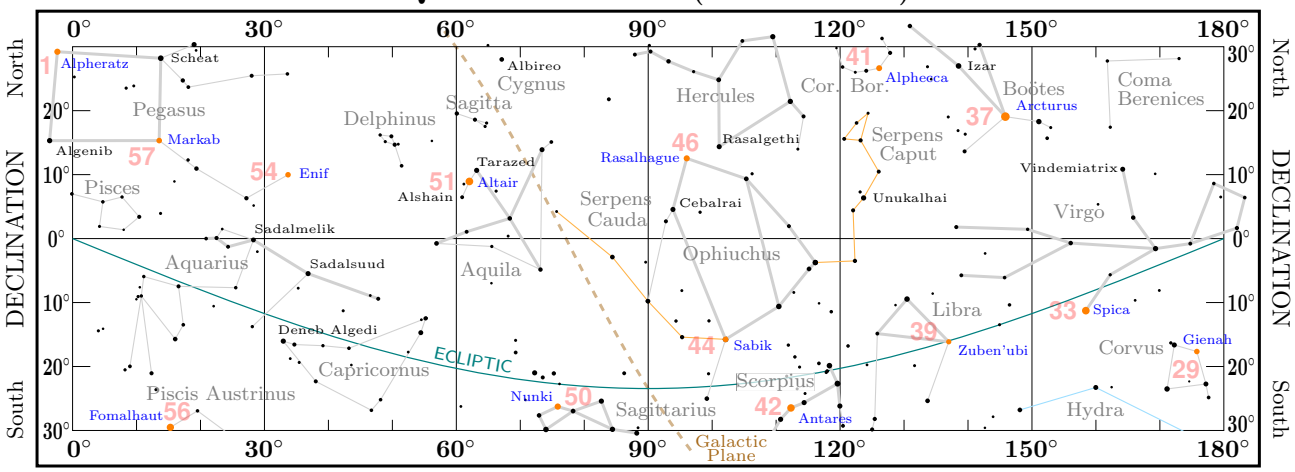
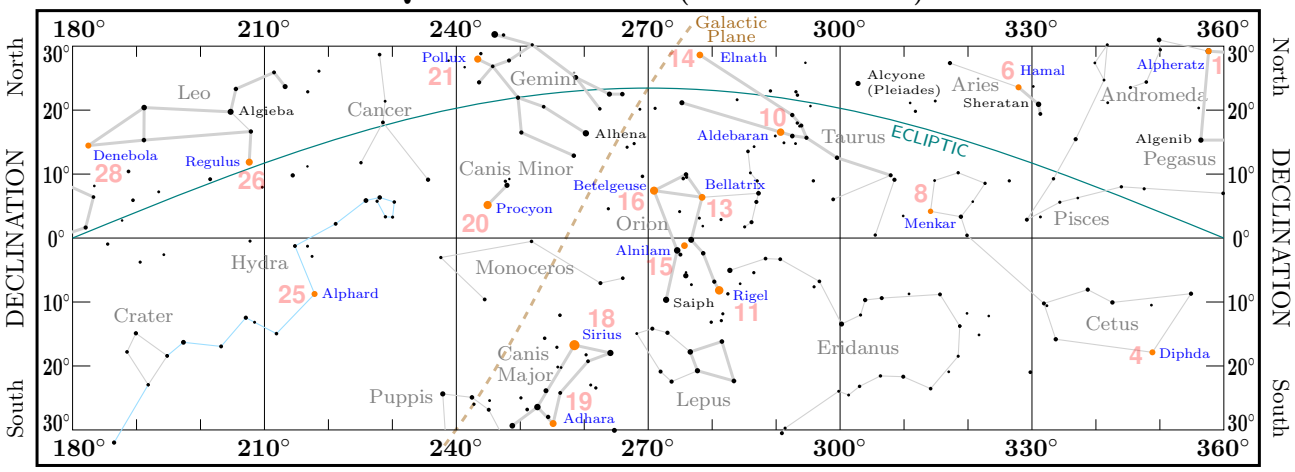
Generated using Skyfield
http://rhodesmill.org/skyfield/

EQUATORIAL STARS (SHA 0° to 180°)



EQUATORIAL STARS (SHA 180° to 360°)



The Nautical Almanac

13.07.2022 - 18.07.2022

Author: Andrew Bauer
Original concept from: Enno Rodegerdts

August 30, 2022

Information in the data page footers

Information pertaining to the IERS EOP data has been added to the odd data page footers if using MiKTeX or TeX Live (2020 or later). The International Earth Rotation Service (IERS) provides accurate data (updated weekly) on the Earth Orientation Parameters (EOP).

Earth's speed of rotation is not constant, i.e. the day length fluctuates.[1] This is due to *internal torques* caused by relative movements and mass redistribution of Earth's core, mantle, oceans, atmosphere, and cryosphere. This has an immediate impact on the GHA values of all celestial objects.

The IERS monitors and measures several parameters taking the actual speed of Earth's rotation into account. Their measured data begins on 2nd Januaray 1973. Predictive data begins following the last day of (obtained) data and extends about 360 days into the future. (The IERS results are published with a delay of about 18-hours between the date of publication and the last available date with measured EOP.[2]) These Nautical Almanac daily pages take the (measured or predicted) UT1-UTC values into account providing highly accurate navigational data especially if the predictions are fairly recent.

As long as either measured or predicted data is available the footer will show:
IERS Earth Orientation data as of dd-mmm-yyyy
This indicates that IERS EOP data is in use - older dates are measured; newer dates are predictions.

If the final date of IERS prediction data is on the current data page, the footer shows:
IERS Earth Orientation predictions end dd-mmm-yyyy

Pages with dates beyond the final date of IERS prediction data have the following footer:
No IERS EOP prediction data available
Skyfield then defaults to using the ΔT and leap second files that ship with Skyfield internally.

The footers mentioned are only displayed as long as **'useIERS = True'** is set in *config.py* to enable use of IERS EOP data.

Brief historical overview

The story begins with the XEphem astronomical library, which is declared 'end of life' by its author, Elwood Charles Downey, as no further updates are planned. He generously gave permission for use of XEphem code in Ephem (also known as Pyephem), an astronomical library authored by Brandon Rhodes. Enno Rodegerdts (https://sv-inua.net/) created the original Nautical Almanac 'daily pages' in Pyalmanac using Python 2 and LaTeX. After contacting him I obtained permission for its future enhancement and maintenance. Pyalmanac uses Ephem.

Meanwhile Brandon Rhodes was working on a far more sophisticated astronomical library, Skyfield. This was 'state of the art' and clearly surpassed the 'Jean Meeus'-based Pyephem/Ephem. Skyfield uses NASA's NAIF (Navigation and Ancillary Information Facility) SPICE algorithms. The results agree with those from the HORIZONS System (*operated by NASA JPL (Jet Propulsion Laboratory) SSD (Solar System Dynamics) group, not by NAIF*). This in turn implies that celestial positions calculated by Skyfield agree with those generated by the United States Naval Observatory and their *Astronomical Almanac* to within 0.0005 arcseconds (half a milliarcsecond).

Pyephem was then in 'maintenance mode'. Clearly Pyalmanac needed adaptation to use Skyfield, and thus SFalmanac was born. However its performance was poor regarding the calculation of 'events' such as: sunrise, sunset, moonrise, moonset, civil twilight start/end and nautical twilight start/end. An interim (faster) solution was required.

