

THE NAUTICAL ALMANAC

13.07.2022 - 18.07.2022

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Disclaimer: These are computer generated tables - use them at your own risk. The accuracy has been randomly checked with JPL HORIZONS System, but cannot be guaranteed. The author claims no liability for any consequences arising from use of these tables. Besides, this publication only contains the 'daily pages' of the Nautical Almanac: an official version of the Nautical Almanac is indispensable.

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 January 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 Rodergerdts (<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.

¹https://en.wikipedia.org/wiki/Day_length_fluctuations

²<https://hpiers.obspm.fr/eoppc/bul/bulb/explanatory.html>

h	Aries			Venus			Mars			Jupiter			Saturn		
Wed	GHA	GHA	Dec	GHA	Dec	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				ν0.8' d0.2' m-3.90			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		ν 0.8' d0.6' m0.3		ν 2.3' d0.0' m-2.52		ν 2.6' 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		ν 0.8' d0.6' m0.3		ν 2.4' d0.0' m-2.52		ν 2.6' 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	-07°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
Anilam	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
Rigel 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			
	GHA	Dec		GHA	ν	Dec	d
Wed							HP
0	178°33.8	N21°51.4		10°13.1	0.7'	S26°54.4	0.7'
1	193°33.7	51.0		24°32.9	0.7'	26°53.7	0.9'
2	208°33.6	50.7		38°52.6	0.7'	26°52.8	1.1'
3	223°33.6	50.3		53°12.3	0.7'	26°51.7	1.3'
4	238°33.5	50.0		67°32.1	0.7'	26°50.3	1.5'
5	253°33.4	49.6		81°51.8	0.8'	26°48.8	1.8'
6	268°33.3	N21°49.2		96°11.6	0.8'	S26°47.0	2.0'
7	283°33.3	48.9		110°31.4	0.8'	26°45.1	2.2'
8	298°33.2	48.5		124°51.2	0.8'	26°42.9	2.4'
9	313°33.1	48.1		139°11.0	0.9'	26°40.5	2.6'
10	328°33.1	47.8		153°30.9	0.9'	26°37.9	2.8'
11	343°33.0	47.4		167°50.8	0.9'	26°35.0	3.0'
12	358°32.9	N21°47.0		182°10.7	1.0'	S26°32.0	3.2'
13	13°32.8	46.7		196°30.7	1.0'	26°28.7	3.5'
14	28°32.8	46.3		210°50.7	1.1'	26°25.3	3.7'
15	43°32.7	45.9		225°10.8	1.1'	26°21.6	3.9'
16	58°32.6	45.6		239°30.9	1.2'	26°17.7	4.1'
17	73°32.6	45.2		253°51.1	1.2'	26°13.7	4.3'
18	88°32.5	N21°44.8		268°11.3	1.3'	S26°09.4	4.5'
19	103°32.4	44.4		282°31.6	1.4'	26°04.9	4.7'
20	118°32.3	44.1		296°52.0	1.4'	26°00.2	4.9'
21	133°32.3	43.7		311°12.4	1.5'	25°55.3	5.1'
22	148°32.2	43.3		325°32.9	1.6'	25°50.2	5.3'
23	163°32.1	43.0		339°53.4	1.6'	25°44.9	5.5'
SD = 15.7' $d = -0.4'$				SD = 16.7'			

