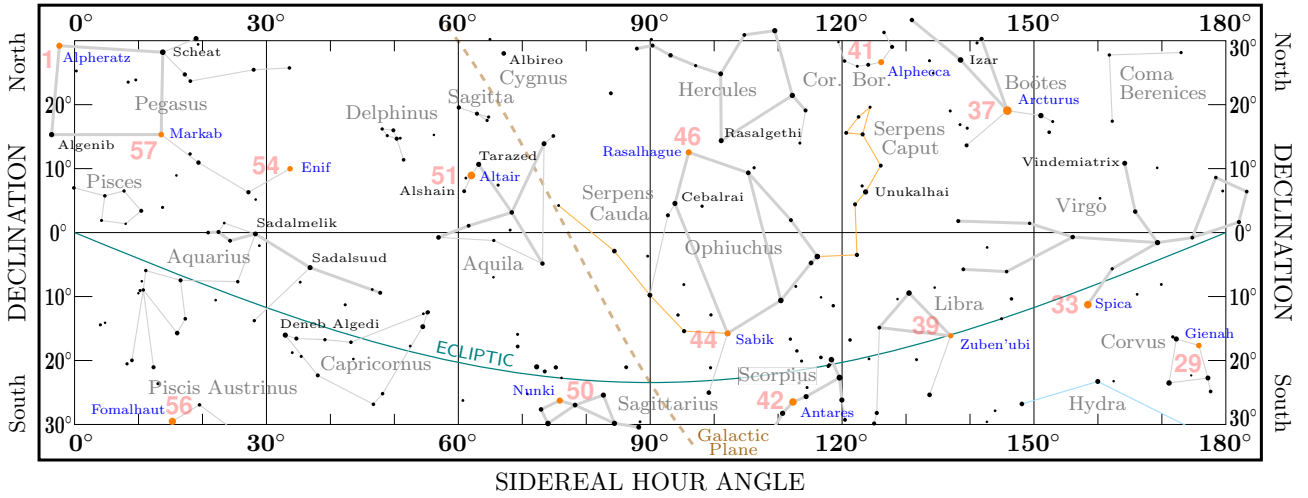
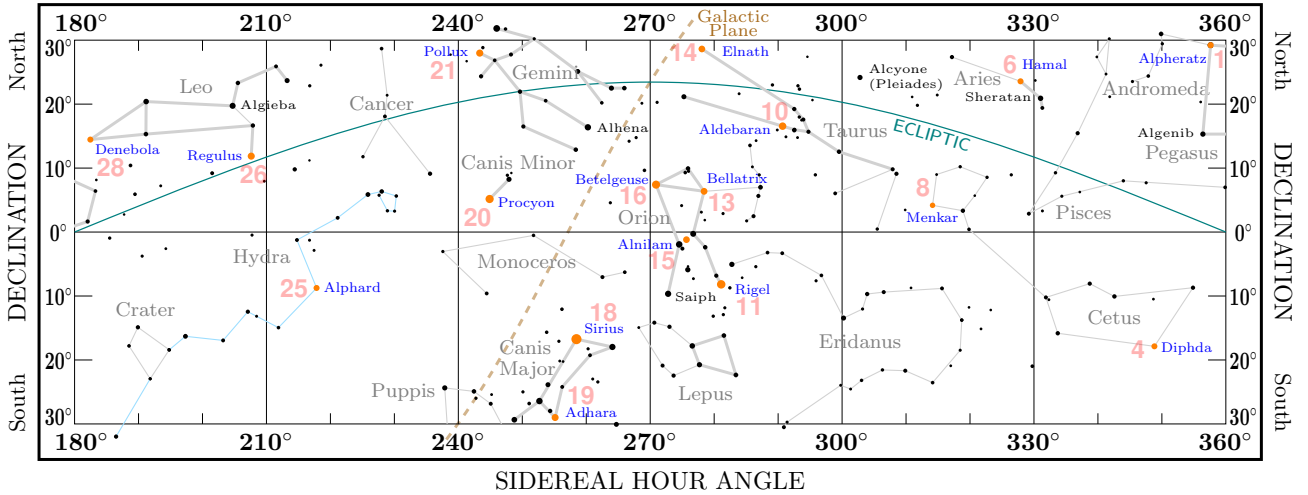