Skyalmanac was the result: a hybrid application using Ephem to calculate 'events' and Skyfield for the rest. This was indeed much faster at the cost of poorer 'event' time data. It took a while to find a better solution: multiprocessing, which was built into SFalmanac. This now could compare to the execution times in Pyalmanac but with improved results.

New functionality was added to SFalmanac: lunar phase as a graphic; Lunar Distance tables and charts. The original Skyalmanac is deprecated and will soon be replaced with the latest SFalmanac code. Since April 2019 http://thenauticalalmanac.com has been publishing Celestial Navigation related material with software provided here.

[1] https://en.wikipedia.org/wiki/Day_length_fluctuations
[2] https://hpiers.obspm.fr/eoppc/bul/bulb/explanatory.html

July 13, 14, 15 UT (Wed., Thu., Fri.)

h	Aries	Venus		Mars		Jupiter		Saturn	
Wed	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	290°51.4	207°27.3	N22°24.4	257°09.8	N11°37.5	282°41.6	N02°03.2	323°59.4	S14°38.6
1	305°53.9	222°26.5	24.6	272°10.6	38.1	297°43.9	03.2	339°02.0	38.7
2	320°56.3	237°25.8	24.9	287°11.4	38.7	312°46.3	03.3	354°04.6	38.7
3	335°58.8	252°25.0	·· 25.1	302°12.2	·· 39.3	327°48.6	·· 03.3	9°07.2	·· 38.8
4	351°01.3	267°24.2	25.4	317°13.1	39.8	342°51.0	03.4	24°09.8	38.8
5	6°03.7	282°23.4	25.6	332°13.9	40.4	357°53.3	03.4	39°12.4	38.9
6	21°06.2	297°22.6	N22°25.9	347°14.7	N11°41.0	12°55.7	N02°03.4	54°15.0	S14°38.9
7	36°08.7	312°21.9	26.1	2°15.5	41.6	27°58.0	03.5	69°17.6	39.0
8	51°11.1	327°21.1	26.3	17°16.3	42.1	43°00.3	03.5	84°20.1	39.0
9	66°13.6	342°20.3	·· 26.6	32°17.1	·· 42.7	58°02.7	·· 03.6	99°22.7	·· 39.1
10	81°16.1	357°19.5	26.8	47°17.9	43.3	73°05.0	03.6	114°25.3	39.1
11	96°18.5	12°18.7	27.0	62°18.7	43.9	88°07.4	03.6	129°27.9	39.2
12	111°21.0	27°18.0	N22°27.3	77°19.6	N11°44.4	103°09.7	N02°03.7	144°30.5	S14°39.2
13	126°23.5	42°17.2	27.5	92°20.4	45.0	118°12.1	03.7	159°33.1	39.3
14	141°25.9	57°16.4	27.7	107°21.2	45.6	133°14.4	03.7	174°35.7	39.3
15	156°28.4	72°15.6	·· 27.9	122°22.0	·· 46.2	148°16.8	·· 03.8	189°38.3	·· 39.4
16	171°30.8	87°14.8	28.2	137°22.8	46.7	163°19.1	03.8	204°40.9	39.4
17	186°33.3	102°14.0	28.4	152°23.6	47.3	178°21.5	03.8	219°43.5	39.5
18	201°35.8	117°13.3	N22°28.6	167°24.4	N11°47.9	193°23.8	N02°03.9	234°46.1	S14°39.5
19	216°38.2	132°12.5	28.9	182°25.3	48.5	208°26.1	03.9	249°48.7	39.6
20	231°40.7	147°11.7	29.1	197°26.1	49.0	223°28.5	04.0	264°51.3	39.7
21	246°43.2	162°10.9	·· 29.3	212°26.9	·· 49.6	238°30.8	·· 04.0	279°53.9	·· 39.7
22	261°45.6	177°10.1	29.5	227°27.7	50.2	253°33.2	04.0	294°56.5	39.8
23	276°48.1	192°09.3	29.7	242°28.5	50.7	268°35.5	04.1	309°59.1	39.8
Mer.pass.	04:36	ν-0.8′	d0.2′	m-3.90	ν0.8′	d0.6′	m0.3	ν2.3′	d0.0′ m-2.51	ν2.6′	d-0.1′ m0.5

Thu	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	291°50.6	207°08.6	N22°30.0	257°29.3	N11°51.3	283°37.9	N02°04.1	325°01.7	S14°39.9
1	306°53.0	222°07.8	30.2	272°30.1	51.9	298°40.2	04.1	340°04.3	39.9
2	321°55.5	237°07.0	30.4	287°30.9	52.5	313°42.6	04.2	355°06.9	40.0
3	336°58.0	252°06.2	·· 30.6	302°31.8	·· 53.0	328°44.9	·· 04.2	10°09.5	·· 40.0
4	352°00.4	267°05.4	30.8	317°32.6	53.6	343°47.3	04.2	25°12.1	40.1
5	7°02.9	282°04.6	31.0	332°33.4	54.2	358°49.6	04.3	40°14.7	40.1
6	22°05.3	297°03.8	N22°31.2	347°34.2	N11°54.7	13°52.0	N02°04.3	55°17.3	S14°40.2
7	37°07.8	312°03.1	31.5	2°35.0	55.3	28°54.3	04.4	70°19.9	40.2
8	52°10.3	327°02.3	31.7	17°35.8	55.9	43°56.7	04.4	85°22.5	40.3
9	67°12.7	342°01.5	·· 31.9	32°36.6	·· 56.4	58°59.0	·· 04.4	100°25.1	·· 40.3
10	82°15.2	357°00.7	32.1	47°37.5	57.0	74°01.4	04.5	115°27.7	40.4
11	97°17.7	11°59.9	32.3	62°38.3	57.6	89°03.7	04.5	130°30.3	40.5
12	112°20.1	26°59.1	N22°32.5	77°39.1	N11°58.2	104°06.1	N02°04.5	145°32.9	S14°40.5
13	127°22.6	41°58.3	32.7	92°39.9	58.7	119°08.5	04.6	160°35.5	40.6
14	142°25.1	56°57.5	32.9	107°40.7	59.3	134°10.8	04.6	175°38.1	40.6
15	157°27.5	71°56.8	·· 33.1	122°41.5	11°59.9	149°13.2	·· 04.6	190°40.7	·· 40.7
16	172°30.0	86°56.0	33.3	137°42.4	12°00.4	164°15.5	04.7	205°43.3	40.7
17	187°32.4	101°55.2	33.5	152°43.2	01.0	179°17.9	04.7	220°45.9	40.8
18	202°34.9	116°54.4	N22°33.7	167°44.0	N12°01.6	194°20.2	N02°04.7	235°48.5	S14°40.8
19	217°37.4	131°53.6	33.9	182°44.8	02.1	209°22.6	04.8	250°51.1	40.9
20	232°39.8	146°52.8	34.1	197°45.6	02.7	224°24.9	04.8	265°53.7	40.9
21	247°42.3	161°52.0	·· 34.3	212°46.4	·· 03.3	239°27.3	·· 04.8	280°56.3	·· 41.0
22	262°44.8	176°51.2	34.5	227°47.2	03.8	254°29.6	04.9	295°58.9	41.0
23	277°47.2	191°50.4	34.7	242°48.1	04.4	269°32.0	04.9	311°01.6	41.1
Mer.pass.	04:32	ν-0.8′	d0.2′	m-3.90	ν0.8′	d0.6′	m0.3	ν2.3′	d0.0′ m-2.52	ν2.6′	d-0.1′ m0.5

