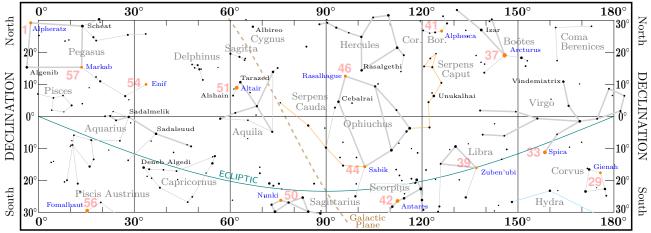
GENERATED USING SKYFIELD

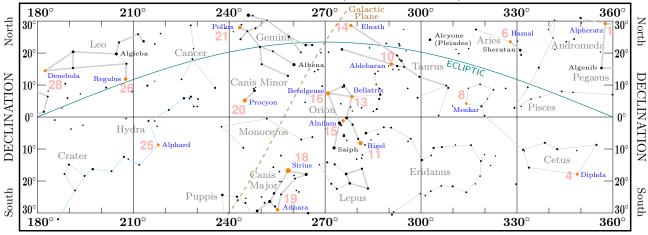
http://rhodesmill.org/skyfield/

EQUATORIAL STARS (SHA 0° to 180°)



SIDEREAL HOUR ANGLE

EQUATORIAL STARS (SHA 180° to 360°)



SIDEREAL HOUR ANGLE

THE NAUTICAL ALMANAC

13.07.2022 - 18.07.2022

Author: Andrew Bauer
Original concept from: Enno Rodegerdts

September 5, 2022

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 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 'uselERS = 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.

