

APPENDIX X

LONG-TERM ALMANAC

This appendix is intended for use when a more complete almanac is not available. It is based principally upon the fact that approximately correct values for the Greenwich hour angle and declination of the sun, and the Greenwich hour angle of Aries, can be obtained from an almanac that is exactly four years out of date. The differences in these values at intervals of exactly four years can be largely removed by applying an average correction to the values obtained from the tables of this appendix. The maximum error in an altitude computed by means of this appendix should not exceed 2'.0 for the sun or 1'.3 for stars.

This four-year, or quadrennial, correction varies throughout the year for the GHA of the sun (between about plus and minus one-fourth of a minute) and for the declination of the sun (between about plus and minus three-fourths of a minute). For the GHA of Aries the quadrennial correction is a constant, (+)1'.84. The appropriate quadrennial correction is applied once for each full four years which has passed since the base year of the tabulation (1956 in this appendix).

The tabulated values for GHA and declination of the sun and GHA of Aries are given in four columns, labeled 0, 1, 2, and 3. The "0" column contains the data for the leap year in each four-year cycle and the 1, 2, and 3 columns contain data for, respectively, the first, second, and third years following each leap year.

The GHA and declination of the sun are given at intervals of three days throughout the four-year cycle, except for the final days of each month, when the interval varies between one and four days. Linear interpolation is made between entries to obtain data for a given day. Additional corrections to the GHA of the sun of 15° per hour, 15' per minute, and 15" per second are made to obtain the GHA at a given time. Declination of the sun is obtained to sufficient accuracy by linear interpolation alone.

The GHA of Aries is given for each month of the four-year cycle. Additional corrections of 0°59'.14 per day, 15°02'.5 per hour, 15' per minute, and 15" per second are made to obtain the GHA at a given time.

The SHA and declination of 38 navigational stars are given for the base year, 1956.0. Annual (not quadrennial) corrections are made to these data to obtain the values for a given year and tenth of a year.

A multiplication table is included as an aid in applying corrections to tabulated values.

Sun tables. 1. Subtract 1956 from the year and divide the difference by four, obtaining (a) a whole number, and (b) a remainder. Enter column indicated by remainder (b) and take out values on either side of given time and date.

2. Multiply quadrennial correction for each value by whole number (a) obtained in step 1 and apply to tabulated values.

3. Divide difference between corrected values by number of days (usually three) between them to determine daily change.

4. Multiply daily change by number of days and tenths since 0^h GMT of earlier tabulated date, and mark correction plus (+) or minus (−) as appropriate.

5. (GHA only.) Enter multiplication table with hours, minutes, and seconds of GMT, and take out corrections A, B, and C, respectively. These are all positive.

6. Apply corrections of steps 4 and 5 to corrected *earlier* values of step 2.

Example.—Find GHA and declination of sun at GMT 17^h13^m49^s on July 18, 1986.

Solution.—Steps 1 and 2: $(1986-1956) \div 4 = 7$, remainder 2. Use column 2, and multiply quadrennial corrections by 7. Corrected values: GHA, July 16, $178^{\circ}32'.0 - (7 \times 0'.23) = 178^{\circ}30'.4$; July 19, $178^{\circ}28'.0 - (7 \times 0'.20) = 178^{\circ}26'.6$. Dec., July 16, $21^{\circ}29'.2 N - (7 \times 0'.35) = 21^{\circ}26'.8 N$; July 19, $20^{\circ}58'.9 N - (7 \times 0'.39) = 20^{\circ}56'.2 N$.

GHA	Declination
July 16 $178^{\circ}30'.4$	July 16 $21^{\circ}26'.8 N$
July 19 $178^{\circ}26'.6$	July 19 $20^{\circ}56'.2 N$
3-day change $(-) 3'.8$ } <i>Step 3</i>	3-day change $(-) 30'.6$ } <i>Step 3</i>
daily change $(-) 1'.3$ }	daily change $(-) 10'.2$ }
days and tenths 2.7 } <i>Step 4</i>	days and tenths 2.7 } <i>Step 4</i>
corr. $(-) 3'.5$ }	corr. $(-) 27'.5$ }
A $255^{\circ}00'.0$ }	0 ^h July 16 $21^{\circ}26'.8 N$ } <i>Step 6</i>
B $3^{\circ}15'.0$ } <i>Step 5</i>	d $20^{\circ}59'.3 N$ }
C $12'.2$ }	
0 ^h July 16 $178^{\circ}30'.4$ } <i>Step 6</i>	
GHA $76^{\circ}54'.1$ }	

Aries table. 1. Subtract 1956 from the year and divide the difference by four, obtaining (a) a whole number, and (b) a remainder. Enter column indicated by remainder (b) and take out value for given month.