Thu	Sun			Moon			
	GHA	Dec		GHA	ν	Dec	d
0	178°32.1	N21°42.6		354°14.1	1.7'	S25°39.4	5.7'
1	193°32.0	42.2		8°34.8	1.8'	25°33.7	5.9'
2	208°31.9	41.8		22°55.6	1.9'	25°27.8	6.1'
3	223°31.9	41.4		37°16.5	2.0'	25°21.8	6.3'
4	238°31.8	41.1		51°37.4	2.1'	25°15.5	6.5'
5	253°31.7	40.7		65°58.5	2.1'	25°09.0	6.7'
6	268°31.7	N21°40.3		80°19.6	2.2'	S25°02.4	6.8'
7	283°31.6	39.9		94°40.9	2.3'	24°55.5	7.0'
8	298°31.5	39.6		109°02.2	2.4'	24°48.5	7.2'
9	313°31.5	39.2		123°23.6	2.5'	24°41.3	7.4'
10	328°31.4	38.8		137°45.1	2.6'	24°33.9	7.6'
11	343°31.3	38.4		152°06.8	2.7'	24°26.3	7.8'
12	358°31.3	N21°38.0		166°28.5	2.8'	S24°18.6	7.9'
13	13°31.2	37.6		180°50.3	2.9'	24°10.6	8.1'
14	28°31.1	37.3		195°12.3	3.1'	24°02.5	8.3'
15	43°31.1	36.9		209°34.3	3.2'	23°54.2	8.4'
16	58°31.0	36.5		223°56.5	3.3'	23°45.8	8.6'
17	73°30.9	36.1		238°18.8	3.4'	23°37.2	8.8'
18	88°30.9	N21°35.7		252°41.2	3.5'	S23°28.4	9.0'
19	103°30.8	35.3		267°03.7	3.6'	23°19.4	9.1'
20	118°30.7	34.9		281°26.3	3.7'	23°10.3	9.3'
21	133°30.7	34.6		295°49.0	3.9'	23°01.1	9.4'
22	148°30.6	34.2		310°11.9	4.0'	22°51.6	9.6'
23	163°30.5	33.8		324°34.9	4.1'	22°42.0	9.7'
SD = 15.7' $d = -0.4'$				SD = 16.7'			

Fri	Sun			Moon			
	GHA	Dec		GHA	ν	Dec	d
0	178°30.5	N21°33.4		338°58.0	4.2'	S22°32.3	9.9'
1	193°30.4	33.0		353°21.2	4.3'	22°22.4	10.0'
2	208°30.3	32.6		7°44.5	4.5'	22°12.3	10.2'
3	223°30.3	32.2		22°08.0	4.6'	22°02.2	10.3'
4	238°30.2	31.8		36°31.6	4.7'	21°51.8	10.5'
5	253°30.1	31.4		50°55.3	4.8'	21°41.3	10.6'
6	268°30.1	N21°31.0		65°19.1	5.0'	S21°30.7	10.8'
7	283°30.0	30.6		79°43.1	5.1'	21°19.9	10.9'
8	298°30.0	30.2		94°07.2	5.2'	21°09.0	11.0'
9	313°29.9	29.9		108°31.5	5.4'	20°58.0	11.2'
10	328°29.8	29.5		122°55.8	5.5'	20°46.9	11.3'
11	343°29.8	29.1		137°20.3	5.6'	20°35.6	11.4'
12	358°29.7	N21°28.7		151°44.9	5.7'	S20°24.1	11.5'
13	13°29.7	28.3		166°09.7	5.9'	20°12.6	11.7'
14	28°29.6	27.9		180°34.5	6.0'	20°00.9	11.8'
15	43°29.5	27.5		194°59.5	6.1'	19°49.1	11.9'
16	58°29.5	27.1		209°24.7	6.3'	19°37.2	12.0'
17	73°29.4	26.7		223°49.9	6.4'	19°25.2	12.1'
18	88°29.3	N21°26.3		238°15.3	6.5'	S19°13.0	12.3'
19	103°29.3	25.9		252°40.9	6.7'	19°00.8	12.4'
20	118°29.2	25.5		267°06.5	6.8'	18°48.4	12.5'
21	133°29.2	25.1		281°32.3	6.9'	18°36.0	12.6'
22	148°29.1	24.6		295°58.2	7.0'	18°23.4	12.7'
23	163°29.0	24.2		310°24.2	7.2'	18°10.7	12.8'
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	■	■	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		Mer. Pass	Moon		Age
	Eqn. of Time 00 ^h mm:ss	12 ^h mm:ss		Mer. Pass. Upper hh:mm	Lower hh:mm	
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.)

