Saturn		Uranus		Neptune	
		Elong.	Mag.	Elong.	Mag.	Elong.	Mag.	Elong.	Mag.	Elong.	Mag.
		°		°		°		°		°	
Jan.	**−3**	E. 81	+0·4	W. 25	−1·8	E. 5	+0·5	E. 112	+5·8	E. 68	+7·9
	7	E. 78	+0·5	W. 33	−1·8	W. 4	+0·5	E. 102	+5·8	E. 58	+7·9
	17	E. 74	+0·7	W. 42	−1·8	W. 13	+0·5	E. 92	+5·8	E. 48	+7·9
	27	E. 71	+0·8	W. 50	−1·9	W. 22	+0·6	E. 82	+5·8	E. 38	+7·9
Feb.	**6**	E. 67	+0·9	W. 58	−1·9	W. 31	+0·6	E. 72	+5·8	E. 28	+8·0
	16	E. 64	+1·0	W. 67	−2·0	W. 40	+0·6	E. 62	+5·8	E. 18	+8·0
	26	E. 61	+1·2	W. 76	−2·0	W. 50	+0·6	E. 53	+5·9	E. 9	+8·0
Mar.	**8**	E. 57	+1·2	W. 84	−2·1	W. 59	+0·6	E. 43	+5·9	W. 1	+8·0
	18	E. 54	+1·3	W. 94	−2·1	W. 68	+0·6	E. 33	+5·9	W. 11	+8·0
	28	E. 51	+1·4	W. 103	−2·2	W. 77	+0·6	E. 24	+5·9	W. 20	+8·0
Apr.	**7**	E. 48	+1·5	W. 113	−2·3	W. 87	+0·6	E. 15	+5·9	W. 30	+8·0
	17	E. 44	+1·6	W. 122	−2·4	W. 96	+0·5	E. 6	+5·9	W. 39	+7·9
	27	E. 41	+1·6	W. 133	−2·4	W. 106	+0·5	W. 4	+5·9	W. 49	+7·9
May	**7**	E. 38	+1·7	W. 143	−2·5	W. 116	+0·4	W. 13	+5·9	W. 58	+7·9
	17	E. 35	+1·7	W. 153	−2·5	W. 126	+0·4	W. 22	+5·9	W. 67	+7·9
	27	E. 32	+1·7	W. 164	−2·6	W. 135	+0·3	W. 31	+5·9	W. 77	+7·9
June	**6**	E. 28	+1·8	W. 175	−2·6	W. 146	+0·2	W. 40	+5·9	W. 86	+7·9
	16	E. 25	+1·8	E. 174	−2·6	W. 156	+0·2	W. 49	+5·9	W. 96	+7·9
	26	E. 22	+1·8	E. 163	−2·6	W. 166	+0·1	W. 58	+5·8	W. 105	+7·9
July	**6**	E. 19	+1·8	E. 153	−2·6	W. 176	+0·1	W. 68	+5·8	W. 115	+7·9
	16	E. 16	+1·8	E. 142	−2·5	E. 174	+0·1	W. 77	+5·8	W. 125	+7·8
	26	E. 13	+1·8	E. 132	−2·5	E. 163	+0·1	W. 86	+5·8	W. 134	+7·8
Aug.	**5**	E. 9	+1·8	E. 122	−2·4	E. 153	+0·2	W. 96	+5·8	W. 144	+7·8
	15	E. 6	+1·8	E. 113	−2·3	E. 143	+0·2	W. 105	+5·8	W. 154	+7·8
	25	E. 3	+1·8	E. 103	−2·3	E. 133	+0·3	W. 115	+5·7	W. 164	+7·8
Sept.	**4**	W. 1	+1·7	E. 94	−2·2	E. 123	+0·3	W. 125	+5·7	W. 174	+7·8
	14	W. 4	+1·8	E. 85	−2·1	E. 113	+0·4	W. 135	+5·7	E. 176	+7·8
	24	W. 7	+1·8	E. 77	−2·1	E. 103	+0·4	W. 145	+5·7	E. 166	+7·8
Oct.	**4**	W. 11	+1·8	E. 68	−2·0	E. 94	+0·5	W. 155	+5·7	E. 156	+7·8
	14	W. 14	+1·8	E. 60	−2·0	E. 84	+0·5	W. 165	+5·7	E. 146	+7·8
	24	W. 17	+1·8	E. 52	−1·9	E. 75	+0·5	W. 175	+5·7	E. 136	+7·8
Nov.	**3**	W. 21	+1·8	E. 43	−1·9	E. 65	+0·6	E. 174	+5·7	E. 126	+7·8
	13	W. 24	+1·8	E. 35	−1·9	E. 56	+0·6	E. 164	+5·7	E. 116	+7·9
	23	W. 28	+1·7	E. 27	−1·9	E. 47	+0·6	E. 153	+5·7	E. 106	+7·9
Dec.	**3**	W. 31	+1·7	E. 20	−1·8	E. 38	+0·6	E. 143	+5·7	E. 95	+7·9
	13	W. 35	+1·7	E. 12	−1·8	E. 29	+0·6	E. 132	+5·7	E. 85	+7·9
	23	W. 38	+1·6	E. 4	−1·8	E. 20	+0·6	E. 122	+5·7	E. 75	+7·9
	33	W. 42	+1·6	W. 4	−1·8	E. 10	+0·5	E. 112	+5·7	E. 65	+7·9

VISUAL MAGNITUDES OF SELECTED DWARF & MINOR PLANETS

	Jan. 7	Feb. 16	Mar. 28	May 7	June 16	July 26	Sept. 4	Oct. 14	Nov. 23	Dec. 33
Ceres	8·9	8·7	8·2	7·5	7·4	8·3	8·9	9·1	9·2	8·9
Pallas	8·9	8·4	7·9	8·4	9·2	9·7	10·0	10·1	10·1	10·2
Juno	8·3	9·1	9·6	10·0	10·2	10·3	10·3	10·7	10·8	10·6
Vesta	8·0	7·9	8·0	8·2	8·3	8·1	7·6	7·0	6·6	7·4
Pluto	15·0	15·1	15·1	15·1	15·0	14·9	15·0	15·1	15·1	15·0

CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
Jan.	1	22	Venus 1°·3 S. of Moon	
	2	06	Saturn in conjunction with Sun	
	3	05	Earth at perihelion	
	3	08	Jupiter 3° S. of Moon	
	6	01	NEW MOON	Eclipse
	6	05	Venus greatest elong. W. (47°)	
	7	02	Uranus stationary	
	9	04	Moon at apogee	
	10	22	Neptune 3° N. of Moon	
	11	12	Pluto in conjunction with Sun	
	12	20	Mars 5° N. of Moon	
	14	07	FIRST QUARTER	
	14	12	Uranus 5° N. of Moon	
	15	21	Venus 8° N. of *Antares*	
	21	05	FULL MOON	Eclipse
	21	20	Moon at perigee	
	22	06	Venus 2° N. of Jupiter	
	27	21	LAST QUARTER	
	30	03	Mercury in superior conjunction	
	31	00	Jupiter 3° S. of Moon	
	31	18	Venus 0°·09 S. of Moon	Occn.
Feb.	2	07	Saturn 0°·6 S. of Moon	Occn.
	2	20	Pluto 0°·6 S. of Moon	Occn.
	4	21	NEW MOON	
	5	09	Moon at apogee	
	6	08	Vesta 1°·1 S. of Moon	Occn.
	7	06	Neptune 3° N. of Moon	
	10	16	Mars 6° N. of Moon	
	10	20	Uranus 5° N. of Moon	
	12	22	FIRST QUARTER	
	13	20	Mars 1°·1 N. of Uranus	
	18	14	Venus 1°·1 N. of Saturn	
	19	09	Moon at perigee	
	19	16	FULL MOON	
	26	11	LAST QUARTER	
	27	01	Mercury greatest elong. E. (18°)	
	27	14	Jupiter 2° S. of Moon	
Mar.	1	18	Saturn 0°·3 S. of Moon	Occn.
	2	04	Pluto 0°·5 S. of Moon	Occn.
	2	21	Venus 1°·2 N. of Moon	
	4	11	Moon at apogee	
	5	02	Pallas stationary	
	5	05	Mercury stationary	
	6	16	NEW MOON	
	7	01	Neptune in conjunction with Sun	
	7	22	Vesta in conjunction with Sun	
	10	04	Uranus 5° N. of Moon	
	11	12	Mars 6° N. of Moon	
	14	10	FIRST QUARTER	
	15	02	Mercury in inferior conjunction	
	19	20	Moon at perigee	
	20	22	Equinox	
	21	02	FULL MOON	
	27	02	Jupiter 1°·9 S. of Moon	
	27	12	Mercury stationary	
	28	04	LAST QUARTER	
	29	05	Saturn 0°·05 N. of Moon	Occn.
	29	12	Pluto 0°·3 S. of Moon	Occn.
Apr.	1	00	Moon at apogee	
	2	04	Venus 3° N. of Moon	
	2	19	Mercury 0°·4 N. of Neptune	
	2	23	Mercury 4° N. of Moon	
	2	23	Neptune 3° N. of Moon	
	5	09	NEW MOON	
	6	13	Uranus 5° N. of Moon	
	8	21	Ceres stationary	
	9	07	Mars 5° N. of Moon	
	10	01	Pallas at opposition	
	10	04	Venus 0°·3 S. of Neptune	
	10	17	Jupiter stationary	
	11	20	Mercury greatest elong. W. (28°)	
	12	19	FIRST QUARTER	
	16	22	Mars 7° N. of *Aldebaran*	
	16	22	Moon at perigee	
	19	11	FULL MOON	
	22	23	Uranus in conjunction with Sun	
	23	12	Jupiter 1°·6 S. of Moon	
	25	09	Pluto stationary	
	25	14	Saturn 0°·4 N. of Moon	Occn.
	25	20	Pluto 0°·07 S. of Moon	Occn.
	26	22	LAST QUARTER	
	28	18	Moon at apogee	
	30	02	Saturn stationary	
	30	08	Neptune 3° N. of Moon	
May	2	12	Venus 4° N. of Moon	
	2	13	Vesta 0°·2 S. of Moon	Occn.
	3	06	Mercury 3° N. of Moon	
	4	23	NEW MOON	
	8	00	Mars 3° N. of Moon	
	12	01	FIRST QUARTER	
	13	22	Moon at perigee	
	18	08	Venus 1°·2 S. of Uranus	
	18	21	FULL MOON	
	19	18	Ceres 1°·2 N. of Moon	Occn.
	20	17	Jupiter 1°·7 S. of Moon	
	21	13	Mercury in superior conjunction	
	22	22	Saturn 0°·5 N. of Moon	Occn.
	23	04	Pluto 0°·07 N. of Moon	Occn.
	26	13	Moon at apogee	

CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
May	26	17	LAST QUARTER	
	27	17	Neptune 4° N. of Moon	
	28	23	Ceres at opposition	
	30	22	Vesta 0°.6 S. of Moon	Occn.
	31	10	Uranus 5° N. of Moon	
June	1	18	Venus 3° N. of Moon	
	3	02	Pallas stationary	
	3	10	NEW MOON	
	4	16	Mercury 4° N. of Moon	
	5	15	Mars 1°.6 N. of Moon	
	7	23	Moon at perigee	
	10	06	FIRST QUARTER	
	10	15	Jupiter at opposition	
	15	15	Ceres 0°.9 S. of Moon	Occn.
	16	19	Jupiter 2° S. of Moon	
	17	09	FULL MOON	
	17	21	Venus 5° N. of *Aldebaran*	
	18	15	Mercury 0°.2 N. of Mars	
	19	04	Saturn 0°.4 N. of Moon	Occn.
	19	11	Pluto 0°.07 N. of Moon	Occn.
	21	05	Mercury 6° S. of *Pollux*	
	21	16	Solstice	
	22	04	Neptune stationary	
	23	07	Mars 6° S. of *Pollux*	
	23	08	Moon at apogee	
	23	23	Mercury greatest elong. E. (25°)	
	24	01	Neptune 4° N. of Moon	
	25	10	LAST QUARTER	
	27	22	Uranus 5° N. of Moon	
July	2	19	NEW MOON	Eclipse
	4	06	Mars 0°.09 S. of Moon	Occn.
	4	09	Mercury 3° S. of Moon	
	4	22	Earth at aphelion	
	5	05	Moon at perigee	
	7	04	Mercury stationary	
	7	14	Mercury 4° S. of Mars	
	9	11	FIRST QUARTER	
	9	17	Saturn at opposition	
	13	20	Jupiter 2° S. of Moon	
	14	15	Pluto at opposition	
	16	07	Saturn 0°.2 N. of Moon	Occn.
	16	17	Pluto 0°.04 S. of Moon	Occn.
	16	22	FULL MOON	Eclipse
	19	17	Ceres stationary	
	21	00	Moon at apogee	
	21	08	Neptune 4° N. of Moon	
	21	13	Mercury in inferior conjunction	
	25	01	LAST QUARTER	
	25	07	Uranus 5° N. of Moon	
	31	19	Mercury stationary	

	d	h		
Aug.	1	03	NEW MOON	
	2	07	Moon at perigee	
	5	22	Mercury 9° S. of *Pollux*	
	7	18	FIRST QUARTER	
	9	23	Jupiter 2° S. of Moon	
	9	23	Mercury greatest elong. W. (19°)	
	11	16	Jupiter stationary	
	12	06	Uranus stationary	
	12	10	Saturn 0°.04 N. of Moon	Occn.
	12	22	Pluto 0°.1 S. of Moon	Occn.
	14	06	Venus in superior conjunction	
	15	12	FULL MOON	
	17	11	Moon at apogee	
	17	13	Neptune 4° N. of Moon	
	21	15	Uranus 5° N. of Moon	
	22	22	Juno in conjunction with Sun	
	23	15	LAST QUARTER	
	30	11	NEW MOON	
	30	16	Moon at perigee	
Sept.	2	11	Mars in conjunction with Sun	
	4	02	Mercury in superior conjunction	
	6	03	FIRST QUARTER	
	6	07	Jupiter 2° S. of Moon	
	8	14	Saturn 0°.04 N. of Moon	Occn.
	9	03	Pluto 0°.08 S. of Moon	Occn.
	10	07	Neptune at opposition	
	13	14	Moon at apogee	
	13	18	Neptune 4° N. of Moon	
	14	05	FULL MOON	
	17	20	Uranus 4° N. of Moon	
	18	06	Saturn stationary	
	22	03	LAST QUARTER	
	23	08	Equinox	
	25	05	Vesta stationary	
	28	02	Moon at perigee	
	28	18	NEW MOON	
	28	23	Mercury 1°.4 N. of *Spica*	
	29	22	Mercury 6° S. of Moon	
Oct.	2	21	Pluto stationary	
	3	01	Venus 3° N. of *Spica*	
	3	20	Jupiter 1°.9 S. of Moon	
	5	17	FIRST QUARTER	
	5	21	Saturn 0°.3 N. of Moon	Occn.
	6	09	Pluto 0°.1 N. of Moon	Occn.
	10	18	Moon at apogee	
	10	23	Neptune 4° N. of Moon	
	13	21	FULL MOON	

CONFIGURATIONS OF SUN, MOON AND PLANETS

	d	h		
Oct.	15	00	Uranus 4° N. of Moon	
	20	04	Mercury greatest elong. E. (25°)	
	21	13	LAST QUARTER	
	26	11	Moon at perigee	
	26	17	Mars 5° S. of Moon	
	28	04	NEW MOON	
	28	08	Uranus at opposition	
	29	14	Venus 4° S. of Moon	
	29	15	Mercury 7° S. of Moon	
	30	08	Mercury 3° S. of Venus	
	31	14	Jupiter 1°.3 S. of Moon	
	31	20	Mercury stationary	
Nov.	2	07	Saturn 0°.6 N. of Moon	Occn.
	2	18	Pluto 0°.4 N. of Moon	Occn.
	4	10	FIRST QUARTER	
	7	05	Neptune 4° N. of Moon	
	7	09	Moon at apogee	
	8	15	Mars 3° N. of *Spica*	
	9	11	Venus 4° N. of *Antares*	
	11	04	Uranus 4° N. of Moon	
	11	15	Mercury in inferior conjunction, transit over Sun	
	12	09	Vesta at opposition	
	12	14	FULL MOON	
	19	21	LAST QUARTER	
	20	15	Mercury stationary	
	23	08	Moon at perigee	
	24	09	Mars 4° S. of Moon	
	24	14	Venus 1°.4 S. of Jupiter	
	25	03	Mercury 1°.9 S. of Moon	
	26	15	NEW MOON	
	27	20	Neptune stationary	
	28	11	Jupiter 0°.7 S. of Moon	
	28	11	Mercury greatest elong. W. (20°)	
	28	19	Venus 1°.9 S. of Moon	Occn.
	29	21	Saturn 0°.9 N. of Moon	Occn.
	30	04	Pluto 0°.5 N. of Moon	Occn.
Dec.	3	02	Pallas in conjunction with Sun	
	4	07	FIRST QUARTER	
	4	12	Neptune 4° N. of Moon	
	5	04	Moon at apogee	
	8	11	Uranus 5° N. of Moon	
	11	05	Venus 1°.8 S. of Saturn	
	12	05	FULL MOON	
	15	16	Mercury 5° N. of *Antares*	
	18	20	Moon at perigee	
	19	05	LAST QUARTER	
	22	04	Solstice	
	23	02	Mars 4° S. of Moon	
	26	05	NEW MOON	Eclipse
	27	12	Saturn 1°.2 N. of Moon	
	27	15	Pluto 0°.6 N. of Moon	Occn.
	27	18	Jupiter in conjunction with Sun	
	29	02	Venus 1°.0 N. of Moon	Occn.
	31	21	Neptune 4° N. of Moon	

. . . continued from page 5

OCCULTATIONS OF PLANETS AND BRIGHT STARS BY THE MOON

Date			Body	Areas of Visibility
	d	h		
Oct.	6	09	Pluto	Australia, Melanesia, S.E. Micronesia, W. Polynesia
Nov.	2	07	Saturn	Kerguelen Is., Prince Edward Island, E. Antarctica, S. Tasmania, New Zealand, S. Polynesia
Nov.	2	18	Pluto	S. South America, South Georgia, southern Africa, Madagascar
Nov.	28	11	Jupiter	N. Africa, most of Europe, Middle East, W. Asia
Nov.	29	21	Saturn	S. New Zealand, Antarctica, South Georgia
Nov.	30	04	Pluto	S. Australasia, Kerguelen Is., parts of Antarctica, S.E. Polynesia
Dec.	27	15	Pluto	S. South America, South Georgia, parts of Antarctica, Kerguelen Is., S. tip of Africa, S. Madagascar
Dec.	29	02	Venus	Antarctica, S. tip of South America

Maps showing the areas of visibility may be found on AsA-Online.

CHRONOLOGICAL CYCLES AND ERAS

Dominical Letter	F	Julian Period (year of)	6732
Epact	24	Roman Indiction	12
Golden Number (Lunar Cycle)	VI	Solar Cycle	12

All dates are given in terms of the Gregorian calendar in which
2019 January 14 corresponds to 2019 January 1 of the Julian calendar.

ERA	YEAR	BEGINS	ERA	YEAR	BEGINS
Byzantine	7528	Sept. 14	Japanese	2679	Jan. 1
Jewish (A.M.)*	5780	Sept. 29	Seleucidæ (Grecian)	2331	Sept. 14
Chinese (jǐ hài)		Feb. 5			(or Oct. 14)
Roman (A.U.C.)	2772	Jan. 14	Saka (Indian)	1941	Mar. 22
Nabonassar	2768	Apr. 19	Diocletian (Coptic)	1736	Sept. 12
			Islamic (Hegira)*	1441	Aug. 31

* Year begins at sunset

RELIGIOUS CALENDARS

Epiphany	Jan. 6	Ascension Day	May 30
Ash Wednesday	Mar. 6	Whit Sunday—Pentecost	June 9
Palm Sunday	Apr. 14	Trinity Sunday	June 16
Good Friday	Apr. 19	First Sunday in Advent	Dec. 1
Easter Day	Apr. 21	Christmas Day (Wednesday)	Dec. 25
First Day of Passover (Pesach)	Apr. 20	Day of Atonement (Yom Kippur)	Oct. 9
Feast of Weeks (Shavuot)	June 9	First day of Tabernacles (Succoth)	Oct. 14
Jewish New Year‡ (Rosh Hashanah)	Sept. 30	Festival of Lights (Hanukkah)	Dec. 23
First day of Ramadân‡	May 6	Islamic New Year‡	Sept. 1
First day of Shawwal‡	June 5		

‡The Jewish and Islamic dates above are tabular dates, which begin at sunset on the previous evening and end at sunset on the date tabulated. In practice, the dates of Islamic fasts and festivals are determined by an actual sighting of the appropriate new Moon.

CIVIL CALENDAR—UNITED STATES OF AMERICA

New Year's Day	Jan. 1	Labor Day	Sept. 2
Martin Luther King's Birthday	Jan. 21	Columbus Day	Oct. 14
Washington's Birthday	Feb. 18	Election Day (in certain States)	Nov. 5
Memorial Day	May 27	Veterans Day	Nov. 11
Independence Day	July 4	Thanksgiving Day	Nov. 28

CIVIL CALENDAR—UNITED KINGDOM

Accession of Queen Elizabeth II	Feb. 6	The Queen's Official Birthday†	June 8
St David (Wales)	Mar. 1	Birthday of Prince Philip, Duke of Edinburgh	June 10
Commonwealth Day	Mar. 11	Remembrance Sunday	Nov. 10
St Patrick (Ireland)	Mar. 17	Birthday of the Prince of Wales	Nov. 14
Birthday of Queen Elizabeth II	Apr. 21	St Andrew (Scotland)	Nov. 30
St George (England)	Apr. 23		
Coronation Day	June 2		

†Date subject to confirmation

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
Day of Month	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year	Day of Week	Day of Year
1	Tue.	1	Fri.	32	Fri.	60	Mon.	91	Wed.	121	Sat.	152
2	Wed.	2	Sat.	33	Sat.	61	Tue.	92	Thu.	122	Sun.	153
3	Thu.	3	Sun.	34	Sun.	62	Wed.	93	Fri.	123	Mon.	154
4	Fri.	4	Mon.	35	Mon.	63	Thu.	94	Sat.	124	Tue.	155
5	Sat.	5	Tue.	36	Tue.	64	Fri.	95	Sun.	125	Wed.	156
6	Sun.	6	Wed.	37	Wed.	65	Sat.	96	Mon.	126	Thu.	157
7	Mon.	7	Thu.	38	Thu.	66	Sun.	97	Tue.	127	Fri.	158
8	Tue.	8	Fri.	39	Fri.	67	Mon.	98	Wed.	128	Sat.	159
9	Wed.	9	Sat.	40	Sat.	68	Tue.	99	Thu.	129	Sun.	160
10	Thu.	10	Sun.	41	Sun.	69	Wed.	100	Fri.	130	Mon.	161
11	Fri.	11	Mon.	42	Mon.	70	Thu.	101	Sat.	131	Tue.	162
12	Sat.	12	Tue.	43	Tue.	71	Fri.	102	Sun.	132	Wed.	163
13	Sun.	13	Wed.	44	Wed.	72	Sat.	103	Mon.	133	Thu.	164
14	Mon.	14	Thu.	45	Thu.	73	Sun.	104	Tue.	134	Fri.	165
15	Tue.	15	Fri.	46	Fri.	74	Mon.	105	Wed.	135	Sat.	166
16	Wed.	16	Sat.	47	Sat.	75	Tue.	106	Thu.	136	Sun.	167
17	Thu.	17	Sun.	48	Sun.	76	Wed.	107	Fri.	137	Mon.	168
18	Fri.	18	Mon.	49	Mon.	77	Thu.	108	Sat.	138	Tue.	169
19	Sat.	19	Tue.	50	Tue.	78	Fri.	109	Sun.	139	Wed.	170
20	Sun.	20	Wed.	51	Wed.	79	Sat.	110	Mon.	140	Thu.	171
21	Mon.	21	Thu.	52	Thu.	80	Sun.	111	Tue.	141	Fri.	172
22	Tue.	22	Fri.	53	Fri.	81	Mon.	112	Wed.	142	Sat.	173
23	Wed.	23	Sat.	54	Sat.	82	Tue.	113	Thu.	143	Sun.	174
24	Thu.	24	Sun.	55	Sun.	83	Wed.	114	Fri.	144	Mon.	175
25	Fri.	25	Mon.	56	Mon.	84	Thu.	115	Sat.	145	Tue.	176
26	Sat.	26	Tue.	57	Tue.	85	Fri.	116	Sun.	146	Wed.	177
27	Sun.	27	Wed.	58	Wed.	86	Sat.	117	Mon.	147	Thu.	178
28	Mon.	28	Thu.	59	Thu.	87	Sun.	118	Tue.	148	Fri.	179
29	Tue.	29			Fri.	88	Mon.	119	Wed.	149	Sat.	180
30	Wed.	30			Sat.	89	Tue.	120	Thu.	150	Sun.	181
31	Thu.	31			Sun.	90			Fri.	151		

JULIAN DATE, 2019

0^h UT	JD	0^h UT	JD	0^h UT	JD
Jan. 0	245 8483·5	May 0	245 8603·5	Sept. 0	245 8726·5
Feb. 0	245 8514·5	June 0	245 8634·5	Oct. 0	245 8756·5
Mar. 0	245 8542·5	July 0	245 8664·5	Nov. 0	245 8787·5
Apr. 0	245 8573·5	Aug. 0	245 8695·5	Dec. 0	245 8817·5

400-day date, JD 245 8800·5 = 2019 November 13·0

Standard epoch, 1900 January 0, 12^h UT = JD 241 5020·0
Standard epoch, B1950·0 = 1950 Jan. 0·923 = JD 243 3282·423
B2019·0 = 2019 Jan. 0·635 = JD 245 8484·135

Standard epoch, J2000·0 = 2000 Jan. 1·5 = JD 245 1545·0
J2019·5 = 2019 July 2·875 = JD 245 8667·375

Day of Month	JULY Day of Week	JULY Day of Year	AUGUST Day of Week	AUGUST Day of Year	SEPTEMBER Day of Week	SEPTEMBER Day of Year	OCTOBER Day of Week	OCTOBER Day of Year	NOVEMBER Day of Week	NOVEMBER Day of Year	DECEMBER Day of Week	DECEMBER Day of Year
1	Mon.	182	Thu.	213	Sun.	244	Tue.	274	Fri.	305	Sun.	335
2	Tue.	183	Fri.	214	Mon.	245	Wed.	275	Sat.	306	Mon.	336
3	Wed.	184	Sat.	215	Tue.	246	Thu.	276	Sun.	307	Tue.	337
4	Thu.	185	Sun.	216	Wed.	247	Fri.	277	Mon.	308	Wed.	338
5	Fri.	186	Mon.	217	Thu.	248	Sat.	278	Tue.	309	Thu.	339
6	Sat.	187	Tue.	218	Fri.	249	Sun.	279	Wed.	310	Fri.	340
7	Sun.	188	Wed.	219	Sat.	250	Mon.	280	Thu.	311	Sat.	341
8	Mon.	189	Thu.	220	Sun.	251	Tue.	281	Fri.	312	Sun.	342
9	Tue.	190	Fri.	221	Mon.	252	Wed.	282	Sat.	313	Mon.	343
10	Wed.	191	Sat.	222	Tue.	253	Thu.	283	Sun.	314	Tue.	344
11	Thu.	192	Sun.	223	Wed.	254	Fri.	284	Mon.	315	Wed.	345
12	Fri.	193	Mon.	224	Thu.	255	Sat.	285	Tue.	316	Thu.	346
13	Sat.	194	Tue.	225	Fri.	256	Sun.	286	Wed.	317	Fri.	347
14	Sun.	195	Wed.	226	Sat.	257	Mon.	287	Thu.	318	Sat.	348
15	Mon.	196	Thu.	227	Sun.	258	Tue.	288	Fri.	319	Sun.	349
16	Tue.	197	Fri.	228	Mon.	259	Wed.	289	Sat.	320	Mon.	350
17	Wed.	198	Sat.	229	Tue.	260	Thu.	290	Sun.	321	Tue.	351
18	Thu.	199	Sun.	230	Wed.	261	Fri.	291	Mon.	322	Wed.	352
19	Fri.	200	Mon.	231	Thu.	262	Sat.	292	Tue.	323	Thu.	353
20	Sat.	201	Tue.	232	Fri.	263	Sun.	293	Wed.	324	Fri.	354
21	Sun.	202	Wed.	233	Sat.	264	Mon.	294	Thu.	325	Sat.	355
22	Mon.	203	Thu.	234	Sun.	265	Tue.	295	Fri.	326	Sun.	356
23	Tue.	204	Fri.	235	Mon.	266	Wed.	296	Sat.	327	Mon.	357
24	Wed.	205	Sat.	236	Tue.	267	Thu.	297	Sun.	328	Tue.	358
25	Thu.	206	Sun.	237	Wed.	268	Fri.	298	Mon.	329	Wed.	359
26	Fri.	207	Mon.	238	Thu.	269	Sat.	299	Tue.	330	Thu.	360
27	Sat.	208	Tue.	239	Fri.	270	Sun.	300	Wed.	331	Fri.	361
28	Sun.	209	Wed.	240	Sat.	271	Mon.	301	Thu.	332	Sat.	362
29	Mon.	210	Thu.	241	Sun.	272	Tue.	302	Fri.	333	Sun.	363
30	Tue.	211	Fri.	242	Mon.	273	Wed.	303	Sat.	334	Mon.	364
31	Wed.	212	Sat.	243			Thu.	304			Tue.	365

MEAN SIDEREAL TIME, 2019

Greenwich mean sidereal time at 0^h UT

	h		h		h		h
Jan. 0	6·6250	Apr. 0	12·5389	July 0	18·5185	Oct. 0	0·5638
Feb. 0	8·6620	May 0	14·5102	Aug. 0	20·5555	Nov. 0	2·6008
Mar. 0	10·5019	June 0	16·5472	Sept. 0	22·5925	Dec. 0	4·5721

Greenwich mean sidereal time (GMST) on day d of month at hour t UT

$$= \text{GMST at } 0^h \text{ UT on day } 0 + 0^h.065\,71\,d + 1^h.002\,74\,t$$

$$\text{Local mean sidereal time} = \text{GMST} \begin{matrix} + \text{ east} \\ - \text{ west} \end{matrix} \text{ longitude}$$