2. Enter multiplication table with whole number (a) of step 1, day of month, hours of GMT, minutes of GMT, and seconds of GMT, and take out corrections D, E, F, G, and C, respectively.

3. Add values of steps 1 and 2.

Example.—Find GHA Υ at GMT 11^h06^m33^s on November 28, 1979.

Solution.—Step 1: $(1979-1956) \div 4 = 5$, remainder 3. Use column 3.

GHA Υ	
Nov.	$38^{\circ}33'.0$
D	$9'.2$
E	$27^{\circ}35'.9$
F	$165^{\circ}27'.1$
G	$1^{\circ}30'.2$
C	$8'.2$
GHA Υ	$233^{\circ}23'.6$

Stars table. 1. Enter table with star name, and take out tabulated values.

2. Subtract 1956.0 from given year and tenth, and multiply annual correction by difference. Apply as correction (+ or -, as appropriate) to value of step 1.

Example.—Find SHA and declination of Spica on September 11, 1995.

Solution.—From decimal table, September 11, 1995 = 1995.7. $1995.7 - 1956.0 = 39.7$.

SHA	Declination
1956.0 $159^{\circ}16'.9$ } <i>Step 1</i>	1956.0 $10^{\circ}55'.9 S$ } <i>Step 1</i>
39.7 $\times (-) 0'.79$ $(-) 31'.4$ } <i>Step 2</i>	39.7 $\times 0'.31$ $(+) 12'.3$ } <i>Step 2</i>
SHA $158^{\circ}45'.5$	d $11^{\circ}08'.2 S$

To determine GHA of star, add GHA Υ and SHA \star for given time and date.

