Celestial Tools and Almanac Oddities

How I learned more than I ever wanted to know about the Nautical Almanac

- Celestial Tools is the only program of its kind expressly developed as a tool for USPS JN and N students.
- USPS teaches extraction of data from the Nautical Almanac, and reduction of sights currently by one calculator method and one tabular method.

Of the stars, planets, the Sun, and the Moon, which bodies are the most difficult for a program to reproduce Nautical Almanac data?

- The Moon?
- Most complicated motion, but not the Moon.
- IMHO, the Sun and Venus are the most difficult.

Accuracy of Nautical Almanac

ACCURACY

24. *Main data.* The quantities tabulated in this Almanac are generally correct to the nearest $0'.1$; the exception is the Sun's GHA which is deliberately adjusted by up to $0'.15$ to reduce the error due to ignoring the *v*-correction. The GHA and Dec at intermediate times cannot be obtained to this precision, since at least two quantities must be added; moreover, the *v*- and *d*-corrections are based on mean values of *v* and *d* and are taken from tables for the whole minute only. The largest error that can occur in the GHA or Dec of any body other than the Sun or Moon is less than $0'.2$; it may reach $0'.25$ for the GHA of the Sun and $0'.3$ for that of the Moon.

In practice it may be expected that only one third of the values of GHA and Dec taken out will have errors larger than $0'.05$ and less than one tenth will have errors larger than $0'.1$.

25. *Altitude corrections.* The errors in the altitude corrections are nominally of the same order as those in GHA and Dec, as they result from the addition of several quantities each correctly rounded off to $0'.1$. But the actual values of the dip and of the refraction at low altitudes may, in extreme atmospheric conditions, differ considerably from the mean values used in the tables.

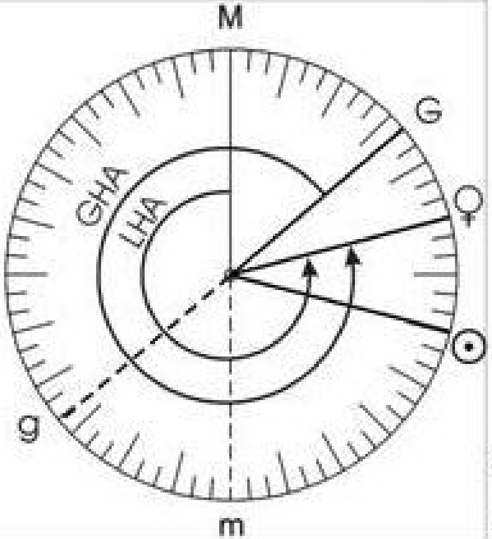
NOT the "gold standard"

TIME

Date	29 June 20XX
WT	05-20-14
WE (f-, s+) (+)	00-07
ZT	05-20-21
ZD (E-, W+) (+)	3
UT	08-20-21
G Day/Mo	29 June

SIGHT DATA

Sight No.	2
Body	Venus
DR L	22° 25.7' N
DR Lo	49° 31.2' W



ALTITUDE

Ht of eye	9.0 ft	
hs	20° 02.6'	
	(+)	(-)
IC	0.5'	
Dip		2.9'
Total	0.5'	2.9'
Corr	(-) 2.4'	
ha	20° 00.2'	
HP ☾		
	(+)	(-)
Main		2.6'
Add'l ☾, Pl	0.4'	
UL☾ -30.00'		
Add'l Ref		
Total	0.4'	2.6'
Corr	(-) 2.2'	
Ho	19° 58.0'	

ALMANAC --- LHA

SHA★		
GHA ♀		
08 hr	329° 08.5'	
20 m 21 s	5° 05.3'	
v (+)	2.4'	
v corr (+)		0.8'
Tot GHA	334° 14.6'	
DR Lo (-)	49° 31.2' W	
LHA	284° 43.4'	

ALMANAC --- DEC

Dec 08 hr	17° 57.6' N	
d (-)	0.2'	
d corr (-)		0.1'
Dec	17° 57.5' N	

Brief Description

- Celestial navigation (and piloting) program for Microsoft Windows
  - (can be run on a Mac under Wine)
- Three main celestial modules:

1) Sight planning - three functions

a) "Twilight" and Moon data calculator

b) "Star Finder" (and Sun-Moon fix availability)

c) 2102-D Star Finder aid

2) Sight reduction & fix - five functions

a) Reduce sight to intercept and azimuth by Law of Cosines

b) Estimated position (for single sight)

c) Fix (for multiple sights)

d) Latitude by altitude of Polaris

e) Equation of Time

3) Noon sight - three functions

a) Zone time of LAN

b) Latitude by noon sight

c) Longitude (and latitude) by observed time of LAN

- All main celestial modules have built-in "almanac"

Brief Description (Cont.)

- Six auxiliary celestial modules:
  1) Sight Reduction methods and Fix
     a) Reduce sight to intercept and azimuth by LoC, NASR, and several other methods using data extracted from the Nautical Almanac
     b) EP, "AP/EP" and DR-LOP distance (for single sight from AP)
     c) Fix (multiple sights) (LoC only)
  2) Sight Averaging (with analysis)
  3) Arc ⇔ Time Conversion, ZT ⇔ LMT Conversion
  4) Navigation Math - Interpolation (single and double)
     (includes sexagesimal-to-decimal converter, angle addition/subtraction, and several time calculators)
  5) Yellow Pages – Increments and Corrections
  6) "Favorite Places"
- No "almanac", just calculators and convenience features

Brief Description (Cont.)

- Ten "Piloting" modules:
  1) The Sailings (Mid-Latitude, Mercator, Accurate Rhumb Line, Great Circle)
     a) Rhumb Line (Mid-Latitude, Mercator, Accurate Rhumb Line) – calculates destination L and Lo, course and distance, set and drift
     b) Great Circle – calculates initial course and distance, maximum latitude, points on route
  2) Wind & Current – calculates CTS, SOA, CMG, SMG
  3) Distance to Horizon/Object
  4) 60D = ST (Time, Speed, Distance)
  5) TVMDC (with deviation table and charted variation calculator)
  6) Length of a degree of longitude and latitude for spherical and WGS84 spheroid Earth
  7) Maneuvering Board

Brief Description (Cont.)

- Ten “Piloting” modules (continued):
  - 8) 2/3 Bearings
    - a) Distance by two bearings
    - b) Fix by cross bearings
    - c) CMG by three bearings
  - 9) Tides
  - 10) Currents

Not so Brief Description (Cont.)

- Three additional "utility" functions:
    1) Select printer
    2) Help
    3) About

From fictitious Reviews of Celestial Tools

- “Its usefulness is astronomical.”
- “Its performance is stellar.”
- “A star among celestial navigation programs.”

- “Out of this world!”
- “Rated 5 Stars. Navigational stars, of course!”

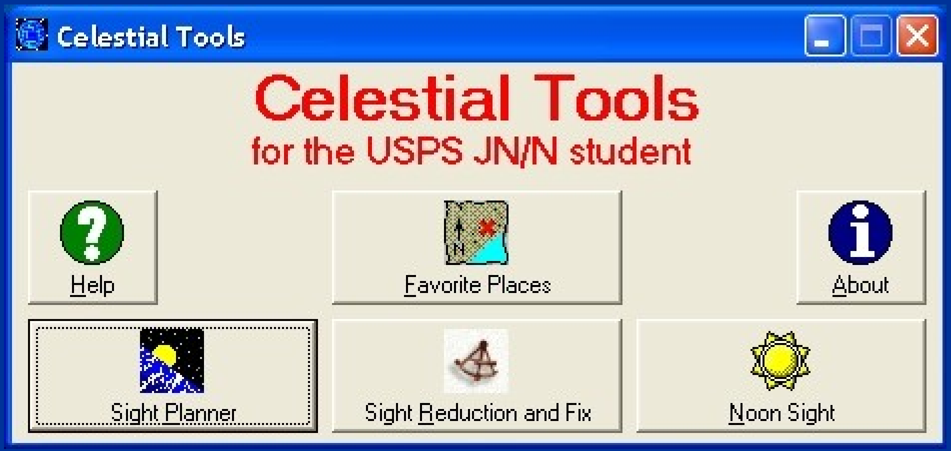
Celestial Tools guarantee

Satisfaction guaranteed or
double your money back

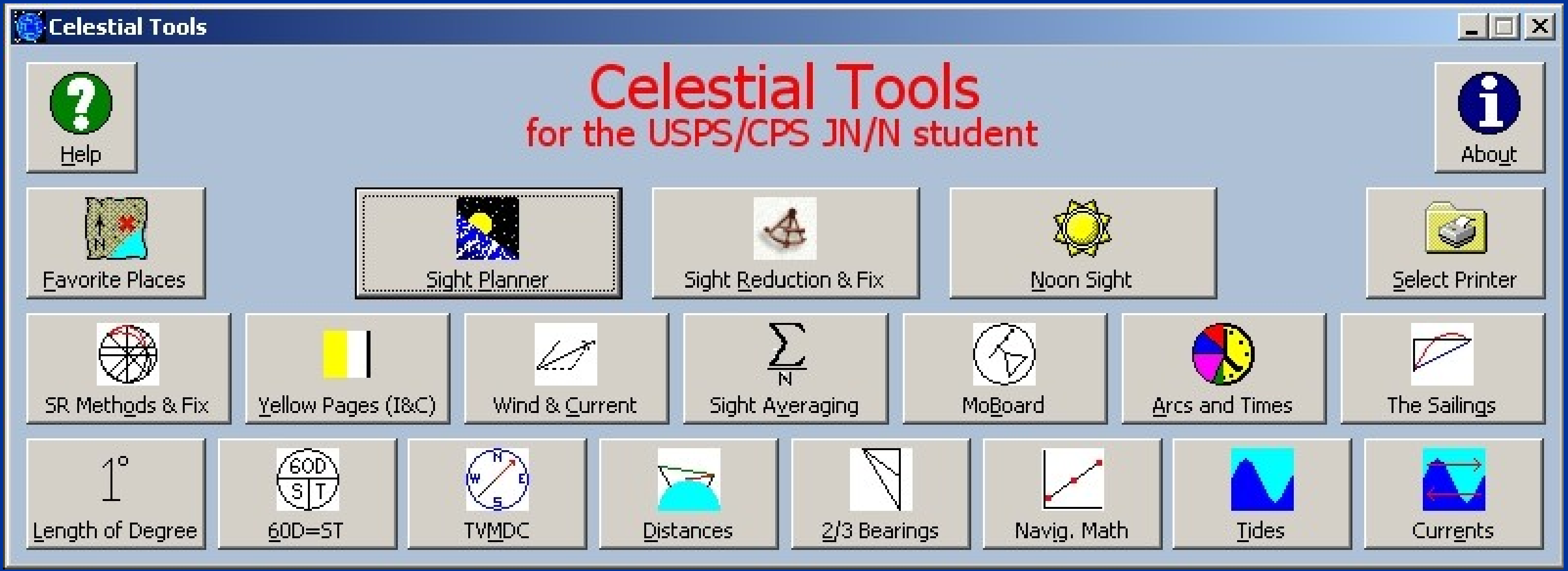
Celestial Tools

- My first and only successful venture into Windows programming
- Started writing it in 2004, based on DOS programs I wrote in early ‘90s
- Adding features and removing bugs ever since
- Sight Planner tool added to USPS N09, N15 courses
- Available on ONCom web site, periodically attached to a NavList message, or just ask (slk1000@aol.com)

Then (V1.0.6-V1.7.0) – just celestial



Now (V5.6.4) – more celestial plus piloting



This presentation includes:

- ~~How the program came to be~~
- ~~What the program is and isn’t~~
- ~~How the program can be used~~
- What it takes to try to please everyone
- What I learned about the Nautical Almanac and other references because of Celestial Tools

Everyone?

Those who want values they can use for practical, on-the-water navigation. Not interested in Nautical Almanac values or extraction of data.

Those who want values that match the Nautical Almanac, for use with USPS courses (exams, sight folders). Want to know how to extract data from the Nautical Almanac.

Those who want data for study.
For them, the Nautical Almanac is not adequate.

Who Will Be Interested?

Those who are taking or plan to take JN or N

JN/N Student

Who Will Be Interested?

Those who have taken JN or N

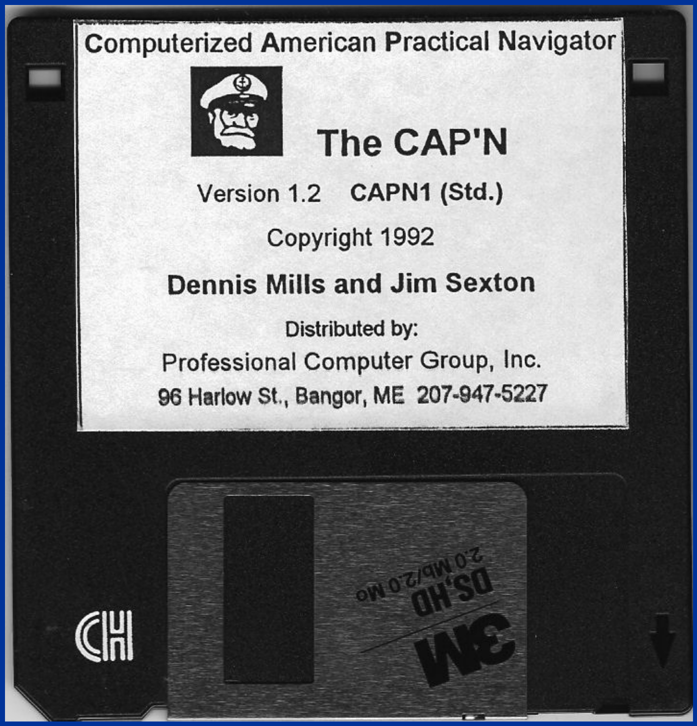
JN/N Graduate

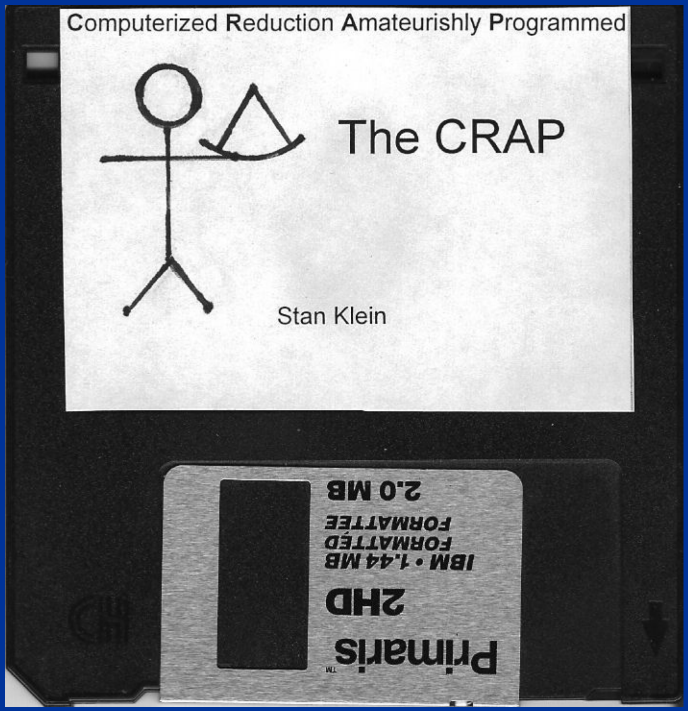
Who Will Be Interested?

Those with an interest in computer programming

Who Will Be Interested?

Those who are interested in what it is like working with a national committee


Computerized American Practical Navigator
The CAP'N
Version 1.2 CAPN1 (Std.)
Copyright 1992
Dennis Mills and Jim Sexton
Distributed by:
Professional Computer Group, Inc.
96 Harlow St., Bangor, ME 207-947-5227


Computerized Reduction Amateurishly Programmed
The CRAP
Stan Klein

Goals

1) Accurate enough to check quality of sights while at the "beach", but not so accurate as to do the work for the student.

2) In a format that would help students find errors in their work.

3) User-friendly.

These goals were almost achieved with V3.0.0, but not fully achieved until V5.1.0.

(Well, not quite.)

Canadian Power & Sail Squadrons/
Escadrilles canadiennes de plaisance

Toronto 2004
CPS 56th Annual Conference
56ième Conférence annuelle ECP

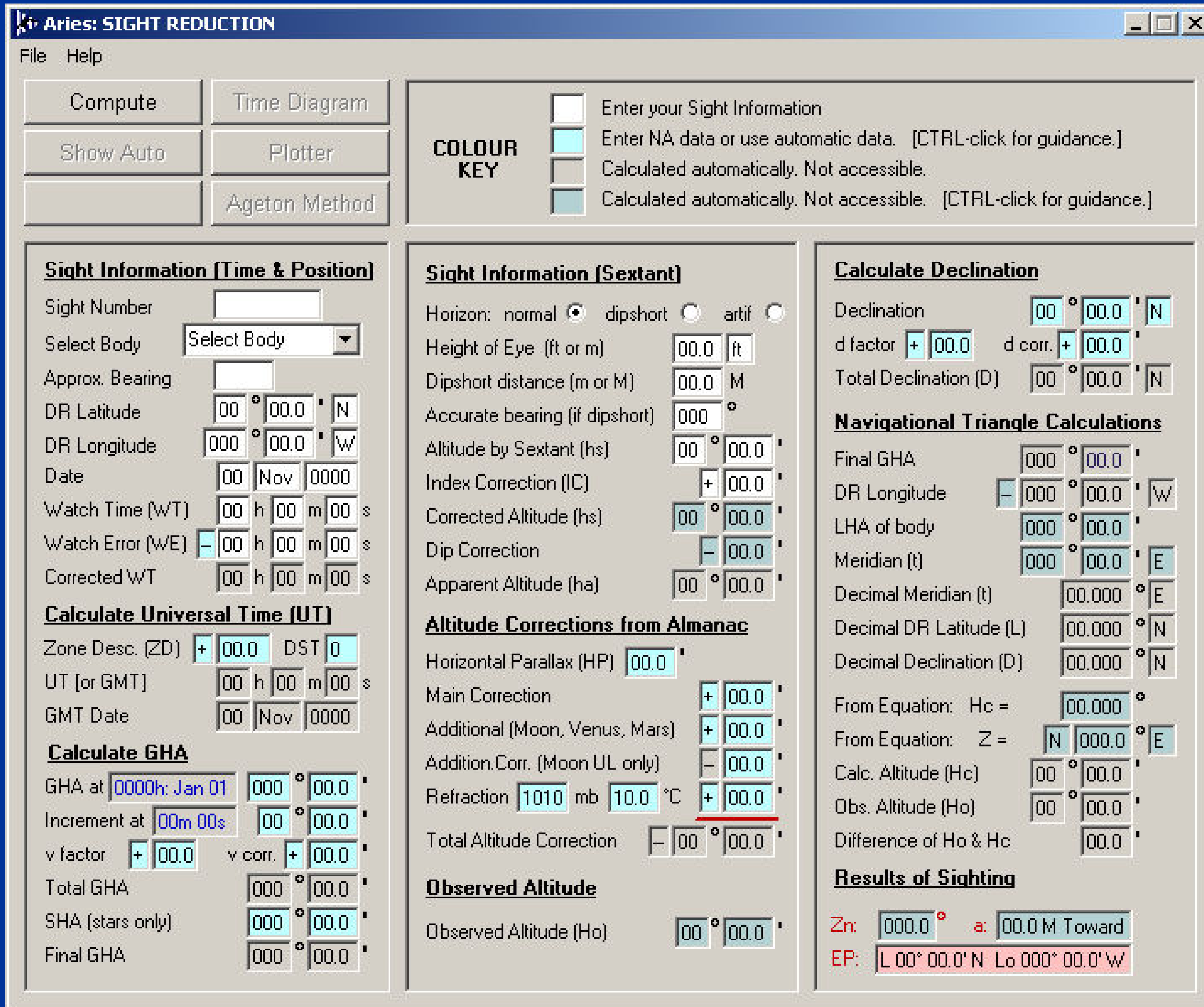
Toronto 2004 Competition Results

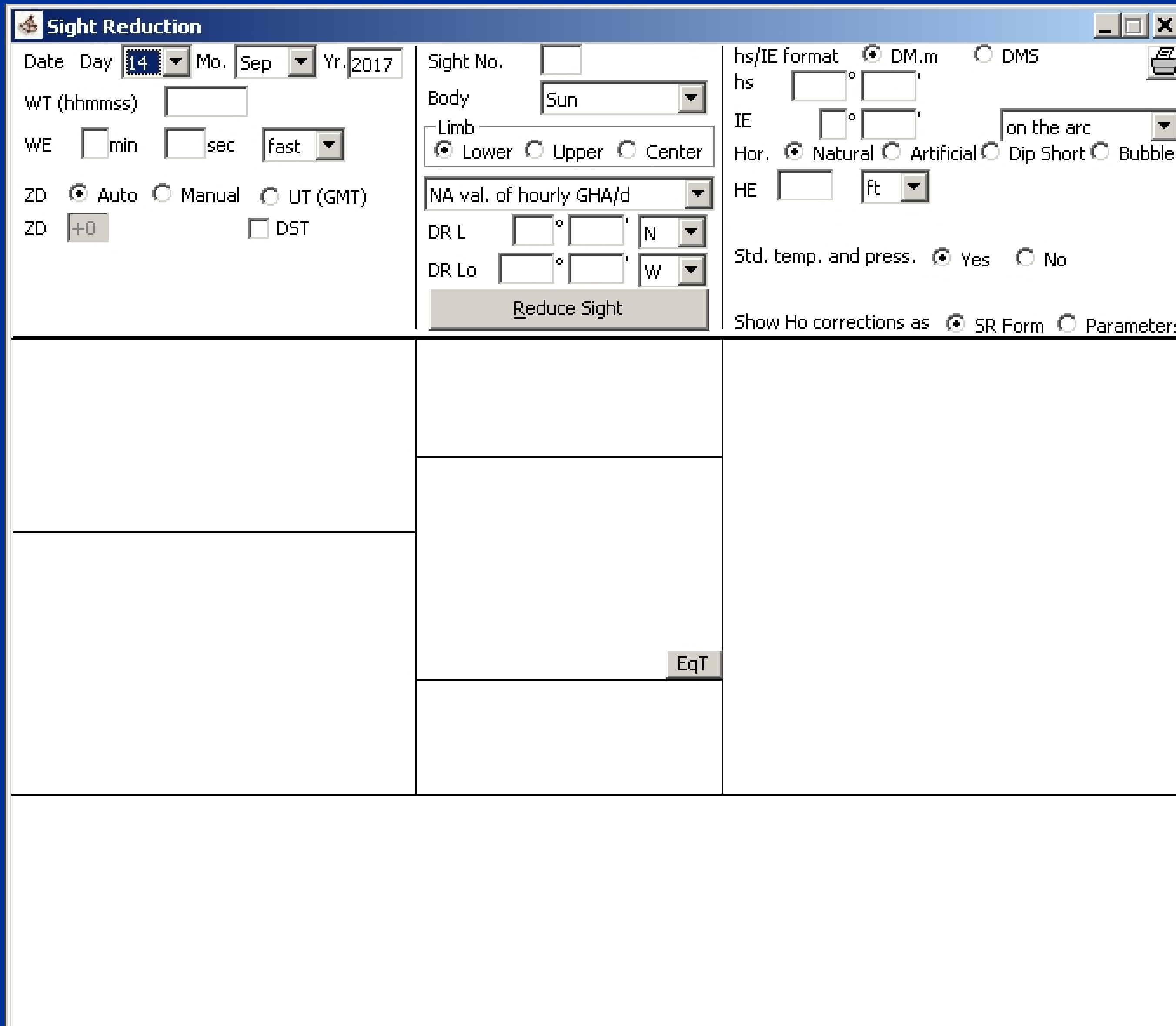
Division 1. Training Aids.