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

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

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

h	Aries	` Ve	nus	M	ars	Jup	oiter	Sat	urn		Stars
Wed	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec		SHA
oved 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	\$14°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	Alpheratz	
2	320°56.3	237°25.8	24.9	287°11.4	38.7	312°46.3	03.3	354°04.6	38.7	Ankaa	353°09.1
3	335°58.8	252°25.0	• • 25.1	302°12.2	• • 39.3	327°48.6	• • 03.3	9°07.2	• • 38.8	Schedar	349°33.2
4	$351^{\circ}01.3$	267°24.2	25.4	$317^{\circ}13.1$	39.8	342°51.0	03.4	24°09.8	38.8	Diphda	348°49.3 335°21.8
5	6°03.7	282°23.4	25.6	332°13.9	40.4	357°53.3	03.4	39°12.4	38.9	Achernar Hamal	335 21.8 327°53.6
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	S 14°38.9	Polaris	315°11.8
7	36°08.7	312°21.9	26.1	2°15.5	41.6	27°58.0	03.5	69° 17.6	39.0	Acamar	315°13.5
8	51°11.1	327°21.1	26.3	17°16.3	42.1	43°00.3	03.5	84°20.1	39.0	Menkar	314°08.4
9	66°13.6	342°20.3	• • 26.6	32°17.1 47°17.9	• • 42.7	58°02.7	• • 03.6	99°22.7	39.1	Mirfak	308°31.4
10 11	81°16.1 96°18.5	357° 19.5 12° 18.7	26.8 27.0	47 17.9 62°18.7	43.3 43.9	73°05.0 88°07.4	03.6 03.6	114°25.3 129°27.9	39.1 39.2	Aldebaran	290°42.2
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	\$14°39.2	Rigel	$281^{\circ}06.1$
13	126°23.5	42° 17.2	27.5	92°20.4	45.0	118° 12.1	03.7	159°33.1	39.3	Capella	280°25.3
14	141°25.9	57° 16.4	27.7	107°21.2	45.6	133° 14.4	03.7	174°35.7	39.3	Bellatrix	278°25.4
15	156°28.4	$72^{\circ}15.6$	• • 27.9	122°22.0	• • 46.2	148°16.8	• • 03.8	189°38.3	• • 39.4	Elnath	278°04.8
16	171°30.8	87° 14.8	28.2	137°22.8	46.7	$163^{\circ}19.1$	03.8	204°40.9	39.4	Alnilam	275°40.1 270°54.6
17	186°33.3	$102^{\circ}14.0$	28.4	152°23.6	47.3	178°21.5	03.8	219°43.5	39.5	Betelgeuse Canopus	
18	201°35.8	117° 13.3	N22°28.6	167°24.4	N11°47.9	193°23.8	N02°03.9		S 14°39.5	Sirius	258°28.4
19	216°38.2	132° 12.5	28.9	182°25.3	48.5	208°26.1	03.9	249°48.7	39.6	Adhara	255°07.9
20	231°40.7	147°11.7	29.1	197°26.1	49.0	223°28.5	04.0	264°51.3	39.7	Procyon	244°53.3
21	246°43.2 261°45.6	162°10.9	• • 29.3	212°26.9	• • 49.6	238°30.8	• • 04.0	279°53.9 294°56.5	• • 39.7	Pollux	243°20.2
22 23	201 45.0 276°48.1	177°10.1 192°09.3	29.5 29.7	227°27.7 242°28.5	50.2 50.7	253°33.2 268°35.5	04.0 04.1	294 50.5 309°59.1	39.8 39.8	Avior	$234^{\circ}16.2$
					_					Suhail	222°48.2
Mer.p	ass. 04:36	ν -0.8′ d0	.2′ m-3.90	$\nu^{0.8'} d0$	0.6′ m0.3	$\nu 2.3' d0.$.0′ m-2.51	$\nu 2.6' d-0$	0.1′ m0.5	Miaplacidus	221°39.5
										Alphard Regulus	217°50.1 207°36.9
Thu	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	Dubhe	193°44.0
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	S 14°39.9	Denebola	182°27.2
1	306°53.0	222°07.8	30.2	272°30.1	51.9	298°40.2	04.1	340°04.3	39.9	Gienah	175°45.8
2	321°55.5	237°07.0	30.4	287°30.9	52.5	313°42.6	04.2	355°06.9 10°09.5	40.0	Acrux	173°02.5
3 4	336°58.0 352°00.4	252°06.2 267°05.4	· · 30.6 30.8	302°31.8 317°32.6	· · 53.0 53.6	328°44.9 343°47.3	· · 04.2 04.2	25° 12.1	· · 40.0 40.1	Gacrux	171°54.0
5	7°02.9	282°04.6	31.0	332° 33.4	54.2	358°49.6	04.2	40°14.7	40.1	Alioth	166°14.9
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	Spica	158°24.4
7	37°07.8	$312^{\circ}03.1$	31.5	2°35.0	55.3	28° 54.3	04.4	70° 19.9	40.2	Alkaid Hadar	152°53.6 148°38.8
8	52°10.3	327°02.3	31.7	17°35.8	55.9	43°56.7	04.4	85°22.5	40.3		140 30.0 147°59.9
9	67°12.7	$342^{\circ}01.5$	• • 31.9	32°36.6	• • 56.4	58° 59.0	• • 04.4	100°25.1	• • 40.3		145°49.7
10	82°15.2	357°00.7	32.1	47°37.5	57.0	74°01.4	04.5	115°27.7	40.4	Rigil Kent.	139°42.9