SUN										
0		Quad. GHA Corr.	1		Date	2		Quad. Dec. Corr.	3	
GHA	Dec.		GHA	Dec.		GHA	Dec.		GHA	Dec.
JANUARY										
179 14.9	23 06.1 S	-0.03	179 09.2	23 02.5 S	1	179 10.9	23 03.6 S	-0.15	179 12.9	23 04.7 S
178 53.7	22 50.8 S	-0.03	178 48.1	22 46.2 S	4	178 49.9	22 47.7 S	-0.20	178 51.8	22 49.1 S
178 33.4	22 31.5 S	-0.02	178 28.0	22 25.9 S	7	178 29.8	22 27.7 S	-0.22	178 31.5	22 29.4 S
178 14.0	22 08.2 S	-0.01	178 09.0	22 01.6 S	10	178 10.8	22 03.7 S	-0.26	178 12.2	22 05.8 S
177 55.9	21 41.0 S	0.00	177 51.3	21 33.4 S	13	177 52.9	21 35.9 S	-0.29	177 54.2	21 38.2 S
177 39.1	21 10.0 S	+0.01	177 35.0	21 01.5 S	16	177 36.4	21 04.2 S	-0.34	177 37.6	21 06.9 S
177 23.8	20 35.3 S	+0.04	177 20.2	20 26.0 S	19	177 21.5	20 28.9 S	-0.36	177 22.5	20 31.9 S
177 10.2	19 57.2 S	+0.05	177 07.1	19 47.0 S	22	177 08.1	19 50.2 S	-0.40	177 09.1	19 53.4 S
176 58.4	19 15.7 S	+0.08	176 55.7	19 04.6 S	25	176 56.4	19 08.1 S	-0.42	176 57.5	19 11.7 S
176 48.3	18 31.0 S	+0.10	176 46.0	18 19.1 S	28	176 46.6	18 22.9 S	-0.45	176 47.6	18 26.7 S
FEBRUARY										
176 37.7	17 26.7 S	+0.12	176 35.9	17 13.9 S	1	176 36.4	17 18.0 S	-0.48	176 37.2	17 22.1 S
176 31.9	16 35.3 S	+0.13	176 30.4	16 21.8 S	4	176 31.0	16 26.1 S	-0.51	176 31.5	16 30.4 S
176 27.9	15 41.2 S	+0.15	176 26.9	15 27.1 S	7	176 27.4	15 31.7 S	-0.54	176 27.5	15 36.1 S
176 25.6	14 44.7 S	+0.15	176 25.1	14 30.0 S	10	176 25.5	14 34.8 S	-0.55	176 25.5	14 39.4 S
176 25.1	13 46.0 S	+0.17	176 25.2	13 30.8 S	13	176 25.4	13 35.8 S	-0.58	176 25.2	13 40.6 S
176 26.3	12 45.3 S	+0.18	176 27.0	12 29.6 S	16	176 26.9	12 34.7 S	-0.61	176 26.5	12 39.7 S
176 29.2	11 42.7 S	+0.20	176 30.3	11 26.6 S	19	176 30.0	11 31.8 S	-0.62	176 29.5	11 36.9 S
176 33.7	10 38.4 S	+0.22	176 35.2	10 22.0 S	22	176 34.7	10 27.3 S	-0.63	176 34.3	10 32.6 S
176 39.6	9 32.7 S	+0.23	176 41.4	9 15.9 S	25	176 40.8	9 21.3 S	-0.64	176 40.4	9 26.7 S
176 47.0	8 25.7 S	+0.24	176 49.0	8 08.6 S	28	176 48.3	8 14.1 S	-0.66	176 47.8	8 19.6 S
MARCH										
176 52.5	7 40.4 S	+0.24	176 51.8	7 45.9 S	1	176 51.1	7 51.4 S	-0.66	176 50.6	7 57.0 S
177 01.8	6 31.7 S	+0.24	177 00.9	6 37.2 S	4	177 00.2	6 42.8 S	-0.67	176 59.6	6 48.5 S
177 12.1	5 22.1 S	+0.24	177 11.0	5 27.6 S	7	177 10.4	5 33.4 S	-0.68	177 09.5	5 39.1 S
177 23.2	4 11.8 S	+0.24	177 22.1	4 17.5 S	10	177 21.5	4 23.3 S	-0.69	177 20.4	4 28.9 S
177 35.1	3 01.1 S	+0.24	177 34.0	3 06.8 S	13	177 33.3	3 12.6 S	-0.71	177 32.1	3 18.3 S
177 47.6	1 50.0 S	+0.24	177 46.6	1 55.8 S	16	177 45.8	2 01.7 S	-0.71	177 44.5	2 07.4 S
178 00.0	0 38.9 S	+0.23	177 59.7	0 44.7 S	19	177 58.7	0 50.5 S	-0.70	177 57.5	0 56.2 S
178 14.0	0 32.2 N	+0.23	178 13.1	0 26.4 N	22	178 12.0	0 20.6 N	+0.70	178 10.8	0 14.9 N
178 27.7	1 45.1 N	+0.23	178 26.8	1 37.3 N	25	178 25.5	1 31.6 N	+0.70	178 24.5	1 25.8 N
178 41.4	2 53.7 N	+0.22	178 40.4	2 47.9 N	28	178 39.2	2 42.2 N	+0.70	178 38.2	2 36.5 N
APRIL										
178 59.6	4 26.9 N	+0.22	178 58.5	4 21.3 N	1	178 57.4	4 15.6 N	+0.70	178 56.4	4 09.9 N
179 13.0	5 36.0 N	+0.19	179 11.9	5 30.5 N	4	179 10.9	5 24.8 N	+0.70	179 09.8	5 19.2 N
179 26.0	6 44.3 N	+0.18	179 24.9	6 38.8 N	7	179 24.0	6 33.2 N	+0.68	179 22.9	6 27.7 N
179 38.4	7 51.5 N	+0.17	179 37.4	7 46.1 N	10	179 36.6	7 40.6 N	+0.68	179 35.5	7 35.2 N
179 50.3	8 57.5 N	+0.14	179 49.5	8 52.2 N	13	179 48.6	8 46.8 N	+0.67	179 47.5	8 41.5 N
180 01.5	10 02.2 N	+0.12	180 00.6	9 56.9 N	16	179 59.9	9 51.7 N	+0.65	179 58.8	9 46.6 N
180 11.8	11 05.4 N	+0.10	180 11.3	11 00.2 N	19	180 10.4	10 55.2 N	+0.64	180 09.4	10 50.1 N
180 21.3	12 06.9 N	+0.09	180 20.9	12 01.9 N	22	180 19.9	11 57.0 N	+0.62	180 19.2	11 52.0 N
180 29.9	13 06.7 N	+0.08	180 29.4	13 01.8 N	25	180 28.5	12 57.1 N	+0.60	180 27.9	12 52.2 N
180 37.3	14 04.5 N	+0.06	180 36.8	13 59.8 N	28	180 36.0	13 55.2 N	+0.59	180 35.6	13 50.5 N
MAY										
180 43.6	15 00.2 N	+0.04	180 43.1	14 55.7 N	1	180 42.5	14 51.3 N	+0.56	180 42.1	14 46.7 N
180 48.6	15 53.7 N	0.00	180 48.2	15 49.4 N	4	180 47.8	15 45.1 N	+0.54	180 47.4	15 40.8 N
180 52.4	16 44.8 N	-0.02	180 52.1	16 40.7 N	7	180 51.8	16 36.6 N	+0.52	180 51.4	16 32.5 N
180 54.8	17 33.4 N	-0.04	180 54.7	17 29.5 N	10	180 54.6	17 25.6 N	+0.50	180 54.2	17 21.8 N
180 56.0	18 19.4 N	-0.08	180 56.1	18 15.7 N	13	180 56.0	18 12.0 N	+0.47	180 55.7	18 08.4 N
180 55.9	19 02.6 N	-0.10	180 56.2	18 59.1 N	16	180 56.1	18 55.7 N	+0.44	180 55.9	18 52.3 N
180 54.5	19 42.9 N	-0.12	180 55.0	19 39.7 N	19	180 54.8	19 36.5 N	+0.40	180 54.9	19 33.3 N
180 52.0	20 20.2 N	-0.14	180 52.6	20 17.2 N	22	180 52.4	20 14.3 N	+0.37	180 52.7	20 11.3 N
180 48.3	20 54.4 N	-0.14	180 48.9	20 51.6 N	25	180 48.8	20 49.0 N	+0.34	180 49.2	20 46.3 N
180 43.5	21 25.3 N	-0.16	180 44.1	21 22.8 N	28	180 44.1	21 20.4 N	+0.30	180 44.7	21 18.0 N
JUNE										
180 35.5	22 01.3 N	-0.18	180 36.0	21 59.2 N	1	180 36.3	21 57.2 N	+0.25	180 36.9	21 55.1 N
180 28.3	22 24.3 N	-0.22	180 28.9	22 22.5 N	4	180 29.3	22 20.8 N	+0.21	180 29.9	22 18.9 N
180 20.3	22 43.8 N	-0.24	180 21.0	22 42.3 N	7	180 21.5	22 40.8 N	+0.18	180 22.0	22 39.3 N
180 11.7	22 59.7 N	-0.25	180 12.5	22 58.5 N	10	180 13.0	22 57.3 N	+0.14	180 13.5	22 56.1 N
180 02.5	23 11.9 N	-0.26	180 03.5	23 11.0 N	13	180 04.0	23 10.1 N	+0.10	180 04.5	23 09.2 N
179 53.0	23 26.5 N	-0.27	179 54.1	23 19.9 N	16	179 54.5	23 19.3 N	+0.06	179 55.1	23 18.7 N
179 43.3	23 35.4 N	-0.27	179 44.4	23 25.1 N	19	179 44.7	23 24.5 N	+0.01	179 45.4	23 24.5 N
179 33.6	23 28.6 N	-0.27	179 34.7	23 26.6 N	22	179 34.9	23 26.5 N	-0.02	179 35.7	23 26.5 N
179 24.0	23 24.0 N	-0.26	179 24.9	23 24.3 N	25	179 25.1	23 24.6 N	-0.07	179 26.1	23 24.9 N
179 14.6	23 17.8 N	-0.26	179 15.4	23 18.3 N	28	179 15.7	23 18.9 N	-0.12	179 16.6	23 19.5 N