First: Stan Klein, Middletown Squadron, USPS

Second: Carol J. Murray, Norvan Squadron

Third : David Eyre, Ballenas Squadron

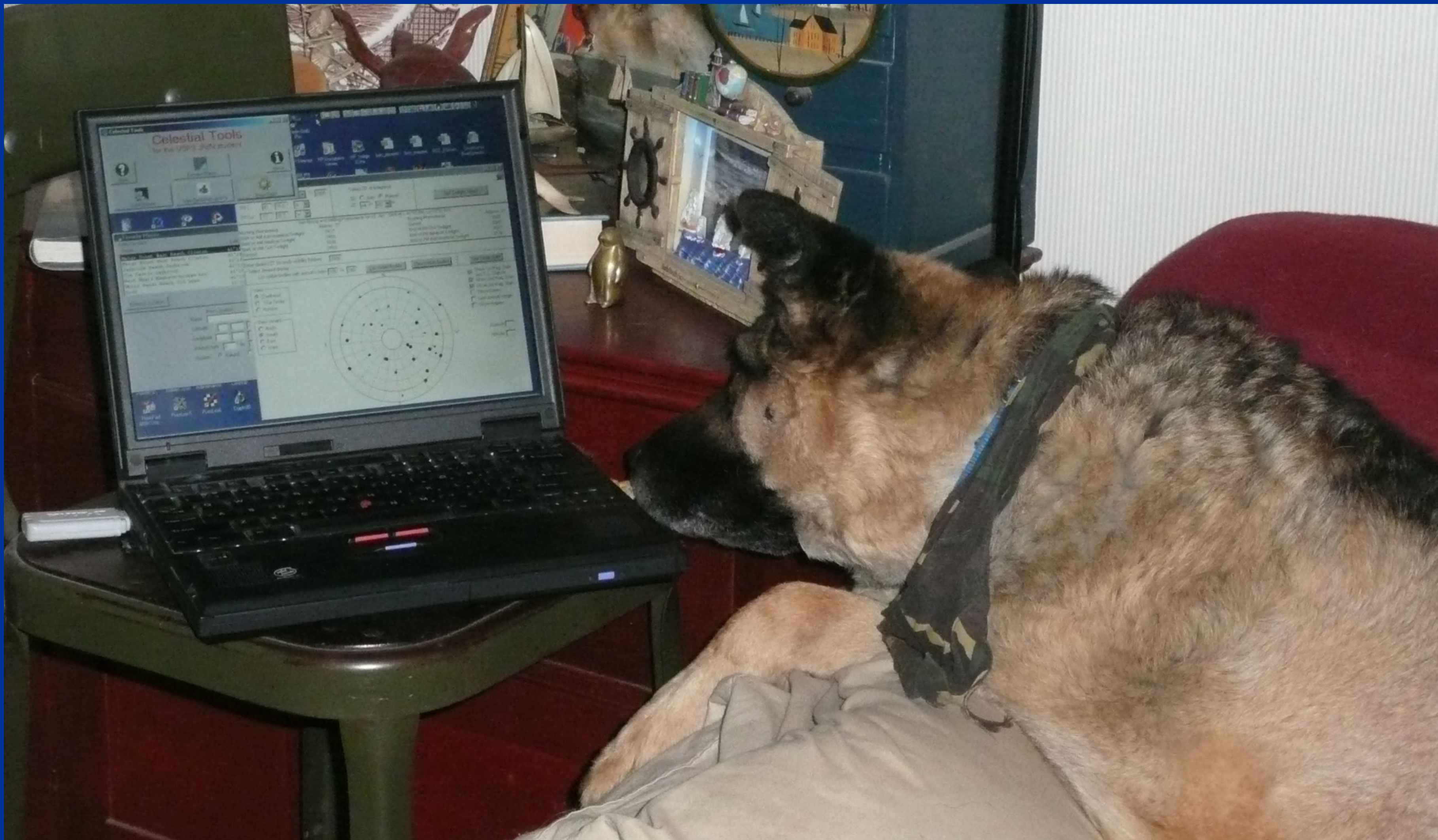

Aries: SIGHT REDUCTION
File
Help
Compute
Time Diagram
Show Auto
Plotter
Ageton Method
COLOUR KEY
Enter your Sight Information
Enter NA data or use automatic data. [CTRL-click for guidance.]
Calculated automatically. Not accessible.
Calculated automatically. Not accessible. [CTRL-click for guidance.]
Sight Information (Time & Position)
Sight Number
Select Body
Select Body
Approx. Bearing
DR Latitude 00 ° 00.0 ' N
DR Longitude 000 ° 00.0 ' W
Date 00 Nov 0000
Watch Time (WT) 00 h 00 m 00 s
Watch Error (WE) – 00 h 00 m 00 s
Corrected WT 00 h 00 m 00 s
Calculate Universal Time (UT)
Zone Desc. (ZD) + 00.0 DST 0
UT [or GMT] 00 h 00 m 00 s
GMT Date 00 Nov 0000
Calculate GHA
GHA at 0000h: Jan 01 000 ° 00.0 '
Increment at 00m 00s 00 ° 00.0 '
v factor + 00.0 v corr. + 00.0 '
Total GHA 000 ° 00.0 '
SHA (stars only) 000 ° 00.0 '
Final GHA 000 ° 00.0 '
Sight Information (Sextant)
Horizon: normal dipshort artif
Height of Eye (ft or m) 00.0 ft
Dipshort distance (m or M) 00.0 M
Accurate bearing (if dipshort) 000 °
Altitude by Sextant (hs) 00 ° 00.0 '
Index Correction (IC) + 00.0 '
Corrected Altitude (hs) 00 ° 00.0 '
Dip Correction – 00.0 '
Apparent Altitude (ha) 00 ° 00.0 '
Altitude Corrections from Almanac
Horizontal Parallax (HP) 00.0 '
Main Correction + 00.0 '
Additional (Moon, Venus, Mars) + 00.0 '
Addition.Corr. (Moon UL only) – 00.0 '
Refraction 1010 mb 10.0 °C + 00.0 '
Total Altitude Correction – 00 ° 00.0 '
Observed Altitude
Observed Altitude (Ho) 00 ° 00.0 '
Calculate Declination
Declination 00 ° 00.0 ' N
d factor + 00.0 d corr. + 00.0 '
Total Declination (D) 00 ° 00.0 ' N
Navigational Triangle Calculations
Final GHA 000 ° 00.0 '
DR Longitude – 000 ° 00.0 ' W
LHA of body 000 ° 00.0 '
Meridian (t) 000 ° 00.0 ' E
Decimal Meridian (t) 00.000 ° E
Decimal DR Latitude (L) 00.000 ° N
Decimal Declination (D) 00.000 ° N
From Equation: Hc = 00.000 °
From Equation: Z = N 000.0 ° E
Calc. Altitude (Hc) 00 ° 00.0 '
Obs. Altitude (Ho) 00 ° 00.0 '
Difference of Ho & Hc 00.0 '
Results of Sighting
Zn: 000.0 ° a: 00.0 M Toward
EP: L 00° 00.0' N Lo 000° 00.0' W


Sight Reduction
Date Day 14 Mo. Sep Yr. 2017
WT (hhmmss)
WE min sec fast
ZD Auto Manual UT (GMT)
ZD +0 DST
Sight No.
Body Sun
Limb
Lower Upper Center
NA val. of hourly GHA/d
DR L N
DR Lo W
Reduce Sight
EqT
hs/IE format DM.m DMS
hs
IE on the arc
Hor. Natural Artificial Dip Short Bubble
HE ft
Std. temp. and press. Yes No
Show Ho corrections as SR Form Parameters


Celestial Tools
So easy a caveman can do it.™


TOUGHBOOK
Celestial Tools
for the USPS/CPS JN/N student
Panasonic
CF-M34


TOUGHBOOK
Panasonic
CF-M34


Celestial Tools


Celestial Tools

On-Line Nautical Almanac Notice

The Educational Department has the following announcement regarding Nautical Almanac data:

> There are several versions of the Nautical Almanac on the Internet. The Offshore Navigation Committee has looked at these and found that the data varies slightly from that found in the commercially printed Nautical Almanac sold by retailers and USPS Headquarters. More importantly, most of these on-line Nautical Almanacs do not provide all the intermediate values required on the SR96 Form (such as SHA, 'd' and 'v' correction), nor do they include the 'increments and corrections' section. Sight folders will be graded using the data from the printed version of the Nautical Almanac, and discrepancies will be considered errors.

Please pass this information to celestial navigation students, sight proctors, and instructors. (16 Oct 05)

What else is “wrong” with most computerized and on-line Nautical Almanacs?

Example: What is the GHA of the Sun on 1 January 2015 at 00h UT?

Navigator Lite	179º12.2’
TheNauticalAlmanac.com	179º12.2’
Reed Navigation	179º12.1’
Erik DeMan	179º12.2’
Italian on-line almanac	179º12.2’
Celestial	179º12.2’
Starstruck Navigation	179º12.22’
Nautical Almanac (Ruiz)	179º12.2’
Celestial Navigator	179º12.169’
Star Finder	179º12.1’
Celestial Navigator (Jones)	179º12.22’
Teacup Celestial	179º12.17’
Sun.xls (Hakel)	179º12.1’
NavSoft’s Nautical Almanac	179º12.0’
ezAlmanac	179º12.0’
USNO Interactive Computer Ephemeris (I.C.E.)	179º12.2’
USNO web site	179º12.2’

Rounded to 0.1’, 12 of these 17 references say 179º12.2’

What does the Nautical Almanac say? 179º12.0'!!!

Is the Nautical Almanac wrong?

In a sense, yes. The Sun's GHA is deliberately adjusted by up to 0.15' to reduce the error due to ignoring the *v*-correction.

About half of the 8760 (8784) hourly Sun GHAs in the Nautical Almanac will be off by as much as 0.3' (0.2').

How does Celestial Tools differ from other similar programs?

Celestial Tools has two modes.

In the "NA" mode, Celestial Tools gives 179º12.0'.
In the "Accurate" mode, Celestial Tools gives 179º12.2'.

In the "NA" mode, Celestial Tools will agree with the hourly GHA of the Sun as listed in the Nautical Almanac almost 99% of the time, and when it is off, it is off by no more than 0.1'.

The only other readily available references that try to duplicate the Nautical Almanac values of the GHA of the Sun are NavSoft's Nautical Almanac and ezAlmanac (Pro) (iOS).

What other “adjustments” does the Nautical Almanac use?

UT	ARIES	VENUS −4.4		MARS +1.8		JUPITER −1.8		SATURN +0.1		STARS		
d h	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	Name	SHA	Dec
2 00	280 22.2	211 39.6	N17 43.9	152 34.6	N20 10.0	115 07.4	N 7 33.6	173 05.3	N22 12.7	Acamar	315 23.8	S40 17.0
01	295 24.6	226 41.8	43.8	167 35.7	09.6	130 09.5	33.4	188 07.4	12.7	Achernar	335 31.9	S57 12.6
02	310 27.1	241 44.1	43.6	182 36.6	09.2	145 11.6	33.3	203 09.5	12.6	Acrux	173 17.6	S63 07.7
03	325 29.6	256 46.3	43.4	197 37.4	08.8	160 13.8	33.1	218 11.6	12.6	Adhara	255 18.5	S28 58.6
04	340 32.0	271 48.5	43.3	212 38.3	08.4	175 15.9	33.0	233 13.8	12.6	Aldebaran	290 57.8	N16 31.1
05	355 34.5	286 50.7	43.1	227 39.1	08.0	190 18.0	32.8	248 15.9	12.5			
06	10 37.0	301 52.9	N17 42.9	242 39.9	N20 07.6	205 20.2	N 7 32.7	263 18.0	N22 12.5	Alioth	166 26.5	N55 56.5
07	25 39.4	316 55.1	42.8	257 40.8	07.2	220 22.3	32.5	278 20.1	12.5	Alkaid	153 04.1	N49 17.7
F 08	40 41.9	331 57.4	42.6	272 41.6	06.8	235 24.4	32.4	293 22.2	12.4	Al Na'ir	27 52.0	S46 56.2
R 09	55 44.4	346 59.6	42.5	287 42.5	06.5	250 26.5	32.2	308 24.3	12.4	Alnilam	275 53.8	S 1 11.8
I 10	70 46.8	2 01.7	42.3	302 43.3	06.1	265 28.7	32.1	323 26.5	12.4	Alphard	218 03.3	S 8 40.6
D 11	85 49.3	17 03.9	42.2	317 44.1	05.7	280 30.8	32.0	338 28.6	12.3			
A 12	100 51.7	32 06.1	N17 42.0	332 45.0	N20 05.3	295 32.9	N 7 31.8	353 30.7	N22 12.3	Alphecca	126 16.7	N26 42.1
Y 13	115 54.2	47 08.3	41.9	347 45.8	04.9	310 35.0	31.7	8 32.8	12.3	Alpheratz	357 50.8	N29 06.7
14	130 56.7	62 10.5	41.7	2 46.7	04.5	325 37.2	31.5	23 34.9	12.2	Altair	62 14.8	N 8 52.7
15	145 59.1	77 12.7	41.5	17 47.5	04.1	340 39.3	31.4	38 37.0	12.2	Ankaa	353 22.4	S42 16.7
16	161 01.6	92 14.9	41.4	32 48.3	03.7	355 41.4	31.2	53 39.2	12.2	Antares	112 34.6	S26 26.6
17	176 04.1	107 17.0	41.3	47 49.2	03.3	10 43.5	31.1	68 41.3	12.1			
18	191 06.5	122 19.2	N17 41.1	62 50.0	N20 02.9	25 45.7	N 7 30.9	83 43.4	N22 12.1	Arcturus	146 02.0	N19 09.7
19	206 09.0	137 21.4	41.0	77 50.9	02.5	40 47.8	30.8	98 45.5	12.1	Atria	107 42.4	S69 02.4
20	221 11.5	152 23.5	40.8	92 51.7	02.1	55 49.9	30.6	113 47.6	12.0	Avior	234 21.7	S59 31.4
21	236 13.9	167 25.7	40.7	107 52.6	01.8	70 52.0	30.5	128 49.7	12.0	Bellatrix	278 39.9	N 6 21.3
22	251 16.4	182 27.8	40.5	122 53.4	01.4	85 54.2	30.3	143 51.9	12.0	Betelgeuse	271 09.2	N 7 24.6
23	266 18.9	197 30.0	40.4	137 54.2	01.0	100 56.3	30.2	158 54.0	11.9			
3 00	281 21.3	212 32.1	N17 40.3	152 55.1	N20 00.6	115 58.4	N 7 30.0	173 56.1	N22 11.9	Canopus	263 59.8	S52 41.7
01	296 23.8	227 34.2	40.1	167 55.9	20 00.2	131 00.5	29.9	188 58.2	11.8	Capella	280 45.3	N46 00.2
02	311 26.2	242 36.4	40.0	182 56.8	19 59.8	146 02.7	29.8	204 00.3	11.8	Deneb	49 36.0	N45 17.6
03	326 28.7	257 38.5	39.8	197 57.6	59.4	161 04.8	29.6	219 02.4	11.8	Denebola	182 40.9	N14 33.0
04	341 31.2	272 40.6	39.7	212 58.5	59.0	176 06.9	29.5	234 04.6	11.7	Diphda	349 02.9	S17 57.6
05	356 33.6	287 42.8	39.6	227 59.3	58.6	191 09.0	29.3	249 06.7	11.7			
06	11 36.1	302 44.9	N17 39.4	243 00.1	N19 58.2	206 11.1	N 7 29.2	264 08.8	N22 11.7	Dubhe	194 00.2	N61 44.0
S 07	26 38.6	317 47.0	39.3	258 01.0	57.8	221 13.3	29.0	279 10.9	11.6	Elnath	278 21.9	N28 36.7
A 08	41 41.0	332 49.1	39.2	273 01.8	57.4	236 15.4	28.9	294 13.0	11.6	Eltanin	90 48.9	N51 29.3
T 09	56 43.5	347 51.2	39.1	288 02.7	57.0	251 17.5	28.7	309 15.1	11.6	Enif	33 53.8	N 9 53.6
U 10	71 46.0	2 53.3	38.9	303 03.5	56.6	266 19.6	28.6	324 17.3	11.5	Fomalhaut	15 31.4	S29 35.8
R 11	86 48.4	17 55.4	38.8	318 04.4	56.2	281 21.8	28.4	339 19.4	11.5			
D 12	101 50.9	32 57.5	N17 38.7	333 05.2	N19 55.8	296 23.9	N 7 28.3	354 21.5	N22 11.5	Gacrux	172 09.1	S57 08.5
A 13	116 53.3	47 59.6	38.6	348 06.0	55.4	311 26.0	28.1	9 23.6	11.4	Gienah	175 59.7	S17 34.0
Y 14	131 55.8	63 01.7	38.4	3 06.9	55.0	326 28.1	28.0	24 25.7	11.4	Hadar	148 58.0	S60 23.9
15	146 58.3	78 03.8	38.3	18 07.7	54.6	341 30.2	27.8	39 27.8	11.4	Hamal	328 08.9	N23 28.9
16	162 00.7	93 05.9	38.2	33 08.6	54.2	356 32.4	27.7	54 29.9	11.3	Kaus Aust.	83 52.7	S34 23.0
17	177 03.2	108 08.0	38.1	48 09.4	53.8	11 34.5	27.5	69 32.1	11.3			
18	192 05.7	123 10.0	N17 38.0	63 10.3	N19 53.4	26 36.6	N 7 27.4	84 34.2	N22 11.3	Kochab	137 18.6	N74 08.5
19	207 08.1	138 12.1	37.9	78 11.1	53.0	41 38.7	27.2	99 36.3	11.2	Markab	13 45.2	N15 13.6
20	222 10.6	153 14.2	37.7	93 12.0	52.7	56 40.8	27.1	114 38.4	11.2	Menkar	314 22.6	N 4 06.5
21	237 13.1	168 16.2	37.6	108 12.8	52.3	71 43.0	26.9	129 40.5	11.1	Menkent	148 15.9	S36 23.7
22	252 15.5	183 18.3	37.5	123 13.7	51.9	86 45.1	26.8	144 42.6	11.1	Miaplacidus	221 42.3	S69 44.2
23	267 18.0	198 20.4	37.4	138 14.5	51.5	101 47.2	26.7	159 44.8	11.1			
4 00	282 20.5	213 22.4	N17 37.3	153 15.3	N19 51.1	116 49.3	N 7 26.5	174 46.9	N22 11.0	Mirfak	308 50.9	N49 52.5
01	297 22.9	228 24.5	37.2	168 16.2	50.7	131 51.4	26.4	189 49.0	11.0	Nunki	76 06.6	S26 17.5
02	312 25.4	243 26.5	37.1	183 17.0	50.3	146 53.6	26.2	204 51.1	11.0	Peacock	53 29.6	S56 43.2
03	327 27.8	258 28.5	37.0	198 17.9	49.9	161 55.7	26.1	219 53.2	10.9	Pollux	243 36.7	N28 01.1
04	342 30.3	273 30.6	36.9	213 18.7	49.5	176 57.8	25.9	234 55.3	10.9	Procyon	245 07.4	N 5 13.0
05	357 32.8	288 32.6	36.8	228 19.6	49.1	191 59.9	25.8	249 57.5	10.9			
06	12 35.2	303 34.7	N17 36.7	243 20.4	N19 48.7	207 02.0	N 7 25.6	264 59.6	N22 10.8	Rasalhague	96 12.6	N12 33.4
07	27 37.7	318 36.7	36.6	258 21.3	48.3	222 04.2	25.5	280 01.7	10.8	Regulus	207 51.2	N11 56.9
08	42 40.2	333 38.7	36.5	273 22.1	47.9	237 06.3	25.3	295 03.8	10.8	Rigel	281 19.1	S 8 11.7
S 09	57 42.6	348 40.7	36.4	288 23.0	47.5	252 08.4	25.2	310 05.9	10.7	Rigil Kent.	140 01.4	S60 51.5
U 10	72 45.1	3 42.7	36.3	303 23.8	47.1	267 10.5	25.0	325 08.0	10.7	Sabik	102 20.3	S15 43.9
N 11	87 47.6	18 44.7	36.2	318 24.7	46.6	282 12.6	24.9	340 10.2	10.7			
D 12	102 50.0	33 46.8	N17 36.1	333 25.5	N19 46.2	297 14.7	N 7 24.7	355 12.3	N22 10.6	Schedar	349 48.8	N56 33.4
A 13	117 52.5	48 48.8	36.0	348 26.3	45.8	312 16.9	24.6	10 14.4	10.6	Shaula	96 31.1	S37 06.5
Y 14	132 55.0	63 50.8	35.9	3 27.2	45.4	327 19.0	24.4	25 16.5	10.5	Sirius	258 40.3	S16 43.2
15	147 57.4	78 52.8	35.8	18 28.0	45.0	342 21.1	24.3	40 18.6	10.5	Spica	158 38.6	S11 11.1
16	162 59.9	93 54.8	35.7	33 28.9	44.6	357 23.2	24.1	55 20.7	10.5	Suhail	222 58.1	S43 27.0
17	178 02.3	108 56.7	35.6	48 29.7	44.2	12 25.3	24.0	70 22.9	10.4			
18	193 04.8	123 58.7	N17 35.6	63 30.6	N19 43.8	27 27.4	N 7 23.8	85 25.0	N22 10.4	Vega	80 43.3	N38 47.2
19	208 07.3	139 00.7	35.5	78 31.4	43.4	42 29.6	23.7	100 27.1	10.4	Zuben'ubi	137 13.1	S16 03.7
20	223 09.7	154 02.7	35.4	93 32.3	43.0	57 31.7	23.5	115 29.2	10.3		SHA	Mer. Pass.
21	238 12.2	169 04.7	35.3	108 33.1	42.6	72 33.8	23.4	130 31.3	10.3		° ′	h m
22	253 14.7	184 06.6	35.2	123 34.0	42.2	87 35.9	23.2	145 33.4	10.3	Venus	291 10.8	9 48
23	268 17.1	199 08.6	35.1	138 34.8	41.8	102 38.0	23.1	160 35.5	10.2	Mars	231 33.8	13 48
										Jupiter	194 37.1	16 14
Mer. Pass. (h m)	5 13.7	*v* 2.1	*d* 0.1	*v* 0.8	*d* 0.4	*v* 2.1	*d* 0.1	*v* 2.1	*d* 0.0	Saturn	252 34.8	12 23