AT 0^h UNIVERSAL TIME

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

Equation of time = apparent time − mean time

AT 0^h UNIVERSAL TIME

Date	Equation of time	Declination	Date	Equation of time	Declination	Date	Equation of time	Declination	Date	Equation of time	Declination
	m s	° ′		m s	° ′		m s	° ′		m s	° ′
July 1	−03 44	+23 08	**Aug. 16**	−04 26	+13 54	**Oct. 1**	+10 06	−02 59	**Nov.16**	+15 24	−18 36
2	03 56	23 04	**17**	04 14	13 35	**2**	10 25	03 22	**17**	15 13	18 51
3	04 07	23 00	**18**	04 01	13 15	**3**	10 45	03 46	**18**	15 02	19 06
4	04 18	22 55	**19**	03 48	12 56	**4**	11 03	04 09	**19**	14 49	19 20
5	04 29	22 50	**20**	03 34	12 37	**5**	11 22	04 32	**20**	14 36	19 34
6	−04 40	+22 44	**21**	−03 19	+12 17	**6**	+11 40	−04 55	**21**	+14 22	−19 48
7	04 50	22 38	**22**	03 05	11 57	**7**	11 58	05 18	**22**	14 07	20 01
8	05 00	22 32	**23**	02 49	11 37	**8**	12 15	05 41	**23**	13 51	20 14
9	05 09	22 25	**24**	02 34	11 16	**9**	12 32	06 04	**24**	13 34	20 26
10	05 18	22 18	**25**	02 18	10 56	**10**	12 49	06 27	**25**	13 17	20 38
11	−05 26	+22 10	**26**	−02 01	+10 35	**11**	+13 05	−06 49	**26**	+12 59	−20 50
12	05 34	22 02	**27**	01 44	10 14	**12**	13 20	07 12	**27**	12 40	21 01
13	05 42	21 54	**28**	01 27	09 53	**13**	13 35	07 35	**28**	12 20	21 12
14	05 49	21 45	**29**	01 09	09 32	**14**	13 50	07 57	**29**	12 00	21 23
15	05 55	21 36	**30**	00 51	09 11	**15**	14 04	08 19	**30**	11 39	21 33
16	−06 01	+21 26	**31**	−00 33	+08 49	**16**	+14 18	−08 41	**Dec. 1**	+11 17	−21 43
17	06 07	21 17	**Sept. 1**	−00 15	08 28	**17**	14 31	09 04	**2**	10 55	21 52
18	06 12	21 06	**2**	+00 04	08 06	**18**	14 43	09 25	**3**	10 32	22 01
19	06 16	20 56	**3**	00 24	07 44	**19**	14 55	09 47	**4**	10 08	22 10
20	06 20	20 45	**4**	00 43	07 22	**20**	15 06	10 09	**5**	09 44	22 18
21	−06 24	+20 34	**5**	+01 03	+07 00	**21**	+15 16	−10 30	**6**	+09 19	−22 25
22	06 27	20 22	**6**	01 23	06 38	**22**	15 26	10 52	**7**	08 54	22 33
23	06 29	20 10	**7**	01 43	06 15	**23**	15 35	11 13	**8**	08 28	22 39
24	06 31	19 58	**8**	02 04	05 53	**24**	15 44	11 34	**9**	08 02	22 46
25	06 32	19 45	**9**	02 24	05 30	**25**	15 51	11 55	**10**	07 35	22 52
26	−06 32	+19 32	**10**	+02 45	+05 08	**26**	+15 58	−12 16	**11**	+07 08	−22 57
27	06 32	19 19	**11**	03 06	04 45	**27**	16 05	12 36	**12**	06 41	23 02
28	06 32	19 06	**12**	03 28	04 22	**28**	16 10	12 56	**13**	06 13	23 06
29	06 31	18 52	**13**	03 49	03 59	**29**	16 15	13 16	**14**	05 45	23 10
30	06 29	18 38	**14**	04 10	03 36	**30**	16 19	13 36	**15**	05 16	23 14
31	−06 26	+18 23	**15**	+04 32	+03 13	**31**	+16 22	−13 56	**16**	+04 48	−23 17
Aug. 1	06 24	18 08	**16**	04 53	02 50	**Nov. 1**	16 24	14 16	**17**	04 19	23 20
2	06 20	17 53	**17**	05 15	02 27	**2**	16 26	14 35	**18**	03 49	23 22
3	06 16	17 38	**18**	05 36	02 04	**3**	16 27	14 54	**19**	03 20	23 24
4	06 11	17 22	**19**	05 58	01 41	**4**	16 27	15 12	**20**	02 50	23 25
5	−06 06	+17 06	**20**	+06 19	+01 18	**5**	+16 26	−15 31	**21**	+02 21	−23 26
6	06 00	16 50	**21**	06 41	00 54	**6**	16 25	15 49	**22**	01 51	23 26
7	05 53	16 33	**22**	07 02	00 31	**7**	16 23	16 07	**23**	01 21	23 26
8	05 46	16 17	**23**	07 23	+00 08	**8**	16 19	16 25	**24**	00 51	23 25
9	05 38	16 00	**24**	07 44	−00 16	**9**	16 15	16 42	**25**	+00 21	23 24
10	−05 29	+15 42	**25**	+08 05	−00 39	**10**	+16 11	−16 59	**26**	−00 09	−23 23
11	05 20	15 25	**26**	08 26	01 02	**11**	16 05	17 16	**27**	00 39	23 21
12	05 11	15 07	**27**	08 46	01 26	**12**	15 58	17 33	**28**	01 09	23 18
13	05 00	14 49	**28**	09 07	01 49	**13**	15 51	17 49	**29**	01 38	23 15
14	04 50	14 31	**29**	09 27	02 13	**14**	15 43	18 05	**30**	02 07	23 12
15	−04 38	+14 12	**30**	+09 47	−02 36	**15**	+15 34	−18 21	**31**	−02 36	−23 08
16	−04 26	+13 54	**Oct. 1**	+10 06	−02 59	**16**	+15 24	−18 36	**32**	−03 05	−23 04

$$\text{UT of transit} = 12^h \overset{-\ \text{east}}{+\ \text{west}} \text{ longitude} - \text{equation of time}$$

AT 0^h UNIVERSAL TIME

Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA
	° ′	° ′		° ′	° ′		° ′	° ′		° ′	° ′
Jan. 0	55 11	138 36	**Feb. 15**	100 51	183 57	**Apr. 1**	145 30	228 11	**May 17**	190 53	273 18
1	56 10	139 35	**16**	101 51	184 56	**2**	146 29	229 10	**18**	191 52	274 17
2	57 10	140 34	**17**	102 50	185 55	**3**	147 29	230 09	**19**	192 50	275 16
3	58 09	141 34	**18**	103 50	186 54	**4**	148 28	231 07	**20**	193 49	276 15
4	59 08	142 33	**19**	104 50	187 53	**5**	149 28	232 06	**21**	194 48	277 13
5	60 08	143 32	**20**	105 49	188 52	**6**	150 27	233 05	**22**	195 47	278 12
6	61 07	144 31	**21**	106 49	189 51	**7**	151 26	234 04	**23**	196 46	279 11
7	62 07	145 31	**22**	107 49	190 51	**8**	152 26	235 03	**24**	197 45	280 10
8	63 06	146 30	**23**	108 48	191 50	**9**	153 25	236 02	**25**	198 44	281 09
9	64 06	147 29	**24**	109 48	192 49	**10**	154 24	237 01	**26**	199 43	282 08
10	65 06	148 28	**25**	110 47	193 48	**11**	155 23	238 00	**27**	200 42	283 06
11	66 05	149 27	**26**	111 47	194 47	**12**	156 23	238 59	**28**	201 41	284 05
12	67 05	150 27	**27**	112 47	195 46	**13**	157 22	239 57	**29**	202 40	285 04
13	68 04	151 26	**28**	113 46	196 45	**14**	158 21	240 56	**30**	203 39	286 03
14	69 04	152 25	**Mar. 1**	114 46	197 44	**15**	159 20	241 55	**31**	204 38	287 02
15	70 04	153 24	**2**	115 45	198 43	**16**	160 20	242 54	**June 1**	205 37	288 01
16	71 03	154 24	**3**	116 45	199 42	**17**	161 19	243 53	**2**	206 35	289 00
17	72 03	155 23	**4**	117 44	200 41	**18**	162 18	244 52	**3**	207 34	289 58
18	73 02	156 22	**5**	118 44	201 40	**19**	163 18	245 50	**4**	208 33	290 57
19	74 02	157 21	**6**	119 44	202 39	**20**	164 17	246 49	**5**	209 32	291 56
20	75 01	158 20	**7**	120 43	203 38	**21**	165 16	247 48	**6**	210 31	292 55
21	76 01	159 19	**8**	121 43	204 37	**22**	166 15	248 47	**7**	211 29	293 54
22	77 00	160 19	**9**	122 42	205 35	**23**	167 14	249 46	**8**	212 28	294 53
23	78 00	161 18	**10**	123 42	206 34	**24**	168 13	250 45	**9**	213 27	295 51
24	79 00	162 17	**11**	124 41	207 33	**25**	169 13	251 44	**10**	214 26	296 50
25	79 59	163 16	**12**	125 41	208 32	**26**	170 12	252 42	**11**	215 25	297 49
26	80 59	164 15	**13**	126 40	209 31	**27**	171 11	253 41	**12**	216 24	298 48
27	81 59	165 14	**14**	127 40	210 30	**28**	172 10	254 40	**13**	217 23	299 47
28	82 58	166 14	**15**	128 39	211 29	**29**	173 09	255 39	**14**	218 21	300 46
29	83 58	167 13	**16**	129 39	212 28	**30**	174 09	256 38	**15**	219 20	301 45
30	84 57	168 12	**17**	130 38	213 27	**May 1**	175 08	257 37	**16**	220 19	302 44
31	85 57	169 11	**18**	131 38	214 26	**2**	176 07	258 35	**17**	221 17	303 43
Feb. 1	86 57	170 10	**19**	132 37	215 25	**3**	177 06	259 34	**18**	222 16	304 41
2	87 56	171 09	**20**	133 37	216 24	**4**	178 05	260 33	**19**	223 15	305 40
3	88 56	172 08	**21**	134 36	217 23	**5**	179 04	261 32	**20**	224 14	306 39
4	89 55	173 07	**22**	135 36	218 22	**6**	180 03	262 31	**21**	225 12	307 38
5	90 55	174 07	**23**	136 35	219 21	**7**	181 02	263 30	**22**	226 11	308 37
6	91 55	175 06	**24**	137 35	220 20	**8**	182 01	264 29	**23**	227 10	309 36
7	92 54	176 05	**25**	138 34	221 19	**9**	183 00	265 27	**24**	228 09	310 35
8	93 54	177 04	**26**	139 34	222 17	**10**	183 59	266 26	**25**	229 08	311 33
9	94 54	178 03	**27**	140 33	223 16	**11**	184 58	267 25	**26**	230 06	312 32
10	95 53	179 02	**28**	141 32	224 15	**12**	185 57	268 24	**27**	231 05	313 31
11	96 53	180 01	**29**	142 32	225 14	**13**	186 56	269 23	**28**	232 04	314 30
12	97 53	181 00	**30**	143 31	226 13	**14**	187 56	270 21	**29**	233 03	315 29
13	98 52	181 59	**31**	144 30	227 12	**15**	188 55	271 20	**30**	234 01	316 28
14	99 52	182 58	**Apr. 1**	145 30	228 11	**16**	189 54	272 19	**July 1**	235 00	317 27
15	100 51	183 57	**2**	146 29	229 10	**17**	190 53	273 18	**2**	235 59	318 26

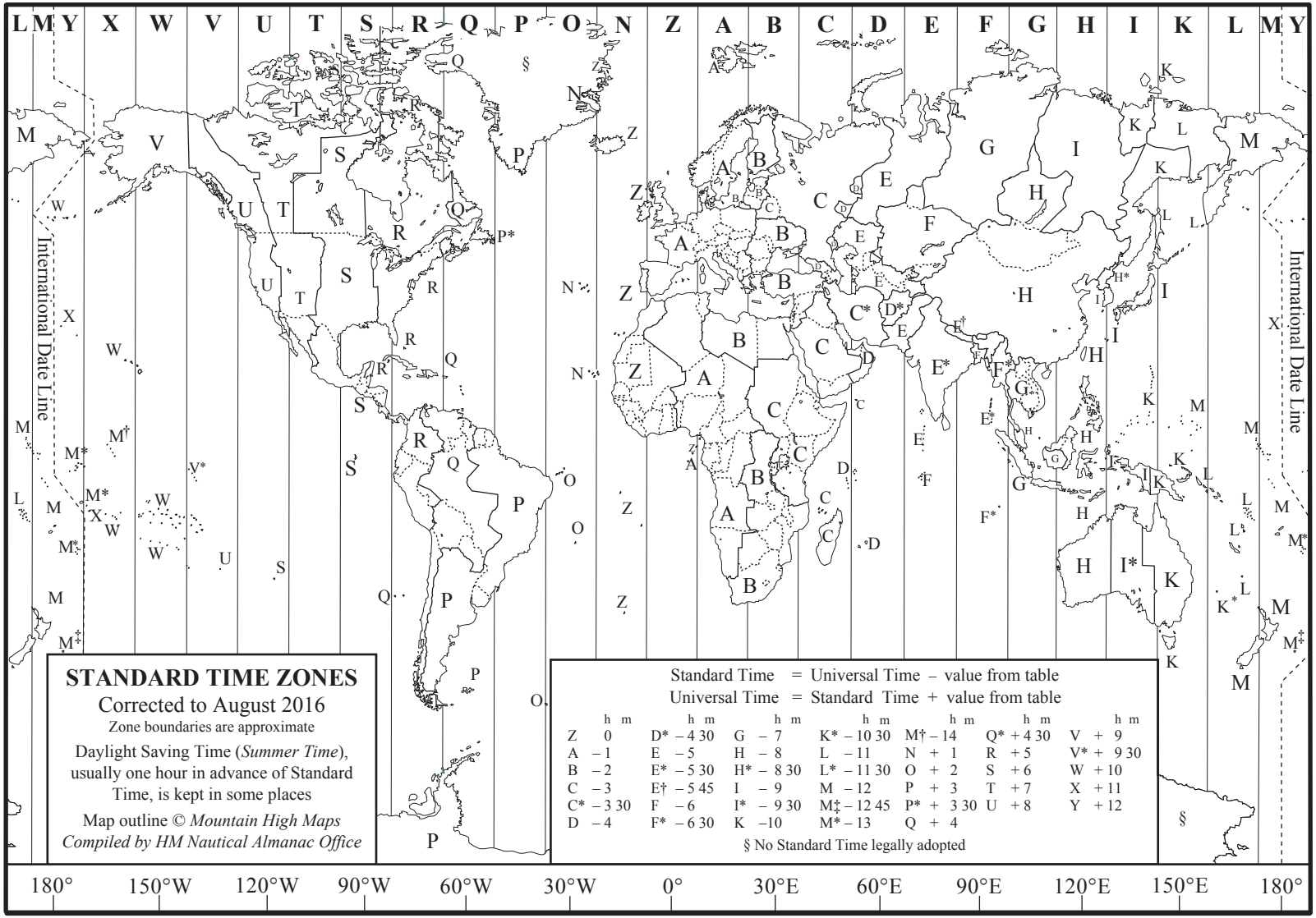
The dates between Jan. 0 and Dec. 32 below are the dates when p changes to the next value.

Polar Distance (p)								
	Polaris:	Jan. 0	39′	May 24	40′	Sept. 23	39′	Dec. 32
	σ Octantis:	Jan. 0	67′	Mar. 1	68′	Aug. 21	67′	Dec. 32

AT 0^h UNIVERSAL TIME

Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA	Date	*Polaris* GHA	σ Oct GHA
	° ′	° ′		° ′	° ′		° ′	° ′		° ′	° ′
July 1	235 00	317 27	**Aug. 16**	279 58	2 41	**Oct. 1**	324 58	48 06	**Nov. 16**	10 10	93 37
2	235 59	318 26	**17**	280 57	3 40	**2**	325 57	49 05	**17**	11 09	94 37
3	236 57	319 25	**18**	281 55	4 39	**3**	326 56	50 04	**18**	12 08	95 36
4	237 56	320 24	**19**	282 54	5 39	**4**	327 55	51 04	**19**	13 07	96 35
5	238 55	321 23	**20**	283 53	6 38	**5**	328 53	52 03	**20**	14 06	97 35
6	239 53	322 22	**21**	284 51	7 37	**6**	329 52	53 02	**21**	15 05	98 34
7	240 52	323 20	**22**	285 50	8 36	**7**	330 51	54 02	**22**	16 05	99 34
8	241 51	324 19	**23**	286 49	9 35	**8**	331 50	55 01	**23**	17 04	100 33
9	242 50	325 18	**24**	287 47	10 34	**9**	332 49	56 00	**24**	18 03	101 32
10	243 48	326 17	**25**	288 46	11 34	**10**	333 48	57 00	**25**	19 02	102 32
11	244 47	327 16	**26**	289 44	12 33	**11**	334 47	57 59	**26**	20 01	103 31
12	245 46	328 15	**27**	290 43	13 32	**12**	335 45	58 58	**27**	21 01	104 31
13	246 44	329 14	**28**	291 42	14 31	**13**	336 44	59 58	**28**	22 00	105 30
14	247 43	330 13	**29**	292 40	15 30	**14**	337 43	60 57	**29**	22 59	106 30
15	248 41	331 12	**30**	293 39	16 29	**15**	338 42	61 57	**30**	23 58	107 29
16	249 40	332 11	**31**	294 38	17 28	**16**	339 41	62 56	**Dec. 1**	24 57	108 28
17	250 39	333 10	**Sept. 1**	295 37	18 28	**17**	340 40	63 55	**2**	25 57	109 28
18	251 37	334 09	**2**	296 35	19 27	**18**	341 39	64 55	**3**	26 56	110 27
19	252 36	335 08	**3**	297 34	20 26	**19**	342 37	65 54	**4**	27 55	111 26
20	253 35	336 07	**4**	298 33	21 25	**20**	343 36	66 54	**5**	28 55	112 26
21	254 33	337 06	**5**	299 31	22 25	**21**	344 35	67 53	**6**	29 54	113 25
22	255 32	338 05	**6**	300 30	23 24	**22**	345 34	68 52	**7**	30 53	114 24
23	256 31	339 04	**7**	301 29	24 23	**23**	346 33	69 52	**8**	31 53	115 24
24	257 29	340 03	**8**	302 27	25 22	**24**	347 32	70 51	**9**	32 52	116 23
25	258 28	341 02	**9**	303 26	26 21	**25**	348 31	71 50	**10**	33 51	117 23
26	259 27	342 01	**10**	304 25	27 21	**26**	349 30	72 50	**11**	34 50	118 22
27	260 25	343 00	**11**	305 23	28 20	**27**	350 29	73 49	**12**	35 50	119 21
28	261 24	343 59	**12**	306 22	29 19	**28**	351 28	74 49	**13**	36 49	120 21
29	262 23	344 58	**13**	307 21	30 18	**29**	352 27	75 48	**14**	37 48	121 20
30	263 21	345 57	**14**	308 20	31 18	**30**	353 26	76 47	**15**	38 48	122 19
31	264 20	346 56	**15**	309 18	32 17	**31**	354 25	77 47	**16**	39 47	123 19
Aug. 1	265 18	347 55	**16**	310 17	33 16	**Nov. 1**	355 24	78 46	**17**	40 46	124 18
2	266 17	348 54	**17**	311 16	34 15	**2**	356 23	79 46	**18**	41 46	125 17
3	267 16	349 53	**18**	312 15	35 15	**3**	357 22	80 45	**19**	42 45	126 17
4	268 14	350 52	**19**	313 13	36 14	**4**	358 21	81 44	**20**	43 45	127 16
5	269 13	351 51	**20**	314 12	37 13	**5**	359 20	82 44	**21**	44 44	128 15
6	270 12	352 50	**21**	315 11	38 13	**6**	0 19	83 43	**22**	45 44	129 15
7	271 10	353 49	**22**	316 09	39 12	**7**	1 18	84 43	**23**	46 43	130 14
8	272 09	354 49	**23**	317 08	40 11	**8**	2 17	85 42	**24**	47 42	131 13
9	273 08	355 48	**24**	318 07	41 11	**9**	3 16	86 41	**25**	48 42	132 13
10	274 06	356 47	**25**	319 06	42 10	**10**	4 15	87 41	**26**	49 41	133 12
11	275 05	357 46	**26**	320 04	43 09	**11**	5 14	88 40	**27**	50 40	134 11
12	276 03	358 45	**27**	321 03	44 08	**12**	6 13	89 40	**28**	51 40	135 10
13	277 02	359 44	**28**	322 02	45 08	**13**	7 12	90 39	**29**	52 39	136 10
14	278 01	0 43	**29**	323 01	46 07	**14**	8 12	91 39	**30**	53 39	137 09
15	278 59	1 42	**30**	324 00	47 06	**15**	9 11	92 38	**31**	54 38	138 08
16	279 58	2 41	**Oct. 1**	324 58	48 06	**16**	10 10	93 37	**32**	55 38	139 07

Form the quantities $C = p \cos$ (local hour angle) and $S = p \sin$ (local hour angle) then
Latitude $= h_0 - C + 0{\cdot}0087\, S^2 \tan h_0$,
Azimuth of *Polaris* $= -S/\cos h_0$ and Azimuth of σ Octantis $= 180^\circ + S/\cos h_0$, where p and h_0 are in degrees and h_0 is the observed altitude corrected for atmospheric refraction and instrument error.



STANDARD TIME ZONES

Corrected to August 2016

Zone boundaries are approximate

Daylight Saving Time (*Summer Time*), usually one hour in advance of Standard Time, is kept in some places

Compiled by HM Nautical Almanac Office

Standard Time = Universal Time – value from table

Universal Time = Standard Time + value from table

	h m		h m		h m		h m		h m		h m		h m
Z	0	D*	– 4 30	G	– 7	K*	– 10 30	M†	– 14	Q*	+ 4 30	V	+ 9
A	– 1	E	– 5	H	– 8	L	– 11	N	+ 1	R	+ 5	V*	+ 9 30
B	– 2	E*	– 5 30	H*	– 8 30	L*	– 11 30	O	+ 2	S	+ 6	W	+ 10
C	– 3	E†	– 5 45	I	– 9	M	– 12	P	+ 3	T	+ 7	X	+ 11
C*	– 3 30	F	– 6	I*	– 9 30	M‡	– 12 45	P*	+ 3 30	U	+ 8	Y	+ 12
D	– 4	F*	– 6 30	K	–10	M*	– 13	Q	+ 4				

§ No Standard Time legally adopted

The times of sunrise and sunset (pages 24–31) and of moonrise and moonset (pages 32–63) are the instants when the upper limbs of the Sun and Moon appear to lie on the horizon for an observer at sea-level. In both cases a fixed allowance of 34′ has been made for refraction; a further allowance of 16′ has been made for the semidiameter of the Sun, while for the Moon the actual value of semidiameter *minus* horizontal parallax has been used. No allowance has been made for the phase of the Moon. The observed times may differ from the tabular times because of variations in refraction and the relative heights of the observer and horizon.

The tabular values are for the universal time (UT) of the phenomena on the Greenwich meridian (longitude 0°). To a first approximation the UT at another longitude is given by subtracting the longitude, expressed in time-measure, if east of Greenwich, or by adding, if west of Greenwich. Alternatively the tables may be regarded as giving the approximate local mean time on all meridians. These times may be converted to standard time by applying the appropriate differences, as indicated in the note on page 4. Linear interpolation may be used to obtain the times for non-tabular latitudes.

In the case of the Sun it may be necessary to interpolate (mentally) to obtain the UT for an intermediate date, but a further interpolation for longitude is not normally required. In the case of the Moon the values must normally be interpolated for longitude, as well as for latitude, since the changes in the tabular values from one day to the next are usually large. The interpolating factor is equal to one twenty-fourth of the longitude if expressed in hours and decimals of an hour; linear interpolation is usually adequate.

Example

To find the times of sunrise and sunset and of moonrise and moonset on 2019 February 18 at latitude N 38° 55′, longitude W 77° 15′. The longitude expressed in time-measure is W $05^{h}\ 09^{m}$. The difference between standard time and UT is -5^{h} in this case.

The relevant tabular values in UT for longitude 0° are as follows:

	Sunrise		Sunset			Moonrise		Moonset	
	+35°	+40°	+35°	+40°		+35°	+40°	+35°	+40°
d	h m	h m	h m	h m	d	h m	h m	h m	h m
Feb. 15	06 46	06 53	17 42	17 35	**Feb. 18**	16 31	16 20	05 51	06 03
19	06 42	06 48	17 46	17 40	**19**	17 44	17 36	06 40	06 50

Interpolating factor for latitude is 3° 55′/ 5° = 0·78
for date for Sun is $3^{d}/4^{d}$ = 0·75
for long. for Moon is $5^{h}\cdot15/24^{h}$ = 0·21

	Sunrise		Sunset		Moonrise		Moonset	
Interpolation to:	d	h m	h m	d	h m	h m		
Latitude N 38° 55′	**Feb. 15**	06 51	17 37	**Feb. 18**	16 22	06 00		
N 38° 55′	**19**	06 47	17 41	**19**	17 38	06 48		
Local mean time	**18**	06 48	17 40	**18**	16 38	06 10		
Adjustment to:								
Universal time	**18**	11 57	22 49	**18**	21 47	11 19		
Standard time	**18**	06 57	17 49	**18**	16 47	06 19		

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

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

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Jan. −2	7 21	7 28	7 34	7 42	7 50	7 58	8 08	8 19	8 32	8 46	9 03	9 24	9 52	10 32
2	7 22	7 28	7 35	7 42	7 50	7 58	8 08	8 19	8 31	8 45	9 02	9 22	9 49	10 26
6	7 22	7 28	7 35	7 42	7 49	7 58	8 07	8 17	8 29	8 43	8 59	9 19	9 43	10 18
10	7 22	7 27	7 34	7 41	7 48	7 56	8 05	8 15	8 26	8 40	8 55	9 13	9 37	10 08
14	7 21	7 26	7 32	7 39	7 46	7 54	8 02	8 12	8 23	8 35	8 50	9 07	9 28	9 57
18	7 19	7 24	7 30	7 36	7 43	7 50	7 59	8 08	8 18	8 30	8 43	8 59	9 19	9 44
22	7 17	7 22	7 27	7 33	7 40	7 47	7 54	8 03	8 12	8 23	8 36	8 51	9 09	9 32
26	7 14	7 19	7 24	7 29	7 35	7 42	7 49	7 57	8 06	8 16	8 28	8 42	8 58	9 18
30	7 11	7 15	7 20	7 25	7 31	7 37	7 43	7 51	7 59	8 08	8 19	8 32	8 46	9 04
Feb. 3	7 07	7 11	7 16	7 20	7 25	7 31	7 37	7 44	7 52	8 00	8 10	8 21	8 34	8 50
7	7 03	7 07	7 11	7 15	7 20	7 25	7 31	7 37	7 44	7 51	8 00	8 10	8 22	8 36
11	6 58	7 02	7 05	7 09	7 14	7 18	7 23	7 29	7 35	7 42	7 50	7 59	8 09	8 21
15	6 53	6 56	7 00	7 03	7 07	7 11	7 16	7 21	7 26	7 32	7 39	7 47	7 56	8 07
19	6 48	6 51	6 54	6 57	7 00	7 04	7 08	7 12	7 17	7 22	7 28	7 35	7 43	7 52
23	6 43	6 45	6 48	6 50	6 53	6 56	6 59	7 03	7 07	7 12	7 17	7 22	7 29	7 37
27	6 37	6 39	6 41	6 43	6 46	6 48	6 51	6 54	6 57	7 01	7 05	7 10	7 15	7 22
Mar. 3	6 31	6 33	6 34	6 36	6 38	6 40	6 42	6 45	6 47	6 50	6 54	6 57	7 02	7 07
7	6 25	6 26	6 27	6 29	6 30	6 32	6 33	6 35	6 37	6 39	6 42	6 45	6 48	6 51
11	6 19	6 19	6 20	6 21	6 22	6 23	6 24	6 25	6 27	6 28	6 30	6 32	6 34	6 36
15	6 12	6 13	6 13	6 14	6 14	6 15	6 15	6 16	6 16	6 17	6 18	6 19	6 20	6 21
19	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06	6 06
23	5 59	5 59	5 59	5 58	5 58	5 57	5 57	5 56	5 55	5 55	5 54	5 53	5 52	5 50
27	5 53	5 52	5 51	5 50	5 49	5 48	5 47	5 46	5 45	5 43	5 42	5 40	5 37	5 35
31	5 46	5 45	5 44	5 43	5 41	5 40	5 38	5 36	5 34	5 32	5 29	5 27	5 23	5 19
Apr. 4	5 40	5 38	5 37	5 35	5 33	5 31	5 29	5 26	5 24	5 21	5 17	5 14	5 09	5 04

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

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

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Mar. 31	5 46	5 45	5 44	5 43	5 41	5 40	5 38	5 36	5 34	5 32	5 29	5 27	5 23	5 19
Apr. 4	5 40	5 38	5 37	5 35	5 33	5 31	5 29	5 26	5 24	5 21	5 17	5 14	5 09	5 04
8	5 34	5 32	5 30	5 28	5 25	5 23	5 20	5 17	5 13	5 10	5 05	5 01	4 55	4 49
12	5 27	5 25	5 23	5 20	5 17	5 14	5 11	5 07	5 03	4 59	4 53	4 48	4 41	4 33
16	5 21	5 19	5 16	5 13	5 10	5 06	5 02	4 58	4 53	4 48	4 42	4 35	4 27	4 17
20	5 16	5 12	5 09	5 06	5 02	4 58	4 53	4 48	4 43	4 37	4 30	4 22	4 13	4 02
24	5 10	5 06	5 03	4 59	4 55	4 50	4 45	4 39	4 33	4 26	4 18	4 09	3 59	3 46
28	5 04	5 01	4 57	4 52	4 48	4 43	4 37	4 31	4 24	4 16	4 07	3 57	3 45	3 31
May 2	4 59	4 55	4 51	4 46	4 41	4 35	4 29	4 22	4 15	4 06	3 56	3 45	3 31	3 15
6	4 55	4 50	4 45	4 40	4 35	4 28	4 22	4 14	4 06	3 56	3 46	3 33	3 18	2 59
10	4 50	4 45	4 40	4 35	4 29	4 22	4 15	4 07	3 58	3 47	3 35	3 21	3 04	2 43
14	4 46	4 41	4 36	4 30	4 23	4 16	4 08	4 00	3 50	3 39	3 26	3 10	2 51	2 27
18	4 43	4 37	4 31	4 25	4 18	4 11	4 02	3 53	3 42	3 30	3 16	2 59	2 39	2 11
22	4 39	4 34	4 28	4 21	4 14	4 06	3 57	3 47	3 36	3 23	3 08	2 49	2 26	1 55
26	4 37	4 31	4 24	4 17	4 10	4 01	3 52	3 42	3 30	3 16	3 00	2 40	2 15	1 39
30	4 34	4 28	4 22	4 14	4 06	3 58	3 48	3 37	3 25	3 10	2 53	2 32	2 04	1 22
June 3	4 33	4 26	4 19	4 12	4 04	3 55	3 45	3 33	3 20	3 05	2 47	2 24	1 54	1 05
7	4 31	4 25	4 18	4 10	4 02	3 53	3 42	3 30	3 17	3 01	2 42	2 18	1 45	0 46
11	4 31	4 24	4 17	4 09	4 01	3 51	3 40	3 28	3 15	2 58	2 39	2 13	1 38	0 24
15	4 31	4 24	4 17	4 09	4 00	3 50	3 40	3 27	3 13	2 57	2 36	2 10	1 34	▭
19	4 31	4 24	4 17	4 09	4 00	3 50	3 39	3 27	3 13	2 56	2 36	2 09	1 31	▭
23	4 32	4 25	4 18	4 10	4 01	3 51	3 40	3 28	3 14	2 57	2 36	2 10	1 32	▭
27	4 33	4 26	4 19	4 11	4 02	3 53	3 42	3 30	3 15	2 59	2 38	2 12	1 35	▭
July 1	4 35	4 28	4 21	4 13	4 04	3 55	3 44	3 32	3 18	3 02	2 42	2 16	1 41	0 16
5	4 37	4 30	4 23	4 15	4 07	3 58	3 47	3 35	3 22	3 06	2 47	2 22	1 49	0 45