11	97°17.7	11°59.9	32.3	62°38.3	57.6	89°03.7	04.5	130°30.3	40.5	Kochab	$137^{\circ}19.4$
12	112°20.1 127°22.6	26°59.1	N22°32.5	77°39.1	N11°58.2	104°06.1	N02°04.5	145°32.9 160°35.5	\$14°40.5	Zuben'ubi	$136^{\circ}58.1$
13 14	142°25.1	41°58.3 56°57.5	32.7 32.9	92°39.9 107°40.7	58.7 59.3	119°08.5 134°10.8	04.6 04.6	175°38.1	40.6 40.6	Alphecca	126°05.3
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	Antares	112°18.1
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	Atria	107°13.7
17	187°32.4	101°55.2	33.5	152°43.2	01.0	179° 17.9	04.7	220°45.9	40.8	Sabik Shaula	102°04.8 96°12.8
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	Rasalhague	96°00.1
19	217°37.4	131°53.6	33.9	182°44.8	02.1	209°22.6	04.8	250°51.1	40.9	Eltanin	90°42.6
20	232°39.8	146°52.8	34.1	197°45.6	02.7	224°24.9	04.8	265°53.7	40.9	Kaus Aust.	83°34.8
21	247°42.3	161°52.0	• • 34.3	212°46.4	• • 03.3	239°27.3	• • 04.8	280°56.3	• • 41.0	Vega	80°34.2
22	262°44.8	176°51.2	34.5	227°47.2 242°48.1	03.8	254°29.6	04.9	295°58.9 311°01.6	41.0	Nunki	75°49.9
23	277°47.2	191°50.4	34.7		04.4	269°32.0	04.9		41.1	Altair	62°01.6
Mer.p	ass. 04:32	ν -0.8' d0	.2′ m-3.90	ν 0.8 $^{\prime}$ d0	0.6' m 0.3	$\nu 2.3' \ d0.$.0′ m-2.52	$\nu 2.6' \ d-0$	0.1^\prime m 0.5	Peacock	53°08.4
										Deneb Enif	49°26.7 33°40.5
Fri	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	Al Na'ir	27°35.1
0	292°49.7	206°49.6	N22°34.9	257°48.9	N12°05.0	284°34.4	N02°04.9		S 14°41.1	Fomalhaut	15°16.6
1	307°52.2	221°48.9	35.1	272°49.7	05.5	299°36.7	05.0	341°06.8	41.2	Scheat	13°47.0
2	322°54.6	236°48.1	35.3	287°50.5	06.1	314°39.1	05.0	356°09.4	41.3	Markab	13°31.7
3	337°57.1	251°47.3	• • 35.5	302°51.3	• • 06.7	329°41.4	• • 05.0	11°12.0	• • 41.3	1 1 12 10/ 1	CLIA
4	352°59.6 8°02.0	266° 46.5 281° 45.7	35.6 35.8	317°52.1 332°52.9	07.2 07.8	344°43.8 359°46.1	05.1	26°14.6 41°17.2	41.4	Jul 13 Wed	SHA 276°35.9
5 6	8°02.0 23°04.5	281° 45.7 296° 44.9	35.8 N22°36.0	332°52.9 347°53.8	07.8 N12°08.4	359°46.1 14°48.5	05.1 N02°05.1		41.4 \$14°41.5	Mars	
7	25 04.5 38°06.9	311°44.1	36.2	2°54.6	08.9	29°50.9	05.2	71°22.4	41.5		351°50.2
8	53°09.4	326° 43.3	36.4	17°55.4	09.5	44°53.2	05.2	86°25.0	41.5	Saturn	33°08.0
9	68°11.9	341°42.5	• • 36.6	32°56.2	• • 10.1	59°55.6	• • 05.2	101°27.6	• • 41.6	1 1 1 4 71	
10	83°14.3	356°41.7	36.8	47°57.0	10.6	74° 57.9	05.3	116°30.2	41.7	Jul 14 Thu	SHA 275°18.0
11	98°16.8	11°40.9	36.9	62°57.8	11.2	90°00.3	05.3	131°32.8	41.7		325°38.8
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			351°47.3
13 14	128°21.7 143°24.2	41°39.3 56°38.5	37.3 37.5	92°59.5 108°00.3	12.3 12.9	120°05.0 135°07.4	05.3 05.4	161°38.0 176°40.6	41.9 41.9	Saturn	33°11.2
14 15	143 24.2 158°26.7	71°37.8	37.6	100 00.3 123°01.1	12.9	150°09.7	•• 05.4	170 40.0 191°43.2	• • 42.0	Jul 15 Fri	SHA
16	173°29.1	86°37.0	37.8	138°01.9	14.0	165°12.1	05.4	206°45.8	42.0		273°59.9
17	188°31.6	101°36.2	38.0	153°02.7	14.6	180°14.5	05.5	221°48.4	42.1		324°59.2
18	203°34.1	116°35.4	N22°38.2	168°03.6	$N12^{\circ}15.1$	195° 16.8	N02°05.5		S 14°42.1		351°44.7
19	218°36.5	131°34.6	38.3	183°04.4	15.7	210°19.2	05.5	251°53.6	42.2	Saturn	33°14.5
20	233°39.0 248°41.4	146°33.8	38.5	198°05.2	16.2 •• 16.8	225°21.5	05.6 •• 05.6	266° 56.2 281° 58.8	42.2 •• 42.3	Horizont	tal parallax
21 22	248°41.4 263°43.9	161°33.0 176°32.2	· · 38.7 38.8	213°06.0 228°06.8	· · 16.8 17.4	240°23.9 255°26.3	05.6 05.6	281°58.8 297°01.4	42.3	1.01120111	Venus:
23	203°45.9 278°46.4	191°31.4	39.0	243°07.6	17.4	270°28.6	05.7	312°04.0	42.4		Mars:
	ass. 04:28		.2′ m-3.90		0.6' m0.3		.0′ m-2.52		0.1′ m0.5		
		ν 0.0 d0	111-3.30	- V U.U U	, 1110.3	ν Δ. Τ u0.	111-4.34	ν Δ.Ο U-(,. <u>.</u> 1110.J		

