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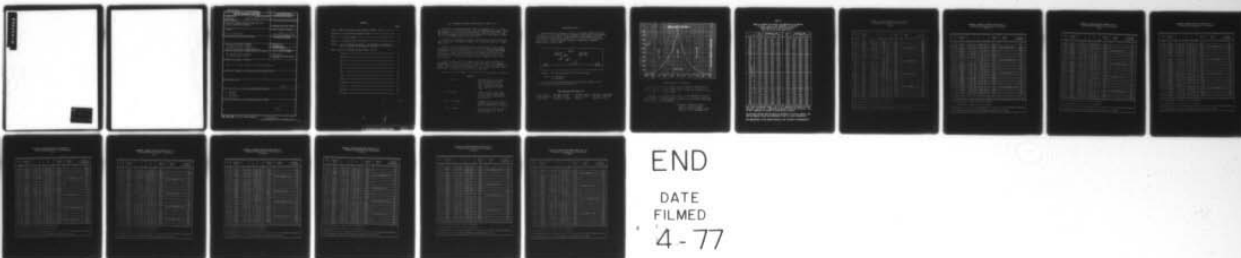
ARMY ELECTRONICS COMMAND WHITE SANDS MISSILE RANGE N--ETC F/G 3/1  
MOONRISE, MOONSET AND MOON PHASES FOR 1977, WHITE SANDS MISSILE--ETC(U)  
OCT 76 D G MCCULLOUGH

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## TIME OF MOONRISE, MOONSET & MOON PHASES AT WSMR IN 1977

Declination and moonrise-moonset times are computed by the U. S. Naval Observatory for Lat. 32° 23' N, Long. 106° 29' W (Headquarters, WSMR). Times are computed for a level horizon, and mountain ranges will affect the time the moon is observed to rise or set by 3-5 minutes for every degree of elevation of the mountain tops above the horizontal.

Information on illumination, phases and eclipses is extracted from "The American Ephemeris and Nautical Almanac, 1977," published by the U. S. Naval Observatory.

Since the moon in its orbital motion around the Earth actually moves from west to east, and completes its orbit in 29 1/2 days, moving eastward through the sky about 12.2° each day, it rises about 50 minutes later each day, on the average. The rise time varies from about 30 to 70 minutes a lunar month primarily due to the eccentricity of the moon's orbit. Also, the moon's orbital plane makes an angle of about 5 degrees with the sun's orbital plane.

Each month there will be one day near the last quarter when there is no moonrise, and another near the first quarter when there is no moonset. In such cases, the time of moonrise or moonset will occur on the day following SHORTLY AFTER MIDNIGHT OF THE DAY MISSED. The moon phases occur about one day earlier each month and 10.9 days earlier each year.

There will be four eclipses in 1977--two of the sun, and two of the moon.

### ECLIPSES

- |                   |   |
|-------------------|---|
| I. 4 April        | Partial eclipse of the moon; the beginning of the umbral phase is visible in North America except extreme northwest. Magnitude of eclipse .198. |
| II. 18 April      | Annular eclipse of the sun or circular ring of light around the moon can be seen mainly in South Africa.  |
| III. 27 September | Penumbraal eclipse of the moon; penumbraal phase visible in North America. Magnitude of eclipse .927.   |
| IV. 12 October    | Total eclipse of the sun; visible in North America and eastern Pacific Ocean.   |

## DECLINATION TABLES

The DECLINATION of the Moon (or Sun) is its angular distance north (+) or south (-) of the Celestial Equator, measured along a great circle passing through the Celestial Poles. It is comparable to geographical latitude. "The Celestial Equator is the projection of the plane of the geographical equator on the celestial sphere."--Glossary of Meteorology, American Meteorological Society, 1959.

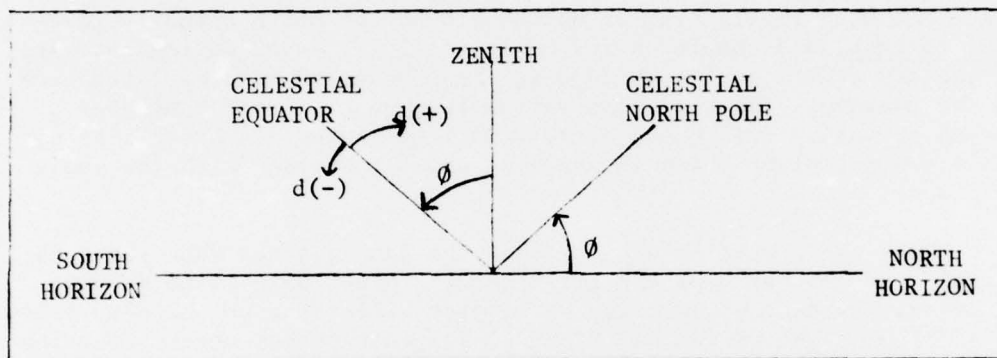


FIGURE 1. Meridian Cross-Section of Celestial Sphere

NOTE:  $d$  = declination  
 $\phi$  = latitude

This diagram shows the direction of the declination angle from the celestial equatorial plane in the meridian.