	Aries			Venus			Mars			Jupiter			Saturn			Stars		
Sat	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	SHA	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	Alpheratz	357°36.7	29°12.7						
1	308°51.3	221°29.8	39.3	273°09.3	19.1	300°33.4	05.7	342°09.2	42.5	Ankaa	353°09.0	-42°10.8						
2	323°53.8	236°29.0	39.5	288°10.1	19.6	315°35.7	05.7	357°11.9	42.6	Schedar	349°33.2	56°39.3						
3	338°56.2	251°28.2	· · 39.7	303°10.9	· · 20.2	330°38.1	· · 05.8	12°14.5	· · 42.6	Diphda	348°49.3	-17°51.7						
4	353°58.7	266°27.4	39.8	318°11.7	20.7	345°40.4	05.8	27°17.1	42.7	Achernar	335°21.8	-57°07.1						
5	9°01.2	281°26.6	40.0	333°12.5	21.3	0°42.8	05.8	42°19.7	42.7	Hamal	327°53.5	23°34.0						
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	Polaris	315°10.5	89°21.2						
7	39°06.1	311°25.0	40.3	3°14.2	22.4	30°47.5	05.9	72°24.9	42.8	Acamar	315°13.5	-40°12.7						
8	54°08.6	326°24.2	40.5	18°15.0	23.0	45°49.9	05.9	87°27.5	42.9	Menkar	314°08.4	4°10.7						
9	69°11.0	341°23.4	· · 40.6	33°15.8	· · 23.5	60°52.3	· · 05.9	102°30.1	· · 42.9	Mirfak	308°31.4	49°56.2						
10	84°13.5	356°22.6	40.8	48°16.6	24.1	75°54.6	06.0	117°32.7	43.0	Aldebaran	290°42.2	16°33.2						
11	99°15.9	11°21.8	40.9	63°17.5	24.6	90°57.0	06.0	132°35.3	43.1	Rigel	281°06.1	-8°10.5						
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	Capella	280°25.3	46°01.1						
13	129°20.9	41°20.2	41.2	93°19.1	25.8	121°01.7	06.1	162°40.5	43.2	Bellatrix	278°25.4	6°22.2						
14	144°23.3	56°19.4	41.4	108°19.9	26.3	136°04.1	06.1	177°43.1	43.2	Elnath	278°04.8	28°37.5						
15	159°25.8	71°18.6	· · 41.5	123°20.7	· · 26.9	151°06.5	· · 06.1	192°45.7	· · 43.3	Alnilam	275°40.1	-1°11.2						
16	174°28.3	86°17.8	41.7	138°21.5	27.4	166°08.8	06.1	207°48.3	43.3	Betelgeuse	270°54.6	7°24.7						
17	189°30.7	101°17.0	41.8	153°22.4	28.0	181°11.2	06.2	222°50.9	43.4	Canopus	263°53.8	-52°42.3						
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	Sirius	258°28.4	-16°44.7						
19	219°35.7	131°15.4	42.1	183°24.0	29.1	211°15.9	06.2	252°56.2	43.5	Adhara	255°07.8	-29°00.1						
20	234°38.1	146°14.6	42.3	198°24.8	29.7	226°18.3	06.3	267°58.8	43.5	Procyon	244°53.3	5°10.1						
21	249°40.6	161°13.8	· · 42.4	213°25.6	· · 30.2	241°20.7	· · 06.3	283°01.4	· · 43.6	Pollux	243°20.2	27°58.4						
22	264°43.0	176°13.0	42.6	228°26.5	30.8	256°23.1	06.3	298°04.0	43.7	Avior	234°16.2	-59°34.9						
23	279°45.5	191°12.2	42.7	243°27.3	31.3	271°25.4	06.3	313°06.6	43.7	Suhail	222°48.2	-43°31.4						
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			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			
															Rigel 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 372°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												


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		Sunrise	Sunset	Twilight	
	Naut.	Civil			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			Moonset		
	Sat	Sun	Mon	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			Moon			
	Eqn.of Time		Mer.	Mer.Pass.			Age
	00 ^h	12 ^h	Pass	Upper	Lower		17-19
	mm:ss	mm:ss	hh:mm	hh:mm	hh:mm		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		