SUN

0		Quad. GHA Corr.	1		Date	2		Quad. Dec. Corr.	3	
GHA	Dec.		GHA	Dec.		GHA	Dec.		GHA	Dec.
JULY										
179 05.7	23 07.8 N	-0.26	179 06.3	23 08.7 N	1	179 06.7	23 09.6 N	-0.15	179 07.5	23 10.4 N
178 57.2	22 54.2 N	-0.26	178 57.8	22 55.4 N	4	178 58.2	22 56.6 N	-0.19	178 58.8	22 57.7 N
178 49.4	22 37.0 N	-0.26	178 50.0	22 38.5 N	7	178 50.4	22 40.0 N	-0.24	178 50.8	22 41.4 N
178 42.4	22 16.3 N	-0.25	178 43.1	22 18.1 N	10	178 43.3	22 19.8 N	-0.27	178 43.7	22 21.5 N
178 36.4	21 52.2 N	-0.23	178 37.1	21 54.3 N	13	178 37.2	21 56.2 N	-0.31	178 37.4	21 58.2 N
178 31.5	21 24.7 N	-0.23	178 32.2	21 27.0 N	16	178 32.0	21 29.2 N	-0.35	178 32.3	21 31.5 N
178 27.8	20 53.9 N	-0.20	178 28.4	20 56.5 N	19	178 28.0	20 58.9 N	-0.39	178 28.3	21 01.5 N
178 25.3	20 19.9 N	-0.17	178 25.7	20 22.8 N	22	178 25.3	20 25.5 N	-0.41	178 25.6	20 28.3 N
178 24.1	19 42.9 N	-0.15	178 24.3	19 46.0 N	25	178 23.8	19 48.9 N	-0.44	178 24.1	19 52.0 N
178 24.3	19 02.9 N	-0.13	178 24.2	19 06.2 N	28	178 23.7	19 09.4 N	-0.47	178 23.9	19 12.8 N