### EQUINOXES AND SOLSTICES, 1977

Vernal Equinox: 1043 MST, 20 March	Autumnal Equinox: 2030 MST, 22 September
Summer Solstice: 0514 MST, 21 June	Winter Solstice: 1624 MST, 21 December
Perihelion: 0300 MST, 3 January	Aphelion: 1300 MST, 5 July

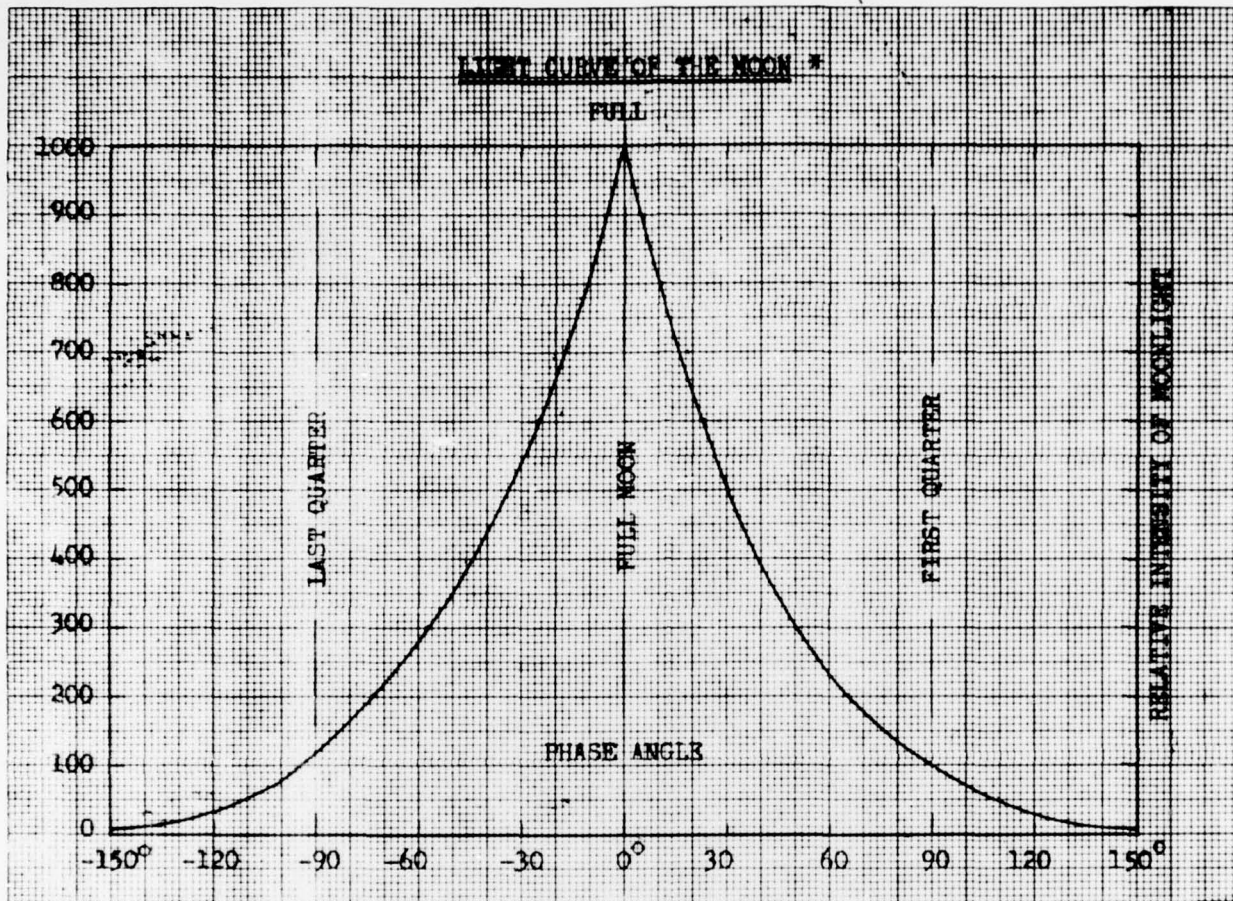


Figure 2

ILLUMINATION DUE TO THE MOON \*

The illumination due to the moon may be estimated roughly from its altitude and phase in the following manner. When the altitude of the full moon is  $65^\circ$  on a clear night, the illumination on a horizontal plane is approximately 0.03 foot-candles.