Dec

29°12.7 -42°10.8

56°39.3

-17°51.7 -57°07.1

 $23^{\circ}34.0$

 $89^{\circ}21.2$

-40°12.7

4°10.6

49°56.2

16°33.2 -8°10.5

 $46^{\circ}01.1$

28°37.5

 $-1^{\circ}11.2$

7°24.7

-52°42.3

-16°44.7 -29°00.1

 $5^{\circ}10.1$

 $27^{\circ}58.4$ -59°34.9

-43°31.4

-69°48.6 -8°45.3

11°51.6 61°38.1

 $14^{\circ}27.0$

 $-17^{\circ}40.0$

 $-63^{\circ}13.6$

 $-57^{\circ}14.5$

55°50.6

-11°16.7

49°12.4 -60°29.1

-36°28.9

 $19^{\circ}04.1$

-60°55.9

 $74^{\circ}04.1$

-16°08.1

26°38.5 -26°28.9

-69°04.2

-15°45.1 $-37^{\circ}07.2$

 $12^{\circ}32.7$

51°29.3

-34°22.4

38°48.3

-26°16.1

-56°39.7 $45^{\circ}21.5$

8°55.7

 $9^{\circ}58.7$

 $-46^{\circ}51.0$

-29°30.1

28°12.1 15°19.5

Mer.pass

10:11

06:51

05:08

02:24

10:12

06:50

05:05

02:19

10:13

06:48

05:01 02:15

Mer.pass

0.1

0.1

Mer.pass

 $6^{\circ}22.2$

h	Su	n			Moon		
Wed	GHA	Dec	GHA	ν	Dec	d	HP
0	178°33.8	N21°51.4	$10^{\circ}13.1$	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 4	223°33.6 238°33.5	· · 50.3 50.0	53°12.3 67°32.1	0.7' 0.7'	26°51.7 26°50.3	1.3' 1.5'	61.3' 61.3'
5	250 33.5 253°33.4	49.6	81°51.8	0.7	26°48.8	1.8'	61.3
6	268°33.3	N21°49.2	96°11.6	0.8'	526°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	$124^{\circ}51.2$	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°33.0 358°32.9	47.4 N21°47.0	167°50.8 182°10.7	0.9' 1.0'	26°35.0 526°32.0	3.0' 3.2'	61.3' 61.3'
12 13	13° 32.8	N21 47.0 46.7	182 10.7 196°30.7	1.0'	26°28.7	3.2 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°32.5 103°32.4	N21°44.8	268°11.3 282°31.6	1.3'	\$26°09.4	4.5'	61.3'
19 20	103° 32.4 118° 32.3	44.4 44.1	282°31.6 296°52.0	1.4' 1.4'	26°04.9 26°00.2	4.7' 4.9'	61.3' 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'		SI	D = 16.7'		
Thu	GHA 178°32.1	Dec N21°42.6	GHA 354°14.1	u 1.7'	Dec \$25°39.4	d 5.7'	HP 61.2'
0 1	178° 32.1 193° 32.0	N21 42.6 42.2	354 14.1 8°34.8	1.7	525°39.4 25°33.7	5.7° 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	$37^{\circ}16.5$	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 \$25°02.4	6.7'	61.2'
6 7	268°31.7 283°31.6	N21°40.3 39.9	80°19.6 94°40.9	2.2' 2.3'	24°55.5	6.8' 7.0'	61.2' 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	$137^{\circ}45.1$	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 13°31.2	N21°38.0	166°28.5 180°50.3	2.8'	\$24°18.6 24°10.6	7.9'	61.1'
13 14	28° 31.1	37.6 37.3	100 50.5 195°12.3	2.9' 3.1'	24 10.6 24°02.5	8.1' 8.3'	61.1' 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	$223^{\circ}56.5$	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 19	88°30.9 103°30.8	N21°35.7 35.3	252°41.2 267°03.7	3.5' 3.6'	\$23°28.4 23°19.4	9.0' 9.1'	61.0' 61.0'
20	118° 30.7	34.9	281°26.3	3.7'	23°10.3	9.1	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'		SI	D = 16.7'		
Fri	GHA	Dec	GHA	ν	Dec	d	НР
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°30.3 223°30.3	32.6	7°44.5	4.5'	22°12.3 22°02.2	10.2' 10.3'	60.8'
3 4	223°30.3 238°30.2	· · 32.2 31.8	22°08.0 36°31.6	4.6' 4.7'	22°02.2 21°51.8	10.3'	60.8' 60.8'
5	250° 30.2 253° 30.1	31.6	50°55.3	4.7	21°41.3	10.5	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 11	328° 29.8 343° 29.8	29.5 29.1	122°55.8 137°20.3	5.5' 5.6'	20°46.9 20°35.6	11.3' 11.4'	60.6' 60.6'
11	343° 29.8 358° 29.7	29.1 N21°28.7	137°20.3 151°44.9	5.7'	20°35.6 \$20°24.1	11.4	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 17	58° 29.5 73° 29.4	27.1 26.7	209°24.7 223°49.9	6.3' 6.4'	19°37.2 19°25.2	12.0' 12.1'	60.5' 60.4'
18	73°29.4 88°29.3	26.7 N21°26.3	223°49.9 238°15.3	6.5'	19°25.2 \$19°13.0	12.1	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°58.2 310°24.2	7.0' 7.2'	18°23.4	12.7'	60.3'
23	163°29.0	24.2	310-24.2		18°10.7	12.8'	60.3'
	SD = 15.7'	d = -0.4'		SI	D = 16.6'		