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

▭ indicates Sun continuously above horizon.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

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

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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 1	4 35	4 28	4 21	4 13	4 04	3 55	3 44	3 32	3 18	3 02	2 42	2 16	1 41	0 16
5	4 37	4 30	4 23	4 15	4 07	3 58	3 47	3 35	3 22	3 06	2 47	2 22	1 49	0 45
9	4 39	4 33	4 26	4 18	4 10	4 01	3 51	3 39	3 26	3 11	2 52	2 29	1 58	1 06
13	4 42	4 36	4 29	4 22	4 14	4 05	3 55	3 44	3 32	3 17	2 59	2 37	2 09	1 25
17	4 45	4 39	4 33	4 26	4 18	4 09	4 00	3 49	3 37	3 23	3 07	2 47	2 20	1 43
21	4 48	4 42	4 36	4 30	4 22	4 14	4 05	3 55	3 44	3 31	3 15	2 56	2 32	2 00
25	4 52	4 46	4 40	4 34	4 27	4 19	4 11	4 01	3 51	3 38	3 24	3 06	2 45	2 16
29	4 55	4 50	4 44	4 38	4 32	4 25	4 17	4 08	3 58	3 46	3 33	3 17	2 57	2 32
Aug. 2	4 59	4 54	4 49	4 43	4 37	4 30	4 23	4 14	4 05	3 54	3 42	3 28	3 10	2 48
6	5 03	4 58	4 53	4 48	4 42	4 36	4 29	4 21	4 13	4 03	3 52	3 39	3 23	3 03
10	5 06	5 02	4 58	4 53	4 47	4 42	4 35	4 28	4 20	4 12	4 01	3 49	3 35	3 18
14	5 10	5 06	5 02	4 58	4 53	4 48	4 42	4 35	4 28	4 20	4 11	4 00	3 48	3 33
18	5 14	5 11	5 07	5 03	4 58	4 54	4 48	4 42	4 36	4 29	4 21	4 11	4 00	3 47
22	5 18	5 15	5 11	5 08	5 04	4 59	4 55	4 50	4 44	4 37	4 30	4 22	4 12	4 01
26	5 22	5 19	5 16	5 13	5 09	5 05	5 01	4 57	4 52	4 46	4 40	4 32	4 24	4 14
30	5 25	5 23	5 20	5 18	5 15	5 11	5 08	5 04	5 00	4 55	4 49	4 43	4 36	4 27
Sept. 3	5 29	5 27	5 25	5 23	5 20	5 17	5 14	5 11	5 07	5 03	4 59	4 53	4 47	4 40
7	5 33	5 31	5 30	5 28	5 26	5 23	5 21	5 18	5 15	5 12	5 08	5 04	4 59	4 53
11	5 37	5 35	5 34	5 33	5 31	5 29	5 27	5 25	5 23	5 20	5 18	5 14	5 11	5 06
15	5 40	5 40	5 39	5 38	5 36	5 35	5 34	5 32	5 31	5 29	5 27	5 25	5 22	5 19
19	5 44	5 44	5 43	5 43	5 42	5 41	5 40	5 40	5 39	5 37	5 36	5 35	5 33	5 31
23	5 48	5 48	5 48	5 48	5 47	5 47	5 47	5 47	5 46	5 46	5 46	5 45	5 45	5 44
27	5 52	5 52	5 52	5 53	5 53	5 53	5 54	5 54	5 54	5 55	5 55	5 56	5 56	5 57
Oct. 1	5 56	5 56	5 57	5 58	5 59	5 59	6 00	6 01	6 02	6 03	6 05	6 06	6 08	6 09
5	6 00	6 01	6 02	6 03	6 04	6 05	6 07	6 08	6 10	6 12	6 14	6 16	6 19	6 22

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

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

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

SUNRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Oct. 1	5 56	5 56	5 57	5 58	5 59	5 59	6 00	6 01	6 02	6 03	6 05	6 06	6 08	6 09
5	6 00	6 01	6 02	6 03	6 04	6 05	6 07	6 08	6 10	6 12	6 14	6 16	6 19	6 22
9	6 04	6 05	6 07	6 08	6 10	6 12	6 14	6 16	6 18	6 21	6 24	6 27	6 31	6 35
13	6 08	6 10	6 12	6 14	6 16	6 18	6 21	6 23	6 26	6 30	6 33	6 38	6 43	6 48
17	6 12	6 14	6 17	6 19	6 22	6 24	6 27	6 31	6 35	6 39	6 43	6 49	6 55	7 02
21	6 16	6 19	6 22	6 24	6 28	6 31	6 34	6 38	6 43	6 48	6 53	7 00	7 07	7 15
25	6 21	6 24	6 27	6 30	6 34	6 37	6 42	6 46	6 51	6 57	7 03	7 11	7 19	7 29
29	6 25	6 28	6 32	6 36	6 40	6 44	6 49	6 54	7 00	7 06	7 14	7 22	7 32	7 43
Nov. 2	6 30	6 33	6 37	6 41	6 46	6 51	6 56	7 02	7 08	7 16	7 24	7 33	7 44	7 57
6	6 34	6 38	6 42	6 47	6 52	6 57	7 03	7 10	7 17	7 25	7 34	7 45	7 57	8 12
10	6 39	6 43	6 48	6 53	6 58	7 04	7 10	7 17	7 25	7 34	7 44	7 56	8 10	8 27
14	6 43	6 48	6 53	6 58	7 04	7 10	7 17	7 25	7 34	7 43	7 54	8 07	8 23	8 42
18	6 48	6 53	6 58	7 04	7 10	7 17	7 24	7 33	7 42	7 52	8 04	8 19	8 36	8 57
22	6 53	6 58	7 03	7 09	7 16	7 23	7 31	7 40	7 50	8 01	8 14	8 30	8 48	9 12
26	6 57	7 02	7 08	7 15	7 22	7 29	7 38	7 47	7 57	8 09	8 23	8 40	9 01	9 27
30	7 01	7 07	7 13	7 20	7 27	7 35	7 44	7 53	8 04	8 17	8 32	8 50	9 12	9 42
Dec. 4	7 05	7 11	7 17	7 24	7 32	7 40	7 49	7 59	8 11	8 24	8 40	8 59	9 23	9 56
8	7 09	7 15	7 21	7 29	7 36	7 45	7 54	8 05	8 17	8 31	8 47	9 07	9 33	10 09
12	7 12	7 18	7 25	7 32	7 40	7 49	7 59	8 09	8 22	8 36	8 53	9 14	9 41	10 20
16	7 15	7 21	7 28	7 36	7 44	7 52	8 02	8 13	8 26	8 40	8 58	9 19	9 47	10 28
20	7 18	7 24	7 31	7 38	7 46	7 55	8 05	8 16	8 29	8 44	9 01	9 23	9 51	10 34
24	7 19	7 26	7 33	7 40	7 48	7 57	8 07	8 18	8 31	8 46	9 03	9 25	9 53	10 35
28	7 21	7 27	7 34	7 41	7 49	7 58	8 08	8 19	8 32	8 46	9 03	9 25	9 53	10 34
32	7 22	7 28	7 35	7 42	7 50	7 59	8 08	8 19	8 31	8 46	9 02	9 23	9 50	10 28
36	7 22	7 28	7 35	7 42	7 50	7 58	8 07	8 18	8 30	8 44	9 00	9 20	9 45	10 21

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

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Jan. 0	1 45	1 47	1 49	1 51	1 53	1 55	1 58	2 00	2 04	2 07	2 11	2 15	2 20	2 26
1	2 49	2 52	2 55	2 58	3 02	3 06	3 10	3 15	3 21	3 27	3 34	3 41	3 51	4 01
2	3 51	3 55	4 00	4 05	4 10	4 15	4 21	4 28	4 36	4 44	4 54	5 06	5 19	5 36
3	4 52	4 57	5 03	5 09	5 15	5 22	5 30	5 38	5 48	5 59	6 12	6 27	6 45	7 08
4	5 51	5 56	6 02	6 09	6 16	6 24	6 33	6 43	6 54	7 07	7 23	7 41	8 03	8 34
5	6 45	6 51	6 58	7 05	7 13	7 21	7 30	7 41	7 53	8 07	8 24	8 44	9 09	9 44
6	7 35	7 41	7 47	7 54	8 02	8 10	8 20	8 30	8 42	8 56	9 12	9 32	9 57	10 30
7	8 19	8 25	8 31	8 37	8 44	8 52	9 01	9 11	9 22	9 34	9 49	10 06	10 27	10 55
8	8 58	9 03	9 08	9 14	9 20	9 27	9 35	9 43	9 52	10 03	10 15	10 29	10 47	11 08
9	9 33	9 37	9 41	9 46	9 51	9 57	10 03	10 09	10 17	10 25	10 35	10 46	10 59	11 14
10	10 04	10 07	10 10	10 14	10 18	10 22	10 26	10 31	10 37	10 43	10 50	10 58	11 07	11 18
11	10 32	10 34	10 37	10 39	10 42	10 44	10 47	10 51	10 54	10 58	11 03	11 08	11 14	11 20
12	10 59	11 00	11 02	11 03	11 04	11 05	11 07	11 08	11 10	11 12	11 14	11 16	11 19	11 22
13	11 26	11 26	11 26	11 26	11 26	11 26	11 25	11 25	11 25	11 25	11 24	11 24	11 24	11 23
14	11 54	11 53	11 52	11 50	11 48	11 47	11 45	11 43	11 41	11 38	11 35	11 32	11 29	11 25
15	12 24	12 22	12 19	12 16	12 13	12 10	12 06	12 02	11 58	11 53	11 48	11 42	11 35	11 27
16	12 58	12 54	12 50	12 46	12 42	12 37	12 32	12 26	12 19	12 12	12 04	11 55	11 44	11 31
17	13 37	13 33	13 27	13 22	13 16	13 10	13 03	12 55	12 46	12 37	12 25	12 12	11 57	11 38
18	14 24	14 18	14 12	14 06	13 59	13 51	13 43	13 33	13 23	13 10	12 56	12 40	12 19	11 53
19	15 20	15 14	15 07	15 00	14 52	14 44	14 34	14 24	14 12	13 58	13 42	13 23	12 59	12 26
20	16 24	16 18	16 12	16 05	15 57	15 49	15 39	15 29	15 17	15 04	14 48	14 29	14 04	13 31
21	17 36	17 30	17 25	17 18	17 12	17 04	16 56	16 47	16 37	16 25	16 11	15 55	15 35	15 10
22	18 50	18 46	18 42	18 37	18 31	18 26	18 19	18 12	18 04	17 55	17 45	17 33	17 19	17 02
23	20 05	20 02	19 59	19 56	19 52	19 48	19 44	19 39	19 34	19 28	19 22	19 14	19 05	18 55
24	21 18	21 17	21 15	21 13	21 11	21 09	21 07	21 05	21 02	20 59	20 56	20 52	20 48	20 43

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Jan. 23	20 05	20 02	19 59	19 56	19 52	19 48	19 44	19 39	19 34	19 28	19 22	19 14	19 05	18 55
24	21 18	21 17	21 15	21 13	21 11	21 09	21 07	21 05	21 02	20 59	20 56	20 52	20 48	20 43
25	22 28	22 28	22 28	22 28	22 28	22 28	22 28	22 28	22 28	22 27	22 27	22 27	22 27	22 27
26	23 36	23 37	23 38	23 40	23 42	23 43	23 45	23 47	23 50	23 52	23 55	23 58	.. ..	.. ..
27	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 02	0 07
28	0 41	0 44	0 47	0 50	0 53	0 56	1 00	1 04	1 09	1 14	1 20	1 27	1 35	1 44
29	1 45	1 49	1 53	1 57	2 02	2 07	2 12	2 19	2 26	2 33	2 42	2 53	3 05	3 19
30	2 46	2 51	2 56	3 02	3 08	3 14	3 22	3 30	3 39	3 49	4 01	4 15	4 32	4 52
31	3 45	3 51	3 57	4 03	4 10	4 18	4 27	4 36	4 47	4 59	5 14	5 31	5 52	6 20
Feb. 1	4 41	4 47	4 53	5 00	5 08	5 16	5 25	5 36	5 48	6 02	6 18	6 37	7 02	7 36
2	5 31	5 37	5 44	5 51	5 59	6 07	6 17	6 28	6 40	6 54	7 10	7 30	7 55	8 30
3	6 17	6 23	6 29	6 36	6 43	6 51	7 00	7 10	7 22	7 35	7 50	8 08	8 31	9 01
4	6 58	7 03	7 09	7 15	7 21	7 29	7 36	7 45	7 55	8 06	8 19	8 35	8 53	9 17
5	7 34	7 38	7 43	7 48	7 54	8 00	8 06	8 13	8 22	8 31	8 41	8 53	9 08	9 25
6	8 06	8 09	8 13	8 17	8 21	8 26	8 31	8 37	8 43	8 50	8 58	9 07	9 17	9 29
7	8 35	8 38	8 40	8 43	8 46	8 49	8 53	8 57	9 01	9 06	9 11	9 17	9 24	9 32
8	9 03	9 04	9 06	9 07	9 09	9 10	9 12	9 14	9 17	9 19	9 22	9 25	9 29	9 33
9	9 29	9 30	9 30	9 30	9 30	9 31	9 31	9 31	9 32	9 32	9 33	9 33	9 34	9 35
10	9 56	9 55	9 54	9 53	9 52	9 51	9 50	9 48	9 47	9 45	9 43	9 41	9 39	9 36
11	10 25	10 23	10 20	10 18	10 16	10 13	10 10	10 07	10 03	9 59	9 55	9 50	9 44	9 38
12	10 56	10 53	10 49	10 46	10 42	10 37	10 33	10 28	10 22	10 16	10 09	10 01	9 51	9 40
13	11 31	11 27	11 22	11 17	11 12	11 06	11 00	10 53	10 45	10 36	10 27	10 15	10 02	9 46
14	12 13	12 07	12 02	11 56	11 49	11 42	11 34	11 25	11 16	11 04	10 52	10 36	10 18	9 56
15	13 02	12 56	12 50	12 43	12 35	12 27	12 18	12 08	11 57	11 44	11 28	11 10	10 47	10 17
16	14 00	13 54	13 48	13 40	13 33	13 24	13 15	13 04	12 52	12 38	12 22	12 02	11 37	11 02

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Feb. 15	13 02	12 56	12 50	12 43	12 35	12 27	12 18	12 08	11 57	11 44	11 28	11 10	10 47	10 17
16	14 00	13 54	13 48	13 40	13 33	13 24	13 15	13 04	12 52	12 38	12 22	12 02	11 37	11 02
17	15 07	15 01	14 55	14 48	14 41	14 33	14 24	14 14	14 03	13 50	13 35	13 17	12 54	12 24
18	16 20	16 15	16 10	16 04	15 58	15 51	15 44	15 36	15 27	15 16	15 04	14 49	14 32	14 11
19	17 36	17 32	17 29	17 24	17 20	17 15	17 09	17 03	16 57	16 49	16 41	16 31	16 19	16 05
20	18 52	18 50	18 47	18 45	18 42	18 39	18 36	18 32	18 28	18 24	18 19	18 13	18 07	17 59
21	20 06	20 05	20 04	20 04	20 03	20 02	20 01	19 59	19 58	19 57	19 55	19 53	19 51	19 49
22	21 18	21 18	21 19	21 20	21 21	21 22	21 23	21 24	21 25	21 27	21 28	21 30	21 32	21 34
23	22 27	22 29	22 31	22 34	22 36	22 39	22 42	22 45	22 49	22 53	22 58	23 03	23 10	23 17
24	23 34	23 37	23 41	23 44	23 49	23 53	23 58	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
25	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 04	0 10	0 17	0 25	0 34	0 44	0 57
26	0 38	0 42	0 47	0 52	0 58	1 04	1 11	1 18	1 27	1 36	1 47	2 00	2 15	2 34
27	1 39	1 44	1 50	1 56	2 03	2 10	2 19	2 28	2 38	2 50	3 04	3 20	3 41	4 07
28	2 36	2 42	2 48	2 55	3 03	3 11	3 20	3 31	3 42	3 56	4 12	4 31	4 55	5 29
Mar. 1	3 28	3 35	3 41	3 48	3 56	4 05	4 14	4 25	4 37	4 52	5 08	5 28	5 54	6 30
2	4 16	4 22	4 28	4 35	4 43	4 51	5 00	5 11	5 22	5 36	5 52	6 11	6 35	7 07
3	4 58	5 03	5 09	5 16	5 22	5 30	5 38	5 48	5 58	6 10	6 24	6 40	7 00	7 26
4	5 35	5 40	5 45	5 50	5 56	6 03	6 10	6 18	6 26	6 36	6 47	7 01	7 16	7 35
5	6 08	6 12	6 16	6 20	6 25	6 30	6 36	6 42	6 49	6 56	7 05	7 15	7 27	7 41
6	6 38	6 41	6 44	6 47	6 51	6 54	6 58	7 03	7 08	7 13	7 19	7 26	7 34	7 43
7	7 06	7 08	7 10	7 12	7 14	7 16	7 18	7 21	7 24	7 27	7 31	7 35	7 39	7 45
8	7 33	7 34	7 34	7 35	7 36	7 36	7 37	7 38	7 39	7 40	7 41	7 43	7 44	7 46
9	8 00	7 59	7 59	7 58	7 57	7 57	7 56	7 55	7 54	7 53	7 51	7 50	7 49	7 47
10	8 28	8 26	8 24	8 22	8 20	8 18	8 15	8 12	8 09	8 06	8 02	7 58	7 53	7 48
11	8 57	8 54	8 51	8 48	8 44	8 41	8 36	8 32	8 27	8 21	8 15	8 08	8 00	7 50

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	−55°	−50°	−45°	−40°	−35°	−30°	−20°	−10°	0°	+10°	+20°	+30°	+35°	+40°
	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
Mar. 9	8 23	8 20	8 18	8 17	8 15	8 14	8 12	8 10	8 08	8 06	8 04	8 02	8 01	8 00
10	9 34	9 27	9 21	9 16	9 12	9 09	9 02	8 57	8 52	8 46	8 41	8 35	8 31	8 28
11	10 48	10 35	10 26	10 18	10 11	10 05	9 54	9 45	9 37	9 29	9 20	9 10	9 04	8 57
12	12 02	11 45	11 31	11 20	11 11	11 03	10 48	10 36	10 25	10 13	10 01	9 47	9 39	9 30
13	13 16	12 55	12 38	12 24	12 12	12 02	11 45	11 30	11 16	11 02	10 47	10 30	10 20	10 09
14	14 28	14 03	13 43	13 27	13 14	13 03	12 43	12 26	12 10	11 54	11 37	11 18	11 06	10 53
15	15 33	15 06	14 45	14 29	14 15	14 03	13 42	13 24	13 07	12 50	12 33	12 12	12 00	11 46
16	16 27	16 02	15 42	15 26	15 12	15 01	14 40	14 23	14 07	13 50	13 33	13 12	13 01	12 47
17	17 10	16 49	16 31	16 17	16 05	15 55	15 37	15 21	15 07	14 52	14 36	14 18	14 07	13 55
18	17 44	17 27	17 14	17 03	16 53	16 45	16 30	16 18	16 06	15 54	15 41	15 26	15 18	15 08
19	18 11	18 00	17 51	17 43	17 36	17 31	17 20	17 12	17 03	16 55	16 46	16 36	16 30	16 23
20	18 34	18 28	18 23	18 19	18 16	18 13	18 08	18 03	17 59	17 54	17 50	17 44	17 41	17 38
21	18 54	18 54	18 53	18 53	18 53	18 53	18 53	18 52	18 52	18 52	18 52	18 52	18 52	18 52
22	19 14	19 19	19 23	19 26	19 29	19 32	19 37	19 41	19 45	19 49	19 53	19 58	20 01	20 04
23	19 35	19 45	19 53	20 00	20 06	20 11	20 20	20 29	20 36	20 44	20 52	21 02	21 08	21 14
24	19 58	20 13	20 25	20 35	20 44	20 52	21 05	21 17	21 28	21 39	21 51	22 05	22 13	22 22
25	20 25	20 45	21 01	21 14	21 25	21 34	21 51	22 06	22 19	22 33	22 48	23 05	23 15	23 27
26	20 58	21 22	21 40	21 55	22 08	22 19	22 38	22 55	23 11	23 27	23 43	.. ..	.. ..	.. ..
27	21 39	22 05	22 25	22 41	22 55	23 07	23 27	23 45	.. ..	.. ..	.. ..	0 03	0 14	0 27
28	22 28	22 55	23 15	23 31	23 45	23 57	.. ..	.. ..	0 02	0 19	0 36	0 57	1 09	1 23
29	23 25	23 50	.. ..	.. ..	.. ..	.. ..	0 17	0 35	0 52	1 09	1 27	1 47	1 59	2 13
30	.. ..	.. ..	0 09	0 24	0 37	0 49	1 08	1 25	1 41	1 57	2 13	2 33	2 44	2 57
31	0 28	0 49	1 06	1 20	1 31	1 41	1 59	2 14	2 28	2 42	2 57	3 14	3 24	3 36
Apr. 1	1 34	1 51	2 05	2 16	2 26	2 35	2 49	3 02	3 14	3 25	3 38	3 52	4 01	4 10
2	2 42	2 55	3 05	3 14	3 21	3 28	3 39	3 49	3 58	4 07	4 16	4 27	4 34	4 41

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Mar. 9	8 00	7 59	7 59	7 58	7 57	7 57	7 56	7 55	7 54	7 53	7 51	7 50	7 49	7 47
10	8 28	8 26	8 24	8 22	8 20	8 18	8 15	8 12	8 09	8 06	8 02	7 58	7 53	7 48
11	8 57	8 54	8 51	8 48	8 44	8 41	8 36	8 32	8 27	8 21	8 15	8 08	8 00	7 50
12	9 30	9 26	9 22	9 18	9 13	9 07	9 02	8 55	8 48	8 40	8 31	8 20	8 08	7 54
13	10 09	10 04	9 58	9 53	9 46	9 40	9 32	9 24	9 15	9 04	8 52	8 38	8 21	8 01
14	10 53	10 48	10 42	10 35	10 28	10 20	10 11	10 01	9 50	9 37	9 23	9 05	8 43	8 15
15	11 46	11 40	11 33	11 26	11 18	11 10	11 00	10 50	10 38	10 24	10 07	9 47	9 22	8 47
16	12 47	12 41	12 35	12 27	12 20	12 11	12 02	11 51	11 40	11 26	11 10	10 50	10 25	9 51
17	13 55	13 50	13 44	13 38	13 31	13 23	13 15	13 06	12 55	12 43	12 29	12 13	11 53	11 26
18	15 08	15 04	14 59	14 54	14 48	14 43	14 36	14 29	14 21	14 12	14 01	13 49	13 34	13 16
19	16 23	16 20	16 17	16 13	16 10	16 05	16 01	15 56	15 51	15 45	15 38	15 30	15 21	15 10
20	17 38	17 36	17 35	17 33	17 31	17 29	17 27	17 24	17 22	17 19	17 15	17 11	17 07	17 02
21	18 52	18 52	18 52	18 52	18 51	18 51	18 51	18 51	18 51	18 51	18 51	18 51	18 51	18 51
22	20 04	20 05	20 07	20 08	20 10	20 12	20 14	20 16	20 19	20 22	20 25	20 29	20 33	20 38
23	21 14	21 17	21 20	21 23	21 27	21 30	21 35	21 39	21 44	21 50	21 56	22 04	22 13	22 23
24	22 22	22 26	22 30	22 35	22 40	22 46	22 52	22 59	23 06	23 15	23 24	23 36	23 49	.. ..
25	23 27	23 32	23 37	23 43	23 50	23 57	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 06
26	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 05	0 13	0 23	0 34	0 47	1 03	1 21	1 45
27	0 27	0 33	0 40	0 46	0 54	1 02	1 11	1 21	1 33	1 46	2 02	2 20	2 44	3 16
28	1 23	1 29	1 36	1 43	1 51	2 00	2 09	2 20	2 33	2 47	3 04	3 25	3 51	4 29
29	2 13	2 19	2 26	2 33	2 41	2 49	2 59	3 10	3 22	3 36	3 53	4 13	4 39	5 14
30	2 57	3 03	3 09	3 16	3 23	3 31	3 40	3 50	4 01	4 14	4 28	4 46	5 08	5 37
31	3 36	3 41	3 46	3 52	3 58	4 05	4 13	4 22	4 31	4 42	4 54	5 09	5 26	5 48
Apr. 1	4 10	4 14	4 19	4 24	4 29	4 34	4 41	4 47	4 55	5 03	5 13	5 24	5 37	5 53
2	4 41	4 44	4 47	4 51	4 55	4 59	5 04	5 09	5 14	5 21	5 28	5 36	5 45	5 56

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Apr. 1	4 10	4 14	4 19	4 24	4 29	4 34	4 41	4 47	4 55	5 03	5 13	5 24	5 37	5 53
2	4 41	4 44	4 47	4 51	4 55	4 59	5 04	5 09	5 14	5 21	5 28	5 36	5 45	5 56
3	5 09	5 11	5 14	5 16	5 19	5 21	5 24	5 28	5 31	5 35	5 40	5 45	5 51	5 57
4	5 36	5 37	5 38	5 39	5 41	5 42	5 43	5 45	5 46	5 48	5 50	5 52	5 55	5 58
5	6 03	6 03	6 03	6 02	6 02	6 02	6 02	6 01	6 01	6 01	6 00	6 00	5 59	5 58
6	6 30	6 29	6 28	6 26	6 24	6 22	6 21	6 18	6 16	6 13	6 10	6 07	6 03	5 59
7	7 00	6 57	6 54	6 51	6 48	6 45	6 41	6 37	6 33	6 28	6 22	6 16	6 09	6 00
8	7 32	7 28	7 24	7 20	7 15	7 10	7 05	6 59	6 52	6 45	6 36	6 27	6 16	6 03
9	8 08	8 03	7 58	7 53	7 47	7 40	7 33	7 25	7 17	7 07	6 55	6 42	6 27	6 07
10	8 51	8 45	8 39	8 32	8 25	8 18	8 09	7 59	7 49	7 36	7 22	7 05	6 45	6 18
11	9 40	9 34	9 27	9 20	9 12	9 04	8 54	8 43	8 31	8 17	8 01	7 41	7 16	6 41
12	10 37	10 31	10 24	10 17	10 09	10 00	9 51	9 40	9 27	9 13	8 56	8 36	8 09	7 32
13	11 41	11 35	11 29	11 22	11 15	11 07	10 58	10 48	10 37	10 24	10 09	9 50	9 27	8 57
14	12 50	12 45	12 40	12 34	12 28	12 21	12 14	12 06	11 57	11 46	11 34	11 20	11 03	10 41
15	14 02	13 58	13 54	13 50	13 46	13 41	13 35	13 29	13 22	13 15	13 06	12 56	12 45	12 31
16	15 15	15 12	15 10	15 07	15 05	15 02	14 58	14 55	14 51	14 46	14 41	14 35	14 29	14 21
17	16 27	16 27	16 26	16 25	16 24	16 23	16 22	16 20	16 19	16 18	16 16	16 14	16 12	16 09
18	17 39	17 40	17 41	17 42	17 43	17 43	17 44	17 46	17 47	17 48	17 50	17 52	17 54	17 56
19	18 51	18 53	18 55	18 57	19 00	19 03	19 06	19 10	19 14	19 18	19 23	19 28	19 35	19 42
20	20 01	20 04	20 08	20 12	20 16	20 21	20 26	20 32	20 38	20 46	20 54	21 03	21 15	21 28
21	21 08	21 13	21 18	21 24	21 30	21 36	21 43	21 51	22 00	22 10	22 22	22 36	22 52	23 12
22	22 13	22 19	22 25	22 31	22 38	22 46	22 55	23 05	23 16	23 28	23 43	.. ..	.. ..	.. ..
23	23 13	23 19	23 25	23 33	23 41	23 49	23 59	.. ..	.. ..	.. ..	.. ..	0 01	0 23	0 52
24	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 10	0 22	0 37	0 54	1 14	1 41	2 19
25	0 06	0 13	0 20	0 27	0 35	0 44	0 54	1 05	1 18	1 32	1 50	2 11	2 38	3 18

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Apr. 24	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 10	0 22	0 37	0 54	1 14	1 41	2 19
25	0 06	0 13	0 20	0 27	0 35	0 44	0 54	1 05	1 18	1 32	1 50	2 11	2 38	3 18
26	0 54	1 00	1 06	1 13	1 21	1 29	1 39	1 49	2 01	2 15	2 31	2 50	3 15	3 48
27	1 35	1 40	1 46	1 53	1 59	2 07	2 15	2 24	2 35	2 47	3 00	3 16	3 36	4 01
28	2 11	2 16	2 20	2 26	2 32	2 38	2 45	2 52	3 01	3 10	3 21	3 34	3 49	4 07
29	2 43	2 46	2 50	2 54	2 59	3 04	3 09	3 15	3 21	3 29	3 37	3 46	3 57	4 10
30	3 12	3 14	3 17	3 20	3 23	3 27	3 30	3 34	3 39	3 44	3 49	3 55	4 03	4 11
May 1	3 39	3 40	3 42	3 44	3 45	3 47	3 49	3 51	3 54	3 57	4 00	4 03	4 07	4 11
2	4 06	4 06	4 06	4 06	4 07	4 07	4 07	4 08	4 08	4 09	4 09	4 10	4 11	4 11
3	4 32	4 31	4 31	4 29	4 28	4 27	4 26	4 24	4 23	4 21	4 19	4 17	4 14	4 11
4	5 01	4 59	4 56	4 54	4 51	4 49	4 45	4 42	4 38	4 34	4 30	4 25	4 19	4 12
5	5 32	5 29	5 25	5 21	5 17	5 13	5 08	5 03	4 57	4 50	4 43	4 34	4 25	4 13
6	6 07	6 03	5 58	5 53	5 47	5 41	5 35	5 27	5 19	5 10	5 00	4 48	4 33	4 16
7	6 48	6 43	6 37	6 30	6 24	6 16	6 08	5 59	5 49	5 37	5 23	5 07	4 48	4 24
8	7 36	7 30	7 23	7 16	7 08	7 00	6 50	6 40	6 28	6 14	5 58	5 38	5 14	4 40
9	8 31	8 25	8 18	8 10	8 02	7 53	7 44	7 32	7 20	7 05	6 48	6 27	5 59	5 20
10	9 33	9 27	9 21	9 14	9 06	8 57	8 48	8 38	8 26	8 12	7 55	7 36	7 11	6 36
11	10 40	10 35	10 29	10 23	10 17	10 09	10 01	9 52	9 42	9 31	9 17	9 01	8 42	8 17
12	11 50	11 46	11 42	11 37	11 32	11 26	11 20	11 13	11 05	10 57	10 47	10 35	10 22	10 05
13	13 01	12 58	12 55	12 52	12 49	12 45	12 41	12 36	12 31	12 25	12 19	12 12	12 03	11 53
14	14 12	14 10	14 09	14 07	14 06	14 04	14 02	14 00	13 57	13 54	13 51	13 48	13 44	13 39
15	15 22	15 22	15 22	15 22	15 22	15 22	15 22	15 23	15 23	15 23	15 23	15 23	15 23	15 24
16	16 32	16 33	16 35	16 37	16 38	16 40	16 43	16 45	16 48	16 51	16 54	16 58	17 02	17 08
17	17 41	17 44	17 47	17 50	17 54	17 58	18 02	18 07	18 12	18 18	18 25	18 32	18 41	18 52
18	18 49	18 54	18 58	19 03	19 08	19 14	19 20	19 27	19 35	19 44	19 54	20 06	20 20	20 37