AUGUST

178 26.5	18 05.2 N	-0.11	178 26.2	18 08.8 N	1	178 25.7	18 12.4 N	-0.52	178 25.6	18 16.0 N
178 29.7	17 18.8 N	-0.11	178 29.3	17 22.7 N	4	178 28.8	17 26.4 N	-0.56	178 28.5	17 30.2 N
178 34.2	16 29.9 N	-0.09	178 33.9	16 34.0 N	7	178 33.2	16 37.9 N	-0.58	178 32.7	16 41.9 N
178 40.1	15 38.6 N	-0.07	178 39.7	15 42.9 N	10	178 39.0	15 47.0 N	-0.60	178 38.3	15 51.1 N
178 47.3	14 45.0 N	-0.05	178 46.9	14 49.5 N	13	178 45.9	14 53.8 N	-0.62	178 45.2	14 58.1 N
178 55.8	13 49.4 N	-0.03	178 55.3	13 54.0 N	16	178 54.1	13 58.4 N	-0.64	178 53.4	14 03.0 N
179 05.4	12 51.7 N	0.00	179 04.9	12 56.5 N	19	179 03.5	13 01.1 N	-0.66	179 02.9	13 05.8 N
179 16.2	11 52.3 N	+0.02	179 15.5	11 57.2 N	22	179 14.1	12 01.9 N	-0.68	179 13.4	12 06.8 N
179 28.1	10 51.1 N	+0.04	179 27.1	10 56.1 N	25	179 25.7	11 01.0 N	-0.69	179 25.0	11 06.0 N
179 40.8	9 48.4 N	+0.06	179 39.7	9 53.5 N	28	179 38.3	9 58.5 N	-0.70	179 37.5	10 03.7 N

SEPTEMBER

179 58.9	8 22.6 N	+0.07	179 57.7	8 27.8 N	1	179 56.4	8 33.0 N	-0.72	179 55.4	8 38.3 N
180 13.3	7 16.8 N	+0.07	180 12.1	7 22.1 N	4	180 10.8	7 27.4 N	-0.73	180 09.6	7 32.8 N
180 28.2	6 09.9 N	+0.08	180 27.1	6 15.4 N	7	180 25.7	6 20.8 N	-0.74	180 24.5	6 26.2 N
180 43.6	5 02.1 N	+0.10	180 42.6	5 07.7 N	10	180 41.1	5 13.1 N	-0.75	180 39.8	5 18.7 N
180 59.4	3 53.6 N	+0.11	180 58.3	3 59.3 N	13	180 56.8	4 04.7 N	-0.75	180 55.5	4 10.3 N
181 15.3	2 44.5 N	+0.12	181 14.3	2 50.2 N	16	181 12.6	2 55.6 N	-0.75	181 11.5	3 01.3 N
181 31.4	1 34.8 N	+0.13	181 30.3	1 40.6 N	19	181 28.6	1 46.1 N	-0.75	181 27.5	1 51.8 N
181 47.3	0 24.9 N	+0.13	181 46.1	0 30.6 N	22	181 44.5	0 36.2 N	-0.75	181 43.5	0 42.0 N
182 03.0	0 45.2 S	+0.14	182 01.7	0 39.5 S	25	182 00.3	0 33.9 S	+0.74	181 59.3	0 28.1 S
182 18.3	1 55.3 S	+0.14	182 17.0	1 49.7 S	28	182 15.7	1 44.0 S	+0.74	182 14.7	1 38.3 S