When the sun's altitude is 65 degrees, the illumination on a horizontal plane is 10,000 foot-candles. The ratio of full moon to sun-plus-sky-light is then roughly three to 1,000,000. Other values for full moonlight follow the same proportion.

\*--"Natural Illumination Charts"

By Com. Dayton R. E. Brown  
 Dept. of the Navy, Bureau of Ships  
 Report No. 374-1, September 1952

TABLE I

TIMES OF SUNRISE AND SUNSET, AND BEGINNINGS AND ENDINGS  
OF CIVIL, NAUTICAL AND ASTRONOMICAL TWILIGHT  
WHITE SANDS MISSILE RANGE, NEW MEXICO  
LAT. 32° 23' N; LONG. 106° 29' W.

DATE	SUN-RISE	BEGINNINGS—SDA			SUN-SET	ENDINGS—SDA		
		6°	12°	18°		6°	12°	18°
JAN. 1	0707	0640	0610	0540	1712	1739	1809	1839
JAN. 11	0707	0641	0611	0542	1722	1748	1818	1847
JAN. 21	0706	0640	0610	0541	1731	1757	1826	1854
JAN. 31	0700	0634	0606	0538	1740	1806	1834	1902
FEB. 10	0652	0627	0559	0531	1749	1814	1842	1910
FEB. 20	0642	0617	0550	0522	1758	1823	1850	1918
MAR. 2	0631	0607	0540	0511	1806	1831	1857	1926
MAR. 12	0618	0555	0528	0500	1813	1838	1905	1933
MAR. 22	0607	0543	0515	0447	1820	1844	1912	1941
APR. 1	0553	0529	0500	0433	1826	1851	1919	1949
APR. 11	0541	0516	0447	0418	1834	1858	1928	1958
APR. 21	0529	0504	0434	0404	1840	1905	1936	2007
MAY 1	0519	0453	0422	0350	1847	1913	1945	2017
MAY 11	0510	0443	0411	0338	1855	1921	1954	2027
MAY 21	0505	0436	0402	0328	1901	1928	2002	2037
MAY 31	0500	0432	0357	0321	1907	1934	2010	2046
JUNE 10	0459	0430	0354	0317	1913	1940	2016	2053
JUNE 20	0500	0431	0354	0317	1915	1942	2019	2057
JUNE 30	0503	0434	0357	0320	1916	1943	2020	2057
JULY 10	0508	0438	0403	0326	1915	1942	2019	2056
JULY 20	0514	0444	0410	0334	1911	1937	2013	2050
JULY 30	0520	0453	0418	0343	1904	1930	2004	2040
AUG. 9	0527	0501	0427	0353	1855	1920	1954	2028
AUG. 19	0534	0508	0436	0403	1845	1910	1942	2015
AUG. 29	0540	0515	0444	0412	1833	1858	1929	2001
SEP. 8	0546	0521	0451	0421	1820	1844	1915	1946
SEP. 18	0552	0528	0459	0428	1807	1831	1901	1931
SEP. 28	0558	0534	0505	0436	1755	1819	1848	1918
OCT. 8	0605	0541	0512	0442	1741	1806	1835	1904
OCT. 18	0612	0548	0518	0449	1729	1754	1823	1853
OCT. 28	0620	0555	0526	0456	1719	1745	1814	1843
NOV. 7	0629	0604	0534	0504	1710	1736	1806	1835
NOV. 17	0637	0612	0542	0511	1704	1731	1800	1830
NOV. 27	0646	0620	0550	0519	1702	1730	1758	1827
DEC. 7	0655	0628	0557	0526	1701	1729	1758	1828
DEC. 17	0701	0634	0603	0533	1705	1732	1800	1830
DEC. 27	0706	0639	0608	0538	1710	1736	1805	1835

SDA = SUN'S DEPRESSION ANGLE. SDA OF 6° = BEGINNING OR ENDING OF CIVIL TWILIGHT. SDA OF 12° = BEGINNING OR ENDING OF NAUTICAL TWILIGHT. SDA OF 18° = BEGINNING OR ENDING OF ASTRONOMICAL TWILIGHT.

VALUES WERE DERIVED FROM THE AMERICAN EPHEMERIS & NAUTICAL ALMANAC, AND THE AIR ALMANAC, WHICH ARE PUBLISHED BY THE U.S. NAVAL OBSERVATORY.

FOR DEFINITIONS OF THE THREE TWILIGHTS, SEE "GLOSSARY OF METEOROLOGY."

MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
JANUARY

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1431	+17° 22'	+16° 36'	0342		82
2	1515	+18° 30'	+18° 7'	0433		89
3	1604	18° 44'	18° 45'	0524		94
4	1656	17° 59'	18° 26'	0613		98
5	1751	16° 16'	17° 8'	0659	FULL MOON, 0510	100
6	1848	13° 38'	14° 54'	0742		100
7	1947	10° 11'	11° 51'	0823		97
8	2047	6° 8'	8° 6'	0902		93
9	2147	1° 40'	3° 52'	0939		87
10	2249	- 3° 00'	-00 39'	1016		79
11	2351	- 7° 36'	- 5° 14'	1054		70
12			- 9° 38'	1133	LAST QUARTER, 1255	59
13	0055	-11° 51'	-13° 34'	1215		48
14	0200	-15° 27'	-16° 45'	1302		37
15	0304	-18° 6'	-18° 54'	1354		26
16	0408	-19° 33'	-19° 46'	1451		17
17	0508	-19° 39'	-19° 16'	1552		9
18	0603	-18° 24'	-17° 27'	1655		4
19	0652	-15° 58'	-14° 34'	1759	NEW MOON, 0711	1
20	0737	-12° 37'	-10° 52'	1901		0
21	0817	- 8° 42'	- 6° 41'	2003		3
22	0854	- 4° 28'	- 2° 20'	2101		7
23	0929	- 0° 10'	+ 1° 58'	2157		13
24	1002	+ 3° 59'	+ 6° 2'	2252		21
25	1036	+ 7° 50'	+ 9° 44'	2346		29
26	1111	+11° 17'			FIRST QUARTER, 2211	39
27	1148	+14° 11'	+12° 57'	0040		48
28	1227	+16° 26'	+15° 32'	0132		57
29	1310	+17° 56'	+17° 23'	0224		66
30	1357	+18° 35'	+18° 25'	0315		75
31	1447	+18° 18'	+18° 32'	0404		83

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

\* Illumination values are for 0000 HRS, Greenwich (Zulu) Time.



MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
MARCH

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1424	+15° 47'	+16° 40'	0328		76
2	1522	+13° 6'	+14° 25'	0412		84
3	1621	+ 9° 36'	+11° 18'	0453		91
4	1724	+ 5° 24'	+ 7° 27'	0533		96
5	1827	+ 0° 45'	+ 3° 4'	0612	FULL MOON, 1013	99
6	1932	- 4° 3'	- 1° 37'	0652		100
7	2037	- 8° 41'	- 6° 19'	0732		98
8	2143	-12° 50'	-10° 26'	0814		93
9	2249	-16° 8'	-14° 26'	0859		86
10	2352	-18° 21'	-17° 15'	0948		77
11			-18° 56'	1041		67
12	0053	-19° 20'	-19° 22'	1137	LAST QUARTER, 0435	55
13	0149	-19° 3'	-18° 33'	1236		44
14	0240	-17° 34'	-16° 35'	1337		33
15	0327	-15° 6'	-13° 43'	1437		23
16	0409	-11° 50'	-10° 8'	1537		15
17	0448	- 8° 3'	- 6° 8'	1636		8
18	0524	- 3° 57'	- 1° 52'	1733		3
19	0559	+ 0 15'	+ 2° 21'	1829	NEW MOON, 1133	1
20	0633	+ 4° 19'	+ 6° 21'	1925		0
21	0707	+ 8° 7'	+ 9° 59'	2019		1
22	0743	+11° 29'	+13° 5'	2113		5
23	0821	+14° 16'	+15° 33'	2206		10
24	0901	+16° 23'	+17° 15'	2257		16
25	0943	+17° 44'	+18° 8'	2347		23
26	1030	+18° 15'				32
27	1119	+17° 51'	+18° 8'	0035	FIRST QUARTER, 1527	41
28	1211	+16° 33'	+17° 14'	0121		51
29	1306	+14° 21'	+15° 26'	0204		60
30	1404	+11° 17'	+12° 46'	0246		70
31	1505	+ 7° 29'	+ 9° 21'	0325		79

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

\* Illumination values are for 0000 HRS, Greenwich (Zulu) Time.

MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
APRIL

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1607	+ 3° 5'	+ 5° 16'	0405		87
2	1711	- 1° 41'	0° 43'	0444		94
3	1817	- 6° 29'	- 4° 2'	0524	FULL MOON, 2109	98
4	1925	-10° 59'	- 8° 40'	0606		100
5	2033	-14° 48'	-12° 50'	0651		99
6	2140	-17° 34'	-16° 10'	0740		95
7	2244	-19° 3'	-18° 23'	0833		89
8	2344	-19° 11'	-19° 17'	0930		80
9			-18° 51'	1030		70
10	0038	-18° 4'	-17° 13'	1131	LAST QUARTER, 1215	59
11	0126	-15° 51'	-14° 35'	1232		48
12	0209	-12° 49'	-11° 13'	1331		37
13	0248	- 9° 12'	- 7° 21'	1430		27
14	0325	- 5° 15'	- 3° 14'	1527		18
15	0400	- 1° 8'	+ 0° 56'	1622		11
16	0434	+ 2° 57'	+ 4° 59'	1718		6
17	0508	+ 6° 48'	+ 8° 43'	1812		2
18	0542	+10° 18'	+12° 1'	1906	NEW MOON, 0335	0
19	0619	+13° 19'	+14° 43'	1959		0
20	0658	+15° 41'	+16° 42'	2051		2
21	0740	+17° 20'	+17° 54'	2141		6
22	0825	+18° 9'	+18° 13'	2230		11
23	0913	+18° 6'	+17° 40'	2316		18
24	1003	+17° 9'				26
25	1056	+15° 20'	+16° 14'	0000		34
26	1151	+12° 42'	+13° 59'	0041	FIRST QUARTER, 0742	44
27	1249	+ 9° 18'	+10° 57'	0120		54
28	1349	+ 5° 16'	+ 7° 14'	0159		64
29	1450	+ 0° 45'	+ 3° 0'	0237		74
30	1555	- 4° 0'	- 1° 35'	0315		83

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

\* Illumination values are for 0000 HRS, Greenwich (Zulu) Time.

MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
MAY

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1701	- 8° 41'	- 6° 16'	0356		91
2	1810	-12° 57'	-10° 44'	0439		96
3	1919	-16° 21'	-14° 36'	0527	FULL MOON, 0603	100
4	2027	-18° 33'	-17° 29'	0619		100
5	2131	-19° 20'	-19° 4'	0716		97
6	2230	-18° 42'	-19° 14'	0817		91
7	2321	-16° 49'	-18° 1'	0919		83
8			-15° 39'	1023		73
9	0008	-13° 58'	-12° 26'	1124	LAST QUARTER, 2108	63
10	0049	-10° 27'	- 8° 39'	1224		52
11	0126	- 6° 32'	- 4° 33'	1322		41
12	0201	- 2° 26'	- 0° 23'	1418		31
13	0235	+ 1° 40'	+ 3° 43'	1513		22
14	0309	+ 5° 35'	+ 7° 33'	1607		15
15	0343	+ 9° 13'	+11° 0'	1701		9
16	0419	+12° 24'	+13° 54'	1754		4
17	0457	+14° 59'	+16° 9'	1846	NEW MOON, 1951	1
18	0538	+16° 54'	+17° 38'	1938		0
19	0622	+18° 1'	+18° 17'	2027		1
20	0709	+18° 17'	+18° 2'	2113		3
21	0758	+17° 39'	+16° 55'	2158		7
22	0850	+16° 9'	+14° 57'	2240		13
23	0944	+13° 50'	+12° 14'	2320		20
24	1040	+10° 45'	+ 8° 51'	2357		29
25	1137	+ 7° 3'			FIRST QUARTER, 2020	38
26	1236	+ 2° 50'	+ 4° 55'	0034		49
27	1337	- 1° 42'	+ 0° 35'	0110		59
28	1440	- 6° 21'	- 3° 58'	0149		70
29	1546	-10° 47'	- 8° 29'	0229		80
30	1655	-14° 39'	-12° 38'	0313		88
31	1803	-17° 34'	-16° 5'	0402		95

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

\* Illumination values are for 0000 HRS, Greenwich (Zulu) Time.

MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
JUNE

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1910	-19° 9'	-18° 26'	0457	FULL MOON, 1331	99
2	2013	-19° 16'	-19° 24'	0557		100
3	2110	-17° 58'	-18° 52'	0701		98
4	2201	-15° 27'	-16° 59'	0806		93
5	2246	-12° 5'	-14° 2'	0910		86
6	2326	- 8° 11'	-10° 20'	1013		77
7			- 6° 13'	1113		67
8	0003	- 4° 1'	- 1° 57'	1212	LAST QUARTER, 0807	57
9	0037	+ 0° 10'	+ 2° 15'	1308		46
10	0111	+ 4° 13'	+ 6° 14'	1402		36
11	0145	+ 7° 59'	+ 9° 50'	1456		27
12	0221	+11° 20'	+12° 57'	1549		19
13	0258	+14° 9'	+15° 27'	1642		12
14	0337	+16° 20'	+17° 14'	1733		7
15	0420	+17° 45'	+18° 11'	1823		3
16	0505	+18° 20'	+18° 16'	1912	NEW MOON, 1123	1
17	0554	+18° 2'	+17° 28'	1957		0
18	0646	+16° 50'	+15° 47'	2040		2
19	0739	+14° 47'	+13° 19'	2120		5
20	0834	+11° 57'	+10° 10'	2159		10
21	0931	+ 8° 29'	+ 6° 26'	2236		16
22	1029	+ 4° 29'	+ 2° 18'	2312		25
23	1127	+ 0° 8'	- 2° 4'	2348		34
24	1228	- 4° 22'			FIRST QUARTER, 0544	44
25	1330	- 8° 46'	- 6° 30'	0026		55
26	1435	-12° 50'	-10° 43'	0106		66
27	1542	-16° 11'	-14° 27'	0151		77
28	1648	-18° 27'	-17° 20'	0242		86
29	1753	-19° 23'	-19° 2'	0337		93
30	1853	-18° 52'	-19° 21'	0439	FULL MOON, 2024	98