UT	ARIES	VENUS −4.5		MARS +1.8		JUPITER −1.8		SATURN +0.1		STARS		
d h	GHA	GHA	Dec	GHA	Dec	GHA	Dec	GHA	Dec	Name	SHA	Dec
5 00	283 19.6	214 10.6	N17 35.1	153 35.7	N19 41.4	117 40.1	N 7 22.9	175 37.7	N22 10.2	Acamar	315 23.8	S40 17.0
01	298 22.1	229 12.5	35.0	168 36.5	41.0	132 42.3	22.8	190 39.8	10.2	Achernar	335 31.8	S57 12.5
02	313 24.5	244 14.5	34.9	183 37.4	40.6	147 44.4	22.6	205 41.9	10.1	Acrux	173 17.6	S63 07.7
03	328 27.0	259 16.4	34.8	198 38.2	40.2	162 46.5	22.5	220 44.0	10.1	Adhara	255 18.5	S28 58.6
04	343 29.5	274 18.4	34.8	213 39.1	39.8	177 48.6	22.3	235 46.1	10.1	Aldebaran	290 57.8	N16 31.1
05	358 31.9	289 20.3	34.7	228 39.9	39.4	192 50.7	22.2	250 48.2	10.0			
06	13 34.4	304 22.3	N17 34.6	243 40.8	N19 39.0	207 52.8	N 7 22.0	265 50.4	N22 10.0	Alioth	166 26.6	N55 56.5
07	28 36.8	319 24.2	34.5	258 41.6	38.6	222 55.0	21.9	280 52.5	09.9	Alkaid	153 04.1	N49 17.7
08	43 39.3	334 26.2	34.5	273 42.5	38.2	237 57.1	21.7	295 54.6	09.9	Al Na'ir	27 52.0	S46 56.2
M 09	58 41.8	349 28.1	34.4	288 43.3	37.8	252 59.2	21.6	310 56.7	09.9	Alnilam	275 53.8	S 1 11.8
O 10	73 44.2	4 30.0	34.3	303 44.2	37.3	268 01.3	21.4	325 58.8	09.8	Alphard	218 03.3	S 8 40.6
N 11	88 46.7	19 31.9	34.3	318 45.0	36.9	283 03.4	21.3	341 00.9	09.8			
D 12	103 49.2	34 33.9	N17 34.2	333 45.9	N19 36.5	298 05.5	N 7 21.1	356 03.1	N22 09.8	Alphecca	126 16.7	N26 42.1
A 13	118 51.6	49 35.8	34.1	348 46.7	36.1	313 07.6	21.0	11 05.2	09.7	Alpheratz	357 50.8	N29 06.7
Y 14	133 54.1	64 37.7	34.1	3 47.6	35.7	328 09.7	20.8	26 07.3	09.7	Altair	62 14.8	N 8 52.7
15	148 56.6	79 39.6	34.0	18 48.4	35.3	343 11.9	20.7	41 09.4	09.7	Ankaa	353 22.4	S42 16.7
16	163 59.0	94 41.5	33.9	33 49.3	34.9	358 14.0	20.5	56 11.5	09.6	Antares	112 34.6	S26 26.6
17	179 01.5	109 43.4	33.9	48 50.1	34.5	13 16.1	20.3	71 13.6	09.6			
18	194 04.0	124 45.3	N17 33.8	63 51.0	N19 34.1	28 18.2	N 7 20.2	86 15.8	N22 09.6	Arcturus	146 02.0	N19 09.7
19	209 06.4	139 47.2	33.8	78 51.8	33.7	43 20.3	20.0	101 17.9	09.5	Atria	107 42.4	S69 02.4
20	224 08.9	154 49.1	33.7	93 52.7	33.3	58 22.4	19.9	116 20.0	09.5	Avior	234 21.7	S59 31.4
21	239 11.3	169 51.0	33.7	108 53.5	32.9	73 24.5	19.7	131 22.1	09.4	Bellatrix	278 39.9	N 6 21.3
22	254 13.8	184 52.9	33.6	123 54.4	32.4	88 26.6	19.6	146 24.2	09.4	Betelgeuse	271 09.2	N 7 24.6
23	269 16.3	199 54.8	33.5	138 55.2	32.0	103 28.8	19.4	161 26.3	09.4			
6 00	284 18.7	214 56.6	N17 33.5	153 56.1	N19 31.6	118 30.9	N 7 19.3	176 28.5	N22 09.3	Canopus	263 59.8	S52 41.7
01	299 21.2	229 58.5	33.4	168 56.9	31.2	133 33.0	19.1	191 30.6	09.3	Capella	280 45.3	N46 00.2
02	314 23.7	245 00.4	33.4	183 57.8	30.8	148 35.1	19.0	206 32.7	09.3	Deneb	49 36.0	N45 17.6
03	329 26.1	260 02.2	33.3	198 58.6	30.4	163 37.2	18.8	221 34.8	09.2	Denebola	182 40.9	N14 33.0
04	344 28.6	275 04.1	33.3	213 59.5	30.0	178 39.3	18.7	236 36.9	09.2	Diphda	349 02.8	S17 57.6
05	359 31.1	290 06.0	33.3	229 00.3	29.6	193 41.4	18.5	251 39.0	09.2			
06	14 33.5	305 07.8	N17 33.2	244 01.2	N19 29.2	208 43.5	N 7 18.4	266 41.1	N22 09.1	Dubhe	194 00.2	N61 44.0
07	29 36.0	320 09.7	33.2	259 02.1	28.7	223 45.7	18.2	281 43.3	09.1	Elnath	278 21.9	N28 36.7
T 08	44 38.4	335 11.5	33.1	274 02.9	28.3	238 47.8	18.1	296 45.4	09.0	Eltanin	90 48.9	N51 29.3
U 09	59 40.9	350 13.4	33.1	289 03.8	27.9	253 49.9	17.9	311 47.5	09.0	Enif	33 53.8	N 9 53.6
E 10	74 43.4	5 15.2	33.0	304 04.6	27.5	268 52.0	17.8	326 49.6	09.0	Fomalhaut	15 31.4	S29 35.8
S 11	89 45.8	20 17.1	33.0	319 05.5	27.1	283 54.1	17.6	341 51.7	08.9			
D 12	104 48.3	35 18.9	N17 33.0	334 06.3	N19 26.7	298 56.2	N 7 17.5	356 53.8	N22 08.9	Gacrux	172 09.1	S57 08.5
A 13	119 50.8	50 20.7	32.9	349 07.2	26.3	313 58.3	17.3	11 56.0	08.9	Gienah	175 59.7	S17 34.0
Y 14	134 53.2	65 22.6	32.9	4 08.0	25.9	329 00.4	17.2	26 58.1	08.8	Hadar	148 58.0	S60 23.9
15	149 55.7	80 24.4	32.9	19 08.9	25.4	344 02.5	17.0	42 00.2	08.8	Hamal	328 08.9	N23 28.9
16	164 58.2	95 26.2	32.8	34 09.7	25.0	359 04.6	16.8	57 02.3	08.8	Kaus Aust.	83 52.7	S34 23.0
17	180 00.6	110 28.0	32.8	49 10.6	24.6	14 06.7	16.7	72 04.4	08.7			
18	195 03.1	125 29.8	N17 32.8	64 11.4	N19 24.2	29 08.9	N 7 16.5	87 06.5	N22 08.7	Kochab	137 18.7	N74 08.5
19	210 05.6	140 31.6	32.7	79 12.3	23.8	44 11.0	16.4	102 08.7	08.7	Markab	13 45.2	N15 13.6
20	225 08.0	155 33.5	32.7	94 13.1	23.4	59 13.1	16.2	117 10.8	08.6	Menkar	314 22.6	N 4 06.5
21	240 10.5	170 35.3	32.7	109 14.0	23.0	74 15.2	16.1	132 12.9	08.6	Menkent	148 15.9	S36 23.7
22	255 12.9	185 37.1	32.6	124 14.9	22.5	89 17.3	15.9	147 15.0	08.5	Miaplacidus	221 42.3	S69 44.2
23	270 15.4	200 38.9	32.6	139 15.7	22.1	104 19.4	15.8	162 17.1	08.5			
7 00	285 17.9	215 40.7	N17 32.6	154 16.6	N19 21.7	119 21.5	N 7 15.6	177 19.2	N22 08.5	Mirfak	308 50.9	N49 52.5
01	300 20.3	230 42.4	32.6	169 17.4	21.3	134 23.6	15.5	192 21.3	08.4	Nunki	76 06.6	S26 17.5
02	315 22.8	245 44.2	32.5	184 18.3	20.9	149 25.7	15.3	207 23.5	08.4	Peacock	53 29.5	S56 43.2
03	330 25.3	260 46.0	32.5	199 19.1	20.5	164 27.8	15.2	222 25.6	08.4	Pollux	243 36.6	N28 01.1
04	345 27.7	275 47.8	32.5	214 20.0	20.0	179 29.9	15.0	237 27.7	08.3	Procyon	245 07.4	N 5 13.0
05	0 30.2	290 49.6	32.5	229 20.8	19.6	194 32.0	14.9	252 29.8	08.3			
06	15 32.7	305 51.3	N17 32.4	244 21.7	N19 19.2	209 34.2	N 7 14.7	267 31.9	N22 08.3	Rasalhague	96 12.6	N12 33.4
W 07	30 35.1	320 53.1	32.4	259 22.6	18.8	224 36.3	14.5	282 34.0	08.2	Regulus	207 51.2	N11 56.9
E 08	45 37.6	335 54.9	32.4	274 23.4	18.4	239 38.4	14.4	297 36.2	08.2	Rigel	281 19.1	S 8 11.7
D 09	60 40.1	350 56.6	32.4	289 24.3	18.0	254 40.5	14.2	312 38.3	08.1	Rigil Kent.	140 01.4	S60 51.5
N 10	75 42.5	5 58.4	32.4	304 25.1	17.5	269 42.6	14.1	327 40.4	08.1	Sabik	102 20.3	S15 43.9
E 11	90 45.0	21 00.2	32.4	319 26.0	17.1	284 44.7	13.9	342 42.5	08.1			
S 12	105 47.4	36 01.9	N17 32.4	334 26.8	N19 16.7	299 46.8	N 7 13.8	357 44.6	N22 08.0	Schedar	349 48.8	N56 33.4
D 13	120 49.9	51 03.7	32.3	349 27.7	16.3	314 48.9	13.6	12 46.7	08.0	Shaula	96 31.1	S37 06.6
A 14	135 52.4	66 05.4	32.3	4 28.5	15.9	329 51.0	13.5	27 48.9	08.0	Sirius	258 40.3	S16 43.2
Y 15	150 54.8	81 07.2	32.3	19 29.4	15.4	344 53.1	13.3	42 51.0	07.9	Spica	158 38.7	S11 11.1
16	165 57.3	96 08.9	32.3	34 30.3	15.0	359 55.2	13.2	57 53.1	07.9	Suhail	222 58.1	S43 27.0
17	180 59.8	111 10.6	32.3	49 31.1	14.6	14 57.3	13.0	72 55.2	07.9			
18	196 02.2	126 12.4	N17 32.3	64 32.0	N19 14.2	29 59.4	N 7 12.8	87 57.3	N22 07.8	Vega	80 43.3	N38 47.2
19	211 04.7	141 14.1	32.3	79 32.8	13.8	45 01.5	12.7	102 59.4	07.8	Zuben'ubi	137 13.1	S16 03.7
20	226 07.2	156 15.8	32.3	94 33.7	13.3	60 03.6	12.5	118 01.5	07.7		SHA	Mer. Pass.
21	241 09.6	171 17.5	32.3	109 34.5	12.9	75 05.7	12.4	133 03.7	07.7		° ′	h m
22	256 12.1	186 19.3	32.3	124 35.4	12.5	90 07.8	12.2	148 05.8	07.7	Venus	290 37.9	9 39
23	271 14.5	201 [illegible]	32.3	139 36.3	12.1	105 09.9	12.1	163 07.9	07.6	Mars	229 37.3	13 43
										Jupiter	194 12.1	16 04
Mer. Pass. (h m)	5 01.9	*v* 1.8	*d* 0.0	*v* 0.9	*d* 0.4	*v* 2.1	*d* 0.2	*v* 2.1	*d* 0.0	Saturn	252 09.7	12 12

What other “adjustments” does the Nautical Almanac use?

It uses the values of the SHA and Dec of the stars at 12h UT of the middle day of the three days on a page (which is also used for the planetary magnitudes).

All references appear to agree on this.

It uses the v and d values of the planets and d value of the Sun based on an “average” of the middle day on a page.

These rarely make a difference, but the values could change somewhere on that page.

Similar to the “Accurate” and “NA” modes for the hourly GHA of the Sun (which also adjusts for the value of d), Celestial Tools also has modes for the SHA and Dec of the stars and the v and d values of the planets, allowing the use of either the actual date and time of the sight or an “average” of the three days of the Nautical Almanac page.

But how is this “average” determined?

Bowditch 2002 and earlier

The correction table for GHA of planets is based upon the mean rate of the Sun, 15° per hour. The v value is the difference between 15° and the change of GHA of the planet between 1200 and 1300 on the middle day of the three shown. The d value is the amount the declination changes between 1200 and 1300 on the middle day. Venus is the only body listed which ever has a negative v value.

Not true!

The "averages" used by the Nautical Almanac to determine the v and d values for the planets and the d value for the Sun are based on the difference between the associated unrounded values at 0h UT of the middle day of the page and 0h UT on the following day, divided by 24, as confirmed by Catherine Hohenkerk of HMNAO.

This is in contrast to what was said in Bowditch (through the 2002 edition), which states that they are based on the difference between the 1200 UT value and the 1300 UT value of the middle day.

Sean Urban, Chief of the Nautical Almanac Office of the US Naval Observatory, had these corrections made in the 2017 edition of Bowditch.

From a NavList message I sent:

I recently asked:

Is the *d* value listed at the bottom of the sun and planets columns of the daily pages of the Nautical Almanac the average (or mean) hourly change in the sun's declination for the three days listed (as stated in the Nautical Almanac and other references) or the amount the declination changes between 1200 and 1300 on the middle day of the three shown (as stated in Bowditch)?

I heard back from Catherine Hohenkerk, and the answer is neither! What the Nautical Almanac uses is the absolute value of the difference between the unrounded declinations at 0h UT of the middle day of the page and 0h UT of the bottom day of the page, divided by 24. I suspect that all three, when rounded to tenths of arc-minutes, will give the same result.

It just goes to show that you can't trust everything you read in Bowditch (Catherine is forwarding this information to the USNO people responsible for Bowditch), and even what is said in the Nautical Almanac is subject to interpretation.

I will be adjusting Celestial Tools to comply with this new information, even though I suspect it won't change anything.

Dear Catherine and Stan,

The next version of Bowditch, likely out mid-2017, will have the correct explanation of d.

Sincerely,

- Sean

Sean E. Urban
Chief, Nautical Almanac Office
US Naval Observatory
Washington, DC

Bowditch 2002 and earlier

The correction table for GHA of planets is based upon the mean rate of the Sun, 15° per hour. The v value is the difference between 15° and the change of GHA of the planet between 1200 and 1300 on the middle day of the three shown. The d value is the amount the declination changes between 1200 and 1300 on the middle day. Venus is the only body listed which ever has a negative v value.

Bowditch 2017

The correction table for GHA of planets is based upon the mean rate of the Sun, 15° per hour. The *v* value is the difference between 15° and the average hourly change of GHA of the planet on the middle day of the three shown. The *d* value is the average hourly amount the declination changes on the middle day. Venus is the only body listed which ever has a negative *v* value.

Bowditch 1995 and 2002 editions
Moon sight
10-00-00 GMT, June 6, 1994

To obtain the Moon's GHA, enter the daily pages in the Moon column and extract the applicable data just as for a star or Sun sight. Determining the Moon's GHA requires an additional correction, the *v* correction.

GHA Moon and *v*	245° 45.1' and +11.3
GHA Increment	0° 00.0'
v Correction	+0.1'
GHA	245° 45.2'

First, record the GHA of the Moon for 10-00-00 on June 16, 1994, from the daily pages of the *Nautical Almanac*. Record also the *v* correction factor; in this case, it is +11.3. The *v* correction factor for the Moon is always positive. The increment correction is, in this case, zero because the sight was recorded on the even hour. To obtain the *v* correction, go to the tables of increments and corrections. In the 0 minute table in the *v* or *d* correction columns, find the correction that corresponds to a *v* = 11.3. The table yields a correction of +0.1'. Adding this correction to the tabulated GHA gives the final GHA as 245° 45.2'.

Is there anything odd about this calculation of GHA?

The whole hour Moon "paradox"

Regarding v and d values and corrections, the Explanation section of the Nautical Almanac makes no procedural distinction between sights taken on the hour and those with minutes and/or seconds - if the body uses them, they should be applied. For most bodies this does not matter, but in the case of the Moon, where the v and d values often exceed 5.9', resulting in v and d corrections of 0.1' (possibly 0.2' for a v or d value of 18.0'), this can create a "paradox". If the non-zero correction is added to the hour value taken from the daily page, the Total GHA will not be the same as the hour value, even though there are no minutes or seconds.

MOON					
GHA	v	Dec		d	HP
° ′	′	° ′		′	′
190 58.4	13.3	S 2 39.8		10.7	56.1
205 30.7	13.2	2 50.5		10.6	56.1
220 02.9	13.3	3 01.1		10.6	56.1
234 35.2	13.3	3 11.7		10.7	56.1
249 07.5	13.4	3 22.4		10.5	56.0
263 39.9	13.3	3 32.9		10.6	56.0
278 12.2	13.3	S 3 43.5		10.5	56.0
292 44.5	13.4	3 54.0		10.5	56.0
307 16.9	13.3	4 04.5		10.5	56.0
321 49.2	13.4	4 15.0		10.5	55.9
336 21.6	13.4	4 25.5		10.4	55.9
350 54.0	13.3	4 35.9		10.4	55.9
5 26.3	13.4	S 4 46.3		10.4	55.9
19 58.7	13.4	4 56.7		10.3	55.8
34 31.1	13.4	5 07.0		10.4	55.8
49 03.5	13.4	5 17.4		10.2	55.8
63 35.9	13.4	5 27.6		10.3	55.8
78 08.3	13.4	5 37.9		10.2	55.8
92 40.7	13.4	S 5 48.1		10.2	55.7
107 13.1	13.4	5 58.3		10.2	55.7
121 45.5	13.5	6 08.5		10.1	55.7
136 18.0	13.4	6 18.6		10.1	55.7
150 50.4	13.4	6 28.7		10.0	55.7
165 22.8	13.4	6 38.7		10.0	55.6
179 55.2	13.5	S 6 48.7		10.0	55.6
194 27.7	13.4	6 58.7		9.9	55.6
209 00.1	13.4	7 08.6		9.9	55.6
223 32.5	13.4	7 18.5		9.9	55.6
238 04.9	13.5	7 28.4		9.8	55.5
252 37.4	13.4	7 38.2		9.7	55.5
267 09.8	13.4	S 7 47.9		9.8	55.5
281 42.2	13.4	7 57.7		9.6	55.5
296 14.6	13.5	8 07.3		9.7	55.5
310 47.1	13.4	8 17.0		9.6	55.4
325 19.5	13.4	8 26.6		9.5	55.4
339 51.9	13.4	8 36.1		9.6	55.4
354 24.3	13.4	S 8 45.7		9.4	55.4
8 56.7	13.4	8 55.1		9.4	55.4
23 29.1	13.4	9 04.5		9.4	55.4
38 01.5	13.4	9 13.9		9.3	55.3
52 33.9	13.4	9 23.2		9.3	55.3
67 06.3	13.4	9 32.5		9.2	55.3
81 38.7	13.3	S 9 41.7		9.2	55.3
96 11.0	13.4	9 50.9		9.1	55.3
110 43.4	13.4	10 00.0		9.1	55.2
125 15.8	13.3	10 09.1		9.0	55.2
139 48.1	13.4	10 18.1		9.0	55.2
154 20.5	13.3	10 27.1		8.9	55.2
168 52.8	13.4	S10 36.0		8.8	55.2
183 25.2	13.3	10 44.8		8.9	55.1
197 57.5	13.3	10 53.7		8.7	55.1
212 29.8	13.3	11 02.4		8.7	55.1
227 02.1	13.3	11 11.1		8.6	55.1
241 34.4	13.3	11 19.7		8.6	55.1
256 06.7	13.3	S11 28.3		8.6	55.1
270 39.0	13.3	11 36.9		8.4	55.0
285 11.3	13.2	11 45.3		8.4	55.0
299 43.5	13.3	11 53.7		8.4	55.0
314 15.8	13.2	12 02.1		8.3	55.0
328 48.0	13.2	12 10.4		8.2	55.0
343 20.2	13.3	S12 18.6		8.2	55.0
357 52.5	13.2	12 26.8		8.1	54.9
12 24.7	13.2	12 34.9		8.0	54.9
26 56.9	13.1	12 42.9		8.0	54.9
41 29.0	13.2	12 50.9		8.0	54.9
56 01.2	13.2	12 58.9		7.8	54.9
70 33.4	13.1	S13 06.7		7.8	54.9
85 05.5	13.2	13 14.5		7.7	54.8
99 37.7	13.1	13 22.2		7.7	54.8
114 09.8	13.1	13 29.9		7.6	54.8
128 41.9	13.1	13 37.5		7.6	54.8
143 14.0	13.1	S13 45.1		7.4	54.8