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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 17	17 41	17 44	17 47	17 50	17 54	17 58	18 02	18 07	18 12	18 18	18 25	18 32	18 41	18 52
18	18 49	18 54	18 58	19 03	19 08	19 14	19 20	19 27	19 35	19 44	19 54	20 06	20 20	20 37
19	19 56	20 01	20 07	20 13	20 20	20 27	20 35	20 44	20 54	21 06	21 19	21 35	21 55	22 21
20	20 58	21 05	21 11	21 18	21 26	21 34	21 44	21 54	22 06	22 20	22 37	22 56	23 22	23 57
21	21 56	22 02	22 09	22 17	22 25	22 34	22 44	22 55	23 08	23 23	23 41	.. ..	.. ..	.. ..
22	22 47	22 53	23 00	23 08	23 16	23 24	23 34	23 45	23 58	.. ..	.. ..	0 03	0 31	1 13
23	23 32	23 37	23 44	23 50	23 58	.. ..	.. ..	.. ..	.. ..	0 12	0 29	0 50	1 17	1 56
24	.. ..	.. ..	.. ..	.. ..	.. ..	0 06	0 15	0 25	0 36	0 49	1 04	1 22	1 44	2 14
25	0 10	0 15	0 21	0 26	0 33	0 40	0 47	0 56	1 05	1 16	1 28	1 42	2 00	2 21
26	0 44	0 48	0 52	0 57	1 02	1 07	1 14	1 20	1 28	1 36	1 45	1 56	2 09	2 24
27	1 14	1 17	1 20	1 23	1 27	1 31	1 36	1 40	1 46	1 52	1 59	2 06	2 15	2 25
28	1 41	1 43	1 45	1 47	1 50	1 52	1 55	1 58	2 01	2 05	2 09	2 14	2 19	2 26
29	2 08	2 08	2 09	2 10	2 11	2 12	2 13	2 14	2 16	2 17	2 19	2 21	2 23	2 25
30	2 34	2 33	2 33	2 33	2 32	2 32	2 31	2 30	2 30	2 29	2 28	2 27	2 26	2 25
31	3 01	3 00	2 58	2 56	2 54	2 52	2 50	2 47	2 44	2 41	2 38	2 34	2 30	2 25
June 1	3 31	3 28	3 25	3 22	3 18	3 15	3 11	3 06	3 01	2 56	2 50	2 43	2 35	2 25
2	4 04	4 00	3 56	3 51	3 46	3 41	3 35	3 29	3 22	3 13	3 04	2 54	2 42	2 27
3	4 43	4 38	4 32	4 27	4 20	4 13	4 06	3 57	3 48	3 37	3 25	3 10	2 53	2 32
4	5 29	5 23	5 16	5 09	5 02	4 54	4 45	4 35	4 23	4 10	3 55	3 36	3 13	2 43
5	6 22	6 16	6 09	6 02	5 54	5 45	5 35	5 24	5 11	4 56	4 39	4 18	3 50	3 12
6	7 24	7 17	7 11	7 03	6 55	6 47	6 37	6 26	6 13	5 59	5 42	5 21	4 54	4 16
7	8 31	8 25	8 19	8 13	8 06	7 58	7 49	7 39	7 29	7 16	7 01	6 44	6 22	5 53
8	9 41	9 37	9 32	9 27	9 21	9 15	9 08	9 00	8 51	8 42	8 31	8 18	8 02	7 43
9	10 52	10 49	10 46	10 42	10 38	10 33	10 29	10 23	10 17	10 11	10 03	9 54	9 44	9 32
10	12 03	12 01	11 59	11 57	11 54	11 52	11 49	11 46	11 43	11 39	11 35	11 30	11 25	11 19

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
June 8	9 41	9 37	9 32	9 27	9 21	9 15	9 08	9 00	8 51	8 42	8 31	8 18	8 02	7 43
9	10 52	10 49	10 46	10 42	10 38	10 33	10 29	10 23	10 17	10 11	10 03	9 54	9 44	9 32
10	12 03	12 01	11 59	11 57	11 54	11 52	11 49	11 46	11 43	11 39	11 35	11 30	11 25	11 19
11	13 12	13 12	13 11	13 11	13 10	13 10	13 09	13 08	13 07	13 07	13 06	13 05	13 03	13 02
12	14 20	14 21	14 22	14 24	14 25	14 26	14 28	14 29	14 31	14 33	14 35	14 38	14 41	14 44
13	15 28	15 31	15 33	15 36	15 39	15 42	15 46	15 49	15 54	15 59	16 04	16 10	16 17	16 26
14	16 35	16 39	16 43	16 47	16 52	16 57	17 03	17 09	17 16	17 23	17 32	17 42	17 54	18 08
15	17 42	17 46	17 52	17 57	18 03	18 10	18 18	18 26	18 35	18 46	18 58	19 12	19 29	19 51
16	18 45	18 51	18 57	19 04	19 11	19 19	19 28	19 38	19 50	20 03	20 18	20 37	21 00	21 31
17	19 45	19 51	19 58	20 05	20 14	20 22	20 32	20 43	20 56	21 11	21 28	21 50	22 18	22 58
18	20 39	20 45	20 52	21 00	21 08	21 17	21 27	21 38	21 51	22 06	22 24	22 46	23 14	23 56
19	21 26	21 33	21 39	21 46	21 54	22 02	22 12	22 22	22 34	22 48	23 04	23 24	23 49	.. ..
20	22 08	22 13	22 19	22 25	22 32	22 40	22 48	22 57	23 07	23 19	23 33	23 49	.. ..	0 22
21	22 43	22 48	22 53	22 58	23 04	23 10	23 17	23 24	23 32	23 42	23 52	.. ..	0 08	0 33
22	23 15	23 18	23 22	23 26	23 30	23 35	23 40	23 46	23 52	23 59	.. ..	0 05	0 19	0 37
23	23 43	23 46	23 48	23 51	23 54	23 57	.. ..	.. ..	.. ..	.. ..	0 07	0 16	0 27	0 39
24	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	0 01	0 04	0 09	0 13	0 18	0 24	0 31	0 39
25	0 10	0 11	0 12	0 14	0 15	0 17	0 19	0 21	0 23	0 26	0 28	0 31	0 35	0 39
26	0 35	0 36	0 36	0 36	0 36	0 36	0 36	0 37	0 37	0 37	0 37	0 38	0 38	0 38
27	1 02	1 01	0 59	0 58	0 57	0 56	0 54	0 52	0 51	0 49	0 47	0 44	0 41	0 38
28	1 30	1 27	1 25	1 22	1 20	1 17	1 13	1 10	1 06	1 02	0 57	0 51	0 45	0 38
29	2 01	1 57	1 53	1 50	1 45	1 41	1 36	1 30	1 24	1 17	1 10	1 01	0 51	0 39
30	2 36	2 32	2 27	2 22	2 16	2 10	2 03	1 55	1 47	1 38	1 27	1 14	1 00	0 42
July 1	3 19	3 13	3 07	3 01	2 54	2 46	2 38	2 28	2 18	2 06	1 52	1 35	1 15	0 49
2	4 09	4 03	3 56	3 49	3 41	3 32	3 23	3 12	3 00	2 45	2 29	2 09	1 43	1 08

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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 1	3 19	3 13	3 07	3 01	2 54	2 46	2 38	2 28	2 18	2 06	1 52	1 35	1 15	0 49
2	4 09	4 03	3 56	3 49	3 41	3 32	3 23	3 12	3 00	2 45	2 29	2 09	1 43	1 08
3	5 08	5 02	4 55	4 48	4 39	4 30	4 21	4 09	3 57	3 42	3 24	3 03	2 35	1 54
4	6 15	6 09	6 03	5 56	5 48	5 40	5 31	5 20	5 09	4 55	4 39	4 20	3 56	3 22
5	7 27	7 22	7 16	7 11	7 04	6 57	6 50	6 41	6 32	6 21	6 08	5 53	5 35	5 13
6	8 40	8 36	8 32	8 28	8 23	8 18	8 13	8 06	8 00	7 52	7 43	7 33	7 21	7 06
7	9 53	9 50	9 48	9 45	9 42	9 39	9 36	9 32	9 28	9 23	9 18	9 12	9 05	8 57
8	11 03	11 03	11 02	11 01	10 59	10 58	10 57	10 56	10 54	10 52	10 50	10 48	10 46	10 43
9	12 13	12 13	12 14	12 14	12 15	12 16	12 17	12 17	12 18	12 20	12 21	12 22	12 24	12 26
10	13 20	13 22	13 24	13 27	13 29	13 32	13 35	13 38	13 41	13 45	13 50	13 55	14 00	14 07
11	14 27	14 30	14 34	14 38	14 42	14 46	14 51	14 56	15 02	15 09	15 17	15 26	15 36	15 48
12	15 33	15 37	15 42	15 47	15 53	15 59	16 06	16 13	16 22	16 31	16 42	16 55	17 11	17 30
13	16 36	16 42	16 48	16 54	17 01	17 09	17 17	17 26	17 37	17 49	18 04	18 21	18 42	19 09
14	17 37	17 43	17 49	17 57	18 04	18 13	18 23	18 33	18 46	19 00	19 17	19 37	20 04	20 41
15	18 32	18 38	18 45	18 53	19 01	19 10	19 20	19 32	19 45	20 00	20 17	20 39	21 08	21 51
16	19 22	19 28	19 35	19 42	19 50	19 59	20 08	20 19	20 32	20 46	21 03	21 24	21 50	22 27
17	20 05	20 11	20 17	20 24	20 31	20 39	20 47	20 57	21 08	21 21	21 35	21 53	22 14	22 42
18	20 43	20 48	20 53	20 59	21 05	21 11	21 19	21 27	21 36	21 46	21 58	22 12	22 28	22 48
19	21 16	21 20	21 24	21 28	21 33	21 38	21 44	21 50	21 58	22 05	22 14	22 25	22 37	22 51
20	21 45	21 48	21 51	21 54	21 58	22 01	22 06	22 10	22 15	22 21	22 27	22 34	22 42	22 52
21	22 12	22 14	22 16	22 18	22 20	22 22	22 24	22 27	22 30	22 33	22 37	22 41	22 46	22 51
22	22 38	22 38	22 39	22 40	22 40	22 41	22 42	22 43	22 44	22 45	22 46	22 47	22 49	22 51
23	23 03	23 03	23 02	23 01	23 01	23 00	22 59	22 58	22 57	22 56	22 55	22 54	22 52	22 50
24	23 30	23 28	23 26	23 24	23 22	23 20	23 17	23 15	23 12	23 08	23 04	23 00	22 56	22 50
25	23 59	23 56	23 53	23 49	23 46	23 42	23 38	23 33	23 28	23 22	23 16	23 08	23 00	22 50

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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 24	23 30	23 28	23 26	23 24	23 22	23 20	23 17	23 15	23 12	23 08	23 04	23 00	22 56	22 50
25	23 59	23 56	23 53	23 49	23 46	23 42	23 38	23 33	23 28	23 22	23 16	23 08	23 00	22 50
26	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	23 55	23 48	23 39	23 30	23 19	23 07	22 52
27	0 31	0 27	0 23	0 18	0 13	0 08	0 02	.. ..	.. ..	.. ..	23 50	23 36	23 18	22 57
28	1 09	1 04	0 59	0 53	0 46	0 39	0 32	0 23	0 14	0 03	.. ..	.. ..	23 39	23 08
29	1 55	1 49	1 43	1 36	1 28	1 20	1 11	1 01	0 49	0 36	0 20	0 02	.. ..	23 38
30	2 50	2 43	2 36	2 29	2 21	2 12	2 02	1 51	1 38	1 23	1 06	0 44	0 17	.. ..
31	3 53	3 47	3 40	3 33	3 25	3 16	3 06	2 56	2 43	2 29	2 12	1 51	1 24	0 46
Aug. 1	5 04	4 59	4 53	4 46	4 39	4 32	4 23	4 14	4 03	3 51	3 36	3 19	2 58	2 30
2	6 19	6 15	6 10	6 05	5 59	5 53	5 47	5 40	5 31	5 22	5 12	4 59	4 45	4 27
3	7 34	7 31	7 28	7 25	7 21	7 17	7 13	7 08	7 03	6 57	6 50	6 42	6 33	6 23
4	8 49	8 47	8 46	8 44	8 42	8 40	8 38	8 36	8 33	8 30	8 27	8 24	8 19	8 15
5	10 01	10 01	10 01	10 01	10 01	10 01	10 01	10 01	10 01	10 01	10 02	10 02	10 02	10 02
6	11 11	11 12	11 14	11 16	11 18	11 20	11 22	11 24	11 27	11 30	11 33	11 37	11 42	11 47
7	12 19	12 22	12 25	12 28	12 32	12 36	12 40	12 45	12 50	12 56	13 03	13 10	13 19	13 30
8	13 26	13 30	13 34	13 39	13 44	13 50	13 56	14 03	14 11	14 20	14 30	14 41	14 55	15 12
9	14 30	14 35	14 41	14 47	14 54	15 01	15 09	15 18	15 28	15 39	15 53	16 09	16 28	16 53
10	15 31	15 37	15 44	15 51	15 58	16 07	16 16	16 27	16 38	16 52	17 08	17 28	17 53	18 28
11	16 28	16 34	16 41	16 48	16 57	17 06	17 16	17 27	17 40	17 55	18 13	18 35	19 03	19 46
12	17 19	17 25	17 32	17 39	17 47	17 56	18 06	18 18	18 30	18 45	19 02	19 24	19 52	20 32
13	18 04	18 10	18 16	18 23	18 30	18 39	18 48	18 58	19 10	19 23	19 38	19 57	20 20	20 51
14	18 43	18 48	18 54	19 00	19 06	19 13	19 21	19 30	19 40	19 51	20 03	20 18	20 37	20 59
15	19 17	19 21	19 26	19 31	19 36	19 42	19 48	19 55	20 03	20 11	20 21	20 33	20 46	21 02
16	19 47	19 51	19 54	19 58	20 02	20 06	20 11	20 16	20 21	20 28	20 35	20 43	20 52	21 03
17	20 15	20 17	20 19	20 22	20 24	20 27	20 30	20 33	20 37	20 41	20 46	20 51	20 56	21 03

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Aug. 16	19 47	19 51	19 54	19 58	20 02	20 06	20 11	20 16	20 21	20 28	20 35	20 43	20 52	21 03
17	20 15	20 17	20 19	20 22	20 24	20 27	20 30	20 33	20 37	20 41	20 46	20 51	20 56	21 03
18	20 41	20 42	20 43	20 44	20 45	20 46	20 48	20 49	20 51	20 53	20 55	20 57	21 00	21 03
19	21 06	21 06	21 06	21 06	21 05	21 05	21 05	21 05	21 04	21 04	21 03	21 03	21 02	21 02
20	21 32	21 31	21 29	21 28	21 26	21 24	21 22	21 20	21 18	21 15	21 12	21 09	21 05	21 01
21	21 59	21 57	21 54	21 51	21 48	21 45	21 41	21 37	21 33	21 28	21 22	21 16	21 09	21 01
22	22 29	22 26	22 22	22 18	22 13	22 08	22 03	21 57	21 50	21 43	21 35	21 26	21 15	21 02
23	23 04	22 59	22 54	22 49	22 43	22 36	22 29	22 22	22 13	22 03	21 52	21 39	21 23	21 04
24	23 45	23 39	23 33	23 27	23 19	23 12	23 03	22 53	22 43	22 30	22 16	21 59	21 38	21 11
25	.. ..	.. ..	.. ..	.. ..	.. ..	23 57	23 47	23 36	23 24	23 09	22 52	22 32	22 06	21 29
26	0 34	0 28	0 21	0 13	0 05	.. ..	.. ..	.. ..	.. ..	.. ..	23 47	23 25	22 57	22 16
27	1 32	1 25	1 18	1 11	1 03	0 54	0 44	0 32	0 20	0 05	.. ..	.. ..	.. ..	23 44
28	2 38	2 32	2 26	2 19	2 11	2 03	1 54	1 43	1 31	1 18	1 02	0 42	0 18	.. ..
29	3 51	3 46	3 41	3 35	3 29	3 22	3 14	3 06	2 56	2 45	2 33	2 18	2 00	1 37
30	5 07	5 04	5 00	4 56	4 51	4 46	4 41	4 34	4 28	4 20	4 11	4 01	3 50	3 36
31	6 24	6 22	6 20	6 17	6 14	6 12	6 08	6 05	6 01	5 57	5 52	5 46	5 40	5 32
Sept. 1	7 40	7 39	7 38	7 38	7 37	7 36	7 35	7 34	7 33	7 32	7 31	7 29	7 27	7 25
2	8 53	8 54	8 55	8 56	8 57	8 59	9 00	9 01	9 03	9 05	9 07	9 09	9 12	9 15
3	10 05	10 07	10 10	10 13	10 16	10 19	10 22	10 26	10 31	10 36	10 41	10 47	10 55	11 03
4	11 15	11 18	11 22	11 27	11 31	11 37	11 42	11 48	11 55	12 03	12 12	12 23	12 35	12 50
5	12 22	12 27	12 32	12 38	12 44	12 51	12 58	13 07	13 16	13 27	13 39	13 54	14 12	14 34
6	13 25	13 31	13 37	13 44	13 51	14 00	14 09	14 19	14 31	14 44	15 00	15 18	15 42	16 15
7	14 24	14 30	14 37	14 44	14 53	15 02	15 12	15 23	15 36	15 51	16 08	16 30	16 59	17 41
8	15 17	15 23	15 30	15 38	15 46	15 55	16 05	16 17	16 30	16 45	17 03	17 25	17 54	18 37
9	16 03	16 09	16 16	16 23	16 31	16 40	16 49	17 00	17 12	17 26	17 42	18 02	18 27	19 02

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Sept. 8	15 17	15 23	15 30	15 38	15 46	15 55	16 05	16 17	16 30	16 45	17 03	17 25	17 54	18 37
9	16 03	16 09	16 16	16 23	16 31	16 40	16 49	17 00	17 12	17 26	17 42	18 02	18 27	19 02
10	16 44	16 49	16 55	17 02	17 08	17 16	17 24	17 34	17 44	17 56	18 10	18 26	18 46	19 11
11	17 19	17 24	17 29	17 34	17 40	17 46	17 53	18 00	18 09	18 18	18 29	18 42	18 57	19 15
12	17 50	17 54	17 58	18 02	18 06	18 11	18 16	18 22	18 28	18 35	18 43	18 53	19 03	19 16
13	18 19	18 21	18 24	18 26	18 29	18 33	18 36	18 40	18 44	18 49	18 54	19 01	19 07	19 15
14	18 45	18 46	18 48	18 49	18 51	18 52	18 54	18 56	18 59	19 01	19 04	19 07	19 11	19 15
15	19 10	19 10	19 10	19 11	19 11	19 11	19 11	19 11	19 12	19 12	19 12	19 13	19 13	19 14
16	19 35	19 34	19 33	19 32	19 31	19 30	19 28	19 27	19 25	19 23	19 21	19 18	19 16	19 13
17	20 02	20 00	19 57	19 55	19 52	19 49	19 46	19 43	19 39	19 35	19 30	19 25	19 19	19 12
18	20 31	20 27	20 24	20 20	20 16	20 11	20 06	20 01	19 55	19 49	19 41	19 33	19 23	19 12
19	21 03	20 59	20 54	20 49	20 43	20 37	20 31	20 23	20 15	20 06	19 56	19 44	19 30	19 13
20	21 41	21 35	21 29	21 23	21 16	21 09	21 01	20 51	20 41	20 30	20 16	20 00	19 41	19 16
21	22 25	22 19	22 12	22 05	21 57	21 49	21 39	21 28	21 16	21 02	20 46	20 26	20 01	19 27
22	23 17	23 11	23 04	22 56	22 48	22 39	22 29	22 17	22 04	21 49	21 31	21 09	20 40	19 57
23	.. ..	.. ..	.. ..	23 58	23 50	23 41	23 31	23 20	23 07	22 53	22 35	22 14	21 46	21 07
24	0 18	0 12	0 05	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	23 57	23 40	23 18	22 50
25	1 27	1 21	1 15	1 08	1 01	0 54	0 45	0 35	0 24	0 12	.. ..	.. ..	.. ..	.. ..
26	2 40	2 35	2 31	2 25	2 20	2 14	2 07	2 00	1 52	1 42	1 31	1 19	1 04	0 45
27	3 55	3 52	3 49	3 46	3 42	3 38	3 34	3 29	3 23	3 17	3 10	3 02	2 53	2 42
28	5 12	5 10	5 09	5 07	5 05	5 03	5 01	4 59	4 56	4 54	4 50	4 47	4 43	4 38
29	6 27	6 27	6 27	6 28	6 28	6 28	6 28	6 29	6 29	6 29	6 30	6 30	6 30	6 31
30	7 42	7 43	7 45	7 47	7 49	7 52	7 54	7 57	8 00	8 03	8 07	8 12	8 17	8 23
Oct. 1	8 55	8 58	9 01	9 05	9 09	9 13	9 18	9 23	9 29	9 36	9 43	9 52	10 02	10 14
2	10 06	10 10	10 15	10 20	10 26	10 32	10 39	10 47	10 55	11 05	11 16	11 29	11 45	12 05

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Oct. 1	8 55	8 58	9 01	9 05	9 09	9 13	9 18	9 23	9 29	9 36	9 43	9 52	10 02	10 14
2	10 06	10 10	10 15	10 20	10 26	10 32	10 39	10 47	10 55	11 05	11 16	11 29	11 45	12 05
3	11 13	11 19	11 25	11 31	11 39	11 46	11 55	12 05	12 16	12 28	12 43	13 01	13 23	13 53
4	12 16	12 22	12 29	12 36	12 44	12 53	13 03	13 15	13 27	13 42	14 00	14 21	14 50	15 31
5	13 12	13 19	13 26	13 34	13 42	13 51	14 02	14 13	14 27	14 42	15 01	15 24	15 55	16 43
6	14 02	14 08	14 15	14 22	14 31	14 40	14 49	15 01	15 13	15 28	15 46	16 07	16 35	17 15
7	14 44	14 50	14 57	15 03	15 11	15 19	15 28	15 37	15 49	16 02	16 16	16 34	16 57	17 26
8	15 21	15 26	15 32	15 37	15 44	15 50	15 58	16 06	16 15	16 26	16 38	16 52	17 08	17 29
9	15 54	15 58	16 02	16 06	16 11	16 17	16 22	16 29	16 36	16 44	16 53	17 03	17 15	17 30
10	16 22	16 25	16 28	16 32	16 35	16 39	16 43	16 48	16 53	16 58	17 04	17 11	17 20	17 29
11	16 49	16 51	16 52	16 54	16 56	16 59	17 01	17 04	17 07	17 10	17 14	17 18	17 23	17 28
12	17 14	17 15	17 15	17 16	17 17	17 17	17 18	17 19	17 20	17 21	17 22	17 23	17 25	17 26
13	17 39	17 39	17 38	17 37	17 37	17 36	17 35	17 34	17 33	17 31	17 30	17 29	17 27	17 25
14	18 05	18 04	18 02	17 59	17 57	17 55	17 52	17 49	17 46	17 43	17 39	17 34	17 29	17 23
15	18 33	18 30	18 27	18 24	18 20	18 16	18 11	18 07	18 01	17 55	17 49	17 41	17 33	17 22
16	19 04	19 00	18 56	18 51	18 46	18 40	18 34	18 27	18 20	18 11	18 02	17 51	17 38	17 22
17	19 40	19 35	19 29	19 23	19 17	19 10	19 02	18 53	18 43	18 32	18 19	18 04	17 46	17 24
18	20 22	20 16	20 09	20 02	19 54	19 46	19 37	19 26	19 15	19 01	18 45	18 26	18 02	17 30
19	21 11	21 04	20 57	20 50	20 41	20 32	20 22	20 10	19 57	19 42	19 24	19 01	18 32	17 49
20	22 07	22 01	21 54	21 46	21 38	21 29	21 18	21 07	20 54	20 38	20 20	19 57	19 27	18 42
21	23 11	23 05	22 59	22 52	22 44	22 36	22 26	22 16	22 04	21 50	21 34	21 15	20 50	20 16
22	.. ..	.. ..	.. ..	.. ..	23 58	23 51	23 43	23 35	23 25	23 14	23 02	22 47	22 29	22 06
23	0 20	0 15	0 10	0 04	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
24	1 33	1 29	1 25	1 21	1 16	1 11	1 05	0 59	0 52	0 45	0 36	0 26	0 14	0 00
25	2 46	2 44	2 42	2 39	2 36	2 33	2 30	2 26	2 22	2 18	2 13	2 07	2 01	1 53

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Oct. 24	1 33	1 29	1 25	1 21	1 16	1 11	1 05	0 59	0 52	0 45	0 36	0 26	0 14	0 00
25	2 46	2 44	2 42	2 39	2 36	2 33	2 30	2 26	2 22	2 18	2 13	2 07	2 01	1 53
26	4 00	4 00	3 59	3 58	3 57	3 57	3 56	3 54	3 53	3 52	3 51	3 49	3 47	3 45
27	5 15	5 15	5 16	5 18	5 19	5 20	5 21	5 23	5 24	5 26	5 28	5 30	5 33	5 36
28	6 29	6 31	6 34	6 37	6 40	6 43	6 47	6 51	6 55	7 00	7 06	7 12	7 20	7 28
29	7 42	7 46	7 50	7 54	7 59	8 05	8 11	8 17	8 25	8 33	8 42	8 53	9 06	9 22
30	8 53	8 58	9 04	9 10	9 16	9 24	9 32	9 41	9 51	10 02	10 15	10 31	10 51	11 15
31	10 00	10 06	10 13	10 20	10 28	10 37	10 46	10 57	11 10	11 24	11 41	12 01	12 28	13 05
Nov. 1	11 02	11 08	11 15	11 23	11 32	11 41	11 52	12 03	12 17	12 33	12 52	13 15	13 47	14 38
2	11 56	12 02	12 10	12 17	12 26	12 35	12 46	12 57	13 11	13 26	13 45	14 08	14 39	15 27
3	12 42	12 48	12 55	13 02	13 10	13 19	13 28	13 39	13 51	14 05	14 21	14 41	15 06	15 41
4	13 22	13 27	13 33	13 39	13 46	13 53	14 01	14 11	14 21	14 32	14 46	15 01	15 21	15 45
5	13 56	14 00	14 05	14 10	14 15	14 21	14 28	14 35	14 43	14 52	15 02	15 14	15 28	15 45
6	14 26	14 29	14 32	14 36	14 40	14 45	14 50	14 55	15 01	15 07	15 15	15 23	15 33	15 44
7	14 53	14 55	14 57	15 00	15 02	15 05	15 08	15 12	15 15	15 20	15 24	15 30	15 36	15 43
8	15 18	15 19	15 20	15 21	15 22	15 24	15 25	15 27	15 28	15 30	15 32	15 35	15 38	15 41
9	15 43	15 43	15 43	15 42	15 42	15 42	15 42	15 41	15 41	15 41	15 40	15 40	15 39	15 39
10	16 08	16 07	16 05	16 04	16 02	16 00	15 58	15 56	15 54	15 51	15 48	15 45	15 41	15 37
11	16 35	16 33	16 30	16 27	16 24	16 20	16 17	16 13	16 08	16 03	15 57	15 51	15 44	15 35
12	17 05	17 02	16 58	16 53	16 49	16 43	16 38	16 32	16 25	16 17	16 09	15 59	15 48	15 34
13	17 40	17 35	17 30	17 24	17 18	17 11	17 04	16 56	16 46	16 36	16 24	16 11	15 54	15 34
14	18 20	18 14	18 08	18 01	17 53	17 45	17 36	17 26	17 15	17 02	16 47	16 29	16 06	15 37
15	19 07	19 00	18 53	18 46	18 37	18 28	18 18	18 07	17 54	17 39	17 21	16 59	16 30	15 48
16	20 02	19 55	19 48	19 40	19 31	19 22	19 11	19 00	18 46	18 30	18 11	17 48	17 16	16 26
17	21 03	20 57	20 50	20 43	20 35	20 26	20 16	20 05	19 52	19 38	19 20	18 59	18 31	17 51

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Nov. 16	20 02	19 55	19 48	19 40	19 31	19 22	19 11	19 00	18 46	18 30	18 11	17 48	17 16	16 26
17	21 03	20 57	20 50	20 43	20 35	20 26	20 16	20 05	19 52	19 38	19 20	18 59	18 31	17 51
18	22 10	22 05	21 59	21 52	21 46	21 38	21 30	21 20	21 10	20 58	20 44	20 27	20 06	19 39
19	23 20	23 16	23 11	23 06	23 01	22 55	22 49	22 42	22 34	22 25	22 15	22 03	21 49	21 31
20	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	23 55	23 48	23 41	23 32	23 22
21	0 31	0 28	0 25	0 22	0 18	0 14	0 10	0 06	0 00	.. ..	.. ..	.. ..	.. ..	.. ..
22	1 42	1 41	1 40	1 38	1 36	1 35	1 33	1 30	1 28	1 25	1 22	1 19	1 15	1 11
23	2 54	2 54	2 54	2 54	2 55	2 55	2 55	2 56	2 56	2 56	2 57	2 57	2 58	2 58
24	4 06	4 08	4 09	4 11	4 13	4 16	4 18	4 21	4 24	4 28	4 32	4 36	4 41	4 47
25	5 18	5 21	5 25	5 28	5 32	5 37	5 42	5 47	5 53	5 59	6 07	6 16	6 26	6 38
26	6 30	6 34	6 39	6 45	6 50	6 57	7 04	7 12	7 20	7 30	7 42	7 55	8 11	8 31
27	7 39	7 45	7 51	7 58	8 05	8 14	8 22	8 32	8 44	8 57	9 12	9 31	9 54	10 25
28	8 45	8 51	8 58	9 06	9 14	9 24	9 34	9 46	9 59	10 14	10 33	10 55	11 26	12 13
29	9 44	9 51	9 58	10 06	10 15	10 24	10 35	10 47	11 01	11 17	11 36	12 01	12 33	13 29
30	10 35	10 42	10 49	10 56	11 04	11 13	11 24	11 35	11 48	12 03	12 21	12 43	13 12	13 54
Dec. 1	11 18	11 24	11 31	11 37	11 45	11 53	12 02	12 12	12 23	12 36	12 51	13 09	13 31	14 00
2	11 55	12 00	12 05	12 11	12 17	12 24	12 31	12 39	12 48	12 59	13 10	13 24	13 40	14 00
3	12 27	12 31	12 35	12 39	12 44	12 49	12 55	13 01	13 08	13 15	13 24	13 34	13 46	13 59
4	12 55	12 58	13 01	13 04	13 07	13 11	13 14	13 19	13 23	13 29	13 34	13 41	13 49	13 58
5	13 21	13 22	13 24	13 26	13 28	13 30	13 32	13 34	13 37	13 40	13 43	13 46	13 51	13 55
6	13 46	13 46	13 46	13 47	13 47	13 48	13 48	13 49	13 49	13 50	13 50	13 51	13 52	13 53
7	14 10	14 10	14 09	14 08	14 07	14 05	14 04	14 03	14 01	14 00	13 58	13 56	13 54	13 51
8	14 36	14 34	14 32	14 30	14 27	14 25	14 22	14 18	14 15	14 11	14 06	14 01	13 56	13 49
9	15 05	15 02	14 58	14 54	14 50	14 46	14 41	14 36	14 30	14 24	14 16	14 08	13 59	13 47
10	15 37	15 33	15 28	15 23	15 17	15 11	15 05	14 58	14 49	14 40	14 30	14 18	14 04	13 46

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

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

MOONSET

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

.. .. indicates phenomenon will occur the next day.