EQUATORIAL STARS (SHA 0° to 180°)



EQUATORIAL STARS (SHA 180° to 360°)



LUNAR DISTANCE

June 2022

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Disclaimer: These are computer generated tables - use them at your own risk. They replicate Lunar Distance algorithms with no guarantee of accuracy. They are intended to encourage the use of sextants, be it as a hobby or as a backup when electronics fail. The author claims no liability for any consequences arising from use of these tables and accompanying charts.

Lunar Distance

The Lunar Distance method (or the old method of “lunars”) is an 18th century technique to find the time, typically to reset ship’s clocks or as an emergency procedure. The method uses the Moon’s apparent motion relative to the Sun, planets or stars like a clock to find a reference time (e.g. GMT). “Until 1906, the Nautical Almanac included lunar distance tables showing predicted geocentric angular distances between the Moon and selected bodies in 3-hour intervals. After the tables were dropped, lunar distances fell more or less into oblivion.”¹

“The methods are a good deal more laborious than the more commonplace procedures of celestial navigation. It is perhaps the most difficult possible operation within the discipline of celestial navigation. However, one argument for maintaining celestial skills is the utility of celestial navigation as an emergency substitute for electronic navigation.”² “Nothing else comes close to the lunar for developing skill with a sextant - and the observation is demanding enough to hold one’s interest for a lifetime.”³ Thus it is still a valuable process to learn and indeed worthwhile mastering. (A practised user can routinely find the correct time to within ± 30 seconds.)

“Because the Moon moves much slower across the sky than the stars, its changing position can be used in sort of a reverse process of sight reduction to find the time.”⁴ “The basic idea of the lunar distance method is easy to comprehend. Since the Moon moves across the celestial sphere at a rate of about 0.5° per hour, the angular distance between the Moon and a celestial body in her path varies at a similar rate and rapidly enough to be used to measure the time. The time corresponding with an observed lunar distance can be found by comparison with tabulated values.”⁵ (The continuous motion of the Moon through the sky day-by-day implies that different celestial bodies will be selected for LD measurements on different days.)

The following Lunar Distance tables can contain up to 8 celestial bodies per day (due to the page width limitation). Generally, an attempt is made to include an even number of objects to the east and west of the Moon. The maximum LD angle chosen for inclusion in the tables is 120° , which is about the maximum angle a sextant can measure.

The celestial bodies available for LD measurement include the Sun, four planets (Venus, Mars, Jupiter, Saturn), 21 navigational stars (with magnitude ≤ 1.5) and Polaris.

Three different strategies are available to select suitable celestial bodies for inclusion in a daily LD table:

- pick celestial bodies closest to the Moon
- pick celestial bodies with the highest hourly LD delta (for best accuracy in time determination)
- pick the brightest celestial bodies (possibly easier to locate in the sky)

The celestial body LD angle at a particular hour of day still needs to fulfill several requirements:

- the LD of the Sun is $>10^\circ$ as the Moon is hardly visible during New Moon. (This applies to all celestial bodies)
- the LD of the Sun is $>40^\circ$ (otherwise the Moon is not visible)
- only LD angles $<120^\circ$ are tabulated
- the angle between the celestial body and the Sun (“Solar Distance”) is $>10^\circ$ (otherwise the celestial body might not be visible)
- the Sun is not between the celestial body and the Moon (based on the Right Ascension of all three)
- the hourly LD delta is $>15'$ of arc (to avoid measurement errors). “The rate of change of LD becomes zero when LD passes through a minimum or maximum, making an observation useless.”⁶
- the rate of change of the hourly LD delta does not exceed 0.016° ($= 0.96'$). This empirical figure removes LD values where linear interpolation (between hours) becomes unreliable.