m 0	SUN PLANETS	ARIES	MOON	v or d	Corr^n	v or d	Corr^n	v or d	Corr^n
s	° ′	° ′	° ′	′	′	′	′	′	′
00	0 00·0	0 00·0	0 00·0	0·0	0·0	6·0	0·1	12·0	0·1
01	0 00·3	0 00·3	0 00·2	0·1	0·0	6·1	0·1	12·1	0·1
02	0 00·5	0 00·5	0 00·5	0·2	0·0	6·2	0·1	12·2	0·1
03	0 00·8	0 00·8	0 00·7	0·3	0·0	6·3	0·1	12·3	0·1
04	0 01·0	0 01·0	0 01·0	0·4	0·0	6·4	0·1	12·4	0·1
05	0 01·3	0 01·3	0 01·2	0·5	0·0	6·5	0·1	12·5	0·1
06	0 01·5	0 01·5	0 01·4	0·6	0·0	6·6	0·1	12·6	0·1
07	0 01·8	0 01·8	0 01·7	0·7	0·0	6·7	0·1	12·7	0·1
08	0 02·0	0 02·0	0 01·9	0·8	0·0	6·8	0·1	12·8	0·1
09	0 02·3	0 02·3	0 02·1	0·9	0·0	6·9	0·1	12·9	0·1
10	0 02·5	0 02·5	0 02·4	1·0	0·0	7·0	0·1	13·0	0·1
11	0 02·8	0 02·8	0 02·6	1·1	0·0	7·1	0·1	13·1	0·1
12	0 03·0	0 03·0	0 02·9	1·2	0·0	7·2	0·1	13·2	0·1
13	0 03·3	0 03·3	0 03·1	1·3	0·0	7·3	0·1	13·3	0·1
14	0 03·5	0 03·5	0 03·3	1·4	0·0	7·4	0·1	13·4	0·1
15	0 03·8	0 03·8	0 03·6	1·5	0·0	7·5	0·1	13·5	0·1
16	0 04·0	0 04·0	0 03·8	1·6	0·0	7·6	0·1	13·6	0·1
17	0 04·3	0 04·3	0 04·1	1·7	0·0	7·7	0·1	13·7	0·1
18	0 04·5	0 04·5	0 04·3	1·8	0·0	7·8	0·1	13·8	0·1
19	0 04·8	0 04·8	0 04·5	1·9	0·0	7·9	0·1	13·9	0·1
20	0 05·0	0 05·0	0 04·8	2·0	0·0	8·0	0·1	14·0	0·1
21	0 05·3	0 05·3	0 05·0	2·1	0·0	8·1	0·1	14·1	0·1
22	0 05·5	0 05·5	0 05·2	2·2	0·0	8·2	0·1	14·2	0·1
23	0 05·8	0 05·8	0 05·5	2·3	0·0	8·3	0·1	14·3	0·1
24	0 06·0	0 06·0	0 05·7	2·4	0·0	8·4	0·1	14·4	0·1
25	0 06·3	0 06·3	0 06·0	2·5	0·0	8·5	0·1	14·5	0·1
26	0 06·5	0 06·5	0 06·2	2·6	0·0	8·6	0·1	14·6	0·1
27	0 06·8	0 06·8	0 06·4	2·7	0·0	8·7	0·1	14·7	0·1
28	0 07·0	0 07·0	0 06·7	2·8	0·0	8·8	0·1	14·8	0·1
29	0 07·3	0 07·3	0 06·9	2·9	0·0	8·9	0·1	14·9	0·1
30	0 07·5	0 07·5	0 07·2	3·0	0·0	9·0	0·1	15·0	0·1
31	0 07·8	0 07·8	0 07·4	3·1	0·0	9·1	0·1	15·1	0·1
32	0 08·0	0 08·0	0 07·6	3·2	0·0	9·2	0·1	15·2	0·1
33	0 08·3	0 08·3	0 07·9	3·3	0·0	9·3	0·1	15·3	0·1
34	0 08·5	0 08·5	0 08·1	3·4	0·0	9·4	0·1	15·4	0·1
35	0 08·8	0 08·8	0 08·4	3·5	0·0	9·5	0·1	15·5	0·1
36	0 09·0	0 09·0	0 08·6	3·6	0·0	9·6	0·1	15·6	0·1
37	0 09·3	0 09·3	0 08·8	3·7	0·0	9·7	0·1	15·7	0·1
38	0 09·5	0 09·5	0 09·1	3·8	0·0	9·8	0·1	15·8	0·1
39	0 09·8	0 09·8	0 09·3	3·9	0·0	9·9	0·1	15·9	0·1
40	0 10·0	0 10·0	0 09·5	4·0	0·0	10·0	0·1	16·0	0·1
41	0 10·3	0 10·3	0 09·8	4·1	0·0	10·1	0·1	16·1	0·1
42	0 10·5	0 10·5	0 10·0	4·2	0·0	10·2	0·1	16·2	0·1
43	0 10·8	0 10·8	0 10·3	4·3	0·0	10·3	0·1	16·3	0·1
44	0 11·0	0 11·0	0 10·5	4·4	0·0	10·4	0·1	16·4	0·1
45	0 11·3	0 11·3	0 10·7	4·5	0·0	10·5	0·1	16·5	0·1
46	0 11·5	0 11·5	0 11·0	4·6	0·0	10·6	0·1	16·6	0·1
47	0 11·8	0 11·8	0 11·2	4·7	0·0	10·7	0·1	16·7	0·1
48	0 12·0	0 12·0	0 11·5	4·8	0·0	10·8	0·1	16·8	0·1
49	0 12·3	0 12·3	0 11·7	4·9	0·0	10·9	0·1	16·9	0·1
50	0 12·5	0 12·5	0 11·9	5·0	0·0	11·0	0·1	17·0	0·1
51	0 12·8	0 12·8	0 12·2	5·1	0·0	11·1	0·1	17·1	0·1
52	0 13·0	0 13·0	0 12·4	5·2	0·0	11·2	0·1	17·2	0·1
53	0 13·3	0 13·3	0 12·6	5·3	0·0	11·3	0·1	17·3	0·1
54	0 13·5	0 13·5	0 12·9	5·4	0·0	11·4	0·1	17·4	0·1
55	0 13·8	0 13·8	0 13·1	5·5	0·0	11·5	0·1	17·5	0·1
56	0 14·0	0 14·0	0 13·4	5·6	0·0	11·6	0·1	17·6	0·1
57	0 14·3	0 14·3	0 13·6	5·7	0·0	11·7	0·1	17·7	0·1
58	0 14·5	0 14·5	0 13·8	5·8	0·0	11·8	0·1	17·8	0·1
59	0 14·8	0 14·8	0 14·1	5·9	0·0	11·9	0·1	17·9	0·1
60	0 15·0	0 15·0	0 14·3	6·0	0·1	12·0	0·1	18·0	0·2

The whole hour Moon "paradox"

Regarding v and d values and corrections, the Explanation section of the Nautical Almanac makes no procedural distinction between sights taken on the hour and those with minutes and/or seconds - if the body uses them, they should be applied. For most bodies this does not matter, but in the case of the Moon, where the v and d values often exceed 5.9', resulting in v and d corrections of 0.1' (possibly 0.2' for a v or d value of 18.0'), this can create a "paradox". If the non-zero correction is added to the hour value taken from the daily page, the Total GHA will not be the same as the hour value, even though there are no minutes or seconds.

The 1995 and 2002 editions of the American Practical Navigator ("Bowditch") do an example of a whole hour Moon reduction. In that example, the v and d corrections are applied. However, according to Catherine Hohenkerk of HM Nautical Almanac Office, although it is not clearly stated in the Explanation, when the hours and minutes are zero there is no need to go into the Increments and Corrections at all.

Bowditch 1995 and 2002 editions
Moon sight
10-00-00 GMT, June 6, 1994

To obtain the Moon's GHA, enter the daily pages in the Moon column and extract the applicable data just as for a star or Sun sight. Determining the Moon's GHA requires an additional correction, the *v* correction.

GHA Moon and *v*	245° 45.1' and +11.3
GHA Increment	0° 00.0'
v Correction	+0.1'
GHA	245° 45.2'

First, record the GHA of the Moon for 10-00-00 on June 16, 1994, from the daily pages of the *Nautical Almanac*. Record also the *v* correction factor; in this case, it is +11.3. The *v* correction factor for the Moon is always positive. The increment correction is, in this case, zero because the sight was recorded on the even hour. To obtain the *v* correction, go to the tables of increments and corrections. In the 0 minute table in the *v* or *d* correction columns, find the correction that corresponds to a $v = 11.3$. The table yields a correction of +0.1'. Adding this correction to the tabulated GHA gives the final GHA as 245° 45.2'.

The whole hour Moon “paradox”

Regarding v and d values and corrections, the Explanation section of the Nautical Almanac makes no procedural distinction between sights taken on the hour and those with minutes and/or seconds - if the body uses them, they should be applied. For most bodies this does not matter, but in the case of the Moon, where the v and d values often exceed 5.9', resulting in v and d corrections of 0.1' (possibly 0.2' for a v or d value of 18.0'), this can create a "paradox". If the non-zero correction is added to the hour value taken from the daily page, the Total GHA will not be the same as the hour value, even though there are no minutes or seconds.

The 1995 and 2002 editions of the American Practical Navigator ("Bowditch") do an example of a whole hour Moon reduction. In that example, the v and d corrections are applied. However, according to Catherine Hohenkerk of HM Nautical Almanac Office, although it is not clearly stated in the Explanation, when the hours and minutes are zero there is no need to go into the Increments and Corrections at all.

This was reported to the USNO. Sean Urban, Chief of the USNO Nautical Almanac Office, agreed with this, and was also of the opinion that using an example exactly on the hour was a poor choice. This was changed in the 2017 edition of Bowditch.

Editions of Bowditch do an example of a Moon sight reduction. 1995 and 2002 editions had the "paradox", using an example on the hour, but the 2017 edition avoided it by using an example not on the hour.

1995 and 2002 editions
10-00-00 GMT, June 6, 1994

To obtain the Moon's GHA, enter the daily pages in the Moon column and extract the applicable data just as for a star or Sun sight. Determining the Moon's GHA requires an additional correction, the *v* correction.

GHA Moon and *v*	245° 45.1' and +11.3
GHA Increment	0° 00.0'
v Correction	+0.1'
GHA	245° 45.2'

First, record the GHA of the Moon for 10-00-00 on June 16, 1994, from the daily pages of the *Nautical Almanac*. Record also the *v* correction factor; in this case, it is +11.3. The *v* correction factor for the Moon is always positive. The increment correction is, in this case, zero because the sight was recorded on the even hour. To obtain the *v* correction, go to the tables of increments and corrections. In the 0 minute table in the *v* or *d* correction columns, find the correction that corresponds to a *v* = 11.3. The table yields a correction of +0.1'. Adding this correction to the tabulated GHA gives the final GHA as 245° 45.2'.

2017 edition
21-01-04 UT, March 22, 2016

To obtain the Moon's GHA, enter the daily pages in the Moon column and extract the applicable data just as for a star or Sun sight. Determining the Moon's GHA requires an additional correction, the *v correction. The v correction is* needed because the Moon's motion is not close to uniform throughout the year.

First, record the GHA of the Moon for 21-00-00 on March 22, 2016, from the daily pages of the *Nautical Almanac.* The increment correction is done as in the previous examples. In this case, it is 15.3' because the sight was taken one minute and four seconds after the hour. From the daily page, record also the v correction factor, it is +15.0. The *v* correction factor for the Moon is always positive. To obtain the *v correction, go to the tables of increments and corrections.* In the 1 minute table in the *v or d correction columns* locate the correction that corresponds to *v = 15.0'. The table* yields a correction of +0.4'. Adding this correction to the tabulated GHA and increment gives the final GHA as 319°43.9'.

Prior to V4.7.3, Celestial Tools showed the increments and corrections for sights taken on the hour. Celestial Tools no longer shows increment values or v or d values or corrections for sights taken on the hour.

Critical table

DIP

Ht. of Eye	Corrⁿ	Ht. of Eye
m	′	ft.
2·4		8·0
	−2·8	
2·6		8·6
	−2·9	
2·8		9·2
	−3·0	
3·0		9·8
	−3·1	
3·2		10·5
	−3·2	
3·4		11·2
	−3·3	
3·6		11·9
	−3·4	
3·8		12·6
	−3·5	
4·0		13·3
	−3·6	
4·3		14·1
	−3·7	
4·5		14·9
	−3·8	
4·7		15·7
	−3·9	
5·0		16·5
	−4·0	
5·2		17·4
	−4·1	
5·5		18·3
	−4·2	
5·8		19·1
	−4·3	
6·1		20·1
	−4·4	
6·3		21·0
	−4·5	
6·6		22·0
	−4·6	
6·9		22·9
	−4·7	
7·2		23·9
	−4·8	
7·5		24·9
	−4·9	
7·9		26·0
	−5·0	
8·2		27·1
	−5·1	
8·5		28·1
	−5·2	
8·8		29·2
	−5·3	
9·2		30·4
	−5·4	
9·5		31·5
	−5·5	
9·9		32·7
	−5·6	
10·3		33·9
	−5·7	
10·6		35·1
	−5·8	
11·0		36·3
	−5·9	
11·4		37·6
	−6·0	
11·8		38·9
	−6·1	
12·2		40·1
	−6·2	
12·6		41·5
	−6·3	
13·0		42·8
	−6·4	
13·4		44·2
	−6·5	
13·8		45·5
	−6·6	
14·2		46·9
	−6·7	
14·7		48·4
	−6·8	
15·1		49·8
	−6·9	
15·5		51·3
	−7·0	
16·0		52·8
	−7·1	
16·5		54·3
	−7·2	
16·9		55·8
	−7·3	
17·4		57·4
	−7·4	
17·9		58·9
	−7·5	
18·4		60·5
	−7·6	
18·8		62·1
	−7·7	
19·3		63·8
	−7·8	
19·8		65·4
	−7·9	
20·4		67·1
	−8·0	
20·9		68·8
	−8·1	
21·4		70·5

Ht. of Eye	Corrⁿ
m	′
1·0	− 1·8
1·5	− 2·2
2·0	− 2·5
2·5	− 2·8
3·0	− 3·0
See table ←	
m	′
20	− 7·9
22	− 8·3
24	− 8·6
26	− 9·0
28	− 9·3
30	− 9·6
32	−10·0
34	−10·3
36	−10·6
38	−10·8
40	−11·1
42	−11·4
44	−11·7
46	−11·9
48	−12·2
ft.	′
2	− 1·4
4	− 1·9
6	− 2·4
8	− 2·7
10	− 3·1
See table ←	
ft.	′
70	− 8·1
75	− 8·4
80	− 8·7
85	− 8·9
90	− 9·2
95	− 9·5
100	− 9·7
105	− 9·9
110	−10·2
115	−10·4
120	−10·6
125	−10·8
130	−11·1
135	−11·3
140	−11·5
145	−11·7
150	−11·9
155	−12·1

Interpolation tables

DIP

Ht. of Eye	Corrn	Ht. of Eye
m	′	ft.
2·4		8·0
	−2·8	
2·6		8·6
	−2·9	
2·8		9·2
	−3·0	
3·0		9·8
	−3·1	
3·2		10·5
	−3·2	
3·4		11·2
	−3·3	
3·6		11·9
	−3·4	
3·8		12·6
	−3·5	
4·0		13·3
	−3·6	
4·3		14·1
	−3·7	
4·5		14·9
	−3·8	
4·7		15·7
	−3·9	
5·0		16·5
	−4·0	
5·2		17·4
	−4·1	
5·5		18·3
	−4·2	
5·8		19·1
	−4·3	
6·1		20·1
	−4·4	
6·3		21·0
	−4·5	
6·6		22·0
	−4·6	
6·9		22·9
	−4·7	
7·2		23·9
	−4·8	
7·5		24·9
	−4·9	
7·9		26·0
	−5·0	
8·2		27·1
	−5·1	
8·5		28·1
	−5·2	
8·8		29·2
	−5·3	
9·2		30·4
	−5·4	
9·5		31·5
	−5·5	
9·9		32·7
	−5·6	
10·3		33·9
	−5·7	
10·6		35·1
	−5·8	
11·0		36·3
	−5·9	
11·4		37·6
	−6·0	
11·8		38·9
	−6·1	
12·2		40·1
	−6·2	
12·6		41·5
	−6·3	
13·0		42·8
	−6·4	
13·4		44·2
	−6·5	
13·8		45·5
	−6·6	
14·2		46·9
	−6·7	
14·7		48·4
	−6·8	
15·1		49·8
	−6·9	
15·5		51·3
	−7·0	
16·0		52·8
	−7·1	
16·5		54·3
	−7·2	
16·9		55·8
	−7·3	
17·4		57·4
	−7·4	
17·9		58·9
	−7·5	
18·4		60·5
	−7·6	
18·8		62·1
	−7·7	
19·3		63·8
	−7·8	
19·8		65·4
	−7·9	
20·4		67·1
	−8·0	
20·9		68·8
	−8·1	
21·4		70·5

Ht. of Eye	Corrn
m	′
1·0	− 1·8
1·5	− 2·2
2·0	− 2·5
2·5	− 2·8
3·0	− 3·0
See table ←	
m	′
20	− 7·9
22	− 8·3
24	− 8·6
26	− 9·0
28	− 9·3
30	− 9·6
32	−10·0
34	−10·3
36	−10·6
38	−10·8
40	−11·1
42	−11·4
44	−11·7
46	−11·9
48	−12·2
ft.	′
2	− 1·4
4	− 1·9
6	− 2·4
8	− 2·7
10	− 3·1
See table ←	
ft.	′
70	− 8·1
75	− 8·4
80	− 8·7
85	− 8·9
90	− 9·2
95	− 9·5
100	− 9·7
105	− 9·9
110	−10·2
115	−10·4
120	−10·6
125	−10·8
130	−11·1
135	−11·3
140	−11·5
145	−11·7
150	−11·9
155	−12·1

HE (ft)	Dip from Critical Table (-')	Dip from Interpolation (-')	Dip from Interpolation (-') to one d.p.
8.1	**2.8**	2.72	**2.7**
8.2	**2.8**	2.74	**2.7**
8.3	2.8	2.76	2.8
8.4	2.8	2.78	2.8
8.5	2.8	2.80	2.8
8.6	2.8	2.82	2.8
8.7	**2.9**	2.84	**2.8**
8.8	2.9	2.86	2.9
8.9	2.9	2.88	2.9
9.0	2.9	2.90	2.9
9.1	2.9	2.92	2.9
9.2	2.9	2.94	2.9
9.3	3.0	2.96	3.0
9.4	3.0	2.98	3.0
9.5	3.0	3.00	3.0
9.6	3.0	3.02	3.0
9.7	3.0	3.04	3.0
9.8	**3.0**	3.06	**3.1**
9.9	3.1	3.08	3.1
10.0	3.1	3.10	3.1

True or false –
The Increments and Corrections tables in the Nautical Almanac remain the same from year to year.

False - Contrary to common belief, not all Increments and Corrections tables are identical. In 2001, four of the 10800 (10980) correction values changed, and are expected to remain with their new values in the future. Specifically these are:

minute	v or d	Corr (pre-2001)	Corr (2001 and later)
22	2.8	1.1	1.0
22	16.4	6.2	6.1
52	9.2	8.1	8.0
52	16.4	14.4	14.3

As of V4.9.0, Celestial Tools Sight Reduction uses the value based on the Greenwich year of the sight, and Yellow Pages (I&C) shows both values. Previous versions only used/showed the 2001 and later values.