UNIVERSAL TIME FOR MERIDIAN OF GREENWICH

MOONRISE

Lat.	+40°	+42°	+44°	+46°	+48°	+50°	+52°	+54°	+56°	+58°	+60°	+62°	+64°	+66°
	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
Dec. 9	15 05	15 02	14 58	14 54	14 50	14 46	14 41	14 36	14 30	14 24	14 16	14 08	13 59	13 47
10	15 37	15 33	15 28	15 23	15 17	15 11	15 05	14 58	14 49	14 40	14 30	14 18	14 04	13 46
11	16 15	16 10	16 04	15 58	15 51	15 43	15 35	15 25	15 15	15 03	14 49	14 33	14 13	13 48
12	17 00	16 54	16 47	16 40	16 32	16 23	16 13	16 02	15 50	15 35	15 18	14 57	14 31	13 54
13	17 54	17 47	17 40	17 32	17 23	17 14	17 03	16 51	16 38	16 22	16 03	15 39	15 08	14 18
14	18 54	18 48	18 41	18 33	18 25	18 16	18 05	17 54	17 41	17 25	17 07	16 44	16 14	15 29
15	20 01	19 55	19 49	19 42	19 35	19 27	19 18	19 08	18 56	18 43	18 28	18 09	17 46	17 15
16	21 11	21 06	21 01	20 56	20 50	20 44	20 37	20 29	20 20	20 10	19 59	19 45	19 29	19 09
17	22 22	22 19	22 15	22 11	22 07	22 03	21 58	21 53	21 47	21 40	21 32	21 23	21 13	21 01
18	23 33	23 31	23 29	23 27	23 25	23 22	23 19	23 16	23 13	23 10	23 05	23 01	22 55	22 49
19	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..	.. ..
20	0 43	0 43	0 42	0 42	0 41	0 41	0 40	0 40	0 39	0 39	0 38	0 37	0 36	0 35
21	1 53	1 54	1 55	1 56	1 58	1 59	2 01	2 03	2 05	2 07	2 10	2 13	2 16	2 20
22	3 02	3 05	3 08	3 11	3 14	3 18	3 22	3 26	3 31	3 36	3 42	3 49	3 57	4 06
23	4 12	4 16	4 21	4 25	4 30	4 36	4 42	4 49	4 56	5 05	5 15	5 26	5 39	5 55
24	5 21	5 27	5 32	5 39	5 45	5 53	6 01	6 10	6 20	6 32	6 45	7 01	7 21	7 47
25	6 28	6 34	6 41	6 48	6 56	7 05	7 15	7 26	7 38	7 53	8 10	8 31	8 58	9 38
26	7 30	7 36	7 44	7 52	8 00	8 10	8 20	8 32	8 46	9 02	9 22	9 46	10 18	11 13
27	8 25	8 31	8 39	8 46	8 55	9 04	9 15	9 27	9 40	9 56	10 15	10 39	11 10	12 00
28	9 12	9 18	9 25	9 32	9 40	9 49	9 58	10 09	10 21	10 35	10 51	11 11	11 37	12 11
29	9 52	9 57	10 03	10 09	10 16	10 23	10 32	10 40	10 51	11 02	11 15	11 31	11 50	12 14
30	10 26	10 31	10 35	10 40	10 46	10 51	10 58	11 05	11 13	11 21	11 31	11 43	11 57	12 13
31	10 56	10 59	11 03	11 06	11 10	11 14	11 19	11 24	11 30	11 36	11 43	11 51	12 00	12 11
32	11 23	11 25	11 27	11 29	11 32	11 34	11 37	11 40	11 44	11 48	11 52	11 57	12 03	12 09
33	11 48	11 49	11 49	11 50	11 51	11 53	11 54	11 55	11 57	11 58	12 00	12 02	12 04	12 07

MOONSET

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

.. .. indicates phenomenon will occur the next day.

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SUMMARY OF ECLIPSES AND TRANSITS FOR 2019

There are five eclipses, three of the Sun and two of the Moon. All times are expressed in Universal Time using $\Delta T = +69^{s}.0$. There is a transit of Mercury across the Sun.

I. *A partial eclipse of the Sun*, January 5-6. See map on page 71. The eclipse begins at $23^{h}\ 34^{m}$ on January 5 and ends at $03^{h}\ 49^{m}$ on January 6. It is visible from eastern Asia, extreme western North America, and the north Pacific Ocean.

II. *A total eclipse of the Moon*, January 21. See map on page 72. The eclipse begins at $02^{h}\ 35^{m}$ and ends at $07^{h}\ 50^{m}$; the total phase begins at $04^{h}\ 41^{m}$ and ends at $05^{h}\ 44^{m}$. It is visible from Africa, Europe, South America, North America, extreme eastern Asia, the Atlantic Ocean, and the Pacific Ocean.

III. *A total eclipse of the Sun*, July 2. See map on page 74. The eclipse begins at $16^{h}\ 55^{m}$ and ends at $21^{h}\ 51^{m}$. Maximum duration of totality is $4^{m}\ 38^{s}$. It is visible from South America, south Central America, and the south Pacific Ocean.

IV. *A partial eclipse of the Moon*, July 16-17. See map on page 77. The eclipse begins at $18^{h}\ 42^{m}$ on July 16 and ends at $00^{h}\ 20^{m}$ on July 17. Time of maximum eclipse is $21^{h}\ 31^{m}$. It is visible from Australia, Antarctica, Asia, Africa, the Middle East, Europe, South America, the Indian Ocean, and the Atlantic Ocean.

V. *An annular eclipse of the Sun*, December 26. See map on page 79. The eclipse begins at $02^{h}\ 30^{m}$ and ends at $08^{h}\ 06^{m}$. Maximum duration of annularity is $3^{m}\ 34^{s}$. It is visible from western Australia, Asia, the Middle East, eastern Europe, extreme eastern Africa, the north Indian Ocean, and the Pacific Ocean.

Local circumstances and animations for upcoming eclipses can be found on *The Astronomical Almanac Online* at http://asa.hmnao.com or http://asa.usno.navy.mil.

Local circumstances and animations for upcoming eclipses can be found on *The Astronomical Almanac Online* at http://asa.hmnao.com or http://asa.usno.navy.mil.

General Information

The elements and circumstances are computed according to Bessel's method from apparent right ascensions and declinations of the Sun and Moon. Semidiameters of the Sun and Moon used in the calculation of eclipses do not include irradiation. The adopted semidiameter of the Sun at unit distance is $15'\ 59''.64$ from the IAU (1976) Astronomical Constants. The apparent semidiameter of the Moon is equal to arcsin ($k \sin \pi$), where π is the Moon's horizontal parallax and k is an adopted constant. In 1982, the IAU adopted $k = 0.272\ 5076$, corresponding to the mean radius of Watts' datum as determined by observations of occultations and to the adopted radius of the Earth.

Standard corrections of $+0''.5$ and $-0''.25$ have been applied to the longitude and latitude of the Moon, respectively, to help correct for the difference between the center of figure and the center of mass.

Refraction is neglected in calculating solar and lunar eclipses. Because the circumstances of eclipses are calculated for the surface of the ellipsoid, refraction is not included in Besselian element polynomials. For local predictions, corrections for refraction are unnecessary; they are required only in precise comparisons of theory with observation in which many other refinements are also necessary.

All time arguments are given provisionally in Universal Time, using $\Delta T(A) = +69^{s}.0$. Once an updated value of ΔT is known, the data on these pages may be expressed in Universal Time as follows:

Define $\delta T = \Delta T - \Delta T(A)$, in units of seconds of time.
Change the times of circumstances given in preliminary Universal Time by subtracting δT.
Correct the tabulated longitudes, $\lambda(A)$, using $\lambda = \lambda(A) + 0.00417807 \times \delta T$ (longitudes are in degrees).
Leave all other quantities unchanged.
The correction of δT is included in the Besselian elements.
Longitude is positive to the east, and negative to the west.

Explanation of Solar Eclipse Diagram

The solar eclipse diagrams in *The Astronomical Almanac* show the region over which different phases of each eclipse may be seen and the times at which these phases occur. Each diagram has a series of dashed curves that show the outline of the Moon's penumbra on the Earth's surface at one-hour intervals. Short dashes show the leading edge and long dashes show the trailing edge. Except for certain extreme cases, the shadow outline moves generally from west to east. The Moon's shadow cone first contacts the Earth's surface where "First Contact" is indicated on the diagram. "Last Contact" is where the Moon's shadow cone last contacts the Earth's surface. The path of the central eclipse, whether for a total, annular, or annular-total eclipse, is marked by two closely spaced curves that cut across all of the dashed curves. These two curves mark the extent of the Moon's umbral shadow on the Earth's surface. Viewers within these boundaries will observe a total, annular, or annular-total eclipse, and viewers outside these boundaries will see a partial eclipse.

Solid curves labeled "Northern" and "Southern Limit of Eclipse" represent the furthest extent north or south of the Moon's penumbra on the Earth's surface. Viewers outside of

these boundaries will not experience any eclipse. When only one of these two curves appears, only part of the Moon's penumbra touches the Earth; the other part is projected into space north or south of the Earth. The solid curves labeled "Eclipse begins at Sunset" and "Eclipse ends at Sunrise" define the other limits.

Another set of solid curves appears on some diagrams as two teardrop shapes (or lobes) on either end of the eclipse path, and on other diagrams as a distorted figure eight. These lobes represent in time the intersection of the Moon's penumbra with the Earth's terminator as the eclipse progresses. As time elapses, the Earth's terminator moves east-to-west while the Moon's penumbra moves west-to-east. These lobes connect to form an elongated figure eight on a diagram when part of the Moon's penumbra stays in contact with the Earth's terminator throughout the eclipse. The lobes become two separate teardrop shapes when the Moon's penumbra breaks contact with the Earth's terminator during the beginning of the eclipse and reconnects with it near the end. In the east, the outer portion of the lobe is labeled "Eclipse begins at Sunset" and marks the first contact between the Moon's penumbra and Earth's terminator in the east. Observers on this curve just fail to see the eclipse. The inner part of the lobe is labeled "Eclipse ends at Sunset" and marks the last contact between the Moon's penumbra and the Earth's terminator in the east. Observers on this curve just see the whole eclipse. The curve bisecting this lobe is labeled "Maximum Eclipse at Sunset" and is part of the sunset terminator at maximum eclipse. Viewers in the eastern half of the lobe will see the Sun set before maximum eclipse; *i.e.* see less than half of the eclipse. Viewers in the western half of the lobe will see the Sun set after maximum eclipse; *i.e.* see more than half of the eclipse. A similar description holds for the western lobe except everything occurs at sunrise instead of sunset.

Computing Local Circumstances for Solar Eclipses

The solar eclipse maps show the path of the eclipse, beginning and ending times of the eclipse, and the region of visibility, including restrictions due to rising and setting of the Sun. The short-dash and long-dash lines show, respectively, the progress of the leading and trailing edge of the penumbra; thus, at a given location, the times of the first and last contact may be interpolated. If further precision is desired, Besselian elements can be utilized.

Besselian elements characterize the geometric position of the shadow of the Moon relative to the Earth. The exterior tangents to the surfaces of the Sun and Moon form the umbral cone; the interior tangents form the penumbral cone. The common axis of these two cones is the axis of the shadow. To form a system of geocentric rectangular coordinates, the geocentric plane perpendicular to the axis of the shadow is taken as the xy-plane. This is called the fundamental plane. The x-axis is the intersection of the fundamental plane with the plane of the equator; it is positive toward the east. The y-axis is positive toward the north. The z-axis is parallel to the axis of the shadow and is positive toward the Moon. The tabular values of x and y are the coordinates, in units of the Earth's equatorial radius, of the intersection of the axis of the shadow with the fundamental plane. The direction of the axis of the shadow is specified by the declination d and hour angle μ of the point on the celestial sphere toward which the axis is directed.

The radius of the umbral cone is regarded as positive for an annular eclipse and negative for a total eclipse. The angles f_1 and f_2 are the angles at which the tangents that form the penumbral and umbral cones, respectively, intersect the axis of the shadow.

To predict accurate local circumstances, calculate the geocentric coordinates $\rho \sin \phi'$ and $\rho \cos \phi'$ from the geodetic latitude ϕ and longitude λ, using the relationships given on pages K11–K12 of *The Astronomical Almanac*. Inclusion of the height h in this calculation is all that is necessary to obtain the local circumstances at high altitudes.

Obtain approximate times for the beginning, middle and end of the eclipse from the eclipse map. For each of these three times compute — from the Besselian element polynomials — the values of x, y, $\sin d$, $\cos d$, μ and l_1 (the radius of the penumbra on the fundamental plane). If the eclipse is central (i.e., total, annular or annular-total), then, at the approximate time of the middle of the eclipse, l_2 (the radius of the umbra on the fundamental plane) is required instead of l_1. The hourly variations x', y' of x and y are needed, and may be obtained by evaluating the derivative of the polynomial expressions for x and y. Values of μ', d', $\tan f_1$ and $\tan f_2$ are nearly constant throughout the eclipse and are given immediately following the Besselian polynomials.

For each of the three approximate times, calculate the coordinates ξ, η, ζ for the observer and the hourly variations ξ' and η' from

$$\begin{aligned}
\xi &= \rho\cos\phi'\sin\theta,\\
\eta &= \rho\sin\phi'\cos d - \rho\cos\phi'\sin d\,\cos\theta,\\
\zeta &= \rho\sin\phi'\sin d + \rho\cos\phi'\cos d\,\cos\theta,\\
\xi' &= \mu'\rho\cos\phi'\cos\theta,\\
\eta' &= \mu'\xi\sin d - \zeta d',
\end{aligned}$$

where

$$\theta = \mu + \lambda$$

for longitudes measured positive towards the east.

Next, calculate

$$\begin{aligned}
u &= x - \xi & u' &= x' - \xi'\\
v &= y - \eta & v' &= y' - \eta'\\
m^2 &= u^2 + v^2 & n^2 &= u'^2 + v'^2 \qquad (m, n > 0)\\
L_i &= l_i - \zeta\tan f_i\\
D &= uu' + vv'\\
\Delta &= \tfrac{1}{n}(uv' - u'v)\\
\sin\psi &= \tfrac{\Delta}{L_i},
\end{aligned}$$

where $i = 1, 2$.

At the approximate times of the beginning and end of the eclipse, L_1 is required. At the approximate time of the middle of the eclipse, L_2 is required if the eclipse is central; L_1 is required if the eclipse is partial.

Neglecting the variation of L, the correction τ to be applied to the approximate time of the middle of the eclipse to obtain the *Universal Time of greatest phase* (in hours) is

$$\tau = -\frac{D}{n^2},$$

which may be expressed in minutes by multiplying by 60. The correction τ to be applied to the approximate times of the beginning and end of the eclipse to obtain the *Universal Times of the penumbral contacts* (in hours) is

$$\tau = \frac{L_1}{n}\cos\psi - \frac{D}{n^2},$$

which may be expressed in minutes by multiplying by 60.

If the eclipse is central, use the approximate time for the middle of the eclipse as a first approximation to the times of umbral contact. The correction τ to be applied to obtain the *Universal Times of the umbral contacts* is

$$\tau = \frac{L_2}{n}\cos\psi - \frac{D}{n^2},$$

which may be expressed in minutes by multiplying by 60.

In the last two equations, the ambiguity in the quadrant of ψ is removed by noting that $\cos\psi$ must be *negative* for the beginning of the eclipse, for the beginning of the annular phase, or for the end of the total phase; $\cos\psi$ must be *positive* for the end of the eclipse, the end of the annular phase, or the beginning of the total phase.

For greater accuracy, the times resulting from the calculation outlined above should be used in place of the original approximate times, and the entire procedure repeated at least once. The calculations for each of the contact times and the time of greatest phase should be performed separately.

The *magnitude of greatest partial eclipse*, in units of the solar diameter is

$$M_1 = \frac{L_1 - m}{(2L_1 - 0.5459)},$$

where the value of m at the time of greatest phase is used. If the magnitude is negative at the time of greatest phase, no eclipse is visible from the location.

The *magnitude of the central phase*, in the same units is

$$M_2 = \frac{L_1 - L_2}{(L_1 + L_2)}.$$

The *position angle of a point of contact* measured eastward (counterclockwise) from the north point of the solar limb is given by

$$\tan P = \frac{u}{v},$$

where u and v are evaluated at the times of contacts computed in the final approximation. The quadrant of P is determined by noting that $\sin P$ has the algebraic sign of u, except for the contacts of the total phase, for which $\sin P$ has the opposite sign to u.

The position angle of the point of contact measured eastward from the vertex of the solar limb is given by

$$V = P - C,$$

where C, the parallactic angle, is obtained with sufficient accuracy from

$$\tan C = \frac{\xi}{\eta},$$

with $\sin C$ having the same algebraic sign as ξ, and the results of the final approximation again being used. The vertex point of the solar limb lies on a great circle arc drawn from the zenith to the center of the solar disk.

Lunar Eclipses

A calculator to produce local circumstances of recent and upcoming lunar eclipses is provided at http://aa.usno.navy.mil/data/docs/LunarEclipse.php

In calculating lunar eclipses, the radius of the geocentric shadow of the Earth is increased by one-fiftieth part to allow for the effect of the atmosphere. Refraction is neglected in calculating solar and lunar eclipses. Standard corrections of $+0''.5$ and $-0''.25$ have been applied to the longitude and latitude of the Moon, respectively, to help correct for the difference between the center of figure and the center of mass.

Explanation of Lunar Eclipse Diagram

Information on lunar eclipses is presented in the form of a diagram consisting of two parts. The upper panel shows the path of the Moon relative to the penumbral and umbral shadows of the Earth. The lower panel shows the visibility of the eclipse from the surface of the Earth. The title of the upper panel includes the type of eclipse, its place in the sequence of eclipses for the year and the Greenwich calendar date of the eclipse. The inner darker circle is the umbral shadow of the Earth and the outer lighter circle is that of the penumbra. The axis of the shadow of the Earth is denoted by (+) with the ecliptic shown for reference purposes. A 30-arcminute scale bar is provided on the right hand side of the diagram and the orientation is given by the cardinal points displayed on the small graphic on the left hand side of the diagram. The position angle (PA) is measured from North point of the lunar disk along the limb of the Moon to the point of contact. It is shown on the graphic by the use of an arc extending anti-clockwise (eastwards) from North terminated with an arrow head.

Moon symbols are plotted at the principal phases of the eclipse to show its position relative to the umbral and penumbral shadows. The UT times of the different phases of the eclipse to the nearest tenth of a minute are printed above or below the Moon symbols as appropriate. P1 and P4 are the first and last external contacts of the penumbra respectively and denote the beginning and end of the penumbral eclipse respectively. U1 and U4 are the first and last external contacts of the umbra denoting the beginning and end of the partial phase of the eclipse respectively. U2 and U3 are the first and last internal contacts of the umbra and denote the beginning and end of the total phase respectively. MID is the middle of the eclipse. The position angle is given for P1 and P4 for penumbral eclipses and U1 and U4 for partial and total eclipses. The UT time of the geocentric opposition in right ascension of the Sun and Moon and the magnitude of the eclipse are given above or below the Moon symbols as appropriate.

The lower panel is a cylindrical equidistant map projection showing the Earth centered on the longitude at which the Moon is in the zenith at the middle of the eclipse. The visibility of the eclipse is displayed by plotting the Moon rise/set terminator for the principal phases of the eclipse for which timing information is provided in the upper panel. The terminator for the middle of the eclipse is not plotted for the sake of clarity.

The unshaded area indicates the region of the Earth from which all the eclipse is visible, whereas the darkest shading indicates the area from which the eclipse is invisible. The different shades of gray indicate regions where the Moon is either rising or setting during the principal phases of the eclipse. The Moon is rising on the left hand side of the diagram after the eclipse has started and is setting on the right hand side of the diagram before the eclipse ends. Labels are provided to this effect.

Symbols are plotted showing the locations for which the Moon is in the zenith at the principal phases of the eclipse. The points at which the Moon is in the zenith at P1 and P4 are denoted by (+), at U1 and U4 by ($\odot$) and at U2 and U3 by ($\oplus$). These symbols are also plotted on the upper panel where appropriate. The value of ΔT used for the calculation of the eclipse circumstances is given below the diagram. Country boundaries are also provided to assist the user in determining the visibility of the eclipse at a particular location.

I. – Partial Eclipse of the Sun, 2019 January 5-6

CIRCUMSTANCES OF THE ECLIPSE

Universal Time of geocentric conjunction in right ascension, January $6^{d}\ 01^{h}\ 43^{m}\ 41^{s}.736$
Julian Date = 2458489.5720108324

		UT			Longitude		Latitude	
		d	h	m	°	′	°	′
Eclipse begins	January	5	23	34.2	+119	24.5	+41	30.5
Greatest eclipse		6	01	41.5	+153	34.3	+67	26.1
Eclipse ends		6	03	48.8	−168	41.3	+43	07.4

Magnitude of greatest eclipse: 0.7148

BESSELIAN ELEMENTS

Let $t = (\mathrm{UT} - 23^{h}) + \delta T / 3600$ in units of hours.

These equations are valid over the range $0^{h}.458 \le t \le 4^{h}.983$. Do not use t outside the given range, and do not omit any terms in the series.

Intersection of the axis of shadow with the fundamental plane:

$$x = -1.38659606 + 0.50818017\,t + 0.00003580\,t^2 - 0.00000581\,t^3$$
$$y = +1.11983606 + 0.00780609\,t + 0.00010357\,t^2$$

Direction of the axis of shadow:

$$\sin d = -0.38363976 + 0.00007756\,t + 0.00000009\,t^2$$
$$\cos d = +0.92348286 + 0.00003217\,t + 0.00000005\,t^2$$
$$\mu = 163°.62425183 + 14.99672873\,t + 0.00000132\,t^2 + 0.00000004\,t^3 - 0.00417807\,\delta T$$

Radius of the shadow on the fundamental plane:

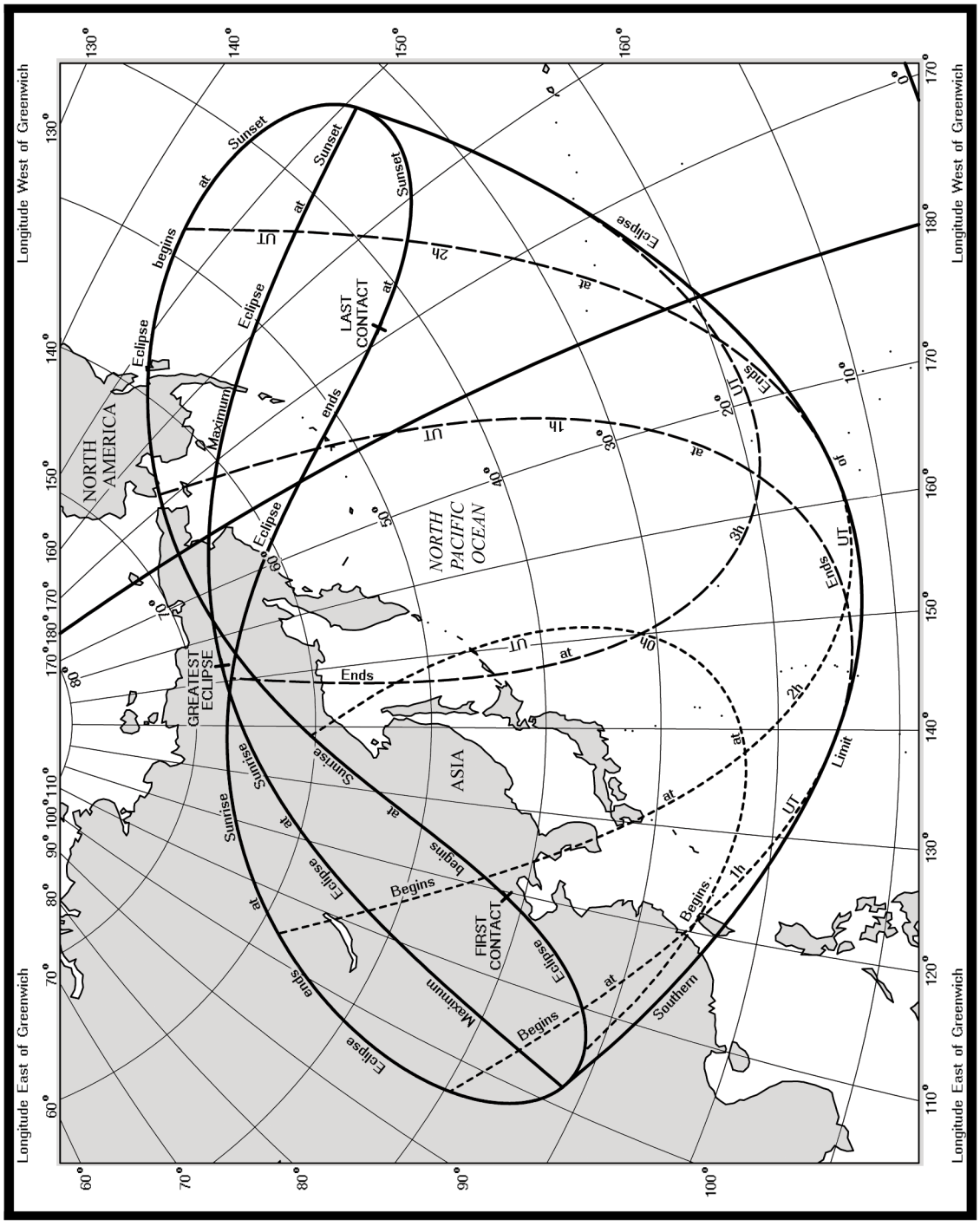
$$\text{penumbra } (l_1) = +0.57246388 + 0.00011749\,t - 0.00001006\,t^2$$
$$\text{umbra } (l_2) = +0.02594811 + 0.00011691\,t - 0.00001001\,t^2$$

Other important quantities:

$$\tan f_1 = +0.004756$$
$$\mu' = +0.261742 \text{ radians per hour}$$
$$d' = +0.000085 \text{ radians per hour}$$

All time arguments are given provisionally in Universal Time, using $\Delta T(A) = 69^{s}.0$.

PARTIAL SOLAR ECLIPSE OF 2019 JANUARY 5-6

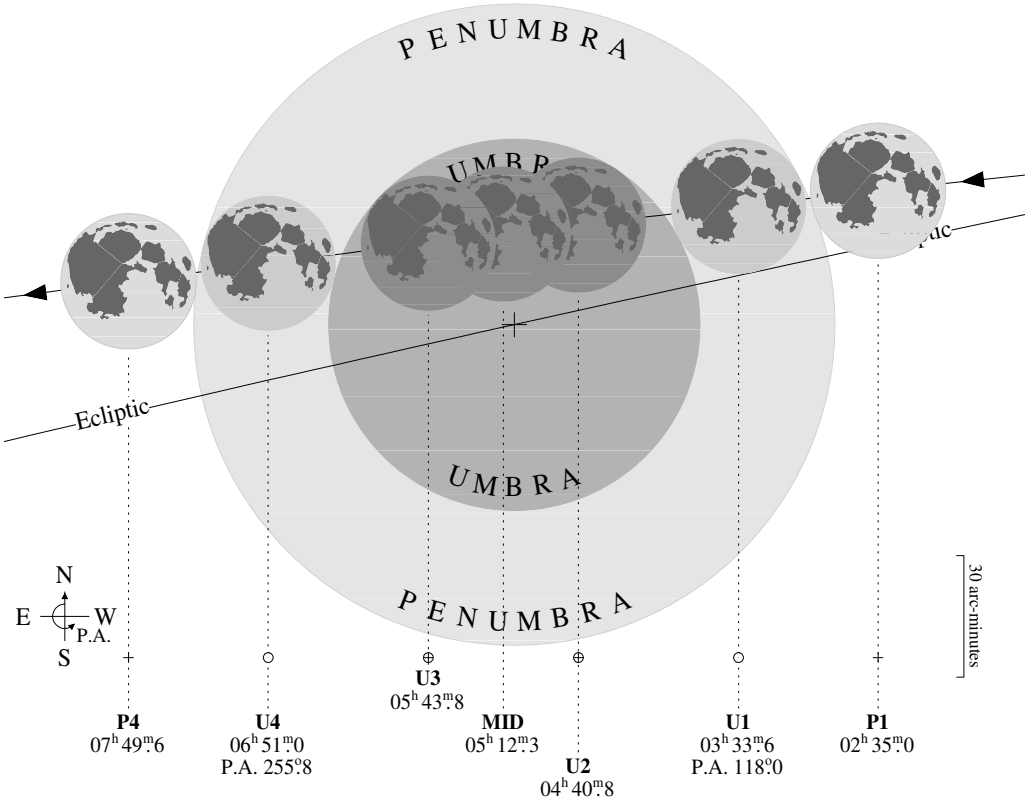


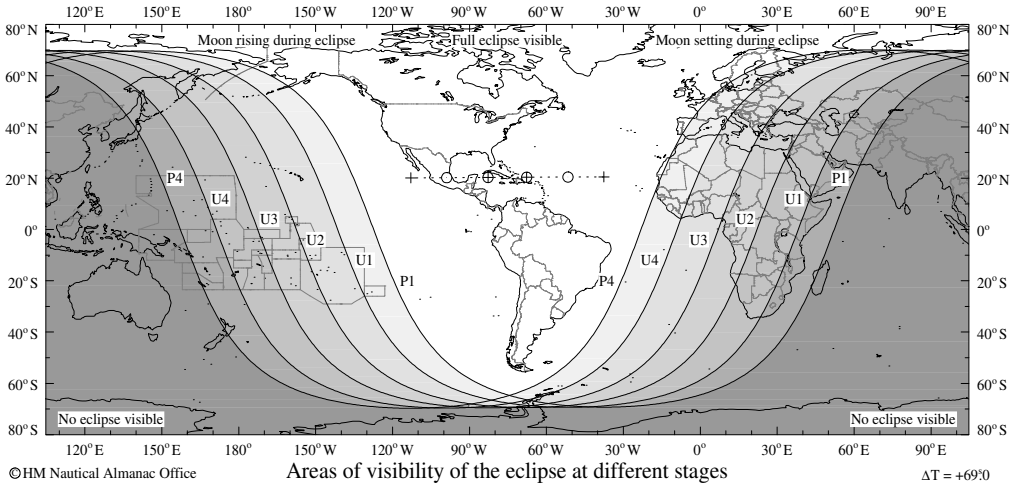
II. - Total Eclipse of the Moon

2019 January 21

UT of geocentric opposition in RA: January $21^{d}\ 5^{h}\ 7^{m}\ 42\overset{s}{.}555$

Umbral magnitude of the eclipse: 1.201





Areas of visibility of the eclipse at different stages

$\Delta T = +69\overset{s}{.}0$

III. – Total Eclipse of the Sun, 2019 July 2

CIRCUMSTANCES OF THE ECLIPSE

Universal Time of geocentric conjunction in right ascension, July $2^d\ 19^h\ 21^m\ 41^s.989$
Julian Date = 2458667.3067359771

		UT d h m	Longitude ° ′	Latitude ° ′
Eclipse begins	July	2 16 55.2	−151 56.6	−23 53.1
Beginning of northern limit of umbra		2 18 01.7	−160 40.2	−37 06.1
Beginning of center line; central eclipse begins		2 18 02.3	−160 25.7	−37 39.5
Beginning of southern limit of umbra		2 18 03.0	−160 10.9	−38 13.1
Central eclipse at local apparent noon		2 19 21.7	−109 24.2	−17 24.2
End of southern limit of umbra		2 20 43.0	− 57 56.7	−36 22.6
End of center line; central eclipse ends		2 20 43.6	− 57 42.7	−35 47.6
End of northern limit of umbra		2 20 44.3	− 57 28.9	−35 12.9
Eclipse ends		2 21 50.7	− 66 29.7	−21 57.4

BESSELIAN ELEMENTS

Let $t = (\mathrm{UT} - 17^h) + \delta T/3600$ in units of hours.