Fri	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	292°49.7	206°49.6	N22°34.9	257°48.9	N12°05.0	284°34.4	N02°04.9	326°04.2	S14°41.1
1	307°52.2	221°48.9	35.1	272°49.7	05.5	299°36.7	05.0	341°06.8	41.2
2	322°54.6	236°48.1	35.3	287°50.5	06.1	314°39.1	05.0	356°09.4	41.3
3	337°57.1	251°47.3	·· 35.5	302°51.3	·· 06.7	329°41.4	·· 05.0	11°12.0	·· 41.3
4	352°59.6	266°46.5	35.6	317°52.1	07.2	344°43.8	05.1	26°14.6	41.4
5	8°02.0	281°45.7	35.8	332°52.9	07.8	359°46.1	05.1	41°17.2	41.4
6	23°04.5	296°44.9	N22°36.0	347°53.8	N12°08.4	14°48.5	N02°05.1	56°19.8	S14°41.5
7	38°06.9	311°44.1	36.2	2°54.6	08.9	29°50.9	05.2	71°22.4	41.5
8	53°09.4	326°43.3	36.4	17°55.4	09.5	44°53.2	05.2	86°25.0	41.6
9	68°11.9	341°42.5	·· 36.6	32°56.2	·· 10.1	59°55.6	·· 05.2	101°27.6	·· 41.6
10	83°14.3	356°41.7	36.8	47°57.0	10.6	74°57.9	05.3	116°30.2	41.7
11	98°16.8	11°40.9	36.9	62°57.8	11.2	90°00.3	05.3	131°32.8	41.7
12	113°19.3	26°40.1	N22°37.1	77°58.7	N12°11.7	105°02.7	N02°05.3	146°35.4	S14°41.8
13	128°21.7	41°39.3	37.3	92°59.5	12.3	120°05.0	05.3	161°38.0	41.9
14	143°24.2	56°38.5	37.5	108°00.3	12.9	135°07.4	05.4	176°40.6	41.9
15	158°26.7	71°37.8	·· 37.6	123°01.1	·· 13.4	150°09.7	·· 05.4	191°43.2	·· 42.0
16	173°29.1	86°37.0	37.8	138°01.9	14.0	165°12.1	05.4	206°45.8	42.0
17	188°31.6	101°36.2	38.0	153°02.7	14.6	180°14.5	05.5	221°48.4	42.1
18	203°34.1	116°35.4	N22°38.2	168°03.6	N12°15.1	195°16.8	N02°05.5	236°51.0	S14°42.1
19	218°36.5	131°34.6	38.3	183°04.4	15.7	210°19.2	05.5	251°53.6	42.2
20	233°39.0	146°33.8	38.5	198°05.2	16.2	225°21.5	05.6	266°56.2	42.2
21	248°41.4	161°33.0	·· 38.7	213°06.0	·· 16.8	240°23.9	·· 05.6	281°58.8	·· 42.3
22	263°43.9	176°32.2	38.8	228°06.8	17.4	255°26.3	05.6	297°01.4	42.3
23	278°46.4	191°31.4	39.0	243°07.6	17.9	270°28.6	05.7	312°04.0	42.4
Mer.pass.	04:28	ν-0.8′	d0.2′	m-3.90	ν0.8′	d0.6′	m0.3	ν2.4′	d0.0′ m-2.52	ν2.6′	d-0.1′ m0.5

Stars

	SHA	Dec
Alpheratz	357°36.8	29°12.7
Ankaa	353°09.1	-42°10.8
Schedar	349°33.2	56°39.3
Diphda	348°49.3	-17°51.7
Achernar	335°21.8	-57°07.1
Hamal	327°53.6	23°34.0
Polaris	315°11.8	89°21.2
Acamar	315°13.5	-40°12.7
Menkar	314°08.4	4°10.6
Mirfak	308°31.4	49°56.2
Aldebaran	290°42.2	16°33.2
Rigel	281°06.1	-8°10.5
Capella	280°25.3	46°01.1
Bellatrix	278°25.4	6°22.2
Elnath	278°04.8	28°37.5
Alnilam	275°40.1	-1°11.2
Betelgeuse	270°54.6	7°24.7
Canopus	263°53.8	-52°42.3
Sirius	258°28.4	-16°44.7
Adhara	255°07.9	-29°00.1
Procyon	244°53.3	5°10.1
Pollux	243°20.2	27°58.4
Avior	234°16.2	-59°34.9
Suhail	222°48.2	-43°31.4
Miaplacidus	221°39.5	-69°48.6
Alphard	217°50.1	-8°45.3
Regulus	207°36.9	11°51.6
Dubhe	193°44.0	61°38.1
Denebola	182°27.2	14°27.0
Gienah	175°45.8	-17°40.0
Acrux	173°02.5	-63°13.6
Gacrux	171°54.0	-57°14.5
Alioth	166°14.9	55°50.6
Spica	158°24.4	-11°16.7
Alkaid	152°53.6	49°12.4
Hadar	148°38.8	-60°29.1
Menkent	147°59.9	-36°28.9
Arcturus	145°49.7	19°04.1
Rigil Kent.	139°42.9	-60°55.9
Kochab	137°19.4	74°04.1
Zuben'ubi	136°58.1	-16°08.1
Alphecca	126°05.3	26°38.5
Antares	112°18.1	-26°28.9
Atria	107°13.7	-69°04.2
Sabik	102°04.8	-15°45.1
Shaula	96°12.8	-37°07.2
Rasalhague	96°00.1	12°32.7
Eltanin	90°42.6	51°29.3
Kaus Aust.	83°34.8	-34°22.4
Vega	80°34.2	38°48.3
Nunki	75°49.9	-26°16.1
Altair	62°01.6	8°55.7
Peacock	53°08.4	-56°39.7
Deneb	49°26.7	45°21.5
Enif	33°40.5	9°58.7
Al Na'ir	27°35.1	-46°51.0
Fomalhaut	15°16.6	-29°30.1
Scheat	13°47.0	28°12.1
Markab	13°31.7	15°19.5

Jul 13 Wed	SHA	Mer.pass
Venus	276°35.9	10:11
Mars	326°18.4	06:51
Jupiter	351°50.2	05:08
Saturn	33°08.0	02:24

Jul 14 Thu	SHA	Mer.pass
Venus	275°18.0	10:12
Mars	325°38.8	06:50
Jupiter	351°47.3	05:05
Saturn	33°11.2	02:19

Jul 15 Fri	SHA	Mer.pass
Venus	273°59.9	10:13
Mars	324°59.2	06:48
Jupiter	351°44.7	05:01
Saturn	33°14.5	02:15