Pre-2001

22 m	SUN PLANETS	ARIES	MOON	v or d	Corrn	v or d	Corrn	v or d	Corrn
s	° ′	° ′	° ′	′	′	′	′	′	′
00	5 30·0	5 30·9	5 15·0	0·0	0·0	6·0	2·3	12·0	4·5
01	5 30·3	5 31·2	5 15·2	0·1	0·0	6·1	2·3	12·1	4·5
02	5 30·5	5 31·4	5 15·4	0·2	0·1	6·2	2·3	12·2	4·6
03	5 30·8	5 31·7	5 15·7	0·3	0·1	6·3	2·4	12·3	4·6
04	5 31·0	5 31·9	5 15·9	0·4	0·2	6·4	2·4	12·4	4·7
05	5 31·3	5 32·2	5 16·2	0·5	0·2	6·5	2·4	12·5	4·7
06	5 31·5	5 32·4	5 16·4	0·6	0·2	6·6	2·5	12·6	4·7
07	5 31·8	5 32·7	5 16·6	0·7	0·3	6·7	2·5	12·7	4·8
08	5 32·0	5 32·9	5 16·9	0·8	0·3	6·8	2·6	12·8	4·8
09	5 32·3	5 33·2	5 17·1	0·9	0·3	6·9	2·6	12·9	4·8
10	5 32·5	5 33·4	5 17·4	1·0	0·4	7·0	2·6	13·0	4·9
11	5 32·8	5 33·7	5 17·6	1·1	0·4	7·1	2·7	13·1	4·9
12	5 33·0	5 33·9	5 17·8	1·2	0·5	7·2	2·7	13·2	5·0
13	5 33·3	5 34·2	5 18·1	1·3	0·5	7·3	2·7	13·3	5·0
14	5 33·5	5 34·4	5 18·3	1·4	0·5	7·4	2·8	13·4	5·0
15	5 33·8	5 34·7	5 18·5	1·5	0·6	7·5	2·8	13·5	5·1
16	5 34·0	5 34·9	5 18·8	1·6	0·6	7·6	2·9	13·6	5·1
17	5 34·3	5 35·2	5 19·0	1·7	0·6	7·7	2·9	13·7	5·1
18	5 34·5	5 35·4	5 19·3	1·8	0·7	7·8	2·9	13·8	5·2
19	5 34·8	5 35·7	5 19·5	1·9	0·7	7·9	3·0	13·9	5·2
20	5 35·0	5 35·9	5 19·7	2·0	0·8	8·0	3·0	14·0	5·3
21	5 35·3	5 36·2	5 20·0	2·1	0·8	8·1	3·0	14·1	5·3
22	5 35·5	5 36·4	5 20·2	2·2	0·8	8·2	3·1	14·2	5·3
23	5 35·8	5 36·7	5 20·5	2·3	0·9	8·3	3·1	14·3	5·4
24	5 36·0	5 36·9	5 20·7	2·4	0·9	8·4	3·2	14·4	5·4
25	5 36·3	5 37·2	5 20·9	2·5	0·9	8·5	3·2	14·5	5·4
26	5 36·5	5 37·4	5 21·2	2·6	1·0	8·6	3·2	14·6	5·5
27	5 36·8	5 37·7	5 21·4	2·7	1·0	8·7	3·3	14·7	5·5
28	5 37·0	5 37·9	5 21·6	2·8	1·1	8·8	3·3	14·8	5·6
29	5 37·3	5 38·2	5 21·9	2·9	1·1	8·9	3·3	14·9	5·6
30	5 37·5	5 38·4	5 22·1	3·0	1·1	9·0	3·4	15·0	5·6
31	5 37·8	5 38·7	5 22·4	3·1	1·2	9·1	3·4	15·1	5·7
32	5 38·0	5 38·9	5 22·6	3·2	1·2	9·2	3·5	15·2	5·7
33	5 38·3	5 39·2	5 22·8	3·3	1·2	9·3	3·5	15·3	5·7
34	5 38·5	5 39·4	5 23·1	3·4	1·3	9·4	3·5	15·4	5·8
35	5 38·8	5 39·7	5 23·3	3·5	1·3	9·5	3·6	15·5	5·8
36	5 39·0	5 39·9	5 23·6	3·6	1·4	9·6	3·6	15·6	5·9
37	5 39·3	5 40·2	5 23·8	3·7	1·4	9·7	3·6	15·7	5·9
38	5 39·5	5 40·4	5 24·0	3·8	1·4	9·8	3·7	15·8	5·9
39	5 39·8	5 40·7	5 24·3	3·9	1·5	9·9	3·7	15·9	6·0
40	5 40·0	5 40·9	5 24·5	4·0	1·5	10·0	3·8	16·0	6·0
41	5 40·3	5 41·2	5 24·7	4·1	1·5	10·1	3·8	16·1	6·0
42	5 40·5	5 41·4	5 25·0	4·2	1·6	10·2	3·8	16·2	6·1
43	5 40·8	5 41·7	5 25·2	4·3	1·6	10·3	3·9	16·3	6·1
44	5 41·0	5 41·9	5 25·5	4·4	1·7	10·4	3·9	16·4	6·2
45	5 41·3	5 42·2	5 25·7	4·5	1·7	10·5	3·9	16·5	6·2
46	5 41·5	5 42·4	5 25·9	4·6	1·7	10·6	4·0	16·6	6·2
47	5 41·8	5 42·7	5 26·2	4·7	1·8	10·7	4·0	16·7	6·3
48	5 42·0	5 42·9	5 26·4	4·8	1·8	10·8	4·1	16·8	6·3
49	5 42·3	5 43·2	5 26·7	4·9	1·8	10·9	4·1	16·9	6·3
50	5 42·5	5 43·4	5 26·9	5·0	1·9	11·0	4·1	17·0	6·4
51	5 42·8	5 43·7	5 27·1	5·1	1·9	11·1	4·2	17·1	6·4
52	5 43·0	5 43·9	5 27·4	5·2	2·0	11·2	4·2	17·2	6·5
53	5 43·3	5 44·2	5 27·6	5·3	2·0	11·3	4·2	17·3	6·5
54	5 43·5	5 44·4	5 27·9	5·4	2·0	11·4	4·3	17·4	6·5
55	5 43·8	5 44·7	5 28·1	5·5	2·1	11·5	4·3	17·5	6·6
56	5 44·0	5 44·9	5 28·3	5·6	2·1	11·6	4·4	17·6	6·6
57	5 44·3	5 45·2	5 28·6	5·7	2·1	11·7	4·4	17·7	6·6
58	5 44·5	5 45·4	5 28·8	5·8	2·2	11·8	4·4	17·8	6·7
59	5 44·8	5 45·7	5 29·0	5·9	2·2	11·9	4·5	17·9	6·7
60	5 45·0	5 45·9	5 29·3	6·0	2·3	12·0	4·5	18·0	6·8

2001 and later

22 m	SUN PLANETS	ARIES	MOON	v or d	Corrn	v or d	Corrn	v or d	Corrn
s	° ′	° ′	° ′	′	′	′	′	′	′
00	5 30·0	5 30·9	5 15·0	0·0	0·0	6·0	2·3	12·0	4·5
01	5 30·3	5 31·2	5 15·2	0·1	0·0	6·1	2·3	12·1	4·5
02	5 30·5	5 31·4	5 15·4	0·2	0·1	6·2	2·3	12·2	4·6
03	5 30·8	5 31·7	5 15·7	0·3	0·1	6·3	2·4	12·3	4·6
04	5 31·0	5 31·9	5 15·9	0·4	0·2	6·4	2·4	12·4	4·7
05	5 31·3	5 32·2	5 16·2	0·5	0·2	6·5	2·4	12·5	4·7
06	5 31·5	5 32·4	5 16·4	0·6	0·2	6·6	2·5	12·6	4·7
07	5 31·8	5 32·7	5 16·6	0·7	0·3	6·7	2·5	12·7	4·8
08	5 32·0	5 32·9	5 16·9	0·8	0·3	6·8	2·6	12·8	4·8
09	5 32·3	5 33·2	5 17·1	0·9	0·3	6·9	2·6	12·9	4·8
10	5 32·5	5 33·4	5 17·4	1·0	0·4	7·0	2·6	13·0	4·9
11	5 32·8	5 33·7	5 17·6	1·1	0·4	7·1	2·7	13·1	4·9
12	5 33·0	5 33·9	5 17·8	1·2	0·5	7·2	2·7	13·2	5·0
13	5 33·3	5 34·2	5 18·1	1·3	0·5	7·3	2·7	13·3	5·0
14	5 33·5	5 34·4	5 18·3	1·4	0·5	7·4	2·8	13·4	5·0
15	5 33·8	5 34·7	5 18·5	1·5	0·6	7·5	2·8	13·5	5·1
16	5 34·0	5 34·9	5 18·8	1·6	0·6	7·6	2·9	13·6	5·1
17	5 34·3	5 35·2	5 19·0	1·7	0·6	7·7	2·9	13·7	5·1
18	5 34·5	5 35·4	5 19·3	1·8	0·7	7·8	2·9	13·8	5·2
19	5 34·8	5 35·7	5 19·5	1·9	0·7	7·9	3·0	13·9	5·2
20	5 35·0	5 35·9	5 19·7	2·0	0·8	8·0	3·0	14·0	5·3
21	5 35·3	5 36·2	5 20·0	2·1	0·8	8·1	3·0	14·1	5·3
22	5 35·5	5 36·4	5 20·2	2·2	0·8	8·2	3·1	14·2	5·3
23	5 35·8	5 36·7	5 20·5	2·3	0·9	8·3	3·1	14·3	5·4
24	5 36·0	5 36·9	5 20·7	2·4	0·9	8·4	3·2	14·4	5·4
25	5 36·3	5 37·2	5 20·9	2·5	0·9	8·5	3·2	14·5	5·4
26	5 36·5	5 37·4	5 21·2	2·6	1·0	8·6	3·2	14·6	5·5
27	5 36·8	5 37·7	5 21·4	2·7	1·0	8·7	3·3	14·7	5·5
28	5 37·0	5 37·9	5 21·6	2·8	1·0	8·8	3·3	14·8	5·6
29	5 37·3	5 38·2	5 21·9	2·9	1·1	8·9	3·3	14·9	5·6
30	5 37·5	5 38·4	5 22·1	3·0	1·1	9·0	3·4	15·0	5·6
31	5 37·8	5 38·7	5 22·4	3·1	1·2	9·1	3·4	15·1	5·7
32	5 38·0	5 38·9	5 22·6	3·2	1·2	9·2	3·5	15·2	5·7
33	5 38·3	5 39·2	5 22·8	3·3	1·2	9·3	3·5	15·3	5·7
34	5 38·5	5 39·4	5 23·1	3·4	1·3	9·4	3·5	15·4	5·8
35	5 38·8	5 39·7	5 23·3	3·5	1·3	9·5	3·6	15·5	5·8
36	5 39·0	5 39·9	5 23·6	3·6	1·4	9·6	3·6	15·6	5·9
37	5 39·3	5 40·2	5 23·8	3·7	1·4	9·7	3·6	15·7	5·9
38	5 39·5	5 40·4	5 24·0	3·8	1·4	9·8	3·7	15·8	5·9
39	5 39·8	5 40·7	5 24·3	3·9	1·5	9·9	3·7	15·9	6·0
40	5 40·0	5 40·9	5 24·5	4·0	1·5	10·0	3·8	16·0	6·0
41	5 40·3	5 41·2	5 24·7	4·1	1·5	10·1	3·8	16·1	6·0
42	5 40·5	5 41·4	5 25·0	4·2	1·6	10·2	3·8	16·2	6·1
43	5 40·8	5 41·7	5 25·2	4·3	1·6	10·3	3·9	16·3	6·1
44	5 41·0	5 41·9	5 25·5	4·4	1·7	10·4	3·9	16·4	6·1
45	5 41·3	5 42·2	5 25·7	4·5	1·7	10·5	3·9	16·5	6·2
46	5 41·5	5 42·4	5 25·9	4·6	1·7	10·6	4·0	16·6	6·2
47	5 41·8	5 42·7	5 26·2	4·7	1·8	10·7	4·0	16·7	6·3
48	5 42·0	5 42·9	5 26·4	4·8	1·8	10·8	4·1	16·8	6·3
49	5 42·3	5 43·2	5 26·7	4·9	1·8	10·9	4·1	16·9	6·3
50	5 42·5	5 43·4	5 26·9	5·0	1·9	11·0	4·1	17·0	6·4
51	5 42·8	5 43·7	5 27·1	5·1	1·9	11·1	4·2	17·1	6·4
52	5 43·0	5 43·9	5 27·4	5·2	2·0	11·2	4·2	17·2	6·5
53	5 43·3	5 44·2	5 27·6	5·3	2·0	11·3	4·2	17·3	6·5
54	5 43·5	5 44·4	5 27·9	5·4	2·0	11·4	4·3	17·4	6·5
55	5 43·8	5 44·7	5 28·1	5·5	2·1	11·5	4·3	17·5	6·6
56	5 44·0	5 44·9	5 28·3	5·6	2·1	11·6	4·4	17·6	6·6
57	5 44·3	5 45·2	5 28·6	5·7	2·1	11·7	4·4	17·7	6·6
58	5 44·5	5 45·4	5 28·8	5·8	2·2	11·8	4·4	17·8	6·7
59	5 44·8	5 45·7	5 29·0	5·9	2·2	11·9	4·5	17·9	6·7
60	5 45·0	5 45·9	5 29·3	6·0	2·3	12·0	4·5	18·0	6·8

Pre-2001

52 m	SUN PLANETS	ARIES	MOON	v or d	Corrn	v or d	Corrn	v or d	Corrn
s	° ′	° ′	° ′	′	′	′	′	′	′
00	13 00·0	13 02·1	12 24·5	0·0	0·0	6·0	5·3	12·0	10·5
01	13 00·3	13 02·4	12 24·7	0·1	0·1	6·1	5·3	12·1	10·6
02	13 00·5	13 02·6	12 24·9	0·2	0·2	6·2	5·4	12·2	10·7
03	13 00·8	13 02·9	12 25·2	0·3	0·3	6·3	5·5	12·3	10·8
04	13 01·0	13 03·1	12 25·4	0·4	0·4	6·4	5·6	12·4	10·9
05	13 01·3	13 03·4	12 25·7	0·5	0·4	6·5	5·7	12·5	10·9
06	13 01·5	13 03·6	12 25·9	0·6	0·5	6·6	5·8	12·6	11·0
07	13 01·8	13 03·9	12 26·1	0·7	0·6	6·7	5·9	12·7	11·1
08	13 02·0	13 04·1	12 26·4	0·8	0·7	6·8	6·0	12·8	11·2
09	13 02·3	13 04·4	12 26·6	0·9	0·8	6·9	6·0	12·9	11·3
10	13 02·5	13 04·6	12 26·9	1·0	0·9	7·0	6·1	13·0	11·4
11	13 02·8	13 04·9	12 27·1	1·1	1·0	7·1	6·2	13·1	11·5
12	13 03·0	13 05·1	12 27·3	1·2	1·1	7·2	6·3	13·2	11·6
13	13 03·3	13 05·4	12 27·6	1·3	1·1	7·3	6·4	13·3	11·6
14	13 03·5	13 05·6	12 27·8	1·4	1·2	7·4	6·5	13·4	11·7
15	13 03·8	13 05·9	12 28·0	1·5	1·3	7·5	6·6	13·5	11·8
16	13 04·0	13 06·1	12 28·3	1·6	1·4	7·6	6·7	13·6	11·9
17	13 04·3	13 06·4	12 28·5	1·7	1·5	7·7	6·7	13·7	12·0
18	13 04·5	13 06·6	12 28·8	1·8	1·6	7·8	6·8	13·8	12·1
19	13 04·8	13 06·9	12 29·0	1·9	1·7	7·9	6·9	13·9	12·2
20	13 05·0	13 07·1	12 29·2	2·0	1·8	8·0	7·0	14·0	12·3
21	13 05·3	13 07·4	12 29·5	2·1	1·8	8·1	7·1	14·1	12·3
22	13 05·5	13 07·7	12 29·7	2·2	1·9	8·2	7·2	14·2	12·4
23	13 05·8	13 07·9	12 30·0	2·3	2·0	8·3	7·3	14·3	12·5
24	13 06·0	13 08·2	12 30·2	2·4	2·1	8·4	7·4	14·4	12·6
25	13 06·3	13 08·4	12 30·4	2·5	2·2	8·5	7·4	14·5	12·7
26	13 06·5	13 08·7	12 30·7	2·6	2·3	8·6	7·5	14·6	12·8
27	13 06·8	13 08·9	12 30·9	2·7	2·4	8·7	7·6	14·7	12·9
28	13 07·0	13 09·2	12 31·1	2·8	2·5	8·8	7·7	14·8	13·0
29	13 07·3	13 09·4	12 31·4	2·9	2·5	8·9	7·8	14·9	13·0
30	13 07·5	13 09·7	12 31·6	3·0	2·6	9·0	7·9	15·0	13·1
31	13 07·8	13 09·9	12 31·9	3·1	2·7	9·1	8·0	15·1	13·2
32	13 08·0	13 10·2	12 32·1	3·2	2·8	9·2	8·1	15·2	13·3
33	13 08·3	13 10·4	12 32·3	3·3	2·9	9·3	8·1	15·3	13·4
34	13 08·5	13 10·7	12 32·6	3·4	3·0	9·4	8·2	15·4	13·5
35	13 08·8	13 10·9	12 32·8	3·5	3·1	9·5	8·3	15·5	13·6
36	13 09·0	13 11·2	12 33·1	3·6	3·2	9·6	8·4	15·6	13·7
37	13 09·3	13 11·4	12 33·3	3·7	3·2	9·7	8·5	15·7	13·7
38	13 09·5	13 11·7	12 33·5	3·8	3·3	9·8	8·6	15·8	13·8
39	13 09·8	13 11·9	12 33·8	3·9	3·4	9·9	8·7	15·9	13·9
40	13 10·0	13 12·2	12 34·0	4·0	3·5	10·0	8·8	16·0	14·0
41	13 10·3	13 12·4	12 34·2	4·1	3·6	10·1	8·8	16·1	14·1
42	13 10·5	13 12·7	12 34·5	4·2	3·7	10·2	8·9	16·2	14·2
43	13 10·8	13 12·9	12 34·7	4·3	3·8	10·3	9·0	16·3	14·3
44	13 11·0	13 13·2	12 35·0	4·4	3·9	10·4	9·1	16·4	14·4
45	13 11·3	13 13·4	12 35·2	4·5	3·9	10·5	9·2	16·5	14·4
46	13 11·5	13 13·7	12 35·4	4·6	4·0	10·6	9·3	16·6	14·5
47	13 11·8	13 13·9	12 35·7	4·7	4·1	10·7	9·4	16·7	14·6
48	13 12·0	13 14·2	12 35·9	4·8	4·2	10·8	9·5	16·8	14·7
49	13 12·3	13 14·4	12 36·2	4·9	4·3	10·9	9·5	16·9	14·8
50	13 12·5	13 14·7	12 36·4	5·0	4·4	11·0	9·6	17·0	14·9
51	13 12·8	13 14·9	12 36·6	5·1	4·5	11·1	9·7	17·1	15·0
52	13 13·0	13 15·2	12 36·9	5·2	4·6	11·2	9·8	17·2	15·1
53	13 13·3	13 15·4	12 37·1	5·3	4·6	11·3	9·9	17·3	15·1
54	13 13·5	13 15·7	12 37·4	5·4	4·7	11·4	10·0	17·4	15·2
55	13 13·8	13 15·9	12 37·6	5·5	4·8	11·5	10·1	17·5	15·3
56	13 14·0	13 16·2	12 37·8	5·6	4·9	11·6	10·2	17·6	15·4
57	13 14·3	13 16·4	12 38·1	5·7	5·0	11·7	10·2	17·7	15·5
58	13 14·5	13 16·7	12 38·3	5·8	5·1	11·8	10·3	17·8	15·6
59	13 14·8	13 16·9	12 38·5	5·9	5·2	11·9	10·4	17·9	15·7
60	13 15·0	13 17·2	12 38·8	6·0	5·3	12·0	10·5	18·0	15·8

2001 and later

52 m	SUN PLANETS	ARIES	MOON	v or d	Corrn	v or d	Corrn	v or d	Corrn
s	° ′	° ′	° ′	′	′	′	′	′	′
00	13 00·0	13 02·1	12 24·5	0·0	0·0	6·0	5·3	12·0	10·5
01	13 00·3	13 02·4	12 24·7	0·1	0·1	6·1	5·3	12·1	10·6
02	13 00·5	13 02·6	12 24·9	0·2	0·2	6·2	5·4	12·2	10·7
03	13 00·8	13 02·9	12 25·2	0·3	0·3	6·3	5·5	12·3	10·8
04	13 01·0	13 03·1	12 25·4	0·4	0·4	6·4	5·6	12·4	10·9
05	13 01·3	13 03·4	12 25·7	0·5	0·4	6·5	5·7	12·5	10·9
06	13 01·5	13 03·6	12 25·9	0·6	0·5	6·6	5·8	12·6	11·0
07	13 01·8	13 03·9	12 26·1	0·7	0·6	6·7	5·9	12·7	11·1
08	13 02·0	13 04·1	12 26·4	0·8	0·7	6·8	6·0	12·8	11·2
09	13 02·3	13 04·4	12 26·6	0·9	0·8	6·9	6·0	12·9	11·3
10	13 02·5	13 04·6	12 26·9	1·0	0·9	7·0	6·1	13·0	11·4
11	13 02·8	13 04·9	12 27·1	1·1	1·0	7·1	6·2	13·1	11·5
12	13 03·0	13 05·1	12 27·3	1·2	1·1	7·2	6·3	13·2	11·6
13	13 03·3	13 05·4	12 27·6	1·3	1·1	7·3	6·4	13·3	11·6
14	13 03·5	13 05·6	12 27·8	1·4	1·2	7·4	6·5	13·4	11·7
15	13 03·8	13 05·9	12 28·0	1·5	1·3	7·5	6·6	13·5	11·8
16	13 04·0	13 06·1	12 28·3	1·6	1·4	7·6	6·7	13·6	11·9
17	13 04·3	13 06·4	12 28·5	1·7	1·5	7·7	6·7	13·7	12·0
18	13 04·5	13 06·6	12 28·8	1·8	1·6	7·8	6·8	13·8	12·1
19	13 04·8	13 06·9	12 29·0	1·9	1·7	7·9	6·9	13·9	12·2
20	13 05·0	13 07·1	12 29·2	2·0	1·8	8·0	7·0	14·0	12·3
21	13 05·3	13 07·4	12 29·5	2·1	1·8	8·1	7·1	14·1	12·3
22	13 05·5	13 07·7	12 29·7	2·2	1·9	8·2	7·2	14·2	12·4
23	13 05·8	13 07·9	12 30·0	2·3	2·0	8·3	7·3	14·3	12·5
24	13 06·0	13 08·2	12 30·2	2·4	2·1	8·4	7·4	14·4	12·6
25	13 06·3	13 08·4	12 30·4	2·5	2·2	8·5	7·4	14·5	12·7
26	13 06·5	13 08·7	12 30·7	2·6	2·3	8·6	7·5	14·6	12·8
27	13 06·8	13 08·9	12 30·9	2·7	2·4	8·7	7·6	14·7	12·9
28	13 07·0	13 09·2	12 31·1	2·8	2·5	8·8	7·7	14·8	13·0
29	13 07·3	13 09·4	12 31·4	2·9	2·5	8·9	7·8	14·9	13·0
30	13 07·5	13 09·7	12 31·6	3·0	2·6	9·0	7·9	15·0	13·1
31	13 07·8	13 09·9	12 31·9	3·1	2·7	9·1	8·0	15·1	13·2
32	13 08·0	13 10·2	12 32·1	3·2	2·8	9·2	8·0	15·2	13·3
33	13 08·3	13 10·4	12 32·3	3·3	2·9	9·3	8·1	15·3	13·4
34	13 08·5	13 10·7	12 32·6	3·4	3·0	9·4	8·2	15·4	13·5
35	13 08·8	13 10·9	12 32·8	3·5	3·1	9·5	8·3	15·5	13·6
36	13 09·0	13 11·2	12 33·1	3·6	3·2	9·6	8·4	15·6	13·7
37	13 09·3	13 11·4	12 33·3	3·7	3·2	9·7	8·5	15·7	13·7
38	13 09·5	13 11·7	12 33·5	3·8	3·3	9·8	8·6	15·8	13·8
39	13 09·8	13 11·9	12 33·8	3·9	3·4	9·9	8·7	15·9	13·9
40	13 10·0	13 12·2	12 34·0	4·0	3·5	10·0	8·8	16·0	14·0
41	13 10·3	13 12·4	12 34·2	4·1	3·6	10·1	8·8	16·1	14·1
42	13 10·5	13 12·7	12 34·5	4·2	3·7	10·2	8·9	16·2	14·2
43	13 10·8	13 12·9	12 34·7	4·3	3·8	10·3	9·0	16·3	14·3
44	13 11·0	13 13·2	12 35·0	4·4	3·9	10·4	9·1	16·4	14·3
45	13 11·3	13 13·4	12 35·2	4·5	3·9	10·5	9·2	16·5	14·4
46	13 11·5	13 13·7	12 35·4	4·6	4·0	10·6	9·3	16·6	14·5
47	13 11·8	13 13·9	12 35·7	4·7	4·1	10·7	9·4	16·7	14·6
48	13 12·0	13 14·2	12 35·9	4·8	4·2	10·8	9·5	16·8	14·7
49	13 12·3	13 14·4	12 36·2	4·9	4·3	10·9	9·5	16·9	14·8
50	13 12·5	13 14·7	12 36·4	5·0	4·4	11·0	9·6	17·0	14·9
51	13 12·8	13 14·9	12 36·6	5·1	4·5	11·1	9·7	17·1	15·0
52	13 13·0	13 15·2	12 36·9	5·2	4·6	11·2	9·8	17·2	15·1
53	13 13·3	13 15·4	12 37·1	5·3	4·6	11·3	9·9	17·3	15·1
54	13 13·5	13 15·7	12 37·4	5·4	4·7	11·4	10·0	17·4	15·2
55	13 13·8	13 15·9	12 37·6	5·5	4·8	11·5	10·1	17·5	15·3
56	13 14·0	13 16·2	12 37·8	5·6	4·9	11·6	10·2	17·6	15·4
57	13 14·3	13 16·4	12 38·1	5·7	5·0	11·7	10·2	17·7	15·5
58	13 14·5	13 16·7	12 38·3	5·8	5·1	11·8	10·3	17·8	15·6
59	13 14·8	13 16·9	12 38·5	5·9	5·2	11·9	10·4	17·9	15·7
60	13 15·0	13 17·2	12 38·8	6·0	5·3	12·0	10·5	18·0	15·8

RE: Another Nautical Almanac question

From Hohenkerk Catherine Catherine.Hohenkerk@UKHO.gov.uk

To slk1000 slk1000@aol.com Jul 17 2013

Dear Stan,

Increments and Corrections are fixed tables.