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

\* Illumination values are for 0000 HRS, Greenwich (Zulu) Time.

MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
JULY

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	1948	-16° 58'	-18° 12'	0544		100
2	2037	-13° 58'	-15° 45'	0650		99
3	2121	-10° 13'	-12° 20'	0756		95
4	2200	- 6° 3'	- 8° 17'	0859		89
5	2237	- 1° 44'	- 3° 57'	0959		81
6	2312	+ 2° 29'	0° 24'	1058		72
7	2347	+ 6° 27'	+ 4° 34'	1154	LAST QUARTER, 2139	62
8			+ 8° 24'	1250		52
9	0021	+10° 1'	+11° 45'	1343		42
10	0058	+13° 4'	+14° 30'	1436		33
11	0136	+15° 31'	+16° 34'	1528		24
12	0218	+17° 14'	+17° 51'	1619		17
13	0302	+18° 9'	+18° 17'	1708		10
14	0350	+18° 12'	+17° 49'	1755		5
15	0441	+17° 21'	+16° 28'	1839		2
16	0534	+15° 36'	+14° 17'	1921	NEW MOON, 0137	00
17	0630	+13° 2'	+11° 21'	2000		1
18	0726	+ 9° 45'	+ 7° 48'	2037		3
19	0823	+ 5° 55'	+ 3° 47'	2114		7
20	0922	+ 1° 41'	- 0° 31'	2150		13
21	1021	- 2° 44'	- 4° 53'	2227		21
22	1122	- 7° 8'	- 9° 7'	2306		30
23	1224	-11° 15'	-12° 57'	2348	FIRST QUARTER, 1238	41
24	1328	-14° 48'				52
25	1433	-17° 28'	-16° 6'	0034		63
26	1536	-19° 0'	-18° 18'	0126		74
27	1637	-19° 12'	-19° 15'	0223		84
28	1734	-18° 1'	-18° 51'	0324		91
29	1825	-15° 37'	-17° 6'	0429		97
30	1912	-12° 15'	-14° 12'	0535	FULL MOON, 0352	100
31	1954	- 8° 15'	-10° 27'	0640		99

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

Declination is given in degrees north (+) or south (-) of the Celestial Equator.

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MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
AUGUST

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	2033	- 3° 56'	- 6° 12'	0743		97
2	2110	+ 0° 25'	- 1° 46'	0844		92
3	2145	+ 4° 35'	+ 2° 34'	0942		85
4	2221	+ 8° 23'	+ 6° 38'	1039		77
5	2257	+11° 42'	+10° 14'	1134		68
6	2335	+14° 26'	+13° 17'	1228	LAST QUARTER, 1340	58
7			+15° 39'	1321		49
8	0015	+16° 28'	+17° 16'	1412		39
9	0058	+17° 43'	+18° 4'	1502		30
10	0145	+18° 8'	+17° 59'	1549		22
11	0234	+17° 39'	+16° 59'	1635		15
12	0327	+16° 17'	+15° 9'	1718		9
13	0422	+14° 3'	+12° 29'	1758		4
14	0518	+11° 2'	+ 9° 9'	1837	NEW MOON, 1431	1
15	0616	+ 7° 22'	+ 5° 15'	1915		0
16	0715	+ 3° 13'	+ 1° 0'	1951		1
17	0815	- 1° 12'	- 3° 23'	2029		5
18	0916	- 5° 39'	- 7° 42'	2107		11
19	1018	- 9° 52'	-11° 39'	2148		18
20	1121	-13° 35'	-15° 0'	2233		28
21	1224	-16° 31'	-17° 29'	2322	FIRST QUARTER, 1804	38
22	1327	-18° 25'				49
23	1427	-19° 7'	-18° 52'	0015		61
24	1524	-18° 30'	-19° 1'	0113		72
25	1616	-16° 41'	-17° 51'	0215		82
26	1704	-13° 48'	-15° 31'	0319		90
27	1747	-10° 9'	-12° 13'	0423		96
28	1827	- 6° 2'	- 8° 15'	0526	FULL MOON, 1310	99
29	1905	- 1° 42'	- 3° 55'	0627		100
30	1941	+ 2° 35'	+ 0° 29'	0727		98
31	2017	+ 6° 35'	+ 4° 42'	0826		95

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D<sub>2</sub> = Declination of Moon at time of Moonset.