OCTOBER

182 33.1	3 05.4 S	+0.14	182 31.9	2 59.7 S	1	182 30.7	2 54.1 S	+0.74	182 29.6	2 48.3 S
182 47.2	4 15.1 S	+0.13	182 46.1	4 09.5 S	4	182 45.0	4 03.8 S	+0.73	182 43.9	3 58.1 S
183 00.6	5 24.4 S	+0.12	182 59.6	5 18.7 S	7	182 58.5	5 13.1 S	+0.72	182 57.4	5 07.5 S
183 13.0	6 33.0 S	+0.12	183 12.2	6 27.4 S	10	183 11.1	6 21.9 S	+0.71	183 10.0	6 16.3 S
183 24.4	7 40.9 S	+0.12	183 23.8	7 35.3 S	13	183 22.7	7 29.9 S	+0.70	183 21.9	7 24.4 S
183 34.7	8 47.8 S	+0.11	183 34.2	8 42.3 S	16	183 33.1	8 37.0 S	+0.68	183 32.5	8 31.5 S
183 43.8	9 53.5 S	+0.11	183 43.3	9 48.2 S	19	183 42.3	9 42.9 S	+0.66	183 41.9	9 37.5 S
183 51.4	10 58.0 S	+0.10	183 50.9	10 52.8 S	22	183 50.1	10 47.6 S	+0.64	183 49.9	10 42.3 S
183 57.6	12 01.0 S	+0.10	183 57.1	11 55.9 S	25	183 56.5	11 50.9 S	+0.63	183 56.4	11 45.7 S
184 02.0	13 02.3 S	+0.08	184 01.6	12 57.4 S	28	184 01.3	12 52.5 S	+0.62	184 01.2	12 47.4 S

NOVEMBER

184 05.3	14 21.3 S	+0.06	184 05.1	14 16.6 S	1	184 05.1	14 11.8 S	+0.57	184 05.0	14 07.0 S
184 05.6	15 18.1 S	+0.04	184 05.7	15 13.5 S	4	184 05.8	15 08.9 S	+0.55	184 05.8	15 04.3 S
184 04.1	16 12.6 S	+0.03	184 04.4	16 08.2 S	7	184 04.7	16 03.8 S	+0.63	184 04.8	15 59.4 S
184 00.8	17 04.7 S	+0.02	184 01.3	17 00.5 S	10	184 01.6	16 56.3 S	+0.50	184 01.9	16 52.1 S
183 55.5	17 54.2 S	0.00	183 56.3	17 50.2 S	13	183 56.6	17 46.2 S	+0.46	183 57.2	17 42.2 S
183 48.4	18 40.8 S	-0.01	183 49.3	18 37.1 S	16	183 49.7	18 33.4 S	+0.42	183 50.6	18 29.6 S
183 39.5	19 24.5 S	-0.01	183 40.4	19 21.0 S	19	183 41.0	19 17.6 S	+0.40	183 42.1	19 14.0 S
183 28.7	20 05.0 S	-0.02	183 29.6	20 01.8 S	22	183 30.5	19 58.6 S	+0.36	183 31.7	19 55.3 S
183 16.0	20 42.3 S	-0.03	183 17.0	20 39.3 S	25	183 18.1	20 36.4 S	+0.33	183 19.5	20 33.4 S
183 01.6	21 16.0 S	-0.06	183 02.7	21 13.4 S	28	183 04.1	21 10.7 S	+0.29	183 05.4	21 08.0 S

DECEMBER

182 45.6	21 46.2 S	-0.08	182 46.9	21 43.8 S	1	182 48.5	21 41.4 S	+0.29	182 49.8	21 39.0 S
182 28.1	22 12.6 S	-0.08	182 29.6	22 10.5 S	4	182 31.3	22 08.4 S	+0.22	182 32.6	22 06.4 S
182 09.3	22 35.1 S	-0.09	182 11.1	22 33.4 S	7	182 12.8	22 31.6 S	+0.18	182 14.2	22 29.9 S
181 49.5	22 53.7 S	-0.09	181 51.4	22 52.3 S	10	181 53.0	22 50.8 S	+0.15	181 54.6	22 49.4 S
181 28.7	23 08.1 S	-0.08	181 30.7	23 07.1 S	13	181 32.3	23 06.0 S	+0.11	181 34.0	23 04.9 S
181 07.2	23 18.5 S	-0.08	181 09.2	23 17.8 S	16	181 10.8	23 17.0 S	+0.06	181 12.7	23 16.3 S
180 45.2	23 24.7 S	-0.08	180 47.1	23 24.3 S	19	180 48.8	23 23.9 S	+0.02	180 50.8	23 23.4 S
180 22.9	23 26.6 S	-0.08	180 24.7	23 26.5 S	22	180 26.5	23 26.5 S	-0.01	180 28.5	23 26.4 S
180 00.5	23 24.3 S	-0.08	180 02.2	23 24.6 S	25	180 04.2	23 24.9 S	-0.05	180 06.1	23 25.2 S
179 38.3	23 17.8 S	-0.07	179 39.9	23 18.4 S	28	179 41.9	23 19.1 S	-0.09	179 43.7	23 19.6 S