Lat.	Twi	light	Sunrise	Sunset	Twi	light
	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.		Moonris	ie .		Moonset	:
	Wed	Thu	Fri	Wed	Thu	Fri
N 72°						
N 70°						
68°			23:57			
66°		_	00:04			03:06
			23:30			
64°	23:55	23:21	23:10	00.04	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
		21.56	22:16	02:08	03:32	05:11
56°	21:22	21:56		000-		05:24
54°	21:05	21:42	22:06	02:27	03:49	
54° 52°	21:05 20:50	21:42 21:31	22:06 21:58	02:43	04:04	05:35
54° 52° 50°	21:05 20:50 20:37	21:42 21:31 21:20	22:06 21:58 21:50	02:43 02:57	04:04 04:16	05:35 05:44
54° 52° 50° 45°	21:05 20:50 20:37 20:11	21:42 21:31 21:20 20:58	22:06 21:58 21:50 21:34	02:43 02:57 03:25	04:04 04:16 04:42	05:35 05:44 06:05
54° 52° 50° 45° N 40°	21:05 20:50 20:37 20:11 19:50	21:42 21:31 21:20 20:58 20:41	22:06 21:58 21:50 21:34 21:21	02:43 02:57 03:25 03:48	04:04 04:16 04:42 05:02	05:35 05:44 06:05 06:22
54° 52° 50° 45° N 40° 35°	21:05 20:50 20:37 20:11 19:50 19:32	21:42 21:31 21:20 20:58 20:41 20:26	22:06 21:58 21:50 21:34 21:21 21:09	02:43 02:57 03:25 03:48 04:06	04:04 04:16 04:42 05:02 05:19	05:35 05:44 06:05 06:22 06:35
54° 52° 50° 45° N 40° 35° 30°	21:05 20:50 20:37 20:11 19:50 19:32 19:17	21:42 21:31 21:20 20:58 20:41 20:26 20:13	22:06 21:58 21:50 21:34 21:21 21:09 20:59	02:43 02:57 03:25 03:48 04:06 04:22	04:04 04:16 04:42 05:02 05:19 05:34	05:35 05:44 06:05 06:22 06:35 06:48
54° 52° 50° 45° N 40° 35° 30° 20°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42	02:43 02:57 03:25 03:48 04:06 04:22 04:49	04:04 04:16 04:42 05:02 05:19 05:34 05:59	05:35 05:44 06:05 06:22 06:35 06:48 07:08
54° 52° 50° 45° N 40° 35° 30° 20° N 10°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:26
54° 52° 50° 45° N 40° 35° 30° 20° N 10° 0°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:26
54° 52° 50° 45° N 40° 35° 30° 20° N 10° 0° S 10°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:26 07:42
54° 52° 50° 45° N 40° 35° 30° 20° N 10° 0° S 10° 20°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40 06:59 07:20	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:26 07:42 07:58 08:16
54° 52° 50° 45° N 40° 35° 20° N 10° 0° S 10° 20° 30°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:13	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40 06:59 07:20 07:44	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:26 07:42 07:58 08:16
54° 52° 50° 45° N 40° 35° 20° N 10° 0° S 10° 20° 30° 35°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:13 17:59	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40 06:59 07:20 07:44 07:58	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35
54° 52° 50° 45° N 40° 35° 20° N 10° 0° S 10° 20° 30° 35° 40°	21:05 20:50 20:37 20:11 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:13 17:59 17:44	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18	04:04 04:16 04:42 05:02 05:19 05:34 05:59 06:20 06:40 06:59 07:20 07:44 07:58 08:15	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35 08:47
54° 52° 50° 45° N 40° 35° 30° N 10° 0° S 10° 20° 35° 40° 45°	21:05 20:50 20:37 20:11 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26 16:05	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:13 17:59 17:44 17:26	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03 18:49	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18	04:04 04:16 04:42 05:02 05:19 06:20 06:40 06:59 07:24 07:58 08:15 08:34	05:35 05:44 06:05 06:22 06:35 06:48 07:08 07:42 07:58 08:16 08:35 08:47 09:00
54° 52° 50° 45° N 40° 35° 30° 20° N 10° 0° S 10° 20° 30° 35° 40° 45° S 50°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26 16:05 15:38	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:33 17:59 17:44 17:26 17:03	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03 18:49 18:32	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18 07:39	04:04 04:16 04:42 05:02 05:19 06:20 06:40 06:59 07:20 07:48 08:15 08:34 08:58	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35 08:47 09:00
54° 52° 50° 45° 81 40° 35° 30° 20° N 10° 0° S 10° 20° 35° 40° 45° S 50° 52°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26 16:05 15:38 15:25	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:35 17:59 17:44 17:26 17:03 16:52	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03 18:49 18:32 18:24	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18 07:39	04:04 04:16 04:42 05:02 05:34 05:59 06:20 06:40 06:59 07:20 07:44 07:58 08:15 08:34	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35 08:47 09:00 09:15
54° 52° 50° 45° N 40° 35° 20° N 10° 0° S 10° 20° 35° 40° 45° 5 50° 52° 54°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26 16:05 15:38 15:25 15:10	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 18:55 18:35 18:13 17:59 17:44 17:26 17:03 16:52 16:39	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03 18:49 18:32 18:24 18:15	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18 07:39 08:07 08:20 08:35	04:04 04:16 04:42 05:02 05:19 05:39 06:20 06:40 06:59 07:20 07:44 07:58 08:15 08:34 08:58 09:09	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35 08:47 09:00 09:15
54° 52° 50° 45° 81 40° 35° 30° 20° N 10° 0° S 10° 20° 35° 40° 45° S 50° 52°	21:05 20:50 20:37 20:11 19:50 19:32 19:17 18:51 18:29 18:08 17:48 17:25 16:59 16:44 16:26 16:05 15:38 15:25	21:42 21:31 21:20 20:58 20:41 20:26 20:13 19:51 19:31 19:13 18:55 18:35 18:35 17:59 17:44 17:26 17:03 16:52	22:06 21:58 21:50 21:34 21:21 21:09 20:59 20:42 20:27 20:13 19:58 19:43 19:25 19:15 19:03 18:49 18:32 18:24	02:43 02:57 03:25 03:48 04:06 04:22 04:49 05:12 05:33 05:55 06:17 06:44 07:00 07:18 07:39	04:04 04:16 04:42 05:02 05:34 05:59 06:20 06:40 06:59 07:20 07:44 07:58 08:15 08:34	05:35 05:44 06:05 06:22 06:35 06:48 07:26 07:42 07:58 08:16 08:35 08:47 09:00 09:15

50	11.50	10.00	11.52	05.15	05.55	10.10	
S 60°	14:02	15:47	17:39	09:43	10:16	10:31	
		Sun		Moon			
Day	Eqn.o	f 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		