Horizontal parallax	
Venus:	0.1
Mars:	0.1

h	Sun		Moon				
Wed	**GHA**	**Dec**	**GHA**	**ν**	**Dec**	**d**	**HP**
0	178°33.8	N21°51.4	10°13.1	0.7′	S26°54.4	0.7′	61.3′
1	193°33.7	51.0	24°32.9	0.7′	26°53.7	0.9′	61.3′
2	208°33.6	50.7	38°52.6	0.7′	26°52.8	1.1′	61.3′
3	223°33.6	·· 50.3	53°12.3	0.7′	26°51.7	1.3′	61.3′
4	238°33.5	50.0	67°32.1	0.7′	26°50.3	1.5′	61.3′
5	253°33.4	49.6	81°51.8	0.8′	26°48.8	1.8′	61.3′
6	268°33.3	N21°49.2	96°11.6	0.8′	S26°47.0	2.0′	61.3′
7	283°33.3	48.9	110°31.4	0.8′	26°45.1	2.2′	61.3′
8	298°33.2	48.5	124°51.2	0.8′	26°42.9	2.4′	61.3′
9	313°33.1	·· 48.1	139°11.0	0.9′	26°40.5	2.6′	61.3′
10	328°33.1	47.8	153°30.9	0.9′	26°37.9	2.8′	61.3′
11	343°33.0	47.4	167°50.8	0.9′	26°35.0	3.0′	61.3′
12	358°32.9	N21°47.0	182°10.7	1.0′	S26°32.0	3.2′	61.3′
13	13°32.8	46.7	196°30.7	1.0′	26°28.7	3.5′	61.3′
14	28°32.8	46.3	210°50.7	1.1′	26°25.3	3.7′	61.3′
15	43°32.7	·· 45.9	225°10.8	1.1′	26°21.6	3.9′	61.3′
16	58°32.6	45.6	239°30.9	1.2′	26°17.7	4.1′	61.3′
17	73°32.6	45.2	253°51.1	1.2′	26°13.7	4.3′	61.3′
18	88°32.5	N21°44.8	268°11.3	1.3′	S26°09.4	4.5′	61.3′
19	103°32.4	44.4	282°31.6	1.4′	26°04.9	4.7′	61.3′
20	118°32.3	44.1	296°52.0	1.4′	26°00.2	4.9′	61.3′
21	133°32.3	·· 43.7	311°12.4	1.5′	25°55.3	5.1′	61.3′
22	148°32.2	43.3	325°32.9	1.6′	25°50.2	5.3′	61.2′
23	163°32.1	43.0	339°53.4	1.6′	25°44.9	5.5′	61.2′
	SD = 15.7′	d = -0.4′	SD = 16.7′				
Thu	**GHA**	**Dec**	**GHA**	**ν**	**Dec**	**d**	**HP**
0	178°32.1	N21°42.6	354°14.1	1.7′	S25°39.4	5.7′	61.2′
1	193°32.0	42.2	8°34.8	1.8′	25°33.7	5.9′	61.2′
2	208°31.9	41.8	22°55.6	1.9′	25°27.8	6.1′	61.2′
3	223°31.9	·· 41.4	37°16.5	2.0′	25°21.8	6.3′	61.2′
4	238°31.8	41.1	51°37.4	2.1′	25°15.5	6.5′	61.2′
5	253°31.7	40.7	65°58.5	2.1′	25°09.0	6.7′	61.2′
6	268°31.7	N21°40.3	80°19.6	2.2′	S25°02.4	6.8′	61.2′
7	283°31.6	39.9	94°40.9	2.3′	24°55.5	7.0′	61.2′
8	298°31.5	39.6	109°02.2	2.4′	24°48.5	7.2′	61.1′
9	313°31.5	·· 39.2	123°23.6	2.5′	24°41.3	7.4′	61.1′
10	328°31.4	38.8	137°45.1	2.6′	24°33.9	7.6′	61.1′
11	343°31.3	38.4	152°06.8	2.7′	24°26.3	7.8′	61.1′
12	358°31.3	N21°38.0	166°28.5	2.8′	S24°18.6	7.9′	61.1′
13	13°31.2	37.6	180°50.3	2.9′	24°10.6	8.1′	61.1′
14	28°31.1	37.3	195°12.3	3.1′	24°02.5	8.3′	61.1′
15	43°31.1	·· 36.9	209°34.3	3.2′	23°54.2	8.4′	61.0′
16	58°31.0	36.5	223°56.5	3.3′	23°45.8	8.6′	61.0′
17	73°30.9	36.1	238°18.8	3.4′	23°37.2	8.8′	61.0′
18	88°30.9	N21°35.7	252°41.2	3.5′	S23°28.4	9.0′	61.0′
19	103°30.8	35.3	267°03.7	3.6′	23°19.4	9.1′	61.0′
20	118°30.7	34.9	281°26.3	3.7′	23°10.3	9.3′	61.0′
21	133°30.7	·· 34.6	295°49.0	3.9′	23°01.1	9.4′	60.9′
22	148°30.6	34.2	310°11.9	4.0′	22°51.6	9.6′	60.9′
23	163°30.5	33.8	324°34.9	4.1′	22°42.0	9.7′	60.9′
	SD = 15.7′	d = -0.4′	SD = 16.7′				
Fri	**GHA**	**Dec**	**GHA**	**ν**	**Dec**	**d**	**HP**
0	178°30.5	N21°33.4	338°58.0	4.2′	S22°32.3	9.9′	60.9′
1	193°30.4	33.0	353°21.2	4.3′	22°22.4	10.0′	60.8′
2	208°30.3	32.6	7°44.5	4.5′	22°12.3	10.2′	60.8′
3	223°30.3	·· 32.2	22°08.0	4.6′	22°02.2	10.3′	60.8′
4	238°30.2	31.8	36°31.6	4.7′	21°51.8	10.5′	60.8′
5	253°30.1	31.4	50°55.3	4.8′	21°41.3	10.6′	60.8′
6	268°30.1	N21°31.0	65°19.1	5.0′	S21°30.7	10.8′	60.7′
7	283°30.0	30.6	79°43.1	5.1′	21°19.9	10.9′	60.7′
8	298°30.0	30.2	94°07.2	5.2′	21°09.0	11.0′	60.7′
9	313°29.9	·· 29.9	108°31.5	5.4′	20°58.0	11.2′	60.7′
10	328°29.8	29.5	122°55.8	5.5′	20°46.9	11.3′	60.6′
11	343°29.8	29.1	137°20.3	5.6′	20°35.6	11.4′	60.6′
12	358°29.7	N21°28.7	151°44.9	5.7′	S20°24.1	11.5′	60.6′
13	13°29.7	28.3	166°09.7	5.9′	20°12.6	11.7′	60.6′
14	28°29.6	27.9	180°34.5	6.0′	20°00.9	11.8′	60.5′
15	43°29.5	·· 27.5	194°59.5	6.1′	19°49.1	11.9′	60.5′
16	58°29.5	27.1	209°24.7	6.3′	19°37.2	12.0′	60.5′
17	73°29.4	26.7	223°49.9	6.4′	19°25.2	12.1′	60.4′
18	88°29.3	N21°26.3	238°15.3	6.5′	S19°13.0	12.3′	60.4′
19	103°29.3	25.9	252°40.9	6.7′	19°00.8	12.4′	60.4′
20	118°29.2	25.5	267°06.5	6.8′	18°48.4	12.5′	60.4′
21	133°29.2	·· 25.1	281°32.3	6.9′	18°36.0	12.6′	60.3′
22	148°29.1	24.6	295°58.2	7.0′	18°23.4	12.7′	60.3′
23	163°29.0	24.2	310°24.2	7.2′	18°10.7	12.8′	60.3′
	SD = 15.7′	d = -0.4′	SD = 16.6′				