ARIES (♈)				
0	1	Month	2	3
98 38.9	99 23.6	Jan.	99 09.3	98 54.9
129 12.2	129 57.0	Feb.	129 42.6	129 28.2
157 47.2	157 32.8	Mar.	157 18.4	157 04.0
188 20.5	188 06.1	Apr.	187 51.7	187 37.3
217 54.6	217 40.3	May	217 25.9	217 11.5
248 27.9	248 13.6	June	247 59.2	247 44.8
278 02.1	277 47.7	July	277 33.3	277 18.9
308 35.4	308 21.1	Aug.	308 06.7	307 52.2
339 08.7	338 54.3	Sept.	338 39.9	338 25.5
8 42.9	8 28.5	Oct.	8 14.1	7 59.7
39 16.2	39 01.8	Nov.	38 47.4	38 33.0
68 50.3	68 35.9	Dec.	68 21.5	68 07.1

STARS				
SHA (1956.0)	Annual Corr.	Star	Dec. (1956.0)	Annual Corr.
315 51.1	-0.57	Acamar	40 28.8 S	-0.24
335 58.8	-0.56	Achernar	57 27.6 S	-0.30
173 57.9	-0.84	Acruz	62 51.3 S	+0.33
291 39.1	-0.86	Aldebaran	16 25.3 N	+0.12
153 32.9	-0.59	Alkaid	49 31.9 N	-0.30
218 38.6	-0.74	Alphard	8 28.0 S	+0.26
126 47.7	-0.64	Alphecca	26 51.7 N	-0.20
358 28.4	-0.78	Alpheratz	28 50.9 N	+0.33
62 50.5	-0.73	Altair	8 45.0 N	+0.16
113 19.4	-0.92	Antares	26 20.2 S	+0.13
146 35.2	-0.68	Arcturus	19 24.6 N	-0.31
109 00.2	-1.59	Atria	68 57.0 S	+0.11
271 48.2	-0.81	Betelgeuse	7 24.0 N	+0.01
264 15.4	-0.33	Canopus	52 40.3 S	+0.03
281 38.5	-1.11	Capella	45 57.3 N	+0.06
50 01.0	-0.51	Deneb	45 07.3 N	+0.21
183 17.8	-0.76	Denebola	14 49.1 N	-0.34
349 39.3	-0.75	Diphda	18 13.7 S	-0.33
194 44.6	-0.92	Dubhe	61 59.3 N	+0.32
34 29.6	-0.74	Enif	9 40.3 N	+0.28
16 11.6	-0.83	Fomalhaut	29 51.4 S	-0.32
328 49.7	-0.85	Hamal	23 15.3 N	+0.28
137 17.8	+0.04	Kochab	74 20.1 N	-0.25
148 58.7	-0.88	Menkent	36 09.3 S	+0.29
309 42.5	-1.07	Mirfak	49 42.4 N	+0.21
76 51.9	-0.93	Nunki	26 21.2 S	-0.08
54 27.3	-1.19	Peacock	56 52.7 S	-0.19
244 20.6	-0.92	Pollux	28 08.0 N	-0.15
245 45.0	-0.78	Procyon	5 20.4 N	-0.15
96 46.6	-0.70	Rasalhague	12 35.4 N	-0.04
208 29.5	-0.80	Regulus	12 11.0 N	-0.29
281 53.7	-0.72	Rigel	8 15.1 S	-0.07
140 51.0	-1.02	Rigel Kent.	60 39.3 S	+0.25
350 30.1	-0.85	Schedar	56 17.8 N	+0.33
259 11.9	-0.66	Sirius	16 39.3 S	+0.08
159 16.9	-0.79	Spica	10 55.9 S	+0.31
223 24.4	-0.55	Suhail	43 15.2 S	+0.24
81 08.3	-0.51	Vega	38 44.5 N	+0.06