Suggested further reading: “Stark Tables: For Clearing the Lunar Distance and Finding Universal Time by Sextant Observation” by Bruce Stark, ISBN 978-0-914025-21-4

¹Henning Umland, Chapter 7 - Finding Time and Longitude by Lunar Distances

²Eric Romelczyk, The Journal of Navigation, Volume 72, Issue 6

³Bruce Stark, page vi, Tables For Clearing the Lunar Distance and Finding Universal Time by Sextant Observation

⁴Bruce Stark, <https://www.celestaire.com/product/tables-for-clearing-the-lunar-distance/>

⁵Henning Umland, Chapter 7 - Finding Time and Longitude by Lunar Distances

⁶Henning Umland, Chapter 7 - Finding Time and Longitude by Lunar Distances

DUT1 = UT1-UTC = -0.0686 sec ΔT = TT-UT1 = +69.2526 sec

2022 June 13 to Jun. 15 UT

Table with columns: h, Moon (GHA, nu, Dec, d, HP), Lunar Distance (objects with largest hourly LD delta) (-Jupiter, -Fomalhaut, -Saturn, -Antares, +Spica, +Arcturus, +Regulus, +Adhara). Includes summary row: SD = 16.5' Mer. pass. 23:27

Table with columns: h, Moon (GHA, nu, Dec, d, HP), Lunar Distance (objects with largest hourly LD delta) (-Mars, -Jupiter, -Fomalhaut, -Saturn, +Antares, +Spica, +Arcturus, +Regulus). Includes summary row: SD = 16.7' Mer. pass. --:--

Table with columns: h, Moon (GHA, nu, Dec, d, HP), Lunar Distance (objects with largest hourly LD delta) (-Mars, -Jupiter, -Fomalhaut, -Saturn, +Antares, +Hadar, +Spica, +Arcturus). Includes summary row: SD = 16.7' Mer. pass. 00:33

DUT1 = UT1-UTC = -0.0531 sec $\Delta T = TT-UT1 = +69.2371$ sec

2022 June 28 to Jun. 30 UT

h		Moon					Lunar Distance (objects with largest hourly LD delta)						
Tue	GHA	ν	Dec	d	HP	+Aldebaran	+Venus	+Mars	+Jupiter	+Achernar	+Fomalhaut	+Saturn	
0	192°35.3	10.7'	N26°03.4	3.5'	53.9'	16°15.6	18°41.4	59°25.5	77°00.9	96°41.8	109°35.9	119°20.2	
1	207°05.0	10.7'	26°06.9	3.4'	53.9'	16°42.3	19°07.8	59°53.3	77°30.3	96°58.7	110°04.2	119°49.8	
2	221°34.7	10.7'	26°10.3	3.3'	53.9'	17°09.2	19°34.2	60°21.2	77°59.7	97°15.6	110°32.5		
3	236°04.3	10.6'	26°13.6	3.1'	53.9'	17°36.2	20°00.6	60°49.0	78°29.0	97°32.5	111°00.8		
4	250°34.0	10.6'	26°16.7	3.0'	53.9'	18°03.3	20°27.0	61°16.8	78°58.4	97°49.3	111°29.0		
5	265°03.6	10.6'	26°19.8	2.9'	53.9'	18°30.5	20°53.4	61°44.7	79°27.7	98°06.1	111°57.3		
6	279°33.2	10.6'	N26°22.7	2.8'	53.9'					New Moon			
7	294°02.7	10.5'	26°25.4	2.6'	53.9'					New Moon			
8	308°32.3	10.5'	26°28.1	2.5'	53.9'					New Moon			
9	323°01.8	10.5'	26°30.6	2.4'	53.9'					New Moon			
10	337°31.3	10.5'	26°33.0	2.3'	53.9'					New Moon			
11	352°00.8	10.5'	26°35.2	2.1'	53.9'					New Moon			
12	6°30.2	10.4'	N26°37.4	2.0'	53.9'					New Moon			
13	20°59.7	10.4'	26°39.4	1.9'	53.9'					New Moon			
14	35°29.1	10.4'	26°41.2	1.7'	53.9'					New Moon			
15	49°58.5	10.4'	26°43.0	1.6'	53.9'					New Moon			
16	64°27.9	10.4'	26°44.6	1.5'	53.9'					New Moon			
17	78°57.3	10.4'	26°46.1	1.4'	53.9'					New Moon			
18	93°26.7	10.4'	N26°47.5	1.2'	53.9'					New Moon			
19	107°56.1	10.4'	26°48.7	1.1'	53.9'					New Moon			
20	122°25.4	10.3'	26°49.8	1.0'	53.9'					New Moon			
21	136°54.8	10.3'	26°50.8	0.8'	53.9'					New Moon			
22	151°24.1	10.3'	26°51.6	0.7'	53.9'					New Moon			
23	165°53.4	10.3'	26°52.3	0.6'	53.9'					New Moon			
SD = 14.7'						Mer. pass. 11:33							