NA 2003 was the first NA that had these fixed tables generated by computer, rather than using copies of tables that had been generated many many years previously.

If you compare the look of the Increment and Corrections tables of NA 2003 or a modern NA with NA 2002 or older versions you will see that the printing looks a lot different.

I can confirm that the UK edition of NA 2002 has the old printed version of the tables.

I have looked up my files and can confirm that the NA 2003 was the first year to include the modern tables.

My notes also confirm that there were 4 cases where the rounding was different. The two cases you mention and minute 52 with v/d 9.2 and 16.4. The decision was taken to continue and use the modern values.

You are the first person to notice this!

I trust this answers your question.

Catherine

^^^

HM Nautical Almanac Office
United Kingdom Hydrographic Office
Admiralty Way
Taunton TA1 2DN
Catherine.Hohenkerk@UKHO.gov.uk

Note that the change first appeared in the 2001 Almanac, not the 2003 Almanac.

True or False –
The magnitudes of the 57 navigational stars in the Nautical Almanac remain the same from year to year.

Before 2006

Name	No	Mag	SHA	Dec
			°	°
Acamar	7	3·1	315	S 40
Achernar	5	0·6	336	S 57
Acrux	30	1·1	173	S 63
Adhara	19	1·6	255	S 29
Aldebaran	10	1·1	291	N 17
Alioth	32	1·7	166	N 56
Alkaid	34	1·9	153	N 49
Al Na'ir	55	2·2	28	S 47
Alnilam	15	1·8	276	S 1
Alphard	25	2·2	218	S 9
Alphecca	41	2·3	126	N 27
Alpheratz	1	2·2	358	N 29
Altair	51	0·9	62	N 9
Ankaa	2	2·4	353	S 42
Antares	42	1·2	113	S 26
Arcturus	37	0·2	146	N 19
Atria	43	1·9	108	S 69
Avior	22	1·7	234	S 60
Bellatrix	13	1·7	279	N 6
Betelgeuse	16	Var.*	271	N 7
Canopus	17	−0·9	264	S 53
Capella	12	0·2	281	N 46
Deneb	53	1·3	50	N 45
Denebola	28	2·2	183	N 15
Diphda	4	2·2	349	S 18
Dubhe	27	2·0	194	N 62
Elnath	14	1·8	278	N 29
Eltanin	47	2·4	91	N 51
Enif	54	2·5	34	N 10
Fomalhaut	56	1·3	16	S 30
Gacrux	31	1·6	172	S 57
Gienah	29	2·8	176	S 18
Hadar	35	0·9	149	S 60
Hamal	6	2·2	328	N 23
Kaus Australis	48	2·0	84	S 34
Kochab	40	2·2	137	N 74
Markab	57	2·6	14	N 15
Menkar	8	2·8	314	N 4
Menkent	36	2·3	148	S 36
Miaplacidus	24	1·8	222	S 70
Mirfak	9	1·9	309	N 50
Nunki	50	2·1	76	S 26
Peacock	52	2·1	53	S 57
Pollux	21	1·2	244	N 28
Procyon	20	0·5	245	N 5
Rasalhague	46	2·1	96	N 13
Regulus	26	1·3	208	N 12
Rigel	11	0·3	281	S 8
Rigil Kentaurus	38	0·1	140	S 61
Sabik	44	2·6	102	S 16
Schedar	3	2·5	350	N 57
Shaula	45	1·7	97	S 37
Sirius	18	−1·6	259	S 17
Spica	33	1·2	159	S 11
Suhail	23	2·2	223	S 43
Vega	49	0·1	81	N 39
Zubenelgenubi	39	2·9	137	S 16

Since 2006

Name	No	Mag	SHA	Dec
			°	°
Acamar	7	3·2	315	S 40
Achernar	5	0·5	335	S 57
Acrux	30	1·3	173	S 63
Adhara	19	1·5	255	S 29
Aldebaran	10	0·9	291	N 17
Alioth	32	1·8	166	N 56
Alkaid	34	1·9	153	N 49
Al Na'ir	55	1·7	28	S 47
Alnilam	15	1·7	276	S 1
Alphard	25	2·0	218	S 9
Alphecca	41	2·2	126	N 27
Alpheratz	1	2·1	358	N 29
Altair	51	0·8	62	N 9
Ankaa	2	2·4	353	S 42
Antares	42	1·0	112	S 26
Arcturus	37	0·0	146	N 19
Atria	43	1·9	108	S 69
Avior	22	1·9	234	S 60
Bellatrix	13	1·6	279	N 6
Betelgeuse	16	Var.*	271	N 7
Canopus	17	−0·7	264	S 53
Capella	12	0·1	281	N 46
Deneb	53	1·3	50	N 45
Denebola	28	2·1	183	N 15
Diphda	4	2·0	349	S 18
Dubhe	27	1·8	194	N 62
Elnath	14	1·7	278	N 29
Eltanin	47	2·2	91	N 51
Enif	54	2·4	34	N 10
Fomalhaut	56	1·2	15	S 30
Gacrux	31	1·6	172	S 57
Gienah	29	2·6	176	S 18
Hadar	35	0·6	149	S 60
Hamal	6	2·0	328	N 24
Kaus Australis	48	1·9	84	S 34
Kochab	40	2·1	137	N 74
Markab	57	2·5	14	N 15
Menkar	8	2·5	314	N 4
Menkent	36	2·1	148	S 36
Miaplacidus	24	1·7	222	S 70
Mirfak	9	1·8	309	N 50
Nunki	50	2·0	76	S 26
Peacock	52	1·9	53	S 57
Pollux	21	1·1	244	N 28
Procyon	20	0·4	245	N 5
Rasalhague	46	2·1	96	N 13
Regulus	26	1·4	208	N 12
Rigel	11	0·1	281	S 8
Rigil Kentaurus	38	−0·3	140	S 61
Sabik	44	2·4	102	S 16
Schedar	3	2·2	350	N 57
Shaula	45	1·6	96	S 37
Sirius	18	−1·5	259	S 17
Spica	33	1·0	159	S 11
Suhail	23	2·2	223	S 43
Vega	49	0·0	81	N 39
Zubenelgenubi	39	2·8	137	S 16

Magnitude bins

1^{st}: <=1.5

2^{nd}: >1.5 <=2.5

3^{rd}: >2.5

50 of the stars changed magnitude in 2006. Only the seven with green arrows did **not** change magnitude.

Of the 50 that changed magnitudes, the four with red arrows also changed bins.

2017

No	Name	Mag	SHA	Dec
			°	°
1	*Alpheratz*	2·1	358	N 29
2	*Ankaa*	2·4	353	S 42
3	*Schedar*	2·2	350	N 57
4	*Diphda*	2·0	349	S 18
5	*Achernar*	0·5	335	S 57
6	*Hamal*	2·0	328	N 24
7	*Acamar*	3·2	315	S 40
8	*Menkar*	2·5	314	N 4
9	*Mirfak*	1·8	309	N 50
10	*Aldebaran*	0·9	291	N 17
11	*Rigel*	0·1	281	S 8
12	*Capella*	0·1	281	N 46
13	*Bellatrix*	1·6	279	N 6
14	*Elnath*	1·7	278	N 29
15	*Alnilam*	1·7	276	S 1
16	*Betelgeuse*	Var.*	271	N 7
17	*Canopus*	−0·7	264	S 53
18	*Sirius*	−1·5	259	S 17
19	*Adhara*	1·5	255	S 29
20	*Procyon*	0·4	245	N 5
21	*Pollux*	1·1	243	N 28
22	*Avior*	1·9	234	S 60
23	*Suhail*	2·2	223	S 43
24	*Miaplacidus*	1·7	222	S 70
25	*Alphard*	2·0	218	S 9
26	*Regulus*	1·4	208	N 12
27	*Dubhe*	1·8	194	N 62
28	*Denebola*	2·1	183	N 14
29	*Gienah*	2·6	176	S 18
30	*Acrux*	1·3	173	S 63
31	*Gacrux*	1·6	172	S 57
32	*Alioth*	1·8	166	N 56
33	*Spica*	1·0	158	S 11
34	*Alkaid*	1·9	153	N 49
35	*Hadar*	0·6	149	S 60
36	*Menkent*	2·1	148	S 36
37	*Arcturus*	0·0	146	N 19
38	*Rigil Kentaurus*	−0·3	140	S 61
39	*Zubenelgenubi*	2·8	137	S 16
40	*Kochab*	2·1	137	N 74
41	*Alphecca*	2·2	126	N 27
42	*Antares*	1·0	112	S 26
43	*Atria*	1·9	107	S 69
44	*Sabik*	2·4	102	S 16
45	*Shaula*	1·6	96	S 37
46	*Rasalhague*	2·1	96	N 13
47	*Eltanin*	2·2	91	N 51
48	*Kaus Australis*	1·9	84	S 34
49	*Vega*	0·0	81	N 39
50	*Nunki*	2·0	76	S 26
51	*Altair*	0·8	62	N 9
52	*Peacock*	1·9	53	S 57
53	*Deneb*	1·3	50	N 45
54	*Enif*	2·4	34	N 10
55	*Al Na'ir*	1·7	28	S 47
56	*Fomalhaut*	1·2	15	S 30
57	*Markab*	2·5	14	N 15

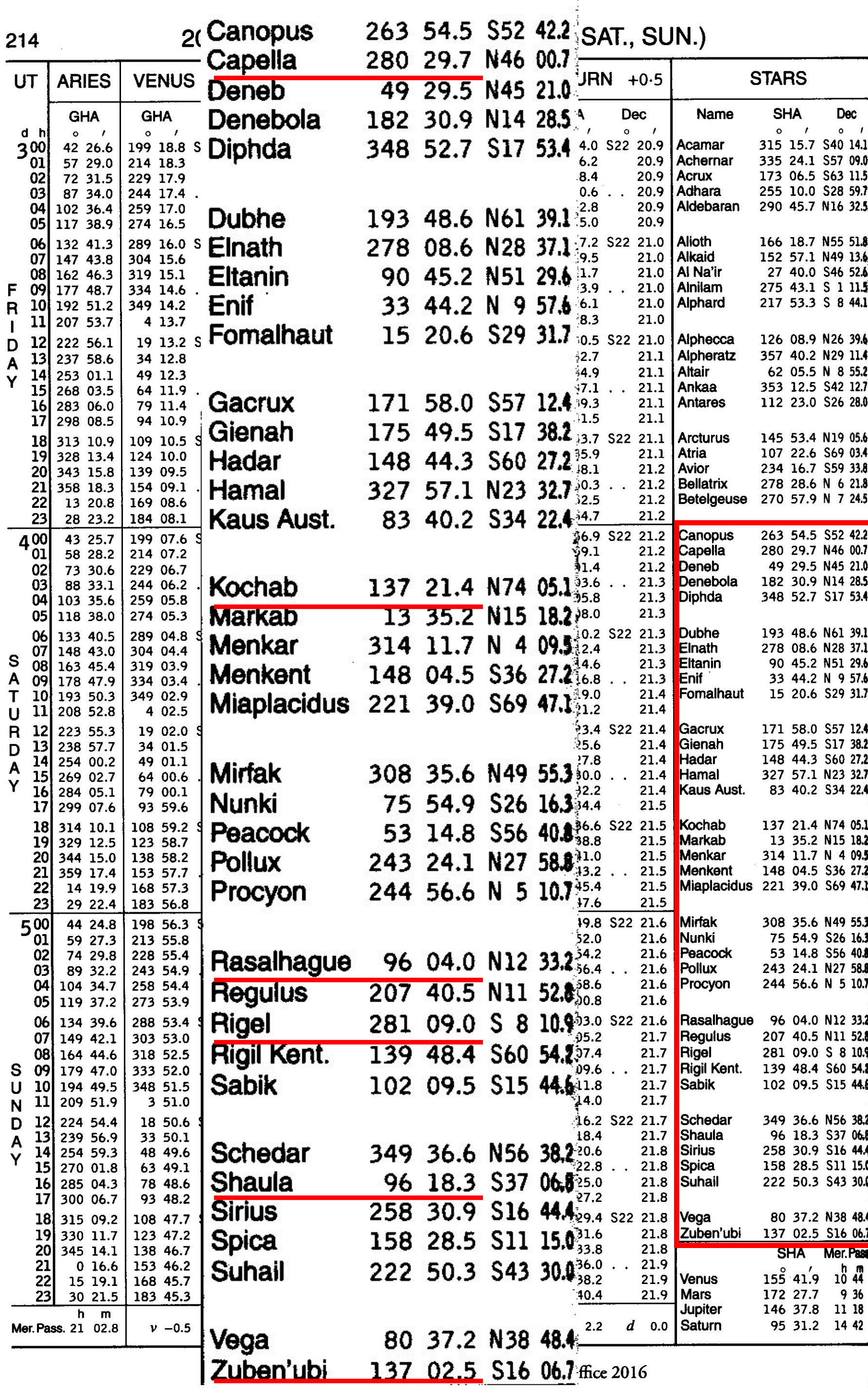
The numbers of the 57 navigational stars were assigned in reverse order of SHA. (At the time of the assignment, RA was used instead of SHA.) Because of proper motion, the positions of the stars slowly change. Which stars are currently “out of order”?

Likely candidates are:

11 Rigel and 12 Capella (SHAs both 281º)

39 Zubenelgenubi and 40 Kochab (SHAs both 137º)

45 Shaula and 46 Rasalhague (SHAs both 96)



Name	SHA	Dec
Acamar	315 15.7	S40 14.1
Achernar	335 24.1	S57 09.0
Acrux	173 06.5	S63 11.5
Adhara	255 10.0	S28 59.7
Aldebaran	290 45.7	N16 32.5
Alioth	166 18.7	N55 51.8
Alkaid	152 57.1	N49 13.6
Al Na'ir	27 40.0	S46 52.6
Alnilam	275 43.1	S 1 11.5
Alphard	217 53.3	S 8 44.1
Alphecca	126 08.9	N26 39.6
Alpheratz	357 40.2	N29 11.4
Altair	62 05.5	N 8 55.2
Ankaa	353 12.5	S42 12.7
Antares	112 23.0	S26 28.0
Arcturus	145 53.4	N19 05.6
Atria	107 22.6	S69 03.4
Avior	234 16.7	S59 33.8
Bellatrix	278 28.6	N 6 21.8
Betelgeuse	270 57.9	N 7 24.5
Canopus	263 54.5	S52 42.2
Capella	280 29.7	N46 00.7
Deneb	49 29.5	N45 21.0
Denebola	182 30.9	N14 28.5
Diphda	348 52.7	S17 53.4
Dubhe	193 48.6	N61 39.1
Elnath	278 08.6	N28 37.1
Eltanin	90 45.2	N51 29.6
Enif	33 44.2	N 9 57.6
Fomalhaut	15 20.6	S29 31.7
Gacrux	171 58.0	S57 12.4
Gienah	175 49.5	S17 38.2
Hadar	148 44.3	S60 27.2
Hamal	327 57.1	N23 32.7
Kaus Aust.	83 40.2	S34 22.4
Kochab	137 21.4	N74 05.1
Markab	13 35.2	N15 18.2
Menkar	314 11.7	N 4 09.5
Menkent	148 04.5	S36 27.2
Miaplacidus	221 39.0	S69 47.1
Mirfak	308 35.6	N49 55.3
Nunki	75 54.9	S26 16.3
Peacock	53 14.8	S56 40.8
Pollux	243 24.1	N27 58.8
Procyon	244 56.6	N 5 10.7
Rasalhague	96 04.0	N12 33.2
Regulus	207 40.5	N11 52.8
Rigel	281 09.0	S 8 10.9
Rigil Kent.	139 48.4	S60 54.2
Sabik	102 09.5	S15 44.6
Schedar	349 36.6	N56 38.2
Shaula	96 18.3	S37 06.8
Sirius	258 30.9	S16 44.4
Spica	158 28.5	S11 15.0
Suhail	222 50.3	S43 30.0
Vega	80 37.2	N38 48.4
Zuben'ubi	137 02.5	S16 06.7

	SHA	Mer. Pass.
Venus	155 41.9	10 44
Mars	172 27.7	9 36
Jupiter	146 37.8	11 18
Saturn	95 31.2	14 42

11 Rigel 281º09.0’

12 Capella 280º29.7’

Still in order

45 Shaula 96º18.3’

46 Rasalhague 96º04.0’

Still in order

39 Zubenelgenubi 137º02.5’

40 Kochab 137º21.4’

Out of order

When did they swap?

SHA Values from Almanac pages

	39 Zubenelgenubi	40 Kochab
1995 September 19, 20, 21	137º20.5’	137º20.4’
1995 September 22, 23, 24	137º20.5’	137º20.5’
1995 September 25, 26, 27	137º20.5’	137º20.5’
1995 September 28, 29, 30	137º20.5’	137º20.6’

Before 2006

The four stars with green arrows changed SHA in 2006

All stars continuously change position a little because of proper motion, but these four had their rounded to whole degrees values of SHA change.

No	Name	Mag	SHA	Dec
			°	°
1	*Alpheratz*	2·2	358	N 29
2	*Ankaa*	2·4	353	S 42
3	*Schedar*	2·5	350	N 57
4	*Diphda*	2·2	349	S 18
5	*Achernar*	0·6	336	S 57
6	*Hamal*	2·2	328	N 23
7	*Acamar*	3·1	315	S 40
8	*Menkar*	2·8	314	N 4
9	*Mirfak*	1·9	309	N 50
10	*Aldebaran*	1·1	291	N 17
11	*Rigel*	0·3	281	S 8
12	*Capella*	0·2	281	N 46
13	*Bellatrix*	1·7	279	N 6
14	*Elnath*	1·8	278	N 29
15	*Alnilam*	1·8	276	S 1
16	*Betelgeuse*	Var.*	271	N 7
17	*Canopus*	−0·9	264	S 53
18	*Sirius*	−1·6	259	S 17
19	*Adhara*	1·6	255	S 29
20	*Procyon*	0·5	245	N 5
21	*Pollux*	1·2	244	N 28
22	*Avior*	1·7	234	S 60
23	*Suhail*	2·2	223	S 43
24	*Miaplacidus*	1·8	222	S 70
25	*Alphard*	2·2	218	S 9
26	*Regulus*	1·3	208	N 12
27	*Dubhe*	2·0	194	N 62
28	*Denebola*	2·2	183	N 15
29	*Gienah*	2·8	176	S 18
30	*Acrux*	1·1	173	S 63
31	*Gacrux*	1·6	172	S 57
32	*Alioth*	1·7	166	N 56
33	*Spica*	1·2	159	S 11
34	*Alkaid*	1·9	153	N 49
35	*Hadar*	0·9	149	S 60
36	*Menkent*	2·3	148	S 36
37	*Arcturus*	0·2	146	N 19
38	*Rigil Kentaurus*	0·1	140	S 61
39	*Zubenelgenubi*	2·9	137	S 16
40	*Kochab*	2·2	137	N 74
41	*Alphecca*	2·3	126	N 27
42	*Antares*	1·2	113	S 26
43	*Atria*	1·9	108	S 69
44	*Sabik*	2·6	102	S 16
45	*Shaula*	1·7	97	S 37
46	*Rasalhague*	2·1	96	N 13
47	*Eltanin*	2·4	91	N 51
48	*Kaus Australis*	2·0	84	S 34
49	*Vega*	0·1	81	N 39
50	*Nunki*	2·1	76	S 26
51	*Altair*	0·9	62	N 9
52	*Peacock*	2·1	53	S 57
53	*Deneb*	1·3	50	N 45
54	*Enif*	2·5	34	N 10
55	*Al Na'ir*	2·2	28	S 47
56	*Fomalhaut*	1·3	16	S 30
57	*Markab*	2·6	14	N 15

Since 2006

No	Name	Mag	SHA	Dec
			°	°
1	*Alpheratz*	2·1	358	N 29
2	*Ankaa*	2·4	353	S 42
3	*Schedar*	2·2	350	N 57
4	*Diphda*	2·0	349	S 18
5	*Achernar*	0·5	335	S 57
6	*Hamal*	2·0	328	N 24
7	*Acamar*	3·2	315	S 40
8	*Menkar*	2·5	314	N 4
9	*Mirfak*	1·8	309	N 50
10	*Aldebaran*	0·9	291	N 17
11	*Rigel*	0·1	281	S 8
12	*Capella*	0·1	281	N 46
13	*Bellatrix*	1·6	279	N 6
14	*Elnath*	1·7	278	N 29
15	*Alnilam*	1·7	276	S 1
16	*Betelgeuse*	Var.*	271	N 7
17	*Canopus*	−0·7	264	S 53
18	*Sirius*	−1·5	259	S 17
19	*Adhara*	1·5	255	S 29
20	*Procyon*	0·4	245	N 5
21	*Pollux*	1·1	243	N 28
22	*Avior*	1·9	234	S 60
23	*Suhail*	2·2	223	S 43
24	*Miaplacidus*	1·7	222	S 70
25	*Alphard*	2·0	218	S 9
26	*Regulus*	1·4	208	N 12
27	*Dubhe*	1·8	194	N 62
28	*Denebola*	2·1	183	N 14
29	*Gienah*	2·6	176	S 18
30	*Acrux*	1·3	173	S 63
31	*Gacrux*	1·6	172	S 57
32	*Alioth*	1·8	166	N 56
33	*Spica*	1·0	158	S 11
34	*Alkaid*	1·9	153	N 49
35	*Hadar*	0·6	149	S 60
36	*Menkent*	2·1	148	S 36
37	*Arcturus*	0·0	146	N 19
38	*Rigil Kentaurus*	−0·3	140	S 61
39	*Zubenelgenubi*	2·8	137	S 16
40	*Kochab*	2·1	137	N 74
41	*Alphecca*	2·2	126	N 27
42	*Antares*	1·0	112	S 26
43	*Atria*	1·9	107	S 69
44	*Sabik*	2·4	102	S 16
45	*Shaula*	1·6	96	S 37
46	*Rasalhague*	2·1	96	N 13
47	*Eltanin*	2·2	91	N 51
48	*Kaus Australis*	1·9	84	S 34
49	*Vega*	0·0	81	N 39
50	*Nunki*	2·0	76	S 26
51	*Altair*	0·8	62	N 9
52	*Peacock*	1·9	53	S 57
53	*Deneb*	1·3	50	N 45
54	*Enif*	2·4	34	N 10
55	*Al Na'ir*	1·7	28	S 47
56	*Fomalhaut*	1·2	15	S 30
57	*Markab*	2·5	14	N 15

True or False –
The Sun Altitude Correction Tables in the Nautical Almanac remain the same from year to year.