Lat.	Twilight		Sunrise	Sunset	Twilight	
	Naut.	Civil			Civil	Naut.
N 72°						
N 70°						
68°						
66°	–:–	–:–	01:31	22:37	–:–	–:–
64°	–:–	–:–	02:12	21:57	–:–	–:–
62°	–:–	00:41	02:40	21:30	23:23	–:–
60°	–:–	01:42	03:02	21:09	22:28	–:–
N 58°	–:–	02:13	03:19	20:52	21:57	–:–
56°	00:38	02:37	03:33	20:38	21:34	23:27
54°	01:33	02:55	03:46	20:25	21:15	22:36
52°	02:03	03:11	03:57	20:14	21:00	22:07
50°	02:25	03:24	04:06	20:05	20:47	21:46
45°	03:04	03:51	04:27	19:45	20:21	21:07
N 40°	03:31	04:11	04:43	19:28	20:00	20:40
35°	03:52	04:28	04:57	19:15	19:44	20:19
30°	04:09	04:42	05:09	19:03	19:30	20:02
20°	04:36	05:05	05:29	18:43	19:07	19:36
N 10°	04:57	05:23	05:46	18:26	18:48	19:15
0°	05:14	05:40	06:02	18:10	18:32	18:58
S 10°	05:30	05:56	06:18	17:54	18:16	18:42
20°	05:44	06:12	06:35	17:37	18:00	18:27
30°	05:59	06:29	06:55	17:17	17:43	18:13
35°	06:07	06:38	07:06	17:06	17:34	18:05
40°	06:15	06:49	07:19	16:53	17:23	17:57
45°	06:24	07:01	07:34	16:38	17:11	17:48
S 50°	06:35	07:15	07:53	16:20	16:57	17:37
52°	06:39	07:22	08:01	16:11	16:50	17:33
54°	06:44	07:29	08:11	16:01	16:43	17:28
56°	06:49	07:37	08:22	15:50	16:35	17:23
58°	06:55	07:46	08:35	15:37	16:26	17:17
S 60°	07:02	07:56	08:50	15:22	16:16	17:11

Lat.	Moonrise			Moonset		
	Wed	Thu	Fri	Wed	Thu	Fri
N 72°						
N 70°						
68°			23:57			
66°			00:04 23:30			03:06
64°	23:55	23:21	23:10		01:01	03:48
62°	22:45	22:52	22:53	00:24	02:11	04:17
60°	22:09	22:29	22:39	01:13	02:46	04:39
N 58°	21:43	22:11	22:26	01:44	03:12	04:56
56°	21:22	21:56	22:16	02:08	03:32	05:11
54°	21:05	21:42	22:06	02:27	03:49	05:24
52°	20:50	21:31	21:58	02:43	04:04	05:35
50°	20:37	21:20	21:50	02:57	04:16	05:44
45°	20:11	20:58	21:34	03:25	04:42	06:05
N 40°	19:50	20:41	21:21	03:48	05:02	06:22
35°	19:32	20:26	21:09	04:06	05:19	06:35
30°	19:17	20:13	20:59	04:22	05:34	06:48
20°	18:51	19:51	20:42	04:49	05:59	07:08
N 10°	18:29	19:31	20:27	05:12	06:20	07:26
0°	18:08	19:13	20:13	05:33	06:40	07:42
S 10°	17:48	18:55	19:58	05:55	06:59	07:58
20°	17:25	18:35	19:43	06:17	07:20	08:16
30°	16:59	18:13	19:25	06:44	07:44	08:35
35°	16:44	17:59	19:15	07:00	07:58	08:47
40°	16:26	17:44	19:03	07:18	08:15	09:00
45°	16:05	17:26	18:49	07:39	08:34	09:15
S 50°	15:38	17:03	18:32	08:07	08:58	09:34
52°	15:25	16:52	18:24	08:20	09:09	09:43
54°	15:10	16:39	18:15	08:35	09:22	09:53
56°	14:52	16:25	18:04	08:54	09:37	10:04
58°	14:30	16:08	17:52	09:15	09:55	10:16
S 60°	14:02	15:47	17:39	09:43	10:16	10:31

Day	Sun			Moon		
	Eqn.of Time		Mer.	Mer.Pass.		Age
	00^h	12^h	Pass	Upper	Lower	14-16
	mm:ss	mm:ss	hh:mm	hh:mm	hh:mm	99-98%
13	05:45	05:48	12:06	–:–	11:51	
14	05:52	05:55	12:06	00:24	12:56	
15	05:58	06:01	12:06	01:28	13:58	

July 16, 17, 18 UT (Sat., Sun., Mon.)

h	Aries	Venus		Mars		Jupiter		Saturn	
Sat	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	293°48.8	206°30.6	N22°39.2	258°08.5	N12°18.5	285°31.0	N02°05.7	327°06.6	S14°42.5
1	308°51.3	221°29.8	39.3	273°09.3	19.1	300°33.4	05.7	342°09.2	42.5
2	323°53.8	236°29.0	39.5	288°10.1	19.6	315°35.7	05.7	357°11.9	42.6
3	338°56.2	251°28.2	·· 39.7	303°10.9	·· 20.2	330°38.1	·· 05.8	12°14.5	·· 42.6
4	353°58.7	266°27.4	39.8	318°11.7	20.7	345°40.4	05.8	27°17.1	42.7
5	9°01.2	281°26.6	40.0	333°12.5	21.3	0°42.8	05.8	42°19.7	42.7
6	24°03.6	296°25.8	N22°40.2	348°13.4	N12°21.9	15°45.2	N02°05.9	57°22.3	S14°42.8
7	39°06.1	311°25.0	40.3	3°14.2	22.4	30°47.5	05.9	72°24.9	42.8
8	54°08.6	326°24.2	40.5	18°15.0	23.0	45°49.9	05.9	87°27.5	42.9
9	69°11.0	341°23.4	·· 40.6	33°15.8	·· 23.5	60°52.3	·· 05.9	102°30.1	·· 42.9
10	84°13.5	356°22.6	40.8	48°16.6	24.1	75°54.6	06.0	117°32.7	43.0
11	99°15.9	11°21.8	40.9	63°17.5	24.6	90°57.0	06.0	132°35.3	43.1
12	114°18.4	26°21.0	N22°41.1	78°18.3	N12°25.2	105°59.4	N02°06.0	147°37.9	S14°43.1
13	129°20.9	41°20.2	41.2	93°19.1	25.8	121°01.7	06.1	162°40.5	43.2
14	144°23.3	56°19.4	41.4	108°19.9	26.3	136°04.1	06.1	177°43.1	43.2
15	159°25.8	71°18.6	·· 41.5	123°20.7	·· 26.9	151°06.5	·· 06.1	192°45.7	·· 43.3
16	174°28.3	86°17.8	41.7	138°21.5	27.4	166°08.8	06.1	207°48.3	43.3
17	189°30.7	101°17.0	41.8	153°22.4	28.0	181°11.2	06.2	222°50.9	43.4
18	204°33.2	116°16.2	N22°42.0	168°23.2	N12°28.5	196°13.6	N02°06.2	237°53.5	S14°43.4
19	219°35.7	131°15.4	42.1	183°24.0	29.1	211°15.9	06.2	252°56.2	43.5
20	234°38.1	146°14.6	42.3	198°24.8	29.7	226°18.3	06.3	267°58.8	43.5
21	249°40.6	161°13.8	·· 42.4	213°25.6	·· 30.2	241°20.7	·· 06.3	283°01.4	·· 43.6
22	264°43.0	176°13.0	42.6	228°26.5	30.8	256°23.1	06.3	298°04.0	43.7
23	279°45.5	191°12.2	42.7	243°27.3	31.3	271°25.4	06.3	313°06.6	43.7
	Mer.pass. 04:24	ν-0.8′	d0.2′ m-3.90	ν0.8′	d0.6′ m0.3	ν2.4′	d0.0′ m-2.53	ν2.6′	d-0.1′ m0.5