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MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
SEPTEMBER

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	2054	+10° 10'	+ 8° 34'	0922		89
2	2132	+13° 11'	+11° 53'	1017		82
3	2211	+15° 32'	+14° 35'	1111		74
4	2254	+17° 8'	+16° 31'	1203		65
5	2338	+17° 54'	+17° 40'	1254	LAST QUARTER, 0733	56
6			+17° 57'	1342		46
7	0026	+17° 48'	+17° 21'	1428		37
8	0117	+16° 50'	+15° 54'	1512		28
9	0211	+14° 59'	+13° 37'	1554		20
10	0306	+12° 19'	+10° 35'	1633		12
11	0404	+ 8° 55'	+ 6° 54'	1711		7
12	0503	+ 4° 57'	+ 2° 45'	1749		2
13	0604	+ 0° 34'	- 1° 40'	1827	NEW MOON, 0223	0
14	0706	- 3° 58'	- 6° 6'	1906		0
15	0809	- 8° 22'	-10° 17'	1947		3
16	0913	-12° 20'	-13° 55'	2031		8
17	1018	-15° 35'	-16° 43'	2120		16
18	1121	-17° 50'	-18° 27'	2212		25
19	1222	-18° 54'	-18° 58'	2308	FIRST QUARTER, 2318	36
20	1319	-18° 42'				47
21	1412	-17° 18'	-18° 14'	0008		58
22	1459	-14° 50'	-16° 20'	0109		69
23	1543	-11° 33'	-13° 26'	0212		79
24	1624	- 7° 41'	- 9° 48'	0314		87
25	1702	- 3° 30'	- 5° 42'	0414		94
26	1738	0° 46'	- 1° 23'	0514		98
27	1814	+ 4° 53'	+ 2° 54'	0613	FULL MOON, 0117	100
28	1850	+ 8° 39'	+ 6° 54'	0710		100
29	1928	+11° 55'	+10° 29'	0806		97
30	2007	+14° 34'	+13° 27'	0900		93

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D<sub>2</sub> = Declination of Moon at time of Moonset.

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**MOONRISE, MOONSET AND MOON PHASES FOR 1977**  
**INCLUDING DECLINATIONS AND ILLUMINATION**  
**OCTOBER**

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	2048	+16° 29'	+15° 44'	0954		87
2	2132	+17° 36'	+17° 13'	1045		80
3	2219	+17° 52'	+17° 51'	1134		72
4	2308	+17° 16'	+17° 38'	1221		63
5	2359	+15° 49'	+16° 33'	1305	LAST QUARTER, 0221	54
6			+14° 39'	1347		44
7	0054	+13° 34'	+11° 59'	1427		35
8	0150	+10° 31'	+ 8° 38'	1506		26
9	0248	+ 6° 50'	+ 4° 43'	1543		17
10	0347	+ 2° 38'	+ 0° 24'	1621		10
11	0449	- 1° 52'	- 4° 5'	1700		4
12	0553	- 6° 25'	- 8° 30'	1741	NEW MOON, 1331	1
13	0658	-10° 43'	-12° 30'	1825		0
14	0804	-14° 24'	-15° 45'	1913		2
15	0910	-17° 8'	-17° 57'	2005		6
16	1014	-18° 40'	-18° 34'	2102		13
17	1114	-18° 53'	-18° 34'	2202		22
18	1209	-17° 49'	-17° 0'	2304		33
19	1258	-15° 39'			FIRST QUARTER, 0546	44
20	1343	-12° 37'	-14° 23'	0005		55
21	1424	- 8° 57'	-10° 59'	0107		66
22	1501	- 4° 55'	- 7° 4'	0207		76
23	1538	- 0° 44'	- 2° 52'	0306		84
24	1613	+ 3° 23'	+ 1° 22'	0404		91
25	1649	+ 7° 15'	+ 5° 26'	0501		96
26	1725	+10° 43'	+ 9° 10'	0557	FULL MOON, 1635	99
27	1803	+13° 38'	+12° 23'	0652		100
28	1844	+15° 51'	+14° 57'	0745		99
29	1927	+17° 17'	+16° 46'	0838		96
30	2013	+17° 54'	+17° 45'	0928		92
31	2101	+17° 39'	+17° 52'	1015		86

D<sub>1</sub> = Declination of Moon at time of Moonrise.