These equations are valid over the range $-0^h.125 \le t \le 5^h.017$. Do not use t outside the given range, and do not omit any terms in the series.

Intersection of the axis of shadow with the fundamental plane:

$$x = -1.33702254 + 0.56599677\,t + 0.00007972\,t^2 - 0.00000880\,t^3$$
$$y = -0.67228557 + 0.01114107\,t - 0.00012565\,t^2 - 0.00000027\,t^3$$

Direction of the axis of shadow:

$$\sin d = +0.39104024 - 0.00005082\,t - 0.00000011\,t^2$$
$$\cos d = +0.92037359 + 0.00002159\,t + 0.00000005\,t^2$$
$$\mu = 73^\circ.97992695 + 14.99950220\,t + 0.00000117\,t^2 - 0.00000002\,t^3 - 0.00417807\,\delta T$$

Radius of the shadow on the fundamental plane:

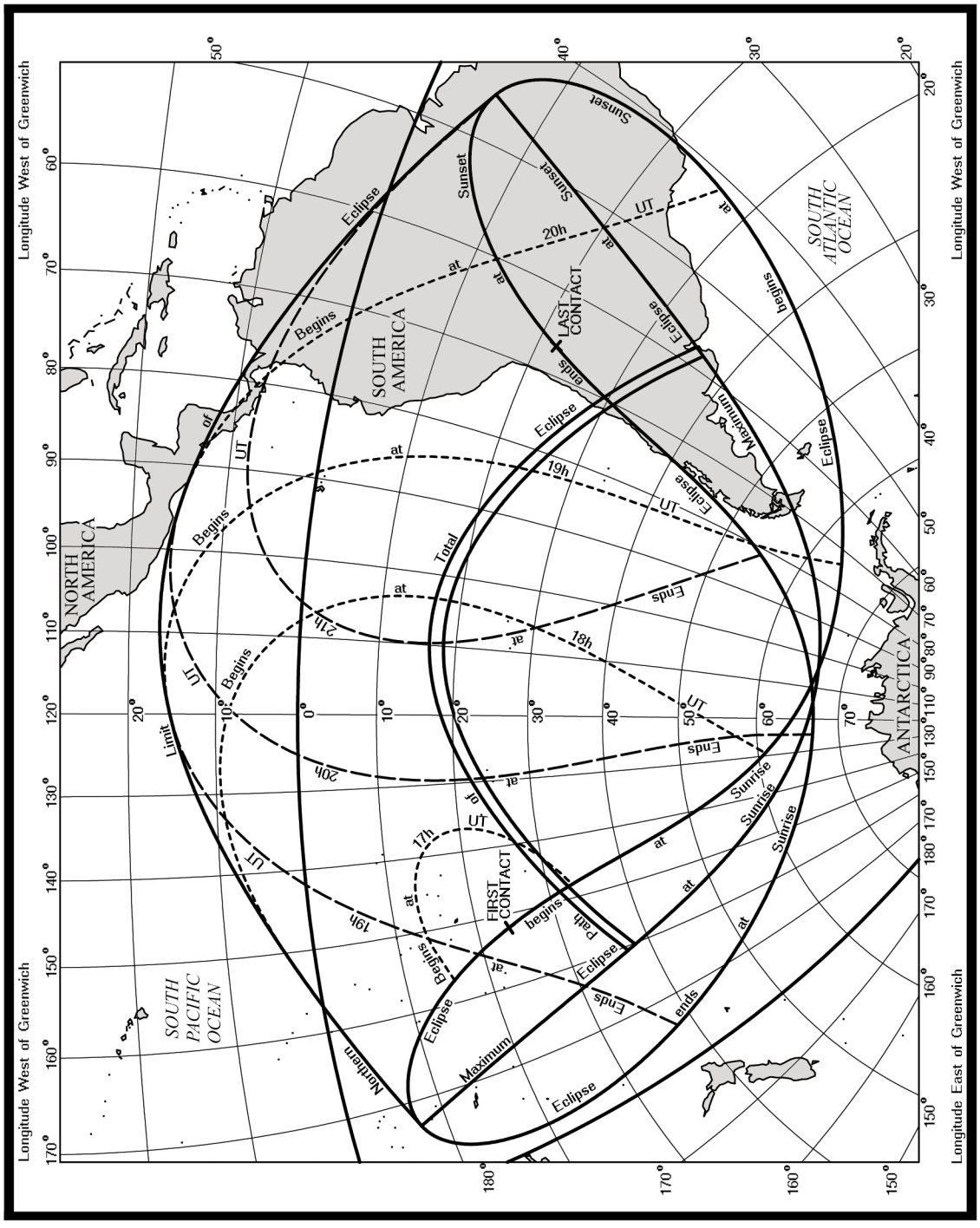
$$\text{penumbra } (l_1) = +0.53778414 - 0.00004217\,t - 0.00001201\,t^2$$
$$\text{umbra } (l_2) = -0.00855846 - 0.00004200\,t - 0.00001192\,t^2 - 0.00000001\,t^3$$

Other important quantities:

$$\tan f_1 = +0.004598$$
$$\tan f_2 = +0.004576$$
$$\mu' = +0.261791 \text{ radians per hour}$$
$$d' = -0.000056 \text{ radians per hour}$$

All time arguments are given provisionally in Universal Time, using $\Delta T(A) = 69^s.0$.

TOTAL SOLAR ECLIPSE OF 2019 JULY 2



PATH OF CENTRAL PHASE: TOTAL SOLAR ECLIPSE OF JULY 2

For limits, see Circumstances of the Eclipse.

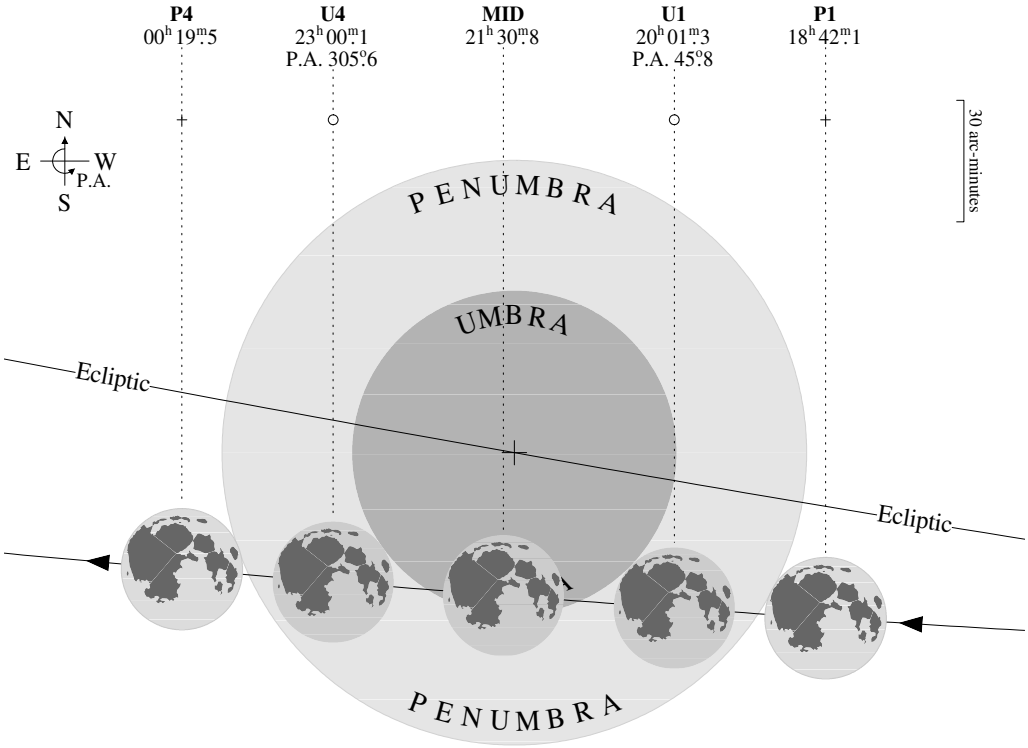
Longitude	Latitude of: Northern Limit	Central Line	Southern Limit	Universal Time at: Northern Limit	Central Line	Southern Limit	On Central Line: Maximum Duration	Sun's Alt.	Sun's Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	°	°
−156 00	−34 55.8	−35 37.2	−36 18.9	18 02 08.7	18 02 45.3	18 03 23.4	2 12.0	4	58
−155 00	−34 27.3	−35 09.2	−35 51.4	18 02 20.7	18 02 55.5	18 03 30.6	2 14.3	5	57
−154 00	−33 58.8	−34 41.0	−35 23.6	18 02 33.5	18 03 07.9	18 03 43.2	2 16.5	6	56
−153 00	−33 29.9	−34 12.6	−34 55.4	18 02 50.7	18 03 24.8	18 04 00.7	2 18.9	7	56
−152 00	−33 00.9	−33 43.9	−34 27.1	18 03 11.0	18 03 44.6	18 04 19.8	2 21.4	8	55
−151 00	−32 31.8	−33 15.1	−33 58.7	18 03 34.2	18 04 07.2	18 04 41.9	2 23.9	9	55
−150 00	−32 02.4	−32 46.2	−33 30.1	18 04 00.4	18 04 32.8	18 05 06.9	2 26.5	10	54
−149 00	−31 33.0	−32 17.1	−33 01.4	18 04 29.8	18 05 01.6	18 05 35.1	2 29.2	11	53
−148 00	−31 03.4	−31 47.9	−32 32.6	18 05 02.4	18 05 33.6	18 06 06.4	2 32.0	12	53
−147 00	−30 33.8	−31 18.6	−32 03.7	18 05 38.5	18 06 08.9	18 06 41.1	2 34.8	13	52
−146 00	−30 04.0	−30 49.3	−31 34.8	18 06 18.1	18 06 47.8	18 07 19.2	2 37.7	14	51
−145 00	−29 34.2	−30 19.8	−31 05.7	18 07 01.4	18 07 30.3	18 08 00.9	2 40.7	16	51
−144 00	−29 04.3	−29 50.4	−30 36.6	18 07 48.4	18 08 16.4	18 08 46.3	2 43.8	17	50
−143 00	−28 34.4	−29 20.8	−30 07.5	18 08 39.3	18 09 06.5	18 09 35.5	2 46.9	18	49
−142 00	−28 04.5	−28 51.3	−29 38.4	18 09 34.3	18 10 00.5	18 10 28.6	2 50.2	19	49
−141 00	−27 34.6	−28 21.8	−29 09.3	18 10 33.4	18 10 58.7	18 11 25.8	2 53.5	20	48
−140 00	−27 04.8	−27 52.4	−28 40.2	18 11 36.7	18 12 01.0	18 12 27.2	2 56.9	21	47
−139 00	−26 35.0	−27 23.0	−28 11.3	18 12 44.4	18 13 07.7	18 13 32.9	3 00.4	22	46
−138 00	−26 05.3	−26 53.8	−27 42.4	18 13 56.7	18 14 18.9	18 14 43.0	3 04.0	24	46
−137 00	−25 35.8	−26 24.7	−27 13.7	18 15 13.5	18 15 34.6	18 15 57.7	3 07.7	25	45
−136 00	−25 06.5	−25 55.8	−26 45.2	18 16 35.1	18 16 55.0	18 17 17.0	3 11.4	26	44
−135 00	−24 37.4	−25 27.1	−26 16.9	18 18 01.5	18 18 20.3	18 18 41.1	3 15.2	27	43
−134 00	−24 08.6	−24 58.6	−25 48.8	18 19 32.8	18 19 50.4	18 20 10.1	3 19.1	28	42
−133 00	−23 40.1	−24 30.5	−25 21.1	18 21 09.1	18 21 25.5	18 21 44.0	3 23.1	29	41
−132 00	−23 12.0	−24 2.7	−24 53.7	18 22 50.6	18 23 05.7	18 23 23.0	3 27.1	31	40
−131 00	−22 44.2	−23 35.3	−24 26.7	18 24 37.2	18 24 51.1	18 25 07.1	3 31.1	32	39
−130 00	−22 17.0	−23 08.4	−24 00.1	18 26 29.0	18 26 41.7	18 26 56.4	3 35.2	33	38
−129 00	−21 50.2	−22 42.1	−23 34.1	18 28 26.0	18 28 37.5	18 28 50.9	3 39.3	34	37
−128 00	−21 24.1	−22 16.2	−23 08.6	18 30 28.3	18 30 38.5	18 30 50.7	3 43.5	35	36
−127 00	−20 58.6	−21 51.1	−22 43.8	18 32 35.9	18 32 44.9	18 32 55.8	3 47.6	37	35
−126 00	−20 33.8	−21 26.6	−22 19.6	18 34 48.7	18 34 56.4	18 35 06.2	3 51.8	38	33
−125 00	−20 09.9	−21 02.9	−21 56.2	18 37 06.7	18 37 13.3	18 37 21.7	3 55.9	39	32
−124 00	−19 46.7	−20 40.1	−21 33.6	18 39 29.8	18 39 35.2	18 39 42.5	4 00.0	40	31
−123 00	−19 24.5	−20 18.1	−21 12.0	18 41 57.9	18 42 02.2	18 42 08.3	4 03.9	41	29
−122 00	−19 03.3	−19 57.2	−20 51.3	18 44 30.9	18 44 34.1	18 44 39.1	4 07.8	42	27
−121 00	−18 43.2	−19 37.3	−20 31.6	18 47 08.5	18 47 10.8	18 47 14.6	4 11.6	43	26
−120 00	−18 24.2	−19 18.5	−20 13.0	18 49 50.7	18 49 52.0	18 49 54.8	4 15.2	44	24
−119 00	−18 06.4	−19 00.9	−19 55.6	18 52 37.2	18 52 37.5	18 52 39.4	4 18.7	45	22
−118 00	−17 49.9	−18 44.5	−19 39.4	18 55 27.6	18 55 27.2	18 55 28.1	4 22.0	46	20
−117 00	−17 34.7	−18 29.5	−19 24.6	18 58 21.8	18 58 20.6	18 58 20.7	4 25.0	46	18
−116 00	−17 21.0	−18 15.9	−19 11.1	19 01 19.3	19 01 17.4	19 01 16.7	4 27.7	47	16
−115 00	−17 08.7	−18 03.7	−18 59.0	19 04 19.8	19 04 17.4	19 04 16.0	4 30.2	48	14
−114 00	−16 57.9	−17 53.0	−18 48.5	19 07 23.0	19 07 20.1	19 07 18.0	4 32.4	48	11
−113 00	−16 48.7	−17 43.9	−18 39.4	19 10 28.4	19 10 25.0	19 10 22.3	4 34.2	49	9
−112 00	−16 41.0	−17 36.3	−18 31.9	19 13 35.6	19 13 31.8	19 13 28.5	4 35.7	49	7
−111 00	−16 35.0	−17 30.3	−18 26.0	19 16 44.2	19 16 40.0	19 16 36.2	4 36.8	49	4
−110 00	−16 30.7	−17 26.0	−18 21.7	19 19 53.6	19 19 49.1	19 19 44.8	4 37.6	50	2
−109 00	−16 28.0	−17 23.4	−18 19.0	19 23 03.4	19 22 58.6	19 22 53.9	4 37.9	50	359
−108 00	−16 27.0	−17 22.3	−18 18.0	19 26 13.2	19 26 08.1	19 26 03.0	4 37.8	50	356
−107 00	−16 27.7	−17 23.0	−18 18.6	19 29 22.4	19 29 17.1	19 29 11.5	4 37.4	49	354

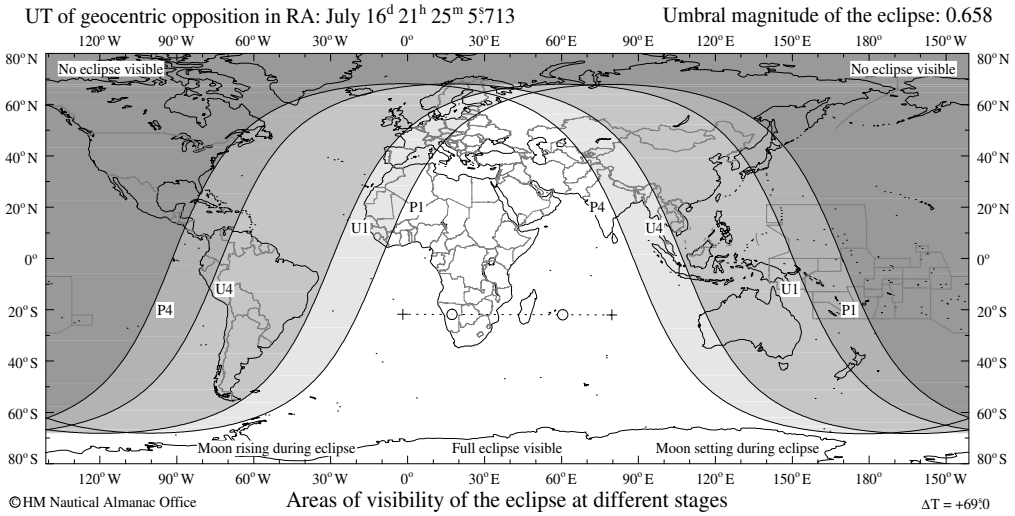
PATH OF CENTRAL PHASE: TOTAL SOLAR ECLIPSE OF JULY 2

Longitude	Latitude of: Northern Limit	Latitude of: Central Line	Latitude of: Southern Limit	Universal Time at: Northern Limit	Universal Time at: Central Line	Universal Time at: Southern Limit	On Central Line: Maximum Duration	On Central Line: Sun's Alt.	On Central Line: Sun's Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	°	°
−106 00	−16 30.0	−17 25.3	−18 20.8	19 32 30.7	19 32 25.1	19 32 19.1	4 36.6	49	351
−105 00	−16 34.0	−17 29.2	−18 24.7	19 35 37.5	19 35 31.6	19 35 25.2	4 35.4	49	349
−104 00	−16 39.6	−17 34.7	−18 30.1	19 38 42.4	19 38 36.2	19 38 29.3	4 33.8	48	347
−103 00	−16 46.8	−17 41.8	−18 37.1	19 41 45.0	19 41 38.5	19 41 31.1	4 31.9	48	344
−102 00	−16 55.5	−17 50.4	−18 45.6	19 44 44.9	19 44 38.0	19 44 30.1	4 29.7	47	342
−101 00	−17 05.7	−18 00.5	−18 55.6	19 47 41.8	19 47 34.4	19 47 25.9	4 27.2	46	340
−100 00	−17 17.4	−18 12.0	−19 07.0	19 50 35.2	19 50 27.3	19 50 18.2	4 24.4	46	338
− 99 00	−17 30.5	−18 24.9	−19 19.7	19 53 24.9	19 53 16.4	19 53 06.7	4 21.4	45	336
− 98 00	−17 44.9	−18 39.2	−19 33.7	19 56 10.6	19 56 01.5	19 55 51.1	4 18.1	44	334
− 97 00	−18 00.5	−18 54.6	−19 49.0	19 58 52.0	19 58 42.3	19 58 31.1	4 14.7	43	332
− 96 00	−18 17.4	−19 11.3	−20 05.4	20 01 29.0	20 01 18.5	20 01 06.5	4 11.1	42	331
− 95 00	−18 35.4	−19 29.0	−20 23.0	20 04 01.3	20 03 50.1	20 03 37.2	4 07.4	41	329
− 94 00	−18 54.5	−19 47.9	−20 41.5	20 06 28.7	20 06 16.7	20 06 03.0	4 03.5	40	328
− 93 00	−19 14.5	−20 07.7	−21 01.1	20 08 51.3	20 08 38.4	20 08 23.7	3 59.6	39	326
− 92 00	−19 35.5	−20 28.4	−21 21.6	20 11 08.7	20 10 55.0	20 10 39.4	3 55.6	38	325
− 91 00	−19 57.4	−20 50.0	−21 42.9	20 13 21.1	20 13 06.4	20 12 49.8	3 51.6	37	323
− 90 00	−20 20.1	−21 12.4	−22 05.0	20 15 28.3	20 15 12.6	20 14 55.1	3 47.5	35	322
− 89 00	−20 43.5	−21 35.5	−22 27.8	20 17 30.3	20 17 13.7	20 16 55.1	3 43.5	34	321
− 88 00	−21 07.6	−21 59.3	−22 51.2	20 19 27.1	20 19 09.5	20 18 50.0	3 39.4	33	320
− 87 00	−21 32.3	−22 23.7	−23 15.3	20 21 18.7	20 21 00.2	20 20 39.6	3 35.4	32	319
− 86 00	−21 57.5	−22 48.6	−23 39.9	20 23 05.2	20 22 45.7	20 22 24.1	3 31.4	31	318
− 85 00	−22 23.3	−23 14.0	−24 05.0	20 24 46.6	20 24 26.1	20 24 03.5	3 27.4	30	317
− 84 00	−22 49.6	−23 39.9	−24 30.5	20 26 23.0	20 26 01.5	20 25 38.0	3 23.5	28	316
− 83 00	−23 16.2	−24 06.2	−24 56.5	20 27 54.4	20 27 31.9	20 27 07.4	3 19.6	27	315
− 82 00	−23 43.2	−24 32.9	−25 22.7	20 29 20.9	20 28 57.5	20 28 32.0	3 15.8	26	314
− 81 00	−24 10.5	−24 59.8	−25 49.3	20 30 42.7	20 30 18.3	20 29 51.9	3 12.1	25	314
− 80 00	−24 38.1	−25 27.1	−26 16.2	20 31 59.7	20 31 34.4	20 31 07.1	3 08.4	24	313
− 79 00	−25 06.0	−25 54.5	−26 43.3	20 33 12.2	20 32 46.0	20 32 17.8	3 04.9	22	312
− 78 00	−25 34.0	−26 22.2	−27 10.6	20 34 20.2	20 33 53.1	20 33 24.1	3 01.3	21	311
− 77 00	−26 02.2	−26 50.0	−27 38.1	20 35 23.8	20 34 55.9	20 34 26.1	2 57.9	20	311
− 76 00	−26 30.5	−27 18.0	−28 05.7	20 36 23.2	20 35 54.4	20 35 23.8	2 54.6	19	310
− 75 00	−26 59.0	−27 46.1	−28 33.4	20 37 18.4	20 36 48.9	20 36 17.5	2 51.3	18	309
− 74 00	−27 27.5	−28 14.2	−29 01.2	20 38 09.6	20 37 39.4	20 37 07.3	2 48.1	17	309
− 73 00	−27 56.1	−28 42.4	−29 29.0	20 38 57.0	20 38 26.0	20 37 53.2	2 45.0	16	308
− 72 00	−28 24.7	−29 10.7	−29 56.9	20 39 40.5	20 39 08.8	20 38 35.3	2 41.9	14	307
− 71 00	−28 53.3	−29 38.9	−30 24.8	20 40 20.4	20 39 48.0	20 39 13.9	2 39.0	13	307
− 70 00	−29 22.0	−30 07.2	−30 52.6	20 40 56.7	20 40 23.7	20 39 49.0	2 36.1	12	306
− 69 00	−29 50.5	−30 35.4	−31 20.5	20 41 29.6	20 40 56.0	20 40 20.7	2 33.3	11	305
− 68 00	−30 19.1	−31 03.6	−31 48.3	20 41 59.1	20 41 25.0	20 40 49.2	2 30.6	10	305
− 67 00	−30 47.5	−31 31.7	−32 16.1	20 42 25.5	20 41 50.8	20 41 14.5	2 27.9	9	304
− 66 00	−31 15.9	−31 59.7	−32 43.7	20 42 48.8	20 42 13.6	20 41 36.8	2 25.3	8	304
− 65 00	−31 44.2	−32 27.7	−33 11.3	20 43 09.2	20 42 33.5	20 41 56.1	2 22.8	7	303
− 64 00	−32 12.4	−32 55.5	−33 38.8	20 43 26.4	20 42 50.7	20 42 11.2	2 20.4	6	302
− 63 00	−32 40.4	−33 23.2	−34 06.2	20 43 39.1	20 43 03.2	20 42 25.6	2 18.0	5	302

For limits, see Circumstances of the Eclipse.

IV. - Partial Eclipse of the Moon 2019 July 16-17





V. – Annular Eclipse of the Sun, 2019 December 26

CIRCUMSTANCES OF THE ECLIPSE

Universal Time of geocentric conjunction in right ascension, December $26^{d}\ 5^{h}\ 14^{m}\ 34^{s}.764$
Julian Date = 2458843.7184579140

		UT d	h	m	Longitude °	′	Latitude °	′
Eclipse begins	December	26	02	29.9	+ 60	33.6	+17	47.3
Beginning of southern limit of umbra		26	03	35.7	+ 47	55.1	+25	18.2
Beginning of center line; central eclipse begins		26	03	36.1	+ 48	12.1	+25	59.1
Beginning of northern limit of umbra		26	03	36.4	+ 48	29.2	+26	40.2
Central eclipse at local apparent noon		26	05	14.6	+101	25.2	+ 1	07.2
End of northern limit of umbra		26	06	59.1	+156	26.8	+19	37.0
End of center line; central eclipse ends		26	06	59.4	+156	42.2	+18	54.0
End of southern limit of umbra		26	06	59.8	+156	57.6	+18	11.2
Eclipse ends		26	08	05.7	+143	59.6	+10	37.2

BESSELIAN ELEMENTS

Let $t = (\mathrm{UT} - 2^{h}) + \delta T / 3600$ in units of hours.

These equations are valid over the range $0^{h}.375 \le t \le 6^{h}.267$. Do not use t outside the given range, and do not omit any terms in the series.

Intersection of the axis of shadow with the fundamental plane:

$$x = -1.73680329 + 0.53542885\,t + 0.00006244\,t^2 - 0.00000715\,t^3$$
$$y = +0.53461897 - 0.03750822\,t + 0.00014037\,t^2 + 0.00000060\,t^3$$

Direction of the axis of shadow:

$$\sin d = -0.39678921 + 0.00002193\,t + 0.00000010\,t^2$$
$$\cos d = +0.91790974 + 0.00000950\,t + 0.00000004\,t^2$$
$$\mu = 209°.94710262 + 14.99626891\,t + 0.00000050\,t^2 - 0.00000002\,t^3 - 0.00417807\,\delta T$$

Radius of the shadow on the fundamental plane:

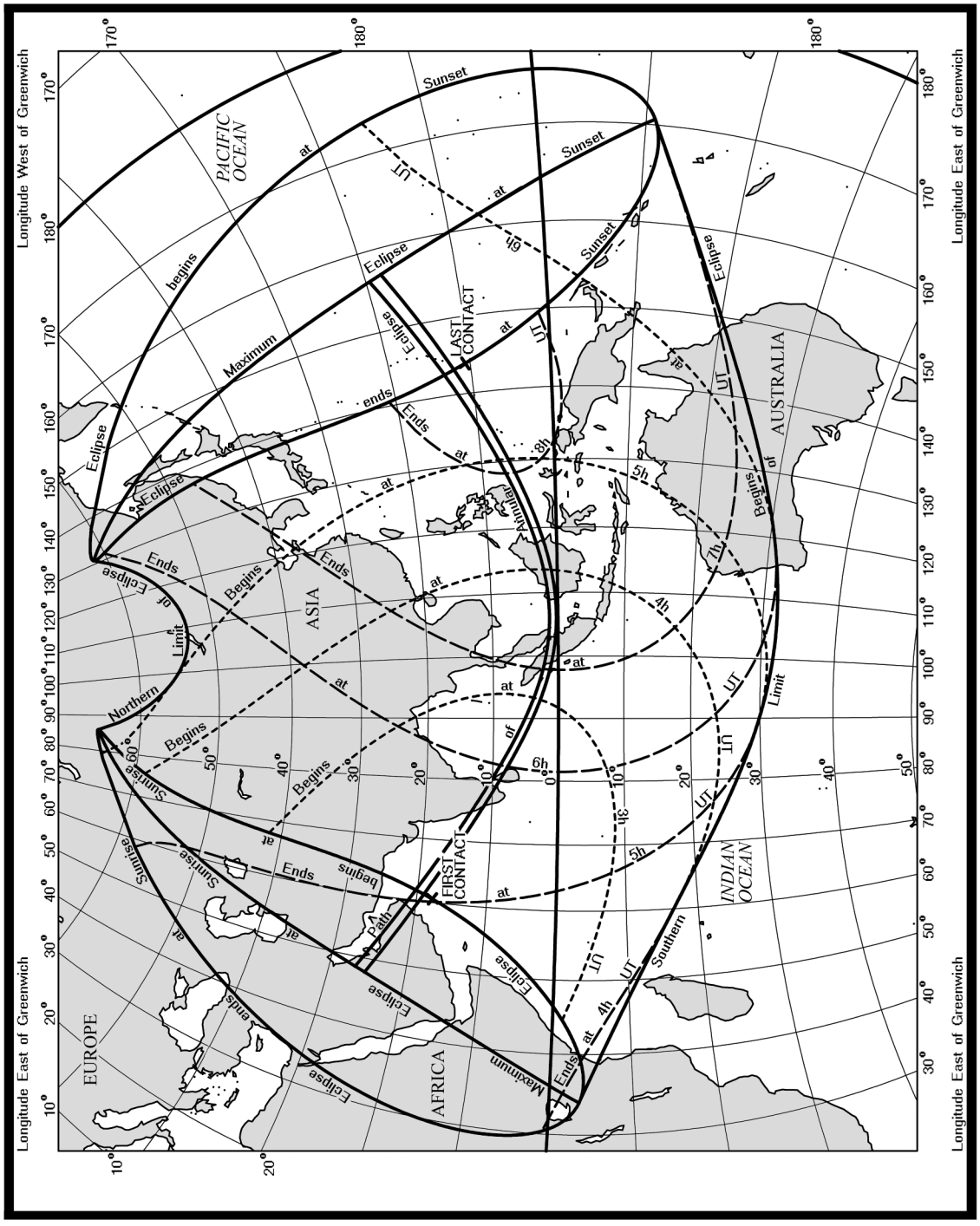
$$\text{penumbra } (l_1) = +0.55842767 + 0.00019522\,t - 0.00001125\,t^2 + 0.00000001\,t^3$$
$$\text{umbra } (l_2) = +0.01198187 + 0.00019419\,t - 0.00001117\,t^2$$

Other important quantities:

$$\tan f_1 = +0.004755$$
$$\tan f_2 = +0.004731$$
$$\mu' = +0.261734 \text{ radians per hour}$$
$$d' = +0.000025 \text{ radians per hour}$$

All time arguments are given provisionally in Universal Time, using $\Delta T(A) = 69^{s}.0$.