A2 ALTITUDE CORRECTION TABLES 10º-90º
SUN

2003

OCT.—MAR. App. Alt.	OCT.—MAR. Lower Limb	OCT.—MAR. Upper Limb	APR.—SEPT. App. Alt.	APR.—SEPT. Lower Limb	APR.—SEPT. Upper Limb
° ′	′	′	° ′	′	′
9 34			9 39		
	+10·8	−21·5		+10·6	−21·2
9 45			9 51		
	+10·9	−21·4		+10·7	−21·1
9 56			10 03		
	+11·0	−21·3		+10·8	−21·0
10 08			10 15		
	+11·1	−21·2		+10·9	−20·9
10 21			10 27		
	+11·2	−21·1		+11·0	−20·8
10 34			10 40		
	+11·3	−21·0		+11·1	−20·7
10 47			10 54		
	+11·4	−20·9		+11·2	−20·6
11 01			11 08		
	+11·5	−20·8		+11·3	−20·5
11 15			11 23		
	+11·6	−20·7		+11·4	−20·4
11 30			11 38		
	+11·7	−20·6		+11·5	−20·3
11 46			11 54		
	+11·8	−20·5		+11·6	−20·2
12 02			12 10		
	+11·9	−20·4		+11·7	−20·1
12 19			12 28		
	+12·0	−20·3		+11·8	−20·0
12 37			12 46		
	+12·1	−20·2		+11·9	−19·9
12 55			13 05		
	+12·2	−20·1		+12·0	−19·8
13 14			13 24		
	+12·3	−20·0		+12·1	−19·7
13 35			13 45		
	+12·4	−19·9		+12·2	−19·6
13 56			14 07		
	+12·5	−19·8		+12·3	−19·5
14 18			14 30		
	+12·6	−19·7		+12·4	−19·4
14 42			14 54		
	+12·7	−19·6		+12·5	−19·3
15 06			15 19		
	+12·8	−19·5		+12·6	−19·2
15 32			15 46		
	+12·9	−19·4		+12·7	−19·1
15 59			16 14		
	+13·0	−19·3		+12·8	−19·0
16 28			16 44		
	+13·1	−19·2		+12·9	−18·9
16 59			17 15		
	+13·2	−19·1		+13·0	−18·8
17 32			17 48		
	+13·3	−19·0		+13·1	−18·7
18 06			18 24		
	+13·4	−18·9		+13·2	−18·6
18 42			19 01		
	+13·5	−18·8		+13·3	−18·5
19 21			19 42		
	+13·6	−18·7		+13·4	−18·4
20 03			20 25		
	+13·7	−18·6		+13·5	−18·3
20 48			21 11		
	+13·8	−18·5		+13·6	−18·2
21 35			22 00		
	+13·9	−18·4		+13·7	−18·1
22 26			22 54		
	+14·0	−18·3		+13·8	−18·0
23 22			23 51		
	+14·1	−18·2		+13·9	−17·9
24 21			24 53		
	+14·2	−18·1		+14·0	−17·8
25 26			26 00		
	+14·3	−18·0		+14·1	−17·7
26 36			27 13		
	+14·4	−17·9		+14·2	−17·6
27 52			28 33		
	+14·5	−17·8		+14·3	−17·5
29 15			30 00		
	+14·6	−17·7		+14·4	−17·4
30 46			31 35		
	+14·7	−17·6		+14·5	−17·3
32 26			33 20		
	+14·8	−17·5		+14·6	−17·2
34 17			35 17		
	+14·9	−17·4		+14·7	−17·1
36 20			37 26		
	+15·0	−17·3		+14·8	−17·0
38 36			39 50		
	+15·1	−17·2		+14·9	−16·9
41 08			42 31		
	+15·2	−17·1		+15·0	−16·8
43 59			45 31		
	+15·3	−17·0		+15·1	−16·7
47 10			48 55		
	+15·4	−16·9		+15·2	−16·6
50 46			52 44		
	+15·5	−16·8		+15·3	−16·5
54 49			57 02		
	+15·6	−16·7		+15·4	−16·4
59 23			61 51		
	+15·7	−16·6		+15·5	−16·3
64 30			67 17		
	+15·8	−16·5		+15·6	−16·2
70 12			73 16		
	+15·9	−16·4		+15·7	−16·1
76 26			79 43		
	+16·0	−16·3		+15·8	−16·0
83 05			86 32		
	+16·1	−16·2		+15·9	−15·9
90 00			90 00		

2004

OCT.—MAR. App. Alt.	OCT.—MAR. Lower Limb	OCT.—MAR. Upper Limb	APR.—SEPT. App. Alt.	APR.—SEPT. Lower Limb	APR.—SEPT. Upper Limb
° ′	′	′	° ′	′	′
9 33			9 39		
	+10·8	−21·5		+10·6	−21·2
9 45			9 50		
	+10·9	−21·4		+10·7	−21·1
9 56			10 02		
	+11·0	−21·3		+10·8	−21·0
10 08			10 14		
	+11·1	−21·2		+10·9	−20·9
10 20			10 27		
	+11·2	−21·1		+11·0	−20·8
10 33			10 40		
	+11·3	−21·0		+11·1	−20·7
10 46			10 53		
	+11·4	−20·9		+11·2	−20·6
11 00			11 07		
	+11·5	−20·8		+11·3	−20·5
11 15			11 22		
	+11·6	−20·7		+11·4	−20·4
11 30			11 37		
	+11·7	−20·6		+11·5	−20·3
11 45			11 53		
	+11·8	−20·5		+11·6	−20·2
12 01			12 10		
	+11·9	−20·4		+11·7	−20·1
12 18			12 27		
	+12·0	−20·3		+11·8	−20·0
12 36			12 45		
	+12·1	−20·2		+11·9	−19·9
12 54			13 04		
	+12·2	−20·1		+12·0	−19·8
13 14			13 24		
	+12·3	−20·0		+12·1	−19·7
13 34			13 44		
	+12·4	−19·9		+12·2	−19·6
13 55			14 06		
	+12·5	−19·8		+12·3	−19·5
14 17			14 29		
	+12·6	−19·7		+12·4	−19·4
14 41			14 53		
	+12·7	−19·6		+12·5	−19·3
15 05			15 18		
	+12·8	−19·5		+12·6	−19·2
15 31			15 45		
	+12·9	−19·4		+12·7	−19·1
15 59			16 13		
	+13·0	−19·3		+12·8	−19·0
16 27			16 43		
	+13·1	−19·2		+12·9	−18·9
16 58			17 14		
	+13·2	−19·1		+13·0	−18·8
17 30			17 47		
	+13·3	−19·0		+13·1	−18·7
18 05			18 23		
	+13·4	−18·9		+13·2	−18·6
18 41			19 00		
	+13·5	−18·8		+13·3	−18·5
19 20			19 41		
	+13·6	−18·7		+13·4	−18·4
20 02			20 24		
	+13·7	−18·6		+13·5	−18·3
20 46			21 10		
	+13·8	−18·5		+13·6	−18·2
21 34			21 59		
	+13·9	−18·4		+13·7	−18·1
22 25			22 52		
	+14·0	−18·3		+13·8	−18·0
23 20			23 49		
	+14·1	−18·2		+13·9	−17·9
24 20			24 51		
	+14·2	−18·1		+14·0	−17·8
25 24			25 58		
	+14·3	−18·0		+14·1	−17·7
26 34			27 11		
	+14·4	−17·9		+14·2	−17·6
27 50			28 31		
	+14·5	−17·8		+14·3	−17·5
29 13			29 58		
	+14·6	−17·7		+14·4	−17·4
30 44			31 33		
	+14·7	−17·6		+14·5	−17·3
32 24			33 18		
	+14·8	−17·5		+14·6	−17·2
34 15			35 15		
	+14·9	−17·4		+14·7	−17·1
36 17			37 24		
	+15·0	−17·3		+14·8	−17·0
38 34			39 48		
	+15·1	−17·2		+14·9	−16·9
41 06			42 28		
	+15·2	−17·1		+15·0	−16·8
43 56			45 29		
	+15·3	−17·0		+15·1	−16·7
47 07			48 52		
	+15·4	−16·9		+15·2	−16·6
50 43			52 41		
	+15·5	−16·8		+15·3	−16·5
54 46			56 59		
	+15·6	−16·7		+15·4	−16·4
59 21			61 50		
	+15·7	−16·6		+15·5	−16·3
64 28			67 15		
	+15·8	−16·5		+15·6	−16·2
70 10			73 14		
	+15·9	−16·4		+15·7	−16·1
76 24			79 42		
	+16·0	−16·3		+15·8	−16·0
83 05			86 31		
	+16·1	−16·2		+15·9	−15·9
90 00			90 00		

The corrections stayed the same, but most transition points changed.

True or False –
The Stars and Planets Altitude Correction Table (refraction portion) in the Nautical Almanac remains the same from year to year.

A2 ALTITUDE CORRECTION TABLES 10º-90º
STARS AND PLANETS

STARS AND PLANETS

App Alt.	Corr^n
° ′	′
9 56	
	−5·3
10 08	
	−5·2
10 20	
	−5·1
10 33	
	−5·0
10 46	
	−4·9
11 00	
	−4·8
11 14	
	−4·7
11 29	
	−4·6
11 45	
	−4·5
12 01	
	−4·4
12 18	
	−4·3
12 35	
	−4·2
12 54	
	−4·1
13 13	
	−4·0
13 33	
	−3·9
13 54	
	−3·8
14 16	
	−3·7
14 40	
	−3·6
15 04	
	−3·5
15 30	
	−3·4
15 57	
	−3·3
16 26	
	−3·2
16 56	
	−3·1
17 28	
	−3·0
18 02	
	−2·9
18 38	
	−2·8
19 17	
	−2·7
19 58	
	−2·6
20 42	
	−2·5
21 28	
	−2·4
22 19	
	−2·3
23 13	
	−2·2
24 11	
	−2·1
25 14	
	−2·0
26 22	
	−1·9
27 36	
	−1·8
28 56	
	−1·7
30 24	
	−1·6
32 00	
	−1·5
33 45	
	−1·4
35 40	
	−1·3
37 48	
	−1·2
40 08	
	−1·1
42 44	
	−1·0
45 36	
	−0·9
48 47	
	−0·8
52 18	
	−0·7
56 11	
	−0·6
60 28	
	−0·5
65 08	
	−0·4
70 11	
	−0·3
75 34	
	−0·2
81 13	
	−0·1
87 03	
	0·0
90 00	

App. Alt.	Additional Corr^n
2003	
VENUS	
Jan. 1–Feb. 20	
°	′
0	
	+0·2
41	
	+0·1
76	
Feb. 21–Dec. 31	
°	′
0	
	+0·1
60	
MARS	
Jan. 1–May 2	
Dec. 17–Dec. 31	
°	′
0	
	+0·1
60	
May 3–June 26	
Oct. 26–Dec. 16	
°	′
0	
	+0·2
41	
	+0·1
76	
June 27–Aug. 1	
Sept. 23–Oct. 25	
°	′
0	
	+0·3
34	
	+0·2
60	
	+0·1
80	
Aug. 2–Sept. 22	
°	′
0	
	+0·4
29	
	+0·3
51	
	+0·2
68	
	+0·1
83	

2003

2004

STARS AND PLANETS

App Alt.	Corr^n
° ′	′
9 55	
	−5·3
10 07	
	−5·2
10 20	
	−5·1
10 32	
	−5·0
10 46	
	−4·9
10 59	
	−4·8
11 14	
	−4·7
11 29	
	−4·6
11 44	
	−4·5
12 00	
	−4·4
12 17	
	−4·3
12 35	
	−4·2
12 53	
	−4·1
13 12	
	−4·0
13 32	
	−3·9
13 53	
	−3·8
14 16	
	−3·7
14 39	
	−3·6
15 03	
	−3·5
15 29	
	−3·4
15 56	
	−3·3
16 25	
	−3·2
16 55	
	−3·1
17 27	
	−3·0
18 01	
	−2·9
18 37	
	−2·8
19 16	
	−2·7
19 56	
	−2·6
20 40	
	−2·5
21 27	
	−2·4
22 17	
	−2·3
23 11	
	−2·2
24 09	
	−2·1
25 12	
	−2·0
26 20	
	−1·9
27 34	
	−1·8
28 54	
	−1·7
30 22	
	−1·6
31 58	
	−1·5
33 43	
	−1·4
35 38	
	−1·3
37 45	
	−1·2
40 06	
	−1·1
42 42	
	−1·0
45 34	
	−0·9
48 45	
	−0·8
52 16	
	−0·7
56 09	
	−0·6
60 26	
	−0·5
65 06	
	−0·4
70 09	
	−0·3
75 32	
	−0·2
81 12	
	−0·1
87 03	
	0·0
90 00	

App. Alt.	Additional Corr^n
2004	
VENUS	
Jan. 1–Feb. 22	
Sept. 23–Dec. 31	
°	′
0	
	+0·1
60	
Feb. 23–Apr. 14	
Aug. 3–Sept. 22	
°	′
0	
	+0·2
41	
	+0·1
76	
Apr. 15–May 7	
July 11–Aug. 2	
°	′
0	
	+0·3
34	
	+0·2
60	
	+0·1
80	
May 8–May 23	
June 25–July 10	
°	′
0	
	+0·4
29	
	+0·3
51	
	+0·2
68	
	+0·1
83	
May 24–June 24	
°	′
0	
	+0·5
26	
	+0·4
46	
	+0·3
60	
	+0·2
73	
	+0·1
84	
MARS	
Jan. 1–Dec. 31	
°	′
0	
	+0·1
60	

Again, the refraction corrections stayed the same, but most transition points changed.

True or False –
The MoonAltitude Correction
Table in the Nautical Almanac
remains the same from year to year.

ALTITUDE CORRECTION TABLES 0º - 35º -- MOON

2003

App. Alt.	0°–4° Corrⁿ	5°–9° Corrⁿ	10°–14° Corrⁿ	15°–19° Corrⁿ	20°–24° Corrⁿ	25°–29° Corrⁿ	30°–34° Corrⁿ	App. Alt.
00	0 33.8	5 58.2	10 62.1	15 62.8	20 62.2	25 60.8	30 58.9	00
10	35.9	58.5	62.2	62.8	62.1	60.8	58.8	10
20	37.8	58.7	62.2	62.8	62.1	60.7	58.8	20
30	39.6	58.9	62.3	62.8	62.1	60.7	58.7	30
40	41.2	59.1	62.3	62.8	62.0	60.6	58.6	40
50	42.6	59.3	62.4	62.7	62.0	60.6	58.5	50
00	1 44.0	6 59.5	11 62.4	16 62.7	21 62.0	26 60.5	31 58.5	00
10	45.2	59.7	62.4	62.7	61.9	60.4	58.4	10
20	46.3	59.9	62.5	62.7	61.9	60.4	58.3	20
30	47.3	60.0	62.5	62.7	61.9	60.3	58.2	30
40	48.3	60.2	62.5	62.7	61.8	60.3	58.2	40
50	49.2	60.3	62.6	62.7	61.8	60.2	58.1	50
00	2 50.0	7 60.5	12 62.6	17 62.7	22 61.7	27 60.1	32 58.0	00
10	50.8	60.6	62.6	62.6	61.7	60.1	57.9	10
20	51.4	60.7	62.6	62.6	61.6	60.0	57.8	20
30	52.1	60.9	62.7	62.6	61.6	59.9	57.8	30
40	52.7	61.0	62.7	62.6	61.5	59.9	57.7	40
50	53.3	61.1	62.7	62.6	61.5	59.8	57.6	50
00	3 53.8	8 61.2	13 62.7	18 62.5	23 61.5	28 59.7	33 57.5	00
10	54.3	61.3	62.7	62.5	61.4	59.7	57.4	10
20	54.8	61.4	62.7	62.5	61.4	59.6	57.4	20
30	55.2	61.5	62.8	62.5	61.3	59.6	57.3	30
40	55.6	61.6	62.8	62.4	61.3	59.5	57.2	40
50	56.0	61.6	62.8	62.4	61.2	59.4	57.1	50
00	4 56.4	9 61.7	14 62.8	19 62.4	24 61.2	29 59.3	34 57.0	00
10	56.7	61.8	62.8	62.3	61.1	59.3	56.9	10
20	57.1	61.9	62.8	62.3	61.1	59.2	56.9	20
30	57.4	61.9	62.8	62.3	61.0	59.1	56.8	30
40	57.7	62.0	62.8	62.2	60.9	59.1	56.7	40
50	57.9	62.1	62.8	62.2	60.9	59.0	56.6	50

HP	L	U	L	U	L	U	L	U	L	U	L	U	L	U	HP
54.0	0.3	0.9	0.3	0.9	0.4	1.0	0.5	1.1	0.6	1.2	0.7	1.3	0.9	1.5	54.0
54.3	0.7	1.1	0.7	1.2	0.7	1.2	0.8	1.3	0.9	1.4	1.1	1.5	1.2	1.7	54.3
54.6	1.1	1.4	1.1	1.4	1.1	1.4	1.2	1.5	1.3	1.6	1.4	1.7	1.5	1.8	54.6
54.9	1.4	1.6	1.5	1.6	1.5	1.6	1.6	1.7	1.6	1.8	1.8	1.9	1.9	2.0	54.9
55.2	1.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	55.2
55.5	2.2	2.0	2.2	2.0	2.3	2.1	2.3	2.1	2.4	2.2	2.4	2.3	2.5	2.4	55.5
55.8	2.6	2.2	2.6	2.2	2.6	2.3	2.7	2.3	2.7	2.4	2.8	2.4	2.9	2.5	55.8
56.1	3.0	2.4	3.0	2.5	3.0	2.5	3.0	2.5	3.1	2.6	3.1	2.6	3.2	2.7	56.1
56.4	3.4	2.7	3.4	2.7	3.4	2.7	3.4	2.7	3.4	2.8	3.5	2.8	3.5	2.9	56.4
56.7	3.7	2.9	3.7	2.9	3.8	2.9	3.8	2.9	3.8	3.0	3.8	3.0	3.9	3.0	56.7
57.0	4.1	3.1	4.1	3.1	4.1	3.1	4.1	3.1	4.2	3.1	4.2	3.2	4.2	3.2	57.0
57.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.4	4.6	3.4	57.3
57.6	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.6	57.6
57.9	5.3	3.8	5.3	3.8	5.2	3.8	5.2	3.7	5.2	3.7	5.2	3.7	5.2	3.7	57.9
58.2	5.6	4.0	5.6	4.0	5.6	4.0	5.6	4.0	5.6	3.9	5.6	3.9	5.6	3.9	58.2
58.5	6.0	4.2	6.0	4.2	6.0	4.2	6.0	4.2	6.0	4.1	5.9	4.1	5.9	4.1	58.5
58.8	6.4	4.4	6.4	4.4	6.4	4.4	6.3	4.4	6.3	4.3	6.3	4.3	6.2	4.2	58.8
59.1	6.8	4.6	6.8	4.6	6.7	4.6	6.7	4.6	6.7	4.5	6.6	4.5	6.6	4.4	59.1
59.4	7.2	4.8	7.1	4.8	7.1	4.8	7.1	4.8	7.0	4.7	7.0	4.7	6.9	4.6	59.4
59.7	7.5	5.1	7.5	5.0	7.5	5.0	7.5	5.0	7.4	4.9	7.3	4.8	7.2	4.7	59.7
60.0	7.9	5.3	7.9	5.3	7.9	5.2	7.8	5.2	7.8	5.1	7.7	5.0	7.6	4.9	60.0
60.3	8.3	5.5	8.3	5.5	8.2	5.4	8.2	5.4	8.1	5.3	8.0	5.2	7.9	5.1	60.3
60.6	8.7	5.7	8.7	5.7	8.6	5.7	8.6	5.6	8.5	5.5	8.4	5.4	8.2	5.3	60.6
60.9	9.1	5.9	9.0	5.9	9.0	5.9	8.9	5.8	8.8	5.7	8.7	5.6	8.6	5.4	60.9
61.2	9.5	6.2	9.4	6.1	9.4	6.1	9.3	6.0	9.2	5.9	9.1	5.8	8.9	5.6	61.2
61.5	9.8	6.4	9.8	6.3	9.7	6.3	9.7	6.2	9.5	6.1	9.4	5.9	9.2	5.8	61.5