D<sub>2</sub> = Declination of Moon at time of Moonset.

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MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
NOVEMBER

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	2151	+16° 33'	+17° 8'	1101		78
2	2243	+14° 38'	+15° 35'	1143		70
3	2337	+11° 59'	+13° 16'	1223	LAST QUARTER, 2058	61
4			+10° 16'	1301		52
5	0032	+ 8° 39'	+ 6° 40'	1338		42
6	0130	+ 4° 46'	+ 2° 36'	1415		32
7	0230	+ 0° 27'	- 1° 46'	1452		23
8	0331	- 4° 4'	- 6° 14'	1532		14
9	0436	- 8° 33'	-10° 31'	1614		7
10	0543	-12° 39'	-14° 15'	1700		2
11	0650	-15° 58'	-17° 6'	1752	NEW MOON, 0009	0
12	0758	-18° 11'	-18° 44'	1848		1
13	0902	-19° 2'	-18° 58'	1949		4
14	1001	-18° 29'	-17° 49'	2053		11
15	1054	-16° 39'	-15° 29'	2157		19
16	1142	-13° 48'	-12° 15'	2300		29
17	1225	-10° 15'			FIRST QUARTER, 1452	40
18	1303	- 6° 16'	- 8° 25'	0001		51
19	1340	- 2° 6'	- 4° 16'	0101		62
20	1415	+ 2° 2'	- 0° 1'	0159		71
21	1450	+ 5° 59'	+ 4° 6'	0255		80
22	1525	+ 9° 35'	+ 7° 57'	0351		87
23	1603	+12° 42'	+11° 20'	0446		93
24	1642	+15° 10'	+14° 9'	0539		97
25	1724	+16° 56'	+16° 15''	0632	FULL MOON, 1031	99
26	1808	+17° 52'	+17° 34'	0723		100
27	1856	+17° 57'	+18° 2'	0812		98
28	1945	+17° 11'	+17° 37'	0858		95
29	2036	+15° 34'	+16° 22'	0942		91
30	2129	+13° 13'	+14° 21'	1022		84

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D<sub>2</sub> = Declination of Moon at time of Moonset.

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MOONRISE, MOONSET AND MOON PHASES FOR 1977  
INCLUDING DECLINATIONS AND ILLUMINATION  
DECEMBER

DAY	MOONRISE MST	D <sub>1</sub>	D <sub>2</sub>	MOONSET MST	PHASES MST	* PERCENT ILLUMINATED
1	2223	+10° 11'	+11° 39'	1100		77
2	2319	+ 6° 35'	+ 8° 21'	1137		68
3			+ 4° 33'	1212	LAST QUARTER, 1416	59
4	0015	+ 2° 34'	+ 0° 25'	1248		49
5	0114	- 1° 46'	- 3° 55'	1325		39
6	0215	- 6° 11'	- 8° 14'	1404		28
7	0319	-10° 27'	-12° 15'	1447		19
8	0425	-14° 13'	-15° 38'	1535		11
9	0533	-17° 7'	-18° 1'	1629		5
10	0640	-18° 48'	-19 5'	1728	NEW MOON, 1033	1
11	0743	-19° 3'	-18° 41'	1833		0
12	0842	-17° 49'	-16° 52'	1939		3
13	0934	-15° 21'	-13° 55'	2045		8
14	1021	-11° 58'	-10° 10'	2150		15
15	1103	- 7° 59'	- 5° 59'	2252		25
16	1141	- 3° 45'	- 1° 38'	2352		35
17	1217	0° 30'			FIRST QUARTER, 0337	45
18	1252	+ 4° 35'	+ 2° 37'	0050		56
19	1328	+ 8° 20'	+ 6° 36'	0146		66
20	1404	+11° 38'	+10° 11'	0241		75
21	1442	+14° 21'	+13° 12'	0335		83
22	1523	+16° 23'	+15° 35'	0428		89
23	1606	+17° 39'	+17° 12'	0519		94
24	1652	+18° 4'	+17° 59'	0609		98
25	1741	+17° 37'	+17° 55'	0656	FULL MOON, 0549	100
26	1832	+16° 19'	+16° 59'	0740		100
27	1924	+14° 14'	+15° 15'	0822		100
28	2018	+11° 26'	+12° 47'	0901		98
29	2112	+ 8° 4'	+ 9° 42'	0939		94
30	2208	+ 4° 14'	+ 6° 7'	1014		89
31	2304	0° 25'	+ 2° 10'	1049		75

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