h		Moon					Lunar Distance (objects with largest hourly LD delta)					
Wed	GHA	ν	Dec	d	HP	-Hadar	-Acruz	-Spica	-Arcturus	-Regulus	-Pollux	
0	180°22.8	10.3'	N26°52.9	0.5'	53.9'				New Moon			
1	194°52.1	10.3'	26°53.4	0.3'	53.9'				New Moon			
2	209°21.4	10.3'	26°53.7	0.2'	53.9'				New Moon			
3	223°50.7	10.3'	26°53.9	0.1'	53.9'				New Moon			
4	238°20.1	10.3'	26°54.0	-0.1'	53.9'				New Moon			
5	252°49.4	10.3'	26°53.9	-0.2'	53.9'				New Moon			
6	267°18.7	10.3'	N26°53.8	-0.3'	53.9'				New Moon			
7	281°48.0	10.3'	26°53.5	-0.4'	53.9'				New Moon			
8	296°17.3	10.3'	26°53.0	-0.6'	53.9'				New Moon			
9	310°46.7	10.3'	26°52.4	-0.7'	53.9'				New Moon			
10	325°16.0	10.3'	26°51.7	-0.8'	53.9'				New Moon			
11	339°45.4	10.4'	26°50.9	-1.0'	53.9'				New Moon			
12	354°14.7	10.4'	N26°49.9	-1.1'	53.9'				New Moon			
13	8°44.1	10.4'	26°48.9	-1.2'	53.9'				New Moon			
14	23°13.4	10.4'	26°47.6	-1.3'	53.9'				New Moon			
15	37°42.8	10.4'	26°46.3	-1.5'	53.9'				New Moon			
16	52°12.2	10.4'	26°44.8	-1.6'	53.9'				New Moon			
17	66°41.6	10.4'	26°43.2	-1.7'	53.9'				New Moon			
18	81°11.1	10.4'	N26°41.5	-1.9'	53.9'				New Moon			
19	95°40.5	10.5'	26°39.6	-2.0'	53.9'				New Moon			
20	110°10.0	10.5'	26°37.6	-2.1'	53.9'				New Moon			
21	124°39.4	10.5'	26°35.5	-2.2'	53.9'				New Moon			
22	139°08.9	10.5'	26°33.3	-2.4'	53.9'				New Moon			
23	153°38.4	10.5'	26°30.9	-2.5'	53.9'	118°41.6	108°10.9	96°58.7	94°02.0	42°57.0	6°39.1	
SD = 14.7'						Mer. pass. 12:24						