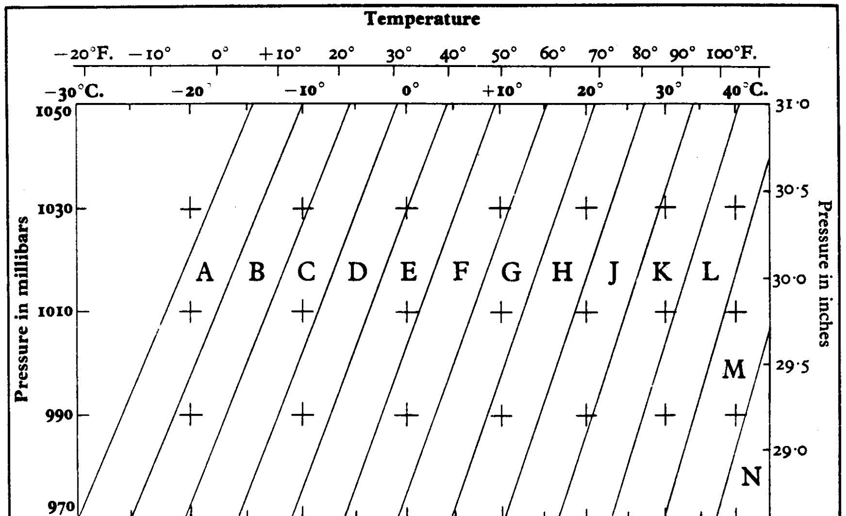
2004

App. Alt.	0°–4° Corrⁿ	5°–9° Corrⁿ	10°–14° Corrⁿ	15°–19° Corrⁿ	20°–24° Corrⁿ	25°–29° Corrⁿ	30°–34° Corrⁿ	App. Alt.
00	0 34.5	5 58.2	10 62.1	15 62.8	20 62.2	25 60.8	30 58.9	00
10	36.5	58.5	62.2	62.8	62.2	60.8	58.8	10
20	38.3	58.7	62.2	62.8	62.1	60.7	58.8	20
30	40.0	58.9	62.3	62.8	62.1	60.7	58.7	30
40	41.5	59.1	62.3	62.8	62.0	60.6	58.6	40
50	42.9	59.3	62.4	62.7	62.0	60.6	58.5	50
00	1 44.2	6 59.5	11 62.4	16 62.7	21 62.0	26 60.5	31 58.5	00
10	45.4	59.7	62.4	62.7	61.9	60.4	58.4	10
20	46.5	59.9	62.5	62.7	61.9	60.4	58.3	20
30	47.5	60.0	62.5	62.7	61.9	60.3	58.2	30
40	48.4	60.2	62.5	62.7	61.8	60.3	58.2	40
50	49.3	60.3	62.6	62.7	61.8	60.2	58.1	50
00	2 50.1	7 60.5	12 62.6	17 62.7	22 61.7	27 60.1	32 58.0	00
10	50.8	60.6	62.6	62.6	61.7	60.1	57.9	10
20	51.5	60.7	62.6	62.6	61.6	60.0	57.8	20
30	52.2	60.9	62.7	62.6	61.6	59.9	57.8	30
40	52.8	61.0	62.7	62.6	61.6	59.9	57.7	40
50	53.4	61.1	62.7	62.6	61.5	59.8	57.6	50
00	3 53.9	8 61.2	13 62.7	18 62.5	23 61.5	28 59.7	33 57.5	00
10	54.4	61.3	62.7	62.5	61.4	59.7	57.4	10
20	54.9	61.4	62.7	62.5	61.4	59.6	57.4	20
30	55.3	61.5	62.8	62.5	61.3	59.5	57.3	30
40	55.7	61.6	62.8	62.4	61.3	59.5	57.2	40
50	56.1	61.6	62.8	62.4	61.2	59.4	57.1	50
00	4 56.4	9 61.7	14 62.8	19 62.4	24 61.2	29 59.3	34 57.0	00
10	56.8	61.8	62.8	62.4	61.1	59.3	56.9	10
20	57.1	61.9	62.8	62.3	61.1	59.2	56.9	20
30	57.4	61.9	62.8	62.3	61.0	59.1	56.8	30
40	57.7	62.0	62.8	62.3	61.0	59.1	56.7	40
50	58.0	62.1	62.8	62.2	60.9	59.0	56.6	50

HP	L	U	L	U	L	U	L	U	L	U	L	U	L	U	HP
54.0	0.3	0.9	0.3	0.9	0.4	1.0	0.5	1.1	0.6	1.2	0.7	1.3	0.9	1.5	54.0
54.3	0.7	1.1	0.7	1.2	0.8	1.2	0.8	1.3	0.9	1.4	1.1	1.5	1.2	1.7	54.3
54.6	1.1	1.4	1.1	1.4	1.1	1.4	1.2	1.5	1.3	1.6	1.4	1.7	1.5	1.8	54.6
54.9	1.4	1.6	1.5	1.6	1.5	1.6	1.6	1.7	1.6	1.8	1.8	1.9	1.9	2.0	54.9
55.2	1.8	1.8	1.8	1.8	1.9	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2	2.2	55.2
55.5	2.2	2.0	2.2	2.0	2.3	2.1	2.3	2.1	2.4	2.2	2.4	2.3	2.5	2.4	55.5
55.8	2.6	2.2	2.6	2.2	2.6	2.3	2.7	2.3	2.7	2.4	2.8	2.4	2.9	2.5	55.8
56.1	3.0	2.4	3.0	2.5	3.0	2.5	3.0	2.5	3.1	2.6	3.1	2.6	3.2	2.7	56.1
56.4	3.3	2.7	3.4	2.7	3.4	2.7	3.4	2.7	3.4	2.8	3.5	2.8	3.5	2.9	56.4
56.7	3.7	2.9	3.7	2.9	3.8	2.9	3.8	2.9	3.8	3.0	3.8	3.0	3.9	3.0	56.7
57.0	4.1	3.1	4.1	3.1	4.1	3.1	4.1	3.1	4.2	3.2	4.2	3.2	4.2	3.2	57.0
57.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.3	4.5	3.4	4.6	3.4	57.3
57.6	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.5	4.9	3.6	57.6
57.9	5.3	3.8	5.3	3.8	5.2	3.8	5.2	3.7	5.2	3.7	5.2	3.7	5.2	3.7	57.9
58.2	5.6	4.0	5.6	4.0	5.6	4.0	5.6	4.0	5.6	3.9	5.6	3.9	5.6	3.9	58.2
58.5	6.0	4.2	6.0	4.2	6.0	4.2	6.0	4.2	6.0	4.1	5.9	4.1	5.9	4.1	58.5
58.8	6.4	4.4	6.4	4.4	6.4	4.4	6.3	4.4	6.3	4.3	6.3	4.3	6.2	4.2	58.8
59.1	6.8	4.6	6.8	4.6	6.7	4.6	6.7	4.6	6.7	4.5	6.6	4.5	6.6	4.4	59.1
59.4	7.2	4.8	7.1	4.8	7.1	4.8	7.1	4.8	7.0	4.7	7.0	4.7	6.9	4.6	59.4
59.7	7.5	5.1	7.5	5.0	7.5	5.0	7.5	5.0	7.4	4.9	7.3	4.8	7.2	4.8	59.7
60.0	7.9	5.3	7.9	5.3	7.9	5.2	7.8	5.2	7.8	5.1	7.7	5.0	7.6	4.9	60.0
60.3	8.3	5.5	8.3	5.5	8.2	5.4	8.2	5.4	8.1	5.3	8.0	5.2	7.9	5.1	60.3
60.6	8.7	5.7	8.7	5.7	8.6	5.7	8.6	5.6	8.5	5.5	8.4	5.4	8.2	5.3	60.6
60.9	9.1	5.9	9.0	5.9	9.0	5.9	8.9	5.8	8.8	5.7	8.7	5.6	8.6	5.4	60.9
61.2	9.5	6.2	9.4	6.1	9.4	6.1	9.3	6.0	9.2	5.9	9.1	5.8	8.9	5.6	61.2
61.5	9.8	6.4	9.8	6.3	9.7	6.3	9.7	6.2	9.5	6.1	9.4	5.9	9.2	5.8	61.5

A4 ALTITUDE CORRECTION TABLES—ADDITIONAL CORRECTIONS

ADDITIONAL REFRACTION CORRECTIONS FOR NON-STANDARD CONDITIONS



App. Alt.	A	B	C	D	E	F	G	H	J	K	L	M	N	App. Alt.
° ′	′	′	′	′	′	′	′	′	′	′	′	′	′	° ′
0 00	−6·9	−5·7	−4·6	−3·4	−2·3	−1·1	0·0	+1·1	+2·3	+3·4	+4·6	+5·7	+6·9	0 00
0 30	5·2	4·4	3·5	2·6	1·7	0·9	0·0	0·9	1·7	2·6	3·5	4·4	5·2	0 30
1 00	4·3	3·5	2·8	2·1	1·4	0·7	0·0	0·7	1·4	2·1	2·8	3·5	4·3	1 00
1 30	3·5	2·9	2·4	1·8	1·2	0·6	0·0	0·6	1·2	1·8	2·4	2·9	3·5	1 30
2 00	3·0	2·5	2·0	1·5	1·0	0·5	0·0	0·5	1·0	1·5	2·0	2·5	3·0	2 00
2 30	−2·5	−2·1	−1·6	−1·2	−0·8	−0·4	0·0	+0·4	+0·8	+1·2	+1·6	+2·1	−2·5	2 30
3 00	2·2	1·8	1·5	1·1	0·7	0·4	0·0	0·4	0·7	1·1	1·5	1·8	2·2	3 00
3 30	2·0	1·6	1·3	1·0	0·7	0·3	0·0	0·3	0·7	1·0	1·3	1·6	2·0	3 30
4 00	1·8	1·5	1·2	0·9	0·6	0·3	0·0	0·3	0·6	0·9	1·2	1·5	1·8	4 00
4 30	1·6	1·4	1·1	0·8	0·5	0·3	0·0	0·3	0·5	0·8	1·1	1·4	1·6	4 30
5 00	−1·5	−1·3	−1·0	−0·8	−0·5	−0·2	0·0	+0·2	+0·5	+0·8	+1·0	+1·3	+1·5	5 00
6	1·3	1·1	0·9	0·6	0·4	0·2	0·0	0·2	0·4	0·6	0·9	1·1	1·3	6
7	1·1	0·9	0·7	0·6	0·4	0·2	0·0	0·2	0·4	0·6	0·7	0·9	1·1	7
8	1·0	0·8	0·7	0·5	0·3	0·2	0·0	0·2	0·3	0·5	0·7	0·8	1·0	8
9	0·9	0·7	0·6	0·4	0·3	0·1	0·0	0·1	0·3	0·4	0·6	0·7	0·9	9
10 00	−0·8	−0·7	−0·5	−0·4	−0·3	−0·1	0·0	+0·1	+0·3	+0·4	−0·5	+0·7	+0·8	10 00
12	0·7	0·6	0·5	0·3	0·2	0·1	0·0	0·1	0·2	0·3	0·5	0·6	0·7	12
14	0·6	0·5	0·4	0·3	0·2	0·1	0·0	0·1	0·2	0·3	0·4	0·5	0·6	14
16	0·5	0·4	0·3	0·3	0·2	0·1	0·0	0·1	0·2	0·3	0·3	0·4	0·5	16
18	0·4	0·4	0·3	0·2	0·2	0·1	0·0	0·1	0·2	0·2	0·3	0·4	0·4	18
20 00	−0·4	−0·3	−0·3	−0·2	−0·1	−0·1	0·0	+0·1	+0·1	+0·2	+0·3	+0·3	+0·4	20 00
25	0·3	0·3	0·2	0·2	0·1	−0·1	0·0	+0·1	0·1	0·2	0·2	0·3	0·3	25
30	0·3	0·2	0·2	0·1	0·1	0·0	0·0	0·0	0·1	0·1	0·2	0·2	0·3	30
35	0·2	0·2	0·1	0·1	0·1	0·0	0·0	0·0	0·1	0·1	0·1	0·2	0·2	35
40	0·2	0·1	0·1	0·1	−0·1	0·0	0·0	0·0	+0·1	0·1	0·1	0·1	0·2	40
50 00	−0·1	−0·1	−0·1	−0·1	0·0	0·0	0·0	0·0	0·0	+0·1	+0·1	+0·1	+0·1	50 00

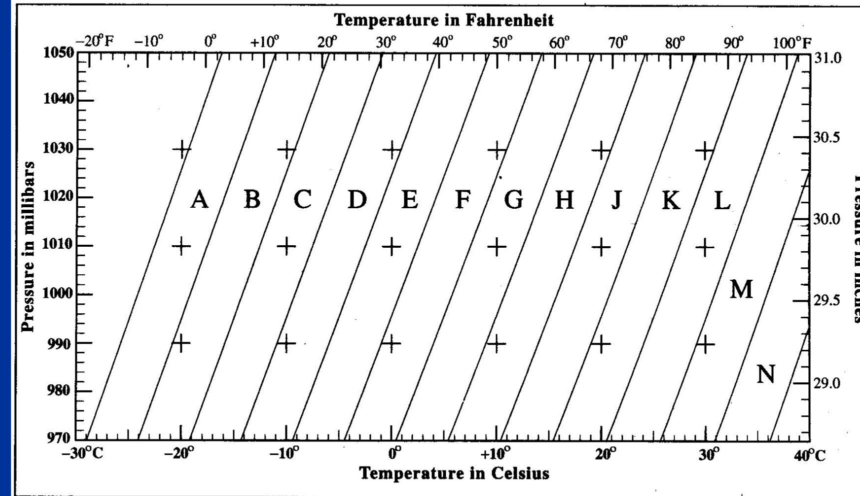
The graph is entered with arguments temperature and pressure to find a zone letter; using as arguments this zone letter and apparent altitude (sextant altitude corrected for dip), a correction is taken from the table. This correction is to be applied to the sextant altitude in addition to the corrections for standard conditions (for the Sun, stars and planets from page A2 and for the Moon from pages xxxiv and xxxv).

2003

2004

A4 ALTITUDE CORRECTION TABLES—ADDITIONAL CORRECTIONS

ADDITIONAL REFRACTION CORRECTIONS FOR NON-STANDARD CONDITIONS



App. Alt.	A	B	C	D	E	F	G	H	J	K	L	M	N	P	App. Alt.
° ′	′	′	′	′	′	′	′	′	′	′	′	′	′	′	° ′
00 00	−7·3	−5·9	−4·6	−3·4	−2·2	−1·1	0·0	+1·0	+2·0	+3·0	+4·0	+4·9	+5·9	+6·9	00 00
00 30	5·5	4·5	3·5	2·6	1·7	0·8	0·0	0·8	1·6	2·3	3·1	3·8	4·5	5·3	00 30
01 00	4·4	3·5	2·8	2·0	1·3	0·7	0·0	0·6	1·2	1·8	2·4	3·0	3·6	4·2	01 00
01 30	3·5	2·9	2·2	1·7	1·1	0·5	0·0	0·5	1·0	1·5	2·0	2·5	2·9	3·4	01 30
02 00	2·9	2·4	1·9	1·4	0·9	0·4	0·0	0·4	0·8	1·3	1·7	2·0	2·4	2·8	02 00
02 30	−2·5	−2·0	−1·6	−1·2	−0·8	−0·4	0·0	+0·4	+0·7	+1·1	+1·4	+1·7	+2·1	+2·4	02 30
03 00	2·1	1·7	1·4	1·0	0·7	0·3	0·0	0·3	0·6	0·9	1·2	1·5	1·8	2·1	03 00
03 30	1·9	1·5	1·2	0·9	0·6	0·3	0·0	0·3	0·5	0·8	1·1	1·3	1·6	1·8	03 30
04 00	1·6	1·3	1·1	0·8	0·5	0·3	0·0	0·2	0·5	0·7	0·9	1·2	1·4	1·6	04 00
04 30	1·5	1·2	0·9	0·7	0·5	0·2	0·0	0·2	0·4	0·6	0·8	1·0	1·3	1·5	04 30
05 00	−1·3	−1·1	−0·9	−0·6	−0·4	−0·2	0·0	+0·2	+0·4	+0·6	+0·8	+0·9	+1·1	+1·3	05 00
06	1·1	0·9	0·7	0·5	0·3	0·2	0·0	0·2	0·3	0·5	0·6	0·8	0·9	1·1	06
07	1·0	0·8	0·6	0·5	0·3	0·1	0·0	0·1	0·3	0·4	0·5	0·7	0·8	0·9	07
08	0·8	0·7	0·5	0·4	0·3	0·1	0·0	0·1	0·2	0·4	0·5	0·6	0·7	0·8	08
09	0·7	0·6	0·5	0·4	0·2	0·1	0·0	0·1	0·2	0·3	0·4	0·5	0·6	0·7	09
10 00	−0·7	−0·5	−0·4	−0·3	−0·2	−0·1	0·0	+0·1	+0·2	+0·3	+0·4	+0·5	+0·6	+0·7	10 00
12	0·6	0·5	0·4	0·3	0·2	0·1	0·0	0·1	0·2	0·2	0·3	0·4	0·5	0·5	12
14	0·5	0·4	0·3	0·2	0·1	0·1	0·0	0·1	0·1	0·2	0·3	0·3	0·4	0·5	14
16	0·4	0·3	0·3	0·2	0·1	0·1	0·0	0·1	0·1	0·2	0·2	0·3	0·3	0·4	16
18	0·4	0·3	0·2	0·2	0·1	−0·1	0·0	+0·1	0·1	0·2	0·2	0·3	0·3	0·4	18
20 00	−0·3	−0·3	−0·2	−0·2	−0·1	0·0	0·0	0·0	+0·1	+0·1	+0·2	+0·2	+0·3	+0·3	20 00
25	0·3	0·2	0·2	0·1	0·1	0·0	0·0	0·0	0·1	0·1	0·1	0·2	0·2	0·2	25
30	0·2	0·2	0·1	0·1	0·1	0·0	0·0	0·0	+0·1	0·1	0·1	0·1	0·2	0·2	30
35	0·2	0·1	0·1	0·1	−0·1	0·0	0·0	0·0	0·0	0·1	0·1	0·1	0·1	0·2	35
40	0·1	0·1	0·1	−0·1	0·0	0·0	0·0	0·0	0·0	+0·1	0·1	0·1	0·1	0·1	40
50 00	−0·1	−0·1	−0·1	0·0	0·0	0·0	0·0	0·0	0·0	0·0	+0·1	+0·1	+0·1	+0·1	50 00

The graph is entered with arguments temperature and pressure to find a zone letter; using as arguments this zone letter and apparent altitude (sextant altitude corrected for index error and dip), a correction is taken from the table. This correction is to be applied to the sextant altitude in addition to the corrections for standard conditions (for the Sun, stars and planets from page A2-A3 and for the Moon from pages xxxiv and xxxv).

2004

Step 3. $X = (-0{\cdot}2588 \times 0{\cdot}8480 - 0{\cdot}7714 \times 0{\cdot}5299)/0{\cdot}8560 = -0{\cdot}7340$

$A = 137^\circ\!.2239$

Step 4. Since $LHA \leq 180^\circ$ then $Z = 360^\circ - A = 222^\circ\!.7761$

8. *Reduction from sextant altitude to observed altitude.* The sextant altitude H_S is corrected for both dip and index error to produce the apparent altitude. The observed altitude H_O is calculated by applying a correction for refraction. For the Sun, Moon, Venus and Mars a correction for parallax is also applied to H, and for the Sun and Moon a further correction for semi-diameter is required. The corrections are calculated as follows:

Step 1. Calculate dip

$$D = 0^\circ\!.0293\sqrt{h}$$

where h is the height of eye above the horizon in metres.

Step 2. Calculate apparent altitude

$$H = H_S + I - D$$

where I is the sextant index error.

Step 3. Calculate refraction (R) at a standard temperature of 10° Celsius (C) and pressure of 1010 millibars (mb)

$$\boxed{R_0 = 0^\circ\!.0167/\tan(H + 7{\cdot}31/(H + 4{\cdot}4))}$$

If the temperature T° C and pressure P mb are known calculate the refraction from

$$R = fR_0 \quad \text{where} \quad f = 0{\cdot}28P/(T + 273)$$

otherwise set $R = R_0$

Step 4. Calculate the parallax in altitude (PA) from the horizontal parallax (HP) and the apparent altitude (H) for the Sun, Moon, Venus and Mars as follows:

$$PA = HP \cos H$$

For the Sun $HP = 0^\circ\!.0024$. This correction is very small and could be ignored.

For the Moon HP is taken for the nearest hour from the main tabular page and converted to degrees.

For Venus and Mars the HP is taken from the critical table at the bottom of page 259 and converted to degrees.

For the navigational stars and the remaining planets, Jupiter and Saturn set $PA = 0$.

If an error of 0'.2 is significant the expression for the parallax in altitude for the Moon should include a small correction OB for the oblateness of the Earth as follows:

$$PA = HP \cos H + OB$$

$$\text{where} \quad OB = -0^\circ\!.0032 \sin^2 Lat \cos H + 0^\circ\!.0032 \sin(2Lat) \cos Z \sin H$$

At mid-latitudes and for altitudes of the Moon below 60° a simple approximation to OB is

$$OB = -0^\circ\!.0017 \cos H$$

2005

Step 3. $X = (-0{\cdot}2588 \times 0{\cdot}8480 - 0{\cdot}7714 \times 0{\cdot}5299)/0{\cdot}8560 = -0{\cdot}7340$

$A = 137^\circ\!.2239$

Step 4. Since $LHA \leq 180^\circ$ then $Z = 360^\circ - A = 222^\circ\!.7761$

8. *Reduction from sextant altitude to observed altitude.* The sextant altitude H_S is corrected for both dip and index error to produce the apparent altitude. The observed altitude H_O is calculated by applying a correction for refraction. For the Sun, Moon, Venus and Mars a correction for parallax is also applied to H, and for the Sun and Moon a further correction for semi-diameter is required. The corrections are calculated as follows:

Step 1. Calculate dip

$$D = 0^\circ\!.0293\sqrt{h}$$

where h is the height of eye above the horizon in metres.

Step 2. Calculate apparent altitude

$$H = H_S + I - D$$

where I is the sextant index error.

Step 3. Calculate refraction (R) at a standard temperature of 10° Celsius (C) and pressure of 1010 millibars (mb)

$$\boxed{R_0 = 0^\circ\!.0167/\tan(H + 7{\cdot}32/(H + 4{\cdot}32))}$$

If the temperature T° C and pressure P mb are known calculate the refraction from

$$R = fR_0 \quad \text{where} \quad f = 0{\cdot}28P/(T + 273)$$

otherwise set $R = R_0$

Step 4. Calculate the parallax in altitude (PA) from the horizontal parallax (HP) and the apparent altitude (H) for the Sun, Moon, Venus and Mars as follows:

$$PA = HP \cos H$$

For the Sun $HP = 0^\circ\!.0024$. This correction is very small and could be ignored.

For the Moon HP is taken for the nearest hour from the main tabular page and converted to degrees.

For Venus and Mars the HP is taken from the critical table at the bottom of page 259 and converted to degrees.

For the navigational stars and the remaining planets, Jupiter and Saturn set $PA = 0$.

If an error of 0'.2 is significant the expression for the parallax in altitude for the Moon should include a small correction OB for the oblateness of the Earth as follows:

$$PA = HP \cos H + OB$$

$$\text{where} \quad OB = -0^\circ\!.0032 \sin^2 Lat \cos H + 0^\circ\!.0032 \sin(2Lat) \cos Z \sin H$$

At mid-latitudes and for altitudes of the Moon below 60° a simple approximation to OB is

$$OB = -0^\circ\!.0017 \cos H$$

This change was implemented in the tables in 2004, but was not shown in the back of the Almanac until 2005.

Changes in 2004 and Later Nautical Almanac Correction Tables

U. S. Naval Observatory has confirmed to the Offshore Navigation Committee that the values for Altitude Corrections in the 2004 Nautical Almanac have been slightly revised from earlier years. The changes are due to a recalculation of refraction and affect the corrections for all