ANNULAR SOLAR ECLIPSE OF 2019 DECEMBER 26



PATH OF CENTRAL PHASE: TOTAL SOLAR ECLIPSE OF DECEMBER 26

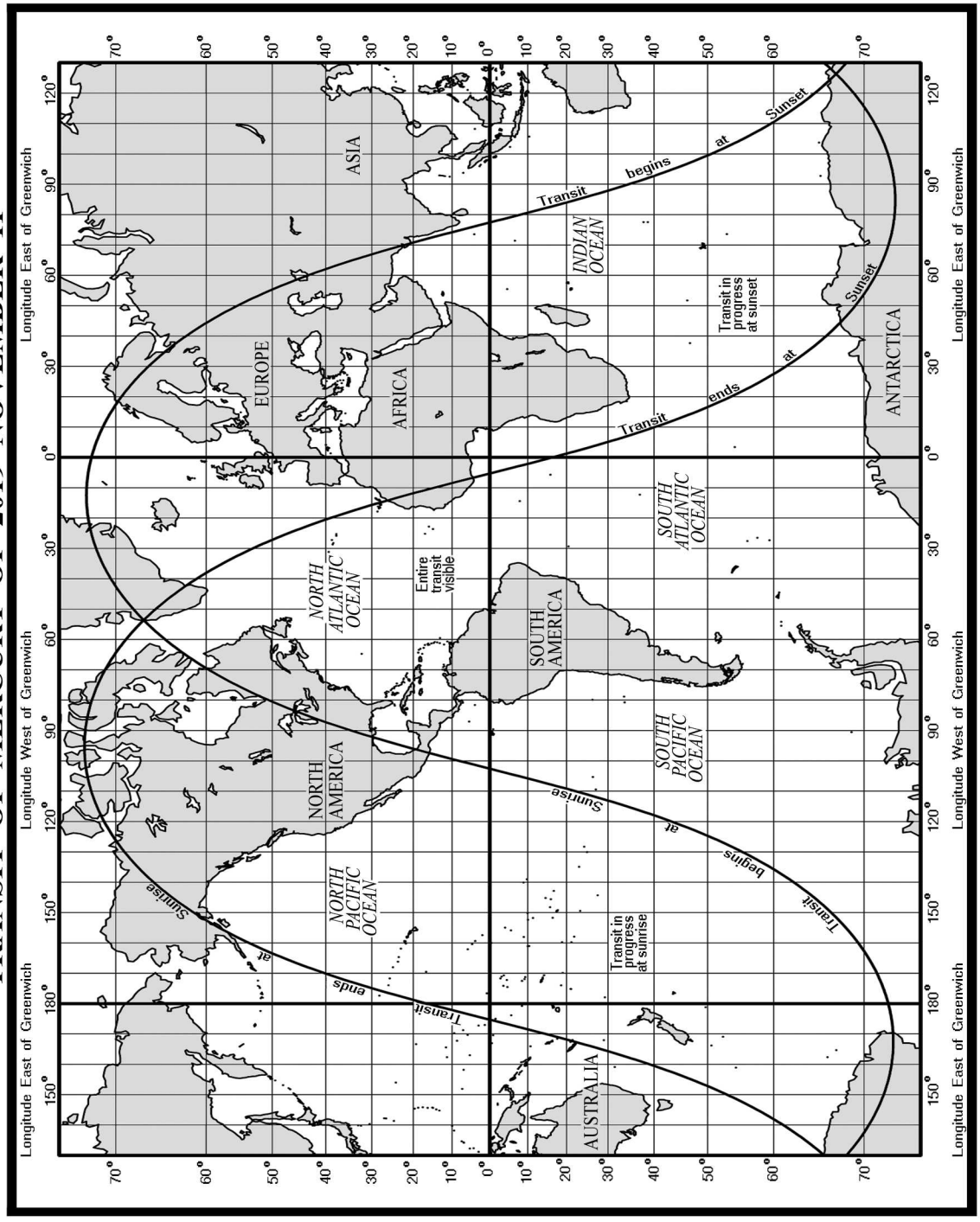
For limits, see Circumstances of the Eclipse.

Longitude	Latitude of: Northern Limit	Central Line	Southern Limit	Universal Time at: Northern Limit	Central Line	Southern Limit	On Central Line: Maximum Duration	Sun's Alt.	Sun's Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	°	°
+ 53 00	+24 34.4	+23 47.2	+23 00.0	3 36 52.6	3 36 32.9	3 36 18.5	2 56.8	5	118
+ 54 00	+24 06.1	+23 18.7	+22 32.1	3 37 01.6	3 36 47.2	3 36 31.0	2 57.1	6	119
+ 55 00	+23 37.1	+22 50.1	+22 03.7	3 37 15.9	3 37 01.8	3 36 48.0	2 57.4	7	119
+ 56 00	+23 07.6	+22 21.1	+21 34.9	3 37 34.6	3 37 20.7	3 37 08.4	2 57.8	8	120
+ 57 00	+22 38.0	+21 51.7	+21 05.8	3 37 55.5	3 37 42.9	3 37 31.7	2 58.1	9	120
+ 58 00	+22 08.0	+21 22.0	+20 36.4	3 38 19.7	3 38 08.2	3 37 58.1	2 58.4	11	120
+ 59 00	+21 37.6	+20 52.0	+20 06.7	3 38 47.1	3 38 36.8	3 38 27.9	2 58.8	12	121
+ 60 00	+21 07.0	+20 21.7	+19 36.7	3 39 17.8	3 39 08.9	3 39 01.1	2 59.2	13	121
+ 61 00	+20 36.1	+19 51.0	+19 06.4	3 39 52.2	3 39 44.5	3 39 38.0	2 59.6	14	122
+ 62 00	+20 04.8	+19 20.1	+18 35.8	3 40 30.2	3 40 23.7	3 40 18.5	3 00.0	15	122
+ 63 00	+19 33.3	+18 48.9	+18 05.0	3 41 12.0	3 41 06.8	3 41 02.8	3 00.5	16	123
+ 64 00	+19 01.5	+18 17.5	+17 33.8	3 41 57.8	3 41 53.9	3 41 51.2	3 00.9	18	123
+ 65 00	+18 29.5	+17 45.7	+17 02.4	3 42 47.7	3 42 45.1	3 42 43.7	3 01.4	19	123
+ 66 00	+17 57.1	+17 13.8	+16 30.8	3 43 41.9	3 43 40.6	3 43 40.5	3 01.9	20	124
+ 67 00	+17 24.6	+16 41.6	+15 58.9	3 44 40.5	3 44 40.6	3 44 41.7	3 02.4	21	124
+ 68 00	+16 51.8	+16 09.1	+15 26.8	3 45 43.7	3 45 45.1	3 45 47.5	3 03.0	23	125
+ 69 00	+16 18.8	+15 36.5	+14 54.6	3 46 51.6	3 46 54.3	3 46 58.1	3 03.6	24	125
+ 70 00	+15 45.7	+15 03.7	+14 22.1	3 48 04.4	3 48 08.5	3 48 13.5	3 04.2	25	126
+ 71 00	+15 12.4	+14 30.8	+13 49.5	3 49 22.3	3 49 27.7	3 49 34.0	3 04.8	27	126
+ 72 00	+14 38.9	+13 57.7	+13 16.8	3 50 45.3	3 50 52.1	3 50 59.7	3 05.5	28	127
+ 73 00	+14 05.4	+13 24.5	+12 44.0	3 52 13.8	3 52 21.9	3 52 30.8	3 06.2	30	127
+ 74 00	+13 31.8	+12 51.3	+12 11.2	3 53 47.8	3 53 57.2	3 54 07.3	3 06.9	31	128
+ 75 00	+12 58.2	+12 18.0	+11 38.3	3 55 27.5	3 55 38.1	3 55 49.5	3 07.7	32	128
+ 76 00	+12 24.6	+11 44.8	+11 05.4	3 57 13.0	3 57 24.9	3 57 37.5	3 08.4	34	129
+ 77 00	+11 51.0	+11 11.6	+10 32.7	3 59 04.5	3 59 17.6	3 59 31.4	3 09.3	35	130
+ 78 00	+11 17.6	+10 38.6	+10 00.0	4 01 02.1	4 01 16.3	4 01 31.2	3 10.1	37	130
+ 79 00	+10 44.3	+10 05.7	+ 9 27.5	4 03 05.9	4 03 21.3	4 03 37.2	3 11.0	38	131
+ 80 00	+10 11.2	+ 9 33.0	+ 8 55.2	4 05 16.0	4 05 32.4	4 05 49.4	3 12.0	40	132
+ 81 00	+ 9 38.4	+ 9 00.6	+ 8 23.2	4 07 32.4	4 07 49.9	4 08 07.8	3 12.9	41	132
+ 82 00	+ 9 06.0	+ 8 28.6	+ 7 51.5	4 09 55.3	4 10 13.7	4 10 32.6	3 14.0	43	133
+ 83 00	+ 8 33.9	+ 7 56.9	+ 7 20.3	4 12 24.7	4 12 43.9	4 13 03.6	3 15.0	44	134
+ 84 00	+ 8 02.4	+ 7 25.8	+ 6 49.6	4 15 00.5	4 15 20.5	4 15 40.9	3 16.1	46	135
+ 85 00	+ 7 31.4	+ 6 55.2	+ 6 19.4	4 17 42.8	4 18 03.4	4 18 24.5	3 17.2	47	136
+ 86 00	+ 7 01.1	+ 6 25.3	+ 5 49.8	4 20 31.4	4 20 52.7	4 21 14.2	3 18.3	49	138
+ 87 00	+ 6 31.5	+ 5 56.1	+ 5 21.0	4 23 26.3	4 23 48.0	4 24 10.0	3 19.4	51	139
+ 88 00	+ 6 02.7	+ 5 27.7	+ 4 53.0	4 26 27.4	4 26 49.4	4 27 11.7	3 20.6	52	140
+ 89 00	+ 5 34.9	+ 5 00.2	+ 4 25.9	4 29 34.4	4 29 56.7	4 30 19.2	3 21.7	53	142
+ 90 00	+ 5 08.0	+ 4 33.7	+ 3 59.8	4 32 47.2	4 33 09.6	4 33 32.1	3 22.9	55	144
+ 91 00	+ 4 42.3	+ 4 08.3	+ 3 34.7	4 36 05.5	4 36 27.8	4 36 50.2	3 24.1	56	146
+ 92 00	+ 4 17.7	+ 3 44.1	+ 3 10.8	4 39 28.9	4 39 51.0	4 40 13.3	3 25.2	58	148
+ 93 00	+ 3 54.4	+ 3 21.1	+ 2 48.1	4 42 57.2	4 43 19.0	4 43 40.9	3 26.3	59	150
+ 94 00	+ 3 32.5	+ 2 59.5	+ 2 26.8	4 46 29.9	4 46 51.3	4 47 12.6	3 27.4	60	153
+ 95 00	+ 3 11.9	+ 2 39.3	+ 2 06.8	4 50 06.7	4 50 27.4	4 50 48.2	3 28.5	61	156
+ 96 00	+ 2 53.0	+ 2 20.5	+ 1 48.3	4 53 46.9	4 54 07.0	4 54 27.0	3 29.4	62	159
+ 97 00	+ 2 35.5	+ 2 03.3	+ 1 31.4	4 57 30.3	4 57 49.5	4 58 08.6	3 30.4	63	162
+ 98 00	+ 2 19.7	+ 1 47.7	+ 1 16.0	5 01 16.2	5 01 34.4	5 01 52.6	3 31.2	64	166
+ 99 00	+ 2 05.7	+ 1 33.8	+ 1 02.3	5 05 04.1	5 05 21.3	5 05 38.4	3 31.9	65	170
+100 00	+ 1 53.3	+ 1 21.6	+ 0 50.2	5 08 53.5	5 09 09.5	5 09 25.4	3 32.6	65	174
+101 00	+ 1 42.7	+ 1 11.1	+ 0 39.8	5 12 43.7	5 12 58.5	5 13 13.3	3 33.1	65	178
+102 00	+ 1 33.9	+ 1 02.4	+ 0 31.2	5 16 34.3	5 16 47.8	5 17 01.3	3 33.6	66	183

PATH OF CENTRAL PHASE: TOTAL SOLAR ECLIPSE OF DECEMBER 26

Longitude	Latitude of: Northern Limit	Central Line	Southern Limit	Universal Time at: Northern Limit	Central Line	Southern Limit	On Central Line: Maximum Duration	Sun's Alt.	Sun's Az.
° ′	° ′	° ′	° ′	h m s	h m s	h m s	m s	°	°
+103 00	+ 1 26.9	+ 0 55.5	+ 0 24.3	5 20 24.7	5 20 36.9	5 20 49.0	3 33.9	66	187
+104 00	+ 1 21.8	+ 0 50.3	+ 0 19.1	5 24 14.3	5 24 25.1	5 24 35.9	3 34.1	65	191
+105 00	+ 1 18.4	+ 0 46.9	+ 0 15.7	5 28 02.6	5 28 12.0	5 28 21.5	3 34.2	65	195
+106 00	+ 1 16.9	+ 0 45.3	+ 0 14.0	5 31 49.0	5 31 57.1	5 32 05.2	3 34.2	64	199
+107 00	+ 1 17.1	+ 0 45.5	+ 0 14.1	5 35 33.1	5 35 39.9	5 35 46.7	3 34.0	64	203
+108 00	+ 1 19.1	+ 0 47.3	+ 0 15.8	5 39 14.5	5 39 20.0	5 39 25.5	3 33.8	63	206
+109 00	+ 1 22.8	+ 0 50.8	+ 0 19.2	5 42 52.6	5 42 56.8	5 43 01.1	3 33.4	62	210
+110 00	+ 1 28.1	+ 0 56.0	+ 0 24.1	5 46 27.0	5 46 30.1	5 46 33.2	3 32.9	61	212
+111 00	+ 1 35.1	+ 1 02.8	+ 0 30.7	5 49 57.5	5 49 59.5	5 50 01.5	3 32.4	60	215
+112 00	+ 1 43.7	+ 1 11.1	+ 0 38.7	5 53 23.6	5 53 24.6	5 53 25.5	3 31.8	58	218
+113 00	+ 1 53.7	+ 1 20.8	+ 0 48.2	5 56 45.0	5 56 45.1	5 56 45.1	3 31.1	57	220
+114 00	+ 2 05.2	+ 1 32.0	+ 0 59.1	6 00 01.5	6 00 00.8	6 00 00.0	3 30.3	56	222
+115 00	+ 2 18.1	+ 1 44.6	+ 1 11.4	6 03 12.9	6 03 11.4	6 03 09.9	3 29.5	55	223
+116 00	+ 2 32.2	+ 1 58.4	+ 1 24.9	6 06 18.9	6 06 16.8	6 06 14.6	3 28.7	53	225
+117 00	+ 2 47.7	+ 2 13.5	+ 1 39.6	6 09 19.4	6 09 16.8	6 09 14.0	3 27.8	52	226
+118 00	+ 3 04.3	+ 2 29.7	+ 1 55.5	6 12 14.2	6 12 11.2	6 12 08.0	3 26.9	50	228
+119 00	+ 3 22.0	+ 2 47.0	+ 2 12.4	6 15 03.2	6 14 59.9	6 14 56.4	3 26.0	49	229
+120 00	+ 3 40.7	+ 3 05.4	+ 2 30.4	6 17 46.4	6 17 42.9	6 17 39.1	3 25.1	47	230
+121 00	+ 4 00.4	+ 3 24.7	+ 2 49.3	6 20 23.7	6 20 20.1	6 20 16.2	3 24.1	46	231
+122 00	+ 4 21.0	+ 3 44.9	+ 3 09.1	6 22 55.1	6 22 51.4	6 22 47.4	3 23.2	44	232
+123 00	+ 4 42.4	+ 4 05.9	+ 3 29.7	6 25 20.5	6 25 16.9	6 25 13.0	3 22.2	43	232
+124 00	+ 5 04.7	+ 4 27.7	+ 3 51.0	6 27 39.9	6 27 36.5	6 27 32.7	3 21.3	41	233
+125 00	+ 5 27.6	+ 4 50.2	+ 4 13.1	6 29 53.5	6 29 50.3	6 29 46.7	3 20.4	40	234
+126 00	+ 5 51.2	+ 5 13.3	+ 4 35.8	6 32 01.2	6 31 58.3	6 31 55.0	3 19.5	38	234
+127 00	+ 6 15.3	+ 5 37.1	+ 4 59.1	6 34 03.1	6 34 00.6	6 33 57.7	3 18.6	37	235
+128 00	+ 6 40.1	+ 6 01.4	+ 5 23.0	6 35 59.3	6 35 57.3	6 35 54.8	3 17.7	36	236
+129 00	+ 7 05.3	+ 6 26.1	+ 5 47.3	6 37 49.8	6 37 48.3	6 37 46.3	3 16.9	34	236
+130 00	+ 7 30.9	+ 6 51.3	+ 6 12.1	6 39 34.8	6 39 33.9	6 39 32.4	3 16.1	33	236
+131 00	+ 7 57.0	+ 7 16.9	+ 6 37.3	6 41 14.3	6 41 14.1	6 41 13.2	3 15.3	31	237
+132 00	+ 8 23.4	+ 7 42.9	+ 7 02.8	6 42 48.5	6 42 49.0	6 42 48.7	3 14.5	30	237
+133 00	+ 8 50.1	+ 8 09.2	+ 7 28.6	6 44 17.5	6 44 18.7	6 44 19.1	3 13.7	29	238
+134 00	+ 9 17.0	+ 8 35.7	+ 7 54.7	6 45 41.4	6 45 43.3	6 45 44.5	3 13.0	27	238
+135 00	+ 9 44.2	+ 9 02.5	+ 8 21.1	6 47 00.3	6 47 03.0	6 47 04.9	3 12.3	26	238
+136 00	+10 11.6	+ 9 29.5	+ 8 47.7	6 48 14.3	6 48 17.8	6 48 20.6	3 11.6	24	239
+137 00	+10 39.2	+ 9 56.6	+ 9 14.4	6 49 23.6	6 49 28.0	6 49 31.5	3 10.9	23	239
+138 00	+11 06.9	+10 23.9	+ 9 41.3	6 50 28.3	6 50 33.5	6 50 38.0	3 10.3	22	239
+139 00	+11 34.7	+10 51.3	+10 08.3	6 51 28.5	6 51 34.6	6 51 39.9	3 09.6	21	240
+140 00	+12 02.6	+11 18.8	+10 35.4	6 52 24.3	6 52 31.4	6 52 37.6	3 09.0	19	240
+141 00	+12 30.6	+11 46.4	+11 02.5	6 53 16.0	6 53 24.0	6 53 31.0	3 08.4	18	240
+142 00	+12 58.6	+12 14.0	+11 29.8	6 54 03.5	6 54 12.4	6 54 20.4	3 07.9	17	241
+143 00	+13 26.6	+12 41.6	+11 57.0	6 54 47.0	6 54 56.9	6 55 05.8	3 07.3	16	241
+144 00	+13 54.6	+13 09.2	+12 24.2	6 55 26.7	6 55 37.6	6 55 47.4	3 06.8	14	241
+145 00	+14 22.6	+13 36.8	+12 51.5	6 56 02.7	6 56 14.5	6 56 25.2	3 06.3	13	242
+146 00	+14 50.6	+14 04.4	+13 18.6	6 56 35.0	6 56 47.8	6 56 59.5	3 05.8	12	242
+147 00	+15 18.4	+14 31.9	+13 45.8	6 57 03.9	6 57 17.6	6 57 30.2	3 05.3	11	242
+148 00	+15 46.3	+14 59.4	+14 12.9	6 57 29.3	6 57 44.0	6 57 57.5	3 04.9	10	243
+149 00	+16 14.0	+15 26.8	+14 39.9	6 57 51.5	6 58 07.2	6 58 21.6	3 04.4	8	243
+150 00	+16 41.7	+15 54.1	+15 06.9	6 58 11.2	6 58 27.1	6 58 42.7	3 04.0	7	243
+151 00	+17 09.2	+16 21.2	+15 33.7	6 58 26.7	6 58 42.5	6 59 00.2	3 03.6	6	243
+152 00	+17 36.5	+16 48.3	+16 00.4	6 58 36.7	6 58 57.4	6 59 13.2	3 03.2	5	244

For limits, see Circumstances of the Eclipse.


TRANSIT OF MERCURY OF 2019 NOVEMBER 11
Longitude East of Greenwich
Longitude West of Greenwich
Longitude East of Greenwich
Longitude West of Greenwich
Longitude East of Greenwich
Longitude East of Greenwich
Transit begins at Sunrise
Transit ends at Sunrise
Transit begins at Sunset
Transit ends at Sunset
Entire transit visible
Transit in progress at sunrise
Transit in progress at sunset
NORTH PACIFIC OCEAN
NORTH AMERICA
NORTH ATLANTIC OCEAN
EUROPE
ASIA
AFRICA
INDIAN OCEAN
SOUTH AMERICA
SOUTH ATLANTIC OCEAN
SOUTH PACIFIC OCEAN
AUSTRALIA
ANTARCTICA

A transit of Mercury over the disk of the Sun will occur on November 11. The entire transit will be visible in eastern North America, South America, Antarctica, extreme southern Greenland, extreme western Africa, and the Atlantic Ocean.

The times provided in the following tables are given provisionally in Universal Time, using $\Delta T(A) = +69^{s}.0$. Once the value of ΔT is known, the data on these pages may be expressed in Universal Time as follows:

Define $\delta T = \Delta T - \Delta T(A)$, in units of seconds of time.

Change the times given in provisional Universal Time by subtracting δT.

Apply the correction 0.00417807 δT to the longitudes in such a way that if δT is positive, the longitudes shift to the east.

Leave all other quantities unchanged.

Longitude is positive to the east and negative to the west.

GEOCENTRIC PHASES

		UT	Position Angle P	Mercury being in the Zenith in Longitude	Latitude
		d h m s	°	° ′	° ′
Ingress, exterior contact	November	11 12 35 27.2	109.8	− 12 36.2	−17 30.5
Ingress, interior contact		11 12 37 08.5	109.8	− 13 01.7	−17 30.5
Least angular distance		11 15 19 48.3	24.3	− 53 56.8	−17 25.8
Egress, interior contact		11 18 02 33.3	298.8	− 94 53.1	−17 21.0
Egress, exterior contact		11 18 04 14.7	298.7	− 95 18.6	−17 21.0

Least angular distance: $1' 15''.9$

The position angle P of the point of contact is reckoned from the north point of the limb of the Sun towards the east as viewed at the geocenter.

The position angle V of the point of contact, reckoned from the vertex of the limb of the Sun towards the east, is found by:

$$V = P - C$$

where C, the parallactic angle, is given by:

$$\tan C = \frac{\cos \phi' \sin h}{\sin \phi' \cos \delta - \cos \phi' \sin \delta \cos h}$$

in which ϕ' is the geocentric latitude of the place, δ is the declination of the Sun, and h is the local hour angle of the Sun; sin C has the same algebraic sign as sin h.

Location	Position		Ingress Exterior Contact		Ingress Interior Contact		Least Angular Distance		Egress Interior Contact		Egress Exterior Contact	
	Latitude	Longitude	UT	*P*	UT	*P*	UT	Separation	UT	*P*	UT	*P*
	° ′	° ′	h m s	°	h m s	°	h m s	′ ″	h m s	°	h m s	°
United States												
Hartford, CT	+41 46.2	− 72 40.6	12 36 03.4	109.9	12 37 44.6	109.9	15 20 12.8	1 13.2	18 02 39.8	298.5	18 04 21.0	298.5
Boston, MA	+42 20.0	− 71 05.0	12 36 02.9	109.9	12 37 44.2	109.9	15 20 12.0	1 13.1	18 02 39.2	298.5	18 04 20.4	298.5
New York, NY	+40 44.0	− 74 00.0	12 36 03.9	109.9	12 37 45.2	109.9	15 20 13.4	1 13.2	18 02 40.1	298.5	18 04 21.2	298.5
Washington, DC	+38 53.7	− 77 02.2	12 36 04.9	109.9	12 37 46.2	109.9	15 20 14.7	1 13.4	18 02 40.9	298.5	18 04 22.1	298.5
Raleigh, NC	+35 49.1	− 78 38.7	12 36 05.8	109.9	12 37 47.1	109.9	15 20 15.5	1 13.6	18 02 40.8	298.6	18 04 21.9	298.5
Atlanta, GA	+33 45.3	− 84 23.4	12 36 07.1	109.9	12 37 48.4	109.9	15 20 18.1	1 13.9	18 02 43.2	298.6	18 04 24.4	298.5
Miami, FL	+25 45.0	− 80 15.0	12 36 07.5	109.9	12 37 48.8	109.8	15 20 15.8	1 14.2	18 02 38.4	298.6	18 04 19.6	298.5
Montgomery, AL	+32 21.7	− 86 16.8	12 36 07.5	109.9	12 37 48.8	109.8	15 20 18.9	1 14.0	18 02 43.9	298.6	18 04 25.0	298.5
Detroit, MI	+42 19.9	− 83 02.8	12 36 04.9	109.9	12 37 46.3	109.9	15 20 17.2	1 13.4	18 02 44.9	298.5	18 04 26.1	298.5
Indianapolis, IN	+39 47.5	− 86 08.9	12 36 05.9	109.9	12 37 47.3	109.9	15 20 18.6	1 13.6	18 02 45.8	298.6	18 04 26.9	298.5
Chicago, IL	+41 50.0	− 87 38.0	. .. .. .	.. .	. .. .. .	.. .	15 20 19.0	1 13.6	18 02 47.0	298.6	18 04 28.2	298.5
Milwaukee, WI	+43 03.0	− 87 57.0	. .. .. .	.. .	. .. .. .	.. .	15 20 19.0	1 13.5	18 02 47.4	298.6	18 04 28.6	298.5
Minneapolis, MN	+44 58.8	− 93 15.1	. .. .. .	.. .	. .. .. .	.. .	15 20 20.6	1 13.6	18 02 50.3	298.6	18 04 31.5	298.5
St. Louis, MO	+38 40.0	− 90 15.0	. .. .. .	.. .	. .. .. .	.. .	15 20 20.3	1 13.8	18 02 47.6	298.6	18 04 28.7	298.5
Louisville, KY	+38 15.3	− 85 45.6	12 36 06.3	109.9	12 37 47.6	109.9	15 20 18.5	1 13.7	18 02 45.2	298.6	18 04 26.3	298.5
Lincoln, NE	+40 48.6	− 96 40.5	. .. .. .	.. .	. .. .. .	.. .	15 20 22.3	1 13.8	18 02 51.2	298.6	18 04 32.4	298.5
Oklahoma City, OK	+35 28.9	− 97 32.1	. .. .. .	.. .	. .. .. .	.. .	15 20 23.2	1 14.1	18 02 50.7	298.6	18 04 31.8	298.5
Denver, CO	+39 44.4	−104 59.1	. .. .. .	.. .	. .. .. .	.. .	15 20 24.9	1 14.1	18 02 55.0	298.6	18 04 36.2	298.5
Salt Lake City, UT	+40 45.0	−111 55.0	. .. .. .	.. .	. .. .. .	.. .	15 20 26.4	1 14.2	18 02 58.3	298.6	18 04 39.5	298.5
Dallas, TX	+32 47.0	− 96 48.2	. .. .. .	.. .	. .. .. .	.. .	15 20 23.1	1 14.3	18 02 49.7	298.6	18 04 30.9	298.5
Houston, TX	+29 45.0	− 95 25.0	. .. .. .	.. .	. .. .. .	.. .	15 20 22.7	1 14.4	18 02 48.3	298.6	18 04 29.4	298.5
Albuquerque, NM	+35 06.6	−106 36.6	. .. .. .	.. .	. .. .. .	.. .	15 20 26.0	1 14.4	18 02 55.2	298.6	18 04 36.4	298.6
Las Vegas, NV	+36 10.6	−115 08.2	. .. .. .	.. .	. .. .. .	.. .	15 20 27.8	1 14.6	18 02 59.4	298.6	18 04 40.6	298.6
Los Angeles, CA	+34 03.0	−118 15.0	. .. .. .	.. .	. .. .. .	.. .	15 20 28.7	1 14.8	18 03 00.7	298.6	18 04 41.9	298.6
San Diego, CA	+32 42.9	−117 09.7	. .. .. .	.. .	. .. .. .	.. .	15 20 28.6	1 14.9	18 03 00.0	298.6	18 04 41.2	298.6
San Francisco, CA	+37 46.8	−122 25.2	. .. .. .	.. .	. .. .. .	.. .	15 20 28.7	1 14.7	18 03 02.7	298.6	18 04 43.9	298.6
Portland, OR	+45 32.0	−122 40.0	. .. .. .	.. .	. .. .. .	.. .	15 20 26.9	1 14.2	18 03 02.7	298.6	18 04 43.9	298.6
Seattle, WA	+47 36.6	−122 20.0	. .. .. .	.. .	. .. .. .	.. .	15 20 26.3	1 14.1	18 03 02.5	298.6	18 04 43.7	298.5
Canada												
St. John's, Nfld.	+47 34.1	− 52 42.4	12 35 56.6	110.0	12 37 37.8	109.9	15 20 03.9	1 12.5	18 02 33.7	298.5	18 04 14.9	298.5
Moncton, N.B.	+46 07.0	− 64 48.2	12 36 00.4	110.0	12 37 41.7	109.9	15 20 09.3	1 12.8	18 02 37.9	298.5	18 04 19.1	298.5
Halifax,N.S.	+44 38.0	− 63 35.0	12 36 00.5	110.0	12 37 41.7	109.9	15 20 08.7	1 12.8	18 02 36.7	298.5	18 04 17.9	298.5
Charlottetown, P.E.I.	+46 14.4	− 63 08.4	12 36 00.0	110.0	12 37 41.2	109.9	15 20 08.5	1 12.8	18 02 37.2	298.5	18 04 18.4	298.5
Montreal, Que.	+45 30.5	− 73 33.2	12 36 02.5	110.0	12 37 43.8	109.9	15 20 13.1	1 13.0	18 02 41.5	298.5	18 04 22.6	298.5
Toronto, Ont.	+43 43.0	− 79 20.4	12 36 04.0	109.9	12 37 45.3	109.9	15 20 15.6	1 13.3	18 02 43.5	298.5	18 04 24.7	298.5
Thunder Bay, Ont.	+48 22.9	− 89 14.8	. .. .. .	.. .	. .. .. .	.. .	15 20 18.7	1 13.3	18 02 49.2	298.5	18 04 30.3	298.5
Winnipeg, Man.	+49 54.0	− 97 08.0	. .. .. .	.. .	. .. .. .	.. .	15 20 20.8	1 13.4	18 02 52.7	298.6	18 04 33.9	298.5
Edmonton, Alta.	+53 34.6	−113 31.0	. .. .. .	.. .	. .. .. .	.. .	15 20 23.2	1 13.6	18 02 59.1	298.6	18 04 40.3	298.5
Iqaluit, Nunavut	+63 44.9	− 68 31.2	. .. .. .	.. .	. .. .. .	.. .	15 20 09.9	1 12.4	18 02 45.6	298.5	18 04 26.9	298.5
Vancouver, B.C.	+49 15.0	−123 06.0	. .. .. .	.. .	. .. .. .	.. .	15 20 25.8	1 14.0	18 03 02.6	298.6	18 04 43.9	298.5