18:15 18:04 17:52

09:15

09:22 09:37 09:55

10:16

54° 56° 58°

15:10 14:52 14:30

16:39 16:25 16:08

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

h	Aries	Ve	nus	М	ars	Jup	oiter	Sat	urn		Stars	
Sat	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec		SHA	Dec
0	293°48.8	$206^{\circ}30.6$	N22°39.2	$258^{\circ}08.5$	$N12^{\circ}18.5$	$285^{\circ}31.0$	N02°05.7		S 14°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 4	338°56.2 353°58.7	251°28.2 266°27.4	· · 39.7 39.8	303°10.9 318°11.7	· · 20.2 20.7	330°38.1 345°40.4	· · 05.8 05.8	12° 14.5 27° 17.1	•• 42.6 42.7	Diphda	348°49.3	-17°51.7
5	9°01.2	281°26.6	40.0	333°12.5	21.3	0°42.8	05.8	42°19.7	42.7	Achernar	335°21.8	-57° 07.1
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	Hamal	327°53.5	23°34.0
7	39°06.1	311°25.0	40.3	3°14.2	22.4	30°47.5	05.9	72°24.9	42.8	Polaris	315°10.5	89°21.2 -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	Acamar Menkar	315°13.5 314°08.4	-40 12.7 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 99°15.9	356° 22.6 11° 21.8	40.8	48° 16.6 63° 17.5	24.1	75°54.6 90°57.0	06.0	117°32.7 132°35.3	43.0	Aldebaran	290°42.2	16°33.2
11 12	99 15.9 114°18.4	26°21.0	40.9 N22°41.1	78° 18.3	24.6 N12°25.2	90°57.0 105°59.4	06.0 N02°06.0	132 33.3 147°37.9	43.1 \$14°43.1	Rigel	$281^{\circ}06.1$	-8°10.5
13	129°20.9	41°20.2	41.2	93°19.1	25.8	121°01.7	06.1	162° 40.5	43.2	Capella	280°25.3	46°01.1
14	144°23.3	56° 19.4	41.4	108° 19.9	26.3	136°04.1	06.1	177° 43.1	43.2	Bellatrix	278°25.4	6°22.2
15	159°25.8	71° 18.6	• • 41.5	123°20.7	• • 26.9	151°06.5	•• 06.1	192°45.7	• • 43.3	Elnath Alnilam	278°04.8 275°40.1	28°37.5 -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 19	204°33.2 219°35.7	116° 16.2 131° 15.4	N22°42.0 42.1	168°23.2 183°24.0	N12°28.5 29.1	196°13.6 211°15.9	N02°06.2 06.2	237°53.5 252°56.2	\$14°43.4 43.5	Sirius	258°28.4	-16°44.7
20	234°38.1	146° 14.6	42.1	198° 24.8	29.7	211 15.9 226°18.3	06.2	267° 58.8	43.5	Adhara	255°07.8	-29°00.1
21	249°40.6	161°13.8	42.4	213°25.6	30.2	241°20.7	06.3	283°01.4	• • 43.6	Procyon	244°53.3	5°10.1
22	264°43.0	176°13.0	42.6	228°26.5	30.8	$256^{\circ}23.1$	06.3	298°04.0	43.7	Pollux	243°20.2	27°58.4 -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	Avior Suhail	234°16.2 222°48.2	-59 34.9 -43°31.4
Mer n	ass. 04:24	ν-0.8' d0	.2′ m-3.90	ν0.8′ d0	0.6' m0.3	ν 2.4' d0	.0′ m-2.53	$\nu 2.6' \ d-0$	0.1′ m0.5	Miaplacidus	221°39.5	-43 31.4 -69°48.6
		- 3.3 40								Alphard	217°50.0	-8°45.3
Sun	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	Regulus	207°36.9	11°51.6
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		Dubhe	193°44.0	61°38.1
1	309°50.4	221° 10.6	43.0	273°28.9	32.4	301°30.2	06.4	343°11.8	43.8	Denebola	182°27.2	14°27.0
2	324°52.9	236°09.8	43.1	288°29.7	33.0	$316^{\circ}32.5$	06.4	358°14.4	43.9	Gienah Acrux	175°45.8 173°02.5	-17°40.0 -63°13.6
3	339°55.4	251°09.0	• • 43.3	303°30.5	• • 33.5	331°34.9	• • 06.4	13° 17.0	• • 43.9	Gacrux	173 02.3 171°54.0	-57° 14.5
4	354°57.8	266°08.2	43.4	318°31.4	34.1	346°37.3	06.5	28° 19.6	44.0	Alioth	166°14.9	55°50.6
5	10°00.3 25°02.8	281°07.4	43.5	333°32.2 348°33.0	34.7 N12°35.2	1°39.7 16°42.0	06.5	43°22.2 58°24.8	44.0	Spica	158°24.5	-11°16.7
6 7	40°05.2	296°06.6 311°05.8	N22°43.7 43.8	3°33.8	35.8	31°44.4	N02°06.5 06.5	73°27.4	\$14°44.1 44.2	Alkaid	152°53.6	49°12.4
8	55°07.7	326°05.0	43.9	18°34.6	36.3	46°46.8	06.6	88°30.1	44.2	Hadar	148°38.8	-60°29.1
9	70°10.2	341°04.2	• • 44.0	33°35.5	36.9	61°49.1	• • 06.6	103°32.7	• • 44.3	Menkent Arcturus	147°59.9 145°49.7	-36°28.9 19°04.1
10	$85^{\circ}12.6$	356°03.4	44.2	48°36.3	37.4	$76^{\circ}51.5$	06.6	118°35.3	44.3	Rigil Kent.	139°42.9	-60°55.9
11	100°15.1	11°02.6	44.3	63°37.1	38.0	91°53.9	06.6	133°37.9	44.4	Kochab	137°19.4	74°04.1
12	115°17.5 130°20.0	26°01.8 41°01.0	N22°44.4	78°37.9 93°38.7	N12°38.5	106°56.3 121°58.6	N02°06.7	148°40.5 163°43.1	\$14°44.4	Zuben'ubi	$136^{\circ}58.2$	-16°08.1