Sun	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	294°48.0	206°11.4	N22°42.8	258°28.1	N12°31.9	286°27.8	N02°06.4	328°09.2	S14°43.8
1	309°50.4	221°10.6	43.0	273°28.9	32.4	301°30.2	06.4	343°11.8	43.8
2	324°52.9	236°09.8	43.1	288°29.7	33.0	316°32.5	06.4	358°14.4	43.9
3	339°55.4	251°09.0	·· 43.3	303°30.5	·· 33.5	331°34.9	·· 06.4	13°17.0	·· 43.9
4	354°57.8	266°08.2	43.4	318°31.4	34.1	346°37.3	06.5	28°19.6	44.0
5	10°00.3	281°07.4	43.5	333°32.2	34.7	1°39.7	06.5	43°22.2	44.0
6	25°02.8	296°06.6	N22°43.7	348°33.0	N12°35.2	16°42.0	N02°06.5	58°24.8	S14°44.1
7	40°05.2	311°05.8	43.8	3°33.8	35.8	31°44.4	06.5	73°27.4	44.2
8	55°07.7	326°05.0	43.9	18°34.6	36.3	46°46.8	06.6	88°30.1	44.2
9	70°10.2	341°04.2	·· 44.0	33°35.5	·· 36.9	61°49.1	·· 06.6	103°32.7	·· 44.3
10	85°12.6	356°03.4	44.2	48°36.3	37.4	76°51.5	06.6	118°35.3	44.3
11	100°15.1	11°02.6	44.3	63°37.1	38.0	91°53.9	06.6	133°37.9	44.4
12	115°17.5	26°01.8	N22°44.4	78°37.9	N12°38.5	106°56.3	N02°06.7	148°40.5	S14°44.4
13	130°20.0	41°01.0	44.6	93°38.7	39.1	121°58.6	06.7	163°43.1	44.5
14	145°22.5	56°00.2	44.7	108°39.6	39.6	137°01.0	06.7	178°45.7	44.5
15	160°24.9	70°59.4	·· 44.8	123°40.4	·· 40.2	152°03.4	·· 06.7	193°48.3	·· 44.6
16	175°27.4	85°58.6	44.9	138°41.2	40.7	167°05.8	06.8	208°50.9	44.7
17	190°29.9	100°57.8	45.0	153°42.0	41.3	182°08.1	06.8	223°53.5	44.7
18	205°32.3	115°57.0	N22°45.2	168°42.8	N12°41.8	197°10.5	N02°06.8	238°56.1	S14°44.8
19	220°34.8	130°56.2	45.3	183°43.7	42.4	212°12.9	06.8	253°58.8	44.8
20	235°37.3	145°55.4	45.4	198°44.5	42.9	227°15.3	06.9	269°01.4	44.9
21	250°39.7	160°54.6	·· 45.5	213°45.3	·· 43.5	242°17.6	·· 06.9	284°04.0	·· 44.9
22	265°42.2	175°53.8	45.6	228°46.1	44.0	257°20.0	06.9	299°06.6	45.0
23	280°44.7	190°52.9	45.8	243°46.9	44.6	272°22.4	06.9	314°09.2	45.1
	Mer.pass. 04:20	ν-0.8′	d0.1′ m-3.90	ν0.8′	d0.6′ m0.3	ν2.4′	d0.0′ m-2.54	ν2.6′	d-0.1′ m0.5

Mon	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec
0	295°47.1	205°52.1	N22°45.9	258°47.8	N12°45.1	287°24.8	N02°07.0	329°11.8	S14°45.1
1	310°49.6	220°51.3	46.0	273°48.6	45.7	302°27.2	07.0	344°14.4	45.2
2	325°52.0	235°50.5	46.1	288°49.4	46.2	317°29.5	07.0	359°17.0	45.2
3	340°54.5	250°49.7	·· 46.2	303°50.2	·· 46.8	332°31.9	·· 07.0	14°19.6	·· 45.3
4	355°57.0	265°48.9	46.3	318°51.0	47.3	347°34.3	07.1	29°22.2	45.3
5	10°59.4	280°48.1	46.4	333°51.9	47.9	2°36.7	07.1	44°24.9	45.4
6	26°01.9	295°47.3	N22°46.5	348°52.7	N12°48.4	17°39.1	N02°07.1	59°27.5	S14°45.4
7	41°04.4	310°46.5	46.6	3°53.5	49.0	32°41.4	07.1	74°30.1	45.5
8	56°06.8	325°45.7	46.7	18°54.3	49.5	47°43.8	07.1	89°32.7	45.6
9	71°09.3	340°44.9	·· 46.8	33°55.2	·· 50.1	62°46.2	·· 07.2	104°35.3	·· 45.6
10	86°11.8	355°44.1	46.9	48°56.0	50.6	77°48.6	07.2	119°37.9	45.7
11	101°14.2	10°43.3	47.0	63°56.8	51.2	92°51.0	07.2	134°40.5	45.7
12	116°16.7	25°42.5	N22°47.1	78°57.6	N12°51.7	107°53.3	N02°07.2	149°43.1	S14°45.8
13	131°19.1	40°41.7	47.2	93°58.4	52.3	122°55.7	07.3	164°45.7	45.8
14	146°21.6	55°40.8	47.3	108°59.3	52.8	137°58.1	07.3	179°48.4	45.9
15	161°24.1	70°40.0	·· 47.4	124°00.1	·· 53.4	153°00.5	·· 07.3	194°51.0	·· 46.0
16	176°26.5	85°39.2	47.5	139°00.9	53.9	168°02.9	07.3	209°53.6	46.0
17	191°29.0	100°38.4	47.6	154°01.7	54.5	183°05.3	07.3	224°56.2	46.1
18	206°31.5	115°37.6	N22°47.7	169°02.6	N12°55.0	198°07.6	N02°07.4	239°58.8	S14°46.1
19	221°33.9	130°36.8	47.8	184°03.4	55.5	213°10.0	07.4	255°01.4	46.2
20	236°36.4	145°36.0	47.9	199°04.2	56.1	228°12.4	07.4	270°04.0	46.2
21	251°38.9	160°35.2	·· 48.0	214°05.0	·· 56.6	243°14.8	·· 07.4	285°06.6	·· 46.3
22	266°41.3	175°34.4	48.1	229°05.8	57.2	258°17.2	07.4	300°09.2	46.3
23	281°43.8	190°33.6	48.2	244°06.7	57.7	273°19.6	07.5	315°11.9	46.4
	Mer.pass. 04:16	ν-0.8′	d0.1′ m-3.90	ν0.8′	d0.5′ m0.3	ν2.4′	d0.0′ m-2.55	ν2.6′	d-0.1′ m0.5