h		Moon					Lunar Distance (objects with largest hourly LD delta)						
Thu	GHA	ν	Dec	d	HP	-Rigel Kent.	-Hadar	-Acruz	-Spica	-Arcturus	-Regulus	\pm Pollux	
0	168°08.0	10.6'	N26°28.4	-2.6'	53.9'		118°23.3	107°55.0	96°29.2	93°36.0	42°27.6	6°11.3	
1	182°37.5	10.6'	26°25.8	-2.7'	53.9'		118°04.9	107°39.1	95°59.7	93°09.9	41°58.2	5°43.7	
2	197°07.1	10.6'	26°23.1	-2.9'	53.9'		117°46.5	107°23.2	95°30.2	92°43.9	41°28.9	5°16.5	
3	211°36.7	10.6'	26°20.2	-3.0'	53.9'		117°28.0	107°07.2	95°00.7	92°17.9	40°59.5	4°49.8	
4	226°06.3	10.7'	26°17.2	-3.1'	53.9'		117°09.4	106°51.1	94°31.2	91°51.8	40°30.1	4°23.7	
5	240°36.0	10.7'	26°14.1	-3.2'	53.9'		116°50.7	106°35.0	94°01.7	91°25.8	40°00.8	3°58.4	
6	255°05.7	10.7'	N26°10.8	-3.4'	53.9'		116°31.9	106°18.8	93°32.2	90°59.7	39°31.4		
7	269°35.4	10.7'	26°07.5	-3.5'	53.9'		116°13.1	106°02.6	93°02.7	90°33.6	39°02.1		
8	284°05.1	10.8'	26°04.0	-3.6'	53.9'		115°54.2	105°46.3	92°33.2	90°07.6	38°32.7		
9	298°34.9	10.8'	26°00.4	-3.7'	53.9'	119°58.4	115°35.2	105°29.9	92°03.7	89°41.5	38°03.4		
10	313°04.7	10.8'	25°56.6	-3.9'	53.9'	119°39.4	115°16.1	105°13.6	91°34.1	89°15.4	37°34.0		
11	327°34.5	10.9'	25°52.8	-4.0'	53.9'	119°20.3	114°57.0	104°57.1	91°04.6	88°49.4	37°04.7		
12	342°04.4	10.9'	N25°48.8	-4.1'	53.9'	119°01.1	114°37.8	104°40.6	90°35.1	88°23.3	36°35.3		
13	356°34.3	10.9'	25°44.7	-4.2'	53.9'	118°41.8	114°18.5	104°24.1	90°05.6	87°57.2	36°06.0		
14	11°04.2	11.0'	25°40.4	-4.4'	53.9'	118°22.5	113°59.1	104°07.5	89°36.0	87°31.2	35°36.6		
15	25°34.2	11.0'	25°36.1	-4.5'	53.9'	118°03.0	113°39.7	103°50.9	89°06.5	87°05.1	35°07.3		
16	40°04.2	11.0'	25°31.6	-4.6'	54.0'	117°43.5	113°20.2	103°34.2	88°37.0	86°39.0	34°37.9		
17	54°34.2	11.1'	25°27.0	-4.7'	54.0'	117°23.9	113°00.7	103°17.5	88°07.4	86°12.9	34°08.6		
18	69°04.3	11.1'	N25°22.3	-4.8'	54.0'	117°04.2	112°41.1	103°00.7	87°37.9	85°46.9	33°39.3		
19	83°34.4	11.1'	25°17.5	-4.9'	54.0'	116°44.5	112°21.4	102°43.9	87°08.3	85°20.8	33°10.0		
20	98°04.5	11.2'	25°12.5	-5.1'	54.0'	116°24.6	112°01.6	102°27.0	86°38.7	84°54.7	32°40.6	4°36.6	
21	112°34.7	11.2'	25°07.5	-5.2'	54.0'	116°04.7	111°41.8	102°10.2	86°09.2	84°28.6	32°11.3	5°03.1	
22	127°04.9	11.3'	25°02.3	-5.3'	54.0'	115°44.7	111°22.0	101°53.2	85°39.6	84°02.5	31°42.0	5°30.1	
23	141°35.2	11.3'	24°57.0	-5.4'	54.0'	115°24.7	111°02.0	101°36.2	85°10.0	83°36.5	31°12.7	5°57.6	
SD = 14.7'						Mer. pass. 13:14							