MULTIPLICATION TABLE							
No.	A	B	C	D	E	F	G
1	15	0 15	0.2	1.8	0 59.1	15 02.5	0 16.0
2	30	0 30	0.5	3.7	1 58.3	30 04.9	0 30.1
3	45	0 45	0.8	5.5	2 57.4	45 07.4	0 45.1
4	60	1 00	1.0	7.4	3 56.6	60 09.9	1 00.2
5	75	1 15	1.2	9.2	4 55.7	75 12.3	1 15.2
6	90	1 30	1.5	11.0	5 54.8	90 14.8	1 30.2
7	105	1 45	1.8	12.9	6 54.0	105 17.2	1 45.3
8	120	2 00	2.0	14.7	7 53.1	120 19.7	2 00.3
9	135	2 15	2.2	16.6	8 52.3	135 22.2	2 15.4
10	150	2 30	2.5	18.4	9 51.4	150 24.6	2 30.4
11	165	2 45	2.8	20.2	10 50.5	165 27.1	2 45.5
12	180	3 00	3.0	22.1	11 49.7	180 29.6	3 00.5
13	195	3 15	3.2	23.9	12 48.8	195 32.0	3 15.5
14	210	3 30	3.5	25.8	13 48.0	210 34.5	3 30.6
15	225	3 45	3.8	27.6	14 47.1	225 37.0	3 45.6
16	240	4 00	4.0	29.4	15 46.2	240 39.4	4 00.7
17	255	4 15	4.2	31.3	16 45.4	255 41.9	4 15.7
18	270	4 30	4.5	33.1	17 44.5	270 44.4	4 30.7
19	285	4 45	4.8	35.0	18 43.7	285 46.8	4 45.8
20	300	5 00	5.0	36.8	19 42.8	300 49.3	5 00.8
21	315	5 15	5.2	38.6	20 41.9	315 51.7	5 15.9
22	330	5 30	5.5	40.5	21 41.1	330 54.2	5 30.9
23	345	5 45	5.8	42.3	22 40.2	345 56.7	5 45.9
24	360	6 00	6.0	44.2	23 39.4	360 59.1	6 01.0
25	—	6 15	6.2	46.0	24 38.5	—	6 16.0
26	—	6 30	6.5	47.8	25 37.6	—	6 31.1
27	—	6 45	6.8	49.7	26 36.8	—	6 46.1
28	—	7 00	7.0	51.5	27 35.9	—	7 01.1
29	—	7 15	7.2	53.4	28 35.1	—	7 16.2
30	—	7 30	7.5	55.2	29 34.2	—	7 31.2
31	—	7 45	7.8	57.0	30 33.3	—	7 46.3
32	—	8 00	8.0	58.9	—	—	8 01.3
33	—	8 15	8.2	60.7	—	—	8 16.4
34	—	8 30	8.5	62.6	—	—	8 31.4
35	—	8 45	8.8	64.4	—	—	8 46.4
36	—	9 00	9.0	66.2	—	—	9 01.5
37	—	9 15	9.2	68.1	—	—	9 16.5
38	—	9 30	9.5	69.9	—	—	9 31.6
39	—	9 45	9.8	71.8	—	—	9 46.6
40	—	10 00	10.0	73.6	—	—	10 01.6
41	—	10 15	10.2	75.4	—	—	10 16.7
42	—	10 30	10.5	77.3	—	—	10 31.7
43	—	10 45	10.8	79.1	—	—	10 46.8
44	—	11 00	11.0	81.0	—	—	11 01.8
45	—	11 15	11.2	82.8	—	—	11 16.8
46	—	11 30	11.5	84.6	—	—	11 31.9
47	—	11 45	11.8	86.5	—	—	11 46.9
48	—	12 00	12.0	88.3	—	—	12 02.0
49	—	12 15	12.2	90.2	—	—	12 17.0
50	—	12 30	12.5	92.0	—	—	12 32.1
51	—	12 45	12.8	93.8	—	—	12 47.1
52	—	13 00	13.0	95.7	—	—	13 02.1
53	—	13 15	13.2	97.5	—	—	13 17.2
54	—	13 30	13.5	99.4	—	—	13 32.2
55	—	13 45	13.8	—	—	—	13 47.3
56	—	14 00	14.0	—	—	—	14 02.3
57	—	14 15	14.2	—	—	—	14 17.3
58	—	14 30	14.5	—	—	—	14 32.4
59	—	14 45	14.8	—	—	—	14 47.4
60	—	15 00	15.0	—	—	—	15 02.5

DECIMAL PARTS OF DAY AND YEAR											
Decimal	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Hour of Day	0000 to 0112	0112 to 0336	0336 to 0600	0600 to 0824	0824 to 1048	1048 to 1312	1312 to 1536	1536 to 1800	1800 to 2024	2024 to 2248	2248 to 2400
Day of Year	Jan. 1 to Jan. 18	Jan. 19 to Feb. 23	Feb. 24 to Apr. 1	Apr. 2 to May 7	May 8 to June 13	June 14 to July 19	July 20 to Aug. 26	Aug. 26 to Sept. 30	Oct. 1 to Nov. 6	Nov. 7 to Dec. 12	Dec. 13 to Dec. 31