13 14	145°22.5	56°00.2	44.6 44.7	93 36.7 108°39.6	39.1 39.6	121 56.0 137°01.0	06.7 06.7	103 45.1 178°45.7	44.5 44.5	Alphecca	126°05.3	26°38.5
15	160°24.9	70°59.4	• • 44.8	123°40.4	40.2	152°03.4	• • 06.7	193°48.3	• • 44.6	Antares	112°18.1	-26°28.9
16	175°27.4	85°58.6	44.9	138°41.2	40.7	167°05.8	06.8	208°50.9	44.7	Atria Sabik	107°13.7 102°04.8	-69°04.2 -15°45.1
17	190°29.9	100°57.8	45.0	153°42.0	41.3	182°08.1	06.8	223°53.5	44.7	Shaula	96°12.8	-37°07.2
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	\$14°44.8	Rasalhague	96°00.1	12°32.7
19	220°34.8	130°56.2	45.3	183°43.7	42.4	212°12.9	06.8	253°58.8	44.8	Eltanin	90°42.6	51°29.3
20 21	235°37.3 250°39.7	145° 55.4 160° 54.6	45.4 •• 45.5	198°44.5 213°45.3	42.9 •• 43.5	227° 15.3 242° 17.6	06.9 •• 06.9	269°01.4 284°04.0	44.9 •• 44.9	Kaus Aust.	83°34.8	-34°22.4
22	265°42.2	175°53.8	45.6	228°46.1	44.0	257°20.0	06.9	299°06.6	45.0	Vega	80°34.2	38°48.3
23	280°44.7	190°52.9	45.8	243°46.9	44.6	272°22.4	06.9	314°09.2	45.1	Nunki Altair	75°49.9 62°01.6	-26°16.1 8°55.7
Mern	ass. 04:20	ν-0 8' d0	.1′ m-3.90	ν0.8′ d0	0.6' m0.3	v2 4' d0	.0′ m-2.54	$\nu 2.6' \ d-0$	11' m0 5	Peacock	53°08.4	-56°39.7
- Wici.p	——————————————————————————————————————	ν 0.0 d0				ν 2.Ψ α σ.		- V Z.O U O		Deneb	49°26.7	45°21.5
NA	CIIA	CIIA	D	CIIA	D	CIIA	D	CHA	D	Enif	33°40.5	9°58.7
Mon 0	GHA 295°47.1	GHA 205° 52.1	Dec N22°45.9	GHA 258° 47.8	Dec N12°45.1	GHA 287°24.8	Dec N02°07.0	GHA 329°11.8	Dec \$14°45.1	Al Na'ir	27°35.1	-46°51.0
1	310°49.6	220°51.3	46.0	273°48.6	45.7	302°27.2	07.0	344° 14.4	45.2	Fomalhaut Scheat	15°16.5 13°46.9	-29°30.1 28°12.2
2	325°52.0	235°50.5	46.1	288°49.4	46.2	$317^{\circ}29.5$	07.0	359°17.0	45.2	Markab	13°31.7	15° 19.5
3	$340^{\circ}54.5$	250°49.7	• • 46.2	$303^{\circ}50.2$	• • 46.8	$332^{\circ}31.9$	•• 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	Jul 16 Sat	SHA	Mer.pass
5	10°59.4 26°01.9	280°48.1	46.4	333°51.9	47.9	2°36.7	07.1	44°24.9	45.4	Venus Mars	272°41.8 324°19.6	10:15 06:47
6 7	41°04.4	295° 47.3 310° 46.5	N22°46.5 46.6	348°52.7 3°53.5	N12°48.4 49.0	17°39.1 32°41.4	N02°07.1 07.1	59° 27.5 74° 30.1	\$14°45.4 45.5	Jupiter	351°42.2	04:57
8	56°06.8	325°45.7	46.7	18°54.3	49.5	47°43.8	07.1	89°32.7	45.6	Saturn	33°17.8	02:11
9	71°09.3	340°44.9	• • 46.8	33°55.2	• • 50.1	62°46.2	• • 07.2	104°35.3	• • 45.6	Jul 17 Sun		
10	86°11.8	355° 44.1	46.9	48°56.0	50.6	77° 48.6	07.2	119°37.9	45.7	Venus	SHA 271°23.4	Mer.pass 10:16
11	101°14.2	10°43.3	47.0	63°56.8	51.2	92°51.0	07.2	134°40.5	45.7	Mars	323°40.1	06:46
12 13	116°16.7 131°19.1	25° 42.5 40° 41.7	N22°47.1 47.2	78°57.6 93°58.4	N12°51.7 52.3	107°53.3 122°55.7	N02°07.2 07.3	149°43.1 164°45.7	\$14°45.8	Jupiter	351°39.8	04:53
13 14	131 19.1 146°21.6	40 41.7 55°40.8	47.2 47.3	93 58.4 108°59.3	52.3 52.8	122 55.7 137°58.1	07.3 07.3	104 45.7 179°48.4	45.8 45.9	Saturn	33°21.2	02:07
15	161°24.1	70°40.0	• • 47.4	124°00.1	• • 53.4	153°00.5	07.3	194°51.0	46.0	Jul 18 Mon	SHA	Mer.pass
16	$176^{\circ}26.5$	$85^{\circ}39.2$	47.5	139°00.9	53.9	$168^{\circ}02.9$	07.3	209°53.6	46.0	Venus	270°05.0	10:17
17	191°29.0	100°38.4	47.6	154°01.7	54.5	183°05.3	07.3	224°56.2	46.1	Mars	$323^{\circ}00.6$	06:44
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	\$14°46.1	Jupiter	351°37.7	04:50
19 20	221°33.9 236°36.4	130° 36.8 145° 36.0	47.8 47.9	184°03.4 199°04.2	55.5 56.1	213°10.0 228°12.4	07.4 07.4	255°01.4 270°04.0	46.2 46.2	Saturn	33°24.7	02:03
21	250°38.9	145° 35.0	• • 48.0	214° 05.0	56.6	243°14.8	07.4	270 04.0 285°06.6	46.3	Horizont	al parallax	
22	266°41.3	175°34.4	48.1	229°05.8	57.2	258° 17.2	07.4	300°09.2	46.3		Venus:	0.1
23	281°43.8	190°33.6	48.2	244°06.7	57.7	273°19.6	07.5	315°11.9	46.4		Mars:	0.1
Mer.p	ass. 04:16	ν-0.8′ d0	.1′ m-3.90	ν 0.8′ d0).5′ m0.3	ν 2.4′ d0.	.0′ m-2.55	ν 2.6′ d-0	0.1′ m0.5			
<u> </u>												