Stars

	SHA	Dec
Alpheratz	357°36.7	29°12.7
Ankaa	353°09.0	-42°10.8
Schedar	349°33.2	56°39.3
Diphda	348°49.3	-17°51.7
Achernar	335°21.8	-57°07.1
Hamal	327°53.5	23°34.0
Polaris	315°10.5	89°21.2
Acamar	315°13.5	-40°12.7
Menkar	314°08.4	4°10.7
Mirfak	308°31.4	49°56.2
Aldebaran	290°42.2	16°33.2
Rigel	281°06.1	-8°10.5
Capella	280°25.3	46°01.1
Bellatrix	278°25.4	6°22.2
Elnath	278°04.8	28°37.5
Alnilam	275°40.1	-1°11.2
Betelgeuse	270°54.6	7°24.7
Canopus	263°53.8	-52°42.3
Sirius	258°28.4	-16°44.7
Adhara	255°07.8	-29°00.1
Procyon	244°53.3	5°10.1
Pollux	243°20.2	27°58.4
Avior	234°16.2	-59°34.9
Suhail	222°48.2	-43°31.4
Miaplacidus	221°39.5	-69°48.6
Alphard	217°50.0	-8°45.3
Regulus	207°36.9	11°51.6
Dubhe	193°44.0	61°38.1
Denebola	182°27.2	14°27.0
Gienah	175°45.8	-17°40.0
Acrux	173°02.5	-63°13.6
Gacrux	171°54.0	-57°14.5
Alioth	166°14.9	55°50.6
Spica	158°24.5	-11°16.7
Alkaid	152°53.6	49°12.4
Hadar	148°38.8	-60°29.1
Menkent	147°59.9	-36°28.9
Arcturus	145°49.7	19°04.1
Rigil Kent.	139°42.9	-60°55.9
Kochab	137°19.4	74°04.1
Zuben'ubi	136°58.2	-16°08.1
Alphecca	126°05.3	26°38.5
Antares	112°18.1	-26°28.9
Atria	107°13.7	-69°04.2
Sabik	102°04.8	-15°45.1
Shaula	96°12.8	-37°07.2
Rasalhague	96°00.1	12°32.7
Eltanin	90°42.6	51°29.3
Kaus Aust.	83°34.8	-34°22.4
Vega	80°34.2	38°48.3
Nunki	75°49.9	-26°16.1
Altair	62°01.6	8°55.7
Peacock	53°08.4	-56°39.7
Deneb	49°26.7	45°21.5
Enif	33°40.5	9°58.7
Al Na'ir	27°35.1	-46°51.0
Fomalhaut	15°16.5	-29°30.1
Scheat	13°46.9	28°12.2
Markab	13°31.7	15°19.5

Jul 16 Sat	SHA	Mer.pass
Venus	272°41.8	10:15
Mars	324°19.6	06:47
Jupiter	351°42.2	04:57
Saturn	33°17.8	02:11

Jul 17 Sun	SHA	Mer.pass
Venus	271°23.4	10:16
Mars	323°40.1	06:46
Jupiter	351°39.8	04:53
Saturn	33°21.2	02:07

Jul 18 Mon	SHA	Mer.pass
Venus	270°05.0	10:17
Mars	323°00.6	06:44
Jupiter	351°37.7	04:50
Saturn	33°24.7	02:03

Horizontal parallax	
Venus:	0.1
Mars:	0.1

h	Sun		Moon				
Sat	**GHA**	**Dec**	**GHA**	*ν*	**Dec**	*d*	**HP**
0	178°29.0	N21°23.8	324°50.4	7.3′	S17°57.9	12.9′	60.2′
1	193°28.9	23.4	339°16.7	7.4′	17°45.1	13.0′	60.2′
2	208°28.9	23.0	353°43.1	7.6′	17°32.1	13.1′	60.2′
3	223°28.8	·· 22.6	8°09.7	7.7′	17°19.0	13.2′	60.1′
4	238°28.8	22.2	22°36.4	7.8′	17°05.9	13.2′	60.1′
5	253°28.7	21.8	37°03.2	7.9′	16°52.6	13.3′	60.1′
6	268°28.6	N21°21.4	51°30.1	8.1′	S16°39.3	13.4′	60.0′
7	283°28.6	21.0	65°57.1	8.2′	16°25.9	13.5′	60.0′
8	298°28.5	20.6	80°24.3	8.3′	16°12.4	13.6′	60.0′
9	313°28.5	·· 20.2	94°51.6	8.4′	15°58.8	13.7′	59.9′
10	328°28.4	19.7	109°19.0	8.5′	15°45.1	13.7′	59.9′
11	343°28.4	19.3	123°46.6	8.7′	15°31.4	13.8′	59.9′
12	358°28.3	N21°18.9	138°14.2	8.8′	S15°17.6	13.9′	59.8′
13	13°28.2	18.5	152°42.0	8.9′	15°03.7	14.0′	59.8′
14	28°28.2	18.1	167°09.9	9.0′	14°49.8	14.0′	59.8′
15	43°28.1	·· 17.7	181°37.9	9.1′	14°35.7	14.1′	59.7′
16	58°28.1	17.3	196°06.1	9.3′	14°21.6	14.2′	59.7′
17	73°28.0	16.9	210°34.3	9.4′	14°07.5	14.2′	59.7′
18	88°28.0	N21°16.4	225°02.7	9.5′	S13°53.3	14.3′	59.6′
19	103°27.9	16.0	239°31.2	9.6′	13°39.0	14.3′	59.6′
20	118°27.9	15.6	253°59.8	9.7′	13°24.7	14.4′	59.5′
21	133°27.8	·· 15.2	268°28.5	9.8′	13°10.3	14.4′	59.5′
22	148°27.7	14.8	282°57.3	9.9′	12°55.8	14.5′	59.5′
23	163°27.7	14.3	297°26.2	10.0′	12°41.3	14.5′	59.4′
	SD = 15.7′	*d* = -0.4′	SD = 16.4′				
Sun	**GHA**	**Dec**	**GHA**	*ν*	**Dec**	*d*	**HP**
0	178°27.6	N21°13.9	311°55.3	10.1′	S12°26.8	14.6′	59.4′
1	193°27.6	13.5	326°24.4	10.2′	12°12.2	14.6′	59.4′
2	208°27.5	13.1	340°53.6	10.4′	11°57.5	14.7′	59.3′
3	223°27.5	·· 12.7	355°23.0	10.5′	11°42.9	14.7′	59.3′
4	238°27.4	12.2	9°52.4	10.6′	11°28.1	14.8′	59.2′
5	253°27.4	11.8	24°22.0	10.7′	11°13.3	14.8′	59.2′
6	268°27.3	N21°11.4	38°51.7	10.8′	S10°58.5	14.9′	59.2′
7	283°27.3	11.0	53°21.4	10.9′	10°43.7	14.9′	59.1′
8	298°27.2	10.5	67°51.3	11.0′	10°28.8	14.9′	59.1′
9	313°27.2	·· 10.1	82°21.2	11.1′	10°13.9	15.0′	59.0′
10	328°27.1	09.7	96°51.3	11.1′	09°58.9	15.0′	59.0′
11	343°27.1	09.3	111°21.4	11.2′	09°43.9	15.0′	59.0′
12	358°27.0	N21°08.8	125°51.7	11.3′	S09°28.9	15.0′	58.9′
13	13°27.0	08.4	140°22.0	11.4′	09°13.9	15.1′	58.9′
14	28°26.9	08.0	154°52.4	11.5′	08°58.8	15.1′	58.9′
15	43°26.9	·· 07.5	169°22.9	11.6′	08°43.7	15.1′	58.8′
16	58°26.8	07.1	183°53.6	11.7′	08°28.6	15.1′	58.8′
17	73°26.8	06.7	198°24.2	11.8′	08°13.4	15.2′	58.7′
18	88°26.7	N21°06.2	212°55.0	11.9′	S07°58.3	15.2′	58.7′
19	103°26.7	05.8	227°25.9	11.9′	07°43.1	15.2′	58.7′
20	118°26.6	05.4	241°56.8	12.0′	07°27.9	15.2′	58.6′
21	133°26.6	·· 04.9	256°27.8	12.1′	07°12.7	15.2′	58.6′
22	148°26.5	04.5	270°58.9	12.2′	06°57.4	15.2′	58.5′
23	163°26.5	04.1	285°30.1	12.3′	06°42.2	15.3′	58.5′
	SD = 15.7′	*d* = -0.4′	SD = 16.2′				
Mon	**GHA**	**Dec**	**GHA**	*ν*	**Dec**	*d*	**HP**
0	178°26.4	N21°03.6	300°01.4	12.3′	S06°26.9	15.3′	58.5′
1	193°26.4	03.2	314°32.7	12.4′	06°11.7	15.3′	58.4′
2	208°26.3	02.8	329°04.1	12.5′	05°56.4	15.3′	58.4′
3	223°26.3	·· 02.3	343°35.6	12.6′	05°41.1	15.3′	58.3′
4	238°26.2	01.9	358°07.2	12.6′	05°25.9	15.3′	58.3′
5	253°26.2	01.5	12°38.8	12.7′	05°10.6	15.3′	58.3′
6	268°26.1	N21°01.0	27°10.5	12.8′	S04°55.3	15.3′	58.2′
7	283°26.1	00.6	41°42.3	12.8′	04°40.0	15.3′	58.2′
8	298°26.0	21°00.1	56°14.1	12.9′	04°24.7	15.3′	58.1′
9	313°26.0	20°59.7	70°46.0	13.0′	04°09.4	15.3′	58.1′
10	328°25.9	59.3	85°17.9	13.0′	03°54.1	15.3′	58.1′
11	343°25.9	58.8	99°50.0	13.1′	03°38.8	15.3′	58.0′
12	358°25.9	N20°58.4	114°22.0	13.1′	S03°23.5	15.3′	58.0′
13	13°25.8	57.9	128°54.2	13.2′	03°08.3	15.3′	57.9′
14	28°25.8	57.5	143°26.4	13.3′	02°53.0	15.3′	57.9′
15	43°25.7	·· 57.0	157°58.6	13.3′	02°37.7	15.3′	57.9′
16	58°25.7	56.6	172°31.0	13.4′	02°22.5	15.2′	57.8′
17	73°25.6	56.2	187°03.3	13.4′	02°07.3	15.2′	57.8′
18	88°25.6	N20°55.7	201°35.7	13.5′	S01°52.0	15.2′	57.7′
19	103°25.5	55.3	216°08.2	13.5′	01°36.8	15.2′	57.7′
20	118°25.5	54.8	230°40.7	13.6′	01°21.6	15.2′	57.7′
21	133°25.5	·· 54.4	245°13.3	13.6′	01°06.4	15.2′	57.6′
22	148°25.4	53.9	259°45.9	13.7′	00°51.3	15.2′	57.6′
23	163°25.4	53.5	274°18.6	13.7′	00°36.1	15.1′	57.5′
	SD = 15.7′	*d* = -0.4′	SD = 15.9′				