Location	Position		Ingress Exterior Contact		Ingress Interior Contact		Least Angular Distance		Egress Interior Contact		Egress Exterior Contact	
	Latitude	Longitude	UT	*P*	UT	*P*	UT	Separation	UT	*P*	UT	*P*
	° ′	° ′	h m s	°	h m s	°	h m s	′ ″	h m s	°	h m s	°
Martinique Fort-de-France	+14 36.0	− 61 05.0	12 36 01.9	109.9	12 37 43.2	109.8	15 20 02.9	1 14.2	18 02 23.1	298.6	18 04 04.3	298.6
Bermuda Hamilton	+32 18.0	− 64 48.0	12 36 03.0	109.9	12 37 44.3	109.9	15 20 08.2	1 13.4	18 02 32.3	298.6	18 04 13.4	298.5
Puerto Rico San Juan	+18 29.0	− 66 08.0	12 36 04.0	109.9	12 37 45.2	109.8	15 20 06.9	1 14.1	18 02 27.5	298.6	18 04 08.7	298.5
Haiti Port-au-Prince	+18 32.0	− 72 20.0	12 36 05.9	109.9	12 37 47.1	109.8	15 20 10.5	1 14.3	18 02 31.2	298.6	18 04 12.4	298.5
Jamaica Kingston	+17 58.0	− 76 48.0	12 36 07.0	109.8	12 37 48.3	109.8	15 20 13.0	1 14.5	18 02 33.7	298.6	18 04 14.9	298.6
Bahamas Nassau	+25 03.6	− 77 20.7	12 36 06.9	109.9	12 37 48.2	109.8	15 20 14.2	1 14.1	18 02 36.5	298.6	18 04 17.6	298.5
Cuba Havana	+23 08.0	− 82 23.0	12 36 08.0	109.9	12 37 49.3	109.8	15 20 16.6	1 14.4	18 02 38.9	298.6	18 04 20.0	298.5
Mexico												
Mexico City	+19 25.0	− 99 10.0	. .. .. .	.. .	. .. .. .	.. .	15 20 23.7	1 15.1	18 02 47.9	298.6	18 04 29.0	298.6
Monterrey	+25 40.0	−100 20.0	. .. .. .	.. .	. .. .. .	.. .	15 20 24.5	1 14.8	18 02 50.1	298.6	18 04 31.2	298.6
Guadalajara	+20 40.0	−103 21.0	. .. .. .	.. .	. .. .. .	.. .	15 20 25.3	1 15.2	18 02 50.6	298.6	18 04 31.8	298.6
Veracruz	+19 26.1	− 96 23.0	12 36 09.2	109.8	12 37 50.6	109.8	15 20 22.7	1 15.0	18 02 46.2	298.6	18 04 27.3	298.6
Guatemala Guatemala City	+14 38.0	− 90 22.0	12 36 08.9	109.8	12 37 50.2	109.8	15 20 19.4	1 15.1	18 02 41.1	298.6	18 04 22.2	298.6
El Salvador San Salvador	+13 40.0	− 89 10.0	12 36 08.7	109.8	12 37 50.1	109.8	15 20 18.7	1 15.1	18 02 40.0	298.6	18 04 21.2	298.6
Honduras Tegucigalpa	+14 05.0	− 87 14.0	12 36 08.6	109.8	12 37 49.9	109.8	15 20 17.8	1 15.1	18 02 38.9	298.6	18 04 20.1	298.6
Belize Belmopan	+17 13.0	− 88 48.0	12 36 08.8	109.8	12 37 50.2	109.8	15 20 19.1	1 14.9	18 02 40.9	298.6	18 04 22.0	298.6
Nicaragua Managua	+12 06.0	− 86 18.0	12 36 08.3	109.8	12 37 49.6	109.8	15 20 17.0	1 15.1	18 02 37.7	298.6	18 04 18.8	298.6
Venezuela Caracas	+10 30.0	− 66 55.0	12 36 03.6	109.8	12 37 44.9	109.8	15 20 05.6	1 14.6	18 02 25.0	298.6	18 04 06.1	298.6
Costa Rica San Jose	+ 9 59.0	− 84 04.0	12 36 07.8	109.8	12 37 49.1	109.8	15 20 15.5	1 15.2	18 02 35.6	298.6	18 04 16.7	298.6
Panama Panama City	+ 8 57.0	− 79 30.0	12 36 06.9	109.8	12 37 48.2	109.8	15 20 12.8	1 15.1	18 02 32.3	298.6	18 04 13.4	298.6
Argentina												
Buenos Aires	−34 40.0	− 58 30.0	12 35 45.3	109.7	12 37 26.6	109.7	15 19 46.6	1 17.2	18 02 08.4	298.8	18 03 49.6	298.7
Cordoba	−31 25.0	− 64 11.0	12 35 48.9	109.7	12 37 30.2	109.7	15 19 50.8	1 17.1	18 02 11.7	298.8	18 03 52.8	298.7
Falkland Islands Stanley	−51 41.5	− 57 51.5	12 35 35.9	109.7	12 37 17.2	109.6	15 19 40.9	1 18.1	18 02 07.4	298.9	18 03 48.7	298.8
Brazil												
Recife	− 8 03.0	− 34 54.0	12 35 44.0	109.8	12 37 25.1	109.8	15 19 39.2	1 14.8	18 02 02.0	298.7	18 03 43.3	298.6
Rio de Janeiro	−22 54.5	− 43 11.8	12 35 43.8	109.8	12 37 25.0	109.7	15 19 40.8	1 16.0	18 02 02.7	298.7	18 03 43.9	298.7
Belo Horizonte	−19 55.1	− 43 56.3	12 35 45.3	109.8	12 37 26.5	109.7	15 19 42.0	1 15.8	18 02 03.5	298.7	18 03 44.7	298.7
Sao Paolo	−23 33.0	− 46 38.0	12 35 45.3	109.8	12 37 26.5	109.7	15 19 42.8	1 16.1	18 02 04.1	298.7	18 03 45.3	298.7

TRANSIT OF MERCURY OF 2019 NOVEMBER 11

Location	Position		Ingress Exterior Contact		Ingress Interior Contact		Least Angular Distance		Egress Interior Contact		Egress Exterior Contact	
	Latitude	Longitude	UT	*P*	UT	*P*	UT	Separation	UT	*P*	UT	*P*
	° ′	° ′	h m s	°	h m s	°	h m s	′ ″	h m s	°	h m s	°
Brazil												
Brasilia	−15 45.0	− 47 57.0	12 35 48.9	109.8	12 37 30.0	109.7	15 19 45.8	1 15.7	18 02 06.2	298.7	18 03 47.4	298.7
Porto Alegre	−30 02.0	− 51 13.8	12 35 44.7	109.7	12 37 25.9	109.7	15 19 43.8	1 16.7	18 02 05.5	298.8	18 03 46.7	298.7
Chile												
Santiago	−33 30.0	− 70 40.0	12 35 49.7	109.7	12 37 31.0	109.6	15 19 53.5	1 17.4	18 02 14.7	298.8	18 03 55.9	298.7
Concepcion	−36 50.0	− 73 03.0	12 35 48.4	109.7	12 37 29.7	109.6	15 19 53.3	1 17.7	18 02 15.3	298.8	18 03 56.5	298.8
Colombia												
Medellin	+ 6 14.2	− 75 34.5	12 36 05.6	109.8	12 37 46.9	109.8	15 20 09.9	1 15.1	18 02 28.9	298.6	18 04 10.0	298.6
Bogota	+ 4 38.0	− 74 05.0	12 36 04.9	109.8	12 37 46.2	109.8	15 20 08.6	1 15.2	18 02 27.4	298.6	18 04 08.5	298.6
Guyana Georgetown	+ 6 46.0	− 58 10.0	12 35 59.7	109.8	12 37 40.9	109.8	15 19 59.1	1 14.5	18 02 18.5	298.6	18 03 59.6	298.6
Suriname Paramaribo	+ 5 52.0	− 55 14.0	12 35 58.3	109.8	12 37 39.5	109.8	15 19 56.9	1 14.5	18 02 16.5	298.6	18 03 57.6	298.6
French Guiana Cayenne	+ 4 55.0	− 52 18.0	12 35 56.7	109.8	12 37 37.9	109.8	15 19 54.6	1 14.5	18 02 14.5	298.6	18 03 55.7	298.6
Bolivia												
Santa Cruz	−17 45.0	− 63 14.0	12 35 54.8	109.7	12 37 36.0	109.7	15 19 55.0	1 16.2	18 02 13.9	298.7	18 03 55.1	298.7
Cochabamba	−17 23.0	− 66 10.0	12 35 55.9	109.7	12 37 37.2	109.7	15 19 56.9	1 16.3	18 02 15.7	298.7	18 03 56.9	298.7
Paraguay Asuncion	−25 15.0	− 57 40.0	12 35 49.5	109.7	12 37 30.7	109.7	15 19 49.1	1 16.5	18 02 09.3	298.7	18 03 50.5	298.7
Ecuador Quito	− 0 15.0	− 78 35.0	12 36 05.0	109.8	12 37 46.3	109.7	15 20 09.9	1 15.6	18 02 28.6	298.7	18 04 09.8	298.6
Peru Lima	−12 06.0	− 77 03.0	12 36 01.0	109.7	12 37 42.4	109.7	15 20 05.2	1 16.3	18 02 23.8	298.7	18 04 05.0	298.7
Uruguay Montevideo	−34 53.0	− 56 10.0	12 35 44.4	109.7	12 37 25.6	109.7	15 19 45.2	1 17.1	18 02 07.3	298.8	18 03 48.5	298.7
Easter Island Hanga Roa	−27 09.0	−109 26.0	12 35 55.6	109.7	12 37 37.1	109.6	15 20 12.4	1 18.2	18 02 37.9	298.8	18 04 19.1	298.8
Pitcairn Islands Adamstown	−25 04.0	−130 06.0	. .. .. .	.. .	. .. .. .	.. .	15 20 16.9	1 18.7	18 02 48.8	298.8	18 04 30.0	298.8
French Polynesia Papeete, Tahiti	−17 32.0	−149 34.0	. .. .. .	.. .	. .. .. .	.. .	15 20 19.7	1 18.7	18 02 59.4	298.9	18 04 40.7	298.8
Kenya Nairobi	− 1 17.0	+ 36 49.0	12 34 59.6	110.0	12 36 40.8	109.9	15 19 09.0	1 14.3	.. ..	... .	.. ..	... .
Mozambique Maputo	−25 58.0	+ 32 35.0	12 34 58.7	109.9	12 36 39.9	109.8	15 19 06.6	1 15.9	.. ..	... .	.. ..	... .
Uganda Kampala	+ 0 18.8	+ 32 34.9	12 35 02.2	110.0	12 36 43.4	109.9	15 19 10.0	1 14.2	.. ..	... .	.. ..	... .
Zimbabwe Harare	−17 51.8	+ 31 01.8	12 35 00.0	109.9	12 36 41.2	109.8	15 19 07.0	1 15.3	.. ..	... .	.. ..	... .
Zambia Lusaka	−15 25.0	+ 28 17.0	12 35 01.8	109.9	12 36 42.9	109.9	15 19 07.7	1 15.1	.. ..	... .	.. ..	... .
South Africa, Rep. of												
Johannesburg	−26 12.3	+ 28 02.7	12 35 01.0	109.9	12 36 42.2	109.8	15 19 07.3	1 15.9	.. ..	... .	.. ..	... .
Cape Town	−33 55.5	+ 18 25.4	12 35 05.8	109.8	12 36 46.9	109.8	15 19 10.0	1 16.3	.. ..	... .	.. ..	... .
Namibia Windhoek	−22 34.2	+ 17 05.0	12 35 07.3	109.9	12 36 48.5	109.8	15 19 10.0	1 15.5	.. ..	... .	.. ..	... .
Angola Luanda	− 8 50.3	+ 13 14.1	12 35 11.9	109.9	12 36 53.0	109.9	15 19 12.8	1 14.5	.. ..	... .	.. ..	... .

Location	Position		Ingress Exterior Contact		Ingress Interior Contact		Least Angular Distance		Egress Interior Contact		Egress Exterior Contact	
	Latitude	Longitude	UT	*P*	UT	*P*	UT	Separation	UT	*P*	UT	*P*
	° ′	° ′	h m s	°	h m s	°	h m s	′ ″	h m s	°	h m s	°
Congo, Democratic Republic of Kinshasa	− 4 19.5	+ 15 19.3	12 35 11.5	109.9	12 36 52.6	109.9	15 19 13.0	1 14.2	.. ..	... .	.. ..	... .
Libya												
Benghazi	+32 07.0	+ 20 04.0	12 35 19.3	110.0	12 37 00.5	110.0	15 19 26.8	1 12.4	.. ..	... .	.. ..	... .
Tripoli	+32 54.1	+ 13 11.1	12 35 23.3	110.0	12 37 04.4	110.0	15 19 29.1	1 12.3	.. ..	... .	.. ..	... .
Central African Republic Bangui	+ 4 22.0	+ 18 35.0	12 35 11.4	110.0	12 36 52.5	109.9	15 19 14.5	1 13.7	.. ..	... .	.. ..	... .
Chad N'Djamena	+12 06.7	+ 15 02.1	12 35 15.8	110.0	12 36 56.9	109.9	15 19 18.4	1 13.2	.. ..	... .	.. ..	... .
Tunisia Tunis	+36 48.0	+ 10 11.0	12 35 26.2	110.1	12 37 07.3	110.0	15 19 32.2	1 12.2	.. ..	... .	.. ..	... .
Cameroon Yaounde	+ 3 52.0	+ 11 31.0	12 35 15.9	110.0	12 36 57.0	109.9	15 19 16.7	1 13.7	.. ..	... .	.. ..	... .
Nigeria Lagos	+ 6 27.2	+ 3 23.8	12 35 21.9	110.0	12 37 03.0	109.9	15 19 20.9	1 13.5	.. ..	... .	.. ..	... .
Algeria Algiers	+36 42.0	+ 3 13.0	12 35 29.9	110.0	12 37 11.0	110.0	15 19 34.5	1 12.2	.. ..	... .	.. ..	... .
Niger Niamey	+13 31.3	+ 2 06.3	12 35 24.6	110.0	12 37 05.7	109.9	15 19 24.1	1 13.1	.. ..	... .	.. ..	... .
Ghana Accra	+ 5 33.0	− 0 12.0	12 35 24.2	110.0	12 37 05.3	109.9	15 19 22.3	1 13.6	.. ..	... .	.. ..	... .
Ivory Coast Abidjan	+ 5 20.2	− 4 01.6	12 35 26.7	109.9	12 37 07.8	109.9	15 19 24.2	1 13.6	.. ..	... .	.. ..	... .
Morocco Rabat	+34 02.0	− 6 50.0	12 35 35.0	110.0	12 37 16.1	110.0	15 19 37.3	1 12.3	.. ..	... .	.. ..	... .
Mali Bamako	+12 39.0	− 8 00.0	12 35 31.2	110.0	12 37 12.3	109.9	15 19 28.8	1 13.2	.. ..	... .	.. ..	... .
Liberia Monrovia	+ 6 19.0	− 10 46.8	12 35 31.6	109.9	12 37 12.7	109.9	15 19 28.1	1 13.6	18 01 59.6	298.6	18 03 40.9	298.6
Western Sahara El Aaiun	+27 09.2	− 13 12.2	12 35 37.5	110.0	12 37 18.6	110.0	15 19 37.3	1 12.6	.. ..	... .	.. ..	... .
Sierra Leone Freetown	+ 8 29.1	− 13 14.1	12 35 33.8	109.9	12 37 14.9	109.9	15 19 30.2	1 13.5	18 02 00.9	298.6	18 03 42.2	298.6
Guinea-Bissau Bissau	+11 51.0	− 15 34.0	12 35 36.1	109.9	12 37 17.2	109.9	15 19 32.7	1 13.3	18 02 02.9	298.6	18 03 44.2	298.6
Mauritania Nouakchott	+18 06.0	− 15 57.0	12 35 37.6	110.0	12 37 18.7	109.9	15 19 35.2	1 13.0	18 02 06.0	298.6	18 03 47.3	298.5
Senegal Dakar	+14 41.6	− 17 26.8	12 35 37.9	110.0	12 37 19.0	109.9	15 19 34.8	1 13.2	18 02 04.6	298.6	18 03 45.9	298.5
Albania Tirana	+41 19.8	+ 19 49.2	12 35 22.9	110.1	12 37 04.1	110.0	15 19 32.4	1 12.1	.. ..	... .	.. ..	... .
Bosnia-Herzegovina Sarajevo	+43 50.9	+ 18 21.4	12 35 24.5	110.1	12 37 05.7	110.0	15 19 34.3	1 12.0	.. ..	... .	.. ..	... .
Austria Vienna	+48 12.5	+ 16 22.4	12 35 27.0	110.1	12 37 08.2	110.0	15 19 37.5	1 12.0	.. ..	... .	.. ..	... .
Croatia Zagreb	+45 49.0	+ 15 59.0	12 35 26.3	110.1	12 37 07.5	110.0	15 19 36.0	1 12.0	.. ..	... .	.. ..	... .
Czech Republic Prague	+50 05.0	+ 14 25.0	12 35 28.5	110.1	12 37 09.7	110.0	15 19 39.1	1 11.9	.. ..	... .	.. ..	... .
Germany												
Munich	+48 08.0	+ 11 34.0	12 35 29.1	110.1	12 37 10.2	110.0	15 19 38.5	1 11.9	.. ..	... .	.. ..	... .
Stuttgart	+48 46.7	+ 9 10.8	12 35 30.3	110.1	12 37 11.5	110.0	15 19 39.6	1 11.9	.. ..	... .	.. ..	... .

TRANSIT OF MERCURY OF 2019 NOVEMBER 11

Location	Position Latitude	Position Longitude	Ingress Exterior Contact UT	Ingress Exterior Contact *P*	Ingress Interior Contact UT	Ingress Interior Contact *P*	Least Angular Distance UT	Least Angular Distance Separation	Egress Interior Contact UT	Egress Interior Contact *P*	Egress Exterior Contact UT	Egress Exterior Contact *P*
	° ′	° ′	h m s	°	h m s	°	h m s	′ ″	h m s	°	h m s	°
Germany												
Dusseldorf	+51 14.2	+ 6 47.0	12 35 32.0	110.1	12 37 13.2	110.0	15 19 41.7	1 11.9	.. ..	... .	.. ..	... .
San Marino San Marino	+43 56.0	+ 12 26.0	12 35 27.3	110.1	12 37 08.5	110.0	15 19 35.8	1 12.0	.. ..	... .	.. ..	... .
Italy												
Rome	+41 54.0	+ 12 30.0	12 35 26.6	110.1	12 37 07.8	110.0	15 19 34.5	1 12.1	.. ..	... .	.. ..	... .
Milan	+45 27.8	+ 9 11.4	12 35 29.3	110.1	12 37 10.5	110.0	15 19 37.6	1 12.0	.. ..	... .	.. ..	... .
Switzerland Zurich	+47 22.0	+ 8 33.0	12 35 30.2	110.1	12 37 11.3	110.0	15 19 38.9	1 11.9	.. ..	... .	.. ..	... .
Netherlands Amsterdam	+52 22.4	+ 4 53.5	12 35 33.1	110.1	12 37 14.3	110.0	15 19 42.9	1 11.9	.. ..	... .	.. ..	... .
France												
Ajaccio, Corsica	+41 55.6	+ 8 44.2	12 35 28.5	110.1	12 37 09.6	110.0	15 19 35.6	1 12.0	.. ..	... .	.. ..	... .
Marseille	+43 17.8	+ 5 22.2	12 35 30.5	110.1	12 37 11.7	110.0	15 19 37.4	1 12.0	.. ..	... .	.. ..	... .
Paris	+48 51.4	+ 2 21.0	12 35 33.4	110.1	12 37 14.5	110.0	15 19 41.6	1 11.9	.. ..	... .	.. ..	... .
Spain												
Barcelona	+41 23.0	+ 2 11.0	12 35 31.6	110.1	12 37 12.8	110.0	15 19 37.4	1 12.0	.. ..	... .	.. ..	... .
Madrid	+40 24.0	− 3 41.0	12 35 34.5	110.0	12 37 15.6	110.0	15 19 39.1	1 12.1	.. ..	... .	.. ..	... .
United Kingdom												
London	+51 30.5	− 0 07.5	12 35 35.1	110.1	12 37 16.2	110.0	15 19 43.8	1 11.9	.. ..	... .	.. ..	... .
Birmingham	+52 29.0	− 1 53.6	12 35 36.0	110.1	12 37 17.2	110.0	15 19 44.9	1 11.9	.. ..	... .	.. ..	... .
Edinburgh	+55 57.0	− 3 09.6	12 35 37.1	110.1	12 37 18.3	110.0	15 19 47.1	1 11.8	.. ..	... .	.. ..	... .
Taunton	+51 01.1	− 3 06.0	12 35 36.2	110.1	12 37 17.4	110.0	15 19 44.5	1 11.9	.. ..	... .	.. ..	... .
Ireland Dublin	+53 20.9	− 6 15.6	12 35 38.0	110.1	12 37 19.2	110.0	15 19 46.7	1 11.9	.. ..	... .	.. ..	... .
Faroe Islands Torshavn	+62 00.0	− 6 47.0	12 35 39.3	110.1	12 37 20.5	110.0	15 19 51.3	1 11.8	.. ..	... .	.. ..	... .
Portugal Lisbon	+38 42.8	− 9 08.4	12 35 37.1	110.0	12 37 18.2	110.0	15 19 40.5	1 12.1	.. ..	... .	.. ..	... .
Ascension Island Georgetown	− 7 55.7	− 14 24.7	12 35 30.7	109.9	12 37 11.8	109.8	15 19 26.3	1 14.5	18 01 55.7	298.7	18 03 37.0	298.6
Canary Islands Las Palmas de Gran Canaria	+28 09.0	− 15 25.0	12 35 39.0	110.0	12 37 20.1	110.0	15 19 38.9	1 12.5	18 02 11.3	298.6	18 03 52.6	298.5
Madeira Funchal	+32 39.1	− 16 54.6	12 35 40.5	110.0	12 37 21.7	110.0	15 19 41.5	1 12.4	18 02 14.3	298.5	18 03 55.6	298.5
Iceland Reykjavik	+64 08.0	− 21 56.0	12 35 44.0	110.1	12 37 25.3	110.0	15 19 56.3	1 11.9	.. ..	... .	.. ..	... .
Cape Verde Islands Praia, Santiago	+14 55.2	− 23 30.5	12 35 41.9	109.9	12 37 23.0	109.9	15 19 38.6	1 13.2	18 02 06.3	298.6	18 03 47.6	298.5
Azores Ponta Delgada	+37 44.0	− 25 40.0	12 35 45.8	110.0	12 37 26.9	110.0	15 19 48.0	1 12.3	18 02 19.4	298.5	18 04 00.7	298.5
South Georgia Grytviken	−54 16.9	− 36 30.5	12 35 27.9	109.7	12 37 09.1	109.6	15 19 31.6	1 17.9	18 02 01.2	298.9	18 03 42.5	298.8
Greenland Nuuk	+64 10.0	− 51 44.0	12 35 51.7	110.0	12 37 33.0	110.0	15 20 05.0	1 12.2	18 02 41.4	298.5	18 04 22.7	298.5

Joint publications of HM Nautical Almanac Office (UKHO) and the United States Naval Observatory

These publications are available from UKHO Distributors and the Superintendent of Documents, U.S. Government Printing Office (USGPO) except where noted.

The Astronomical Almanac (AsA) and *The Astronomical Almanac Online* (AsA Online) contain ephemerides of the Sun, Moon, planets and their natural satellites, as well as data on eclipses and other astronomical phenomena. The AsA is an annual volume while AsA Online is updated annually. The data are calculated cooperatively by the British and American offices. A full list of contributors is given on page vii of the AsA (UKHO GP100) and on AsA Online.

The Nautical Almanac contains ephemerides at an interval of one hour and auxiliary astronomical data for marine navigation. (UKHO NP314)

The Air Almanac contains ephemerides at an interval of ten minutes and auxiliary astronomical data for air navigation. This publication is now distributed solely on CD-ROM and is only available from USGPO.

Rapid Sight Reduction Tables for Navigation (AP 3270 / NP 303), 3 volumes, formerly entitled *Sight Reduction Tables for Air Navigation*. Volume 1, selected stars for epoch 2020·0, containing the altitude to $1'$ and true azimuth to 1° for the seven stars most suitable for navigation, for all latitudes and hour angles of Aries.

Other publications of HM Nautical Almanac Office (UKHO)

The Star Almanac for Land Surveyors (NP 321) contains the Greenwich hour angle of Aries and the position of the Sun, tabulated for every six hours, and represented by monthly polynomial coefficients. Positions of all stars brighter than magnitude 4·0 are tabulated monthly to a precision of $0^s.1$ in right ascension and $1''$ in declination. A CD-ROM is included which contains the electronic edition plus coefficients, in ASCII format, representing the data.

NavPac and Compact Data for 2016–2020 (DP 330) contains software, algorithms and data, which are mainly in the form of polynomial coefficients, for calculating the positions of the Sun, Moon, navigational planets and bright stars. It enables navigators to compute their position at sea from sextant observations using Windows OS XP/Vista/7/8/10 for the period 1986–2020. The tabular data are also supplied as ASCII files on the CD-ROM.

Planetary and Lunar Coordinates, 2001–2020 provides low-precision astronomical data and phenomena for use well in advance of the annual ephemerides. It contains heliocentric, geocentric, spherical and rectangular coordinates of the Sun, Moon and planets, eclipse maps and auxiliary data. All the tabular ephemerides are supplied solely on CD-ROM as ASCII and Adobe's portable document format files. The full printed edition is published in the United States by Willmann-Bell Inc, PO Box 35025, Richmond VA 23235, USA.

Rapid Sight Reduction Tables for Navigation (AP 3270 / NP 303), 3 volumes, formerly entitled *Sight Reduction Tables for Air Navigation*. Volumes 2 and 3 contain altitudes to $1'$ and azimuths to 1° for integral degrees of declination from N 29° to S 29°, for relevant latitudes and all hour angles at which the zenith distance is less than 95° providing for sights of the Sun, Moon and planets.

The UK Air Almanac (AP1602) contains data useful in the planning of activities where the level of illumination is important, particularly aircraft movements, and is produced to the general requirements of the Royal Air Force. It may be downloaded from the website http://astro.ukho.gov.uk/nao/publicat/ukaa.html.

NAO Technical Notes are issued irregularly to disseminate astronomical data concerning ephemerides or astronomical phenomena.

Other publications of the United States Naval Observatory

Astronomical Papers of the American Ephemeris† are issued irregularly and contain reports of research in celestial mechanics with particular relevance to ephemerides.

U.S. Naval Observatory Circulars† are issued irregularly to disseminate astronomical data concerning ephemerides or astronomical phenomena.

U.S. Naval Observatory Circular No. 179, The IAU Resolutions on Astronomical Reference Systems, Time Scales, and Earth Rotation Models explains resolutions and their effects on the data (see Web Links).

Explanatory Supplement to The Astronomical Almanac, (3rd edition). This book is an authoritative source on the basis and derivation of information contained in *The Astronomical Almanac*. It contains material that is relevant to positional and dynamical astronomy and to chronology. The publication is a collaborative work with authors from the U.S. Naval Observatory, H.M. Nautical Almanac Office, the Jet Propulsion Laboratory, and others. This edition is published by and available from University Science Books, whose UK distributor is Palgrave Macmillan.

MICA is an interactive astronomical almanac for professional applications. Software for both PC systems with Intel processors and Apple Macintosh computers is provided on a single CD-ROM. *MICA* allows a user to compute, to full precision, much of the tabular data contained in *The Astronomical Almanac*, as well as data for specific times and locations. All calculations are made in real time and data are not interpolated from tables. MICA is a product of the U.S. Naval Observatory; it is published by and available from Willmann-Bell Inc. The latest version covers the interval 1800-2050.

† Many of these publications are available from the Nautical Almanac Office, U.S. Naval Observatory, Washington, DC 20392-5420, see Web Links on the next page for availability.

Publications of other countries

Apparent Places of Fundamental Stars is prepared by the Astronomisches Rechen-Institut, Heidelberg (http://www.ari.uni-heidelberg.de). The printed version of APFS gives the data for a few fundamental stars only, together with the explanation and examples. The apparent places of stars using the FK6 or Hipparcos catalogues are provided by the on-line database ARIAPFS (http://www.ari.uni-heidelberg.de/ariapfs). The printed booklet also contains the so-called '10-Day-Stars' and the 'Circumpolar Stars' and is available from Der Kleine Buch Verlag, Leopoldstrasse 7b, 76133 Karlsruhe, Germany.

Ephemerides of Minor Planets is prepared annually by the Institute of Applied Astronomy (http://www.ipa.nw.ru), and published by the Russian Academy of Sciences. Included in this volume are elements, opposition dates and opposition ephemerides of all numbered minor planets. This volume is available from the Institute of Applied Astronomy, Naberezhnaya Kutuzova 10, St. Petersburg, 191187 Russia.

Electronic Publications

The Astronomical Almanac Online: The companion publication of *The Astronomical Almanac*, providing data best presented in machine-readable form. It typically does not duplicate the data from the book. It does, in some cases, provide additional information or greater precision than the printed data. Examples of data found on *The Astronomical Almanac Online* are searchable databases, eclipse and occultation maps, errata found in the printed publication, and a searchable glossary. It is available at

http://asa.usno.navy.mil — WWW — **http://asa.hmnao.com**

Please refer to the relevant World Wide Web address for further details about the publications and services provided by the following organisations.

U.S. Naval Observatory

- U.S. Naval Observatory portal at http://www.usno.navy.mil/USNO
- USNO Astronomical Applications Department portal at http://aa.usno.navy.mil/
- USNO Data Services at http://aa.usno.navy.mil/data/
- NOVAS astrometry software at http://aa.usno.navy.mil/software/novas/
- *USNO Circular 179* at http://aa.usno.navy.mil/publications/docs/Circular_179.php
- *The Astronomical Almanac Online*—WWW— at http://asa.usno.navy.mil

H.M. Nautical Almanac Office

- General information at http://astro.ukho.gov.uk or http://www.gov.uk/HMNAO
- *The Astronomical Almanac Online*—WWW— at http://asa.hmnao.com/
- Eclipses Online at http://astro.ukho.gov.uk/eclipse/
- Online data services at http://astro.ukho.gov.uk/websurf/
- Crescent MoonWatch at http://astro.ukho.gov.uk/moonwatch/

International Astronomical Organizations

- IAU: International Astronomical Union at http://www.iau.org
- IERS: International Earth Rotation and Reference Systems Service at http://www.iers.org
- SOFA: IAU Standards of Fundamental Astronomy at http://www.iausofa.org
- NSFA: IAU Working Group on Numerical Standards at http://maia.usno.navy.mil/NSFA/
- CDS: Centre de Données astronomiques de Strasbourg at http://cdsweb.u-strasbg.fr

Publishers and Suppliers

- The UK Hydrographic Office (UKHO) at http://www.gov.uk/UKHO
- U.S. Government Printing Office (USGPO) at http://bookstore.gpo.gov
- University Science Books at http://www.uscibooks.com
- Willmann-Bell at http://www.willbell.com
- Macmillan Distribution at http://www.palgrave.com