h	Su	n			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 2	193°28.9 208°28.9	23.4 23.0	339°16.7 353°43.1	7.4' 7.6'	17°45.1 17°32.1	13.0' 13.1'	60.2' 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'	$17^{\circ}05.9$	13.2'	60.1'
5	253°28.7	21.8	37°03.2 51°30.1	7.9'	16°52.6	13.3'	60.1'
6 7	268°28.6 283°28.6	N21°21.4 21.0	65°57.1	8.1' 8.2'	\$16°39.3 16°25.9	13.4' 13.5'	60.0' 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 11	328°28.4 343°28.4	19.7 19.3	109°19.0 123°46.6	8.5' 8.7'	15°45.1 15°31.4	13.7' 13.8'	59.9' 59.9'
12	358°28.3	N21° 18.9	138°14.2	8.8'	\$15°17.6	13.9	59.8'
13	13°28.2	18.5	152°42.0	8.9'	$15^{\circ}03.7$	14.0'	59.8'
14	28°28.2 43°28.1	18.1	167°09.9 181°37.9	9.0'	14°49.8 14°35.7	14.0'	59.8'
15 16	43 28.1 58°28.1	· · 17.7 17.3	181 37.9 196°06.1	9.1' 9.3'	14 35.7 14°21.6	14.1' 14.2'	59.7' 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 20	103°27.9 118°27.9	16.0 15.6	239°31.2 253°59.8	9.6' 9.7'	13°39.0 13°24.7	14.3' 14.4'	59.6' 59.5'
21	133°27.8	15.2	255 59.6 268°28.5	9.1 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'		SE	0 = 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°27.6 208°27.5	13.5 13.1	326°24.4 340°53.6	10.2' 10.4'	12°12.2 11°57.5	14.6' 14.7'	59.4' 59.3'
2	208°27.5 223°27.5	13.1	340°53.6 355°23.0	10.4	11°57.5 11°42.9	14.7' 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 7	268°27.3 283°27.3	N21°11.4 11.0	38°51.7 53°21.4	10.8' 10.9'	\$10°58.5 10°43.7	14.9' 14.9'	59.2' 59.1'
8	298°27.2	10.5	67°51.3	11.0'	10° 43.7 10° 28.8	14.9	59.1
9	313°27.2	• • 10.1	82°21.2	11.1'	$10^{\circ}13.9$	15.0'	59.0'
10	328°27.1 343°27.1	09.7	96°51.3 111°21.4	11.1' 11.2'	09°58.9 09°43.9	15.0'	59.0'
11 12	343 27.1 358°27.0	09.3 N21°08.8	111 21.4 125°51.7	11.2	509°28.9	15.0' 15.0'	59.0' 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 16	43°26.9 58°26.8	· · 07.5 07.1	169°22.9 183°53.6	11.6' 11.7'	08°43.7 08°28.6	15.1' 15.1'	58.8' 58.8'
17	73°26.8	06.7	198°24.2	11.8'	08°13.4	15.2'	58.7'
18	88°26.7	$N21^{\circ}06.2$	212°55.0	11.9'	S07°58.3	15.2'	58.7'
19 20	103°26.7 118°26.6	05.8 05.4	227°25.9 241°56.8	11.9'	07°43.1 07°27.9	15.2' 15.2'	58.7' 58.6'
21	133°26.6	04.9	241 50.8 256°27.8	12.1'	07 27.9 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'		SE	0 = 16.2'		
Mon	GHA	Dec	GHA	ν	Dec	d	HP
0	178°26.4	N21°03.6	300°01.4	12.3'	506°26.9	15.3'	58.5'
1 2	193°26.4 208°26.3	03.2 02.8	314°32.7 329°04.1	12.4' 12.5'	06°11.7 05°56.4	15.3' 15.3'	58.4' 58.4'
3	208° 20.3° 26.3° 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 6	253°26.2 268°26.1	01.5 N21°01.0	12°38.8 27°10.5	12.7' 12.8'	05°10.6 \$04°55.3	15.3' 15.3'	58.3' 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	$56^{\circ}14.1$	12.9'	04°24.7	15.3'	58.1'
9 10	313°26.0 328°25.9	20°59.7 59.3	70°46.0 85°17.9	13.0' 13.0'	04°09.4 03°54.1	15.3' 15.3'	58.1' 58.1'
10 11	328°25.9 343°25.9	59.3 58.8	85°17.9 99°50.0	13.0'	03°54.1 03°38.8	15.3'	58.1° 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°54.2 143°26.4	13.2'	03°08.3	15.3'	57.9'
14 15	28°25.8 43°25.7	57.5 •• 57.0	143°26.4 157°58.6	13.3' 13.3'	02°53.0 02°37.7	15.3' 15.3'	57.9' 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 19	88°25.6 103°25.5	N20°55.7 55.3	201°35.7 216°08.2	13.5' 13.5'	\$01°52.0 01°36.8	15.2' 15.2'	57.7' 57.7'
20	103°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 23	148°25.4 163°25.4	53.9 53.5	259°45.9 274°18.6	13.7' 13.7'	00°51.3 00°36.1	15.2' 15.1'	57.6' 57.5'
23	SD = 15.7'	d = -0.4'	214 10.0		$00^{\circ}36.1$ 0 = 15.9'	13.1	31.3
	JD — 13.1	u — -0.4		3L	_ 10.9		

Lat.	Twi	light	Sunrise	Sunset	Twi	light
Lat.	Naut.	Civil	Junise	Juliset	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	80:80	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.		Moonris	e		Moonset			
Lat.	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		

		Sun		Moon			
Day	Eqn.of Time		Mer.	Mer.	Mer.Pass.		
,	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		