Lat.	**Twilight** Naut.	Civil	**Sunrise**	**Sunset**	**Twilight** Civil	Naut.
N 72°	▭	▭	▭	▭	▭	▭
N 70°	▭	▭	▭	▭	▭	▭
68°	–:–	–:–	–:–	23:43	–:–	–:–
66°	–:–	–:–	01:44	22:25	–:–	–:–
64°	–:–	–:–	02:21	21:49	–:–	–:–
62°	–:–	01:03	02:47	21:23	23:04	–:–
60°	–:–	01:51	03:07	21:04	22:18	–:–
N 58°	–:–	02:21	03:24	20:47	21:50	–:–
56°	00:58	02:43	03:38	20:34	21:28	23:09
54°	01:42	03:00	03:50	20:22	21:11	22:28
52°	02:09	03:15	04:00	20:11	20:56	22:01
50°	02:30	03:28	04:10	20:02	20:44	21:41
45°	03:07	03:54	04:29	19:42	20:18	21:04
N 40°	03:34	04:14	04:45	19:27	19:58	20:38
35°	03:54	04:30	04:59	19:13	19:42	20:18
30°	04:11	04:43	05:10	19:02	19:29	20:01
20°	04:37	05:06	05:30	18:42	19:06	19:35
N 10°	04:58	05:24	05:47	18:25	18:48	19:15
0°	05:15	05:40	06:03	18:10	18:32	18:58
S 10°	05:30	05:56	06:18	17:54	18:17	18:43
20°	05:44	06:11	06:35	17:38	18:01	18:28
30°	05:58	06:28	06:54	17:19	17:45	18:14
35°	06:06	06:37	07:05	17:08	17:36	18:07
40°	06:14	06:47	07:17	16:55	17:25	17:59
45°	06:23	06:59	07:32	16:41	17:14	17:50
S 50°	06:33	07:13	07:50	16:23	17:00	17:40
52°	06:37	07:19	07:58	16:14	16:53	17:36
54°	06:42	07:26	08:08	16:05	16:46	17:31
56°	06:47	07:34	08:19	15:54	16:39	17:26
58°	06:52	07:43	08:31	15:42	16:30	17:21
S 60°	06:58	07:52	08:45	15:28	16:21	17:15

Lat.	**Moonrise** Sat	Sun	Mon	**Moonset** Sat	Sun	Mon
N 72°	01:45	00:06 23:24	22:52	03:32	07:02	09:26
N 70°	00:35 23:44	23:15	22:51	04:40	07:21	09:32
68°	23:27	23:07	22:50	05:16	07:36	09:37
66°	23:13	23:01	22:49	05:41	07:48	09:41
64°	23:02	22:55	22:49	06:01	07:58	09:44
62°	22:52	22:50	22:48	06:17	08:06	09:47
60°	22:43	22:46	22:48	06:30	08:13	09:50
N 58°	22:36	22:42	22:48	06:41	08:20	09:52
56°	22:29	22:39	22:47	06:51	08:25	09:54
54°	22:23	22:36	22:47	06:59	08:30	09:56
52°	22:18	22:33	22:47	07:07	08:35	09:58
50°	22:13	22:31	22:46	07:14	08:39	09:59
45°	22:02	22:25	22:46	07:28	08:47	10:03
N 40°	21:53	22:21	22:45	07:40	08:55	10:05
35°	21:46	22:17	22:45	07:50	09:01	10:08
30°	21:39	22:13	22:44	07:59	09:06	10:10
20°	21:27	22:07	22:44	08:14	09:15	10:13
N 10°	21:17	22:02	22:43	08:27	09:24	10:16
0°	21:07	21:57	22:43	08:39	09:31	10:19
S 10°	20:57	21:51	22:42	08:51	09:38	10:22
20°	20:47	21:46	22:42	09:04	09:46	10:25
30°	20:35	21:40	22:41	09:18	09:55	10:28
35°	20:28	21:36	22:41	09:27	10:00	10:30
40°	20:20	21:32	22:41	09:36	10:06	10:32
45°	20:10	21:27	22:40	09:47	10:12	10:34
S 50°	19:59	21:21	22:40	10:00	10:20	10:37
52°	19:54	21:19	22:39	10:06	10:24	10:38
54°	19:48	21:16	22:39	10:13	10:28	10:40
56°	19:41	21:13	22:39	10:21	10:32	10:41
58°	19:34	21:09	22:39	10:29	10:37	10:43
S 60°	19:26	21:05	22:38	10:38	10:42	10:45

Day	**Sun** Eqn.of Time 00^h mm:ss	12^h mm:ss	Mer. Pass hh:mm	**Moon** Mer.Pass. Upper hh:mm	Lower hh:mm	Age 17-19 92-76%
16	06:04	06:07	12:06	02:26	14:53	
17	06:09	06:12	12:06	03:19	15:44	
18	06:14	06:17	12:06	04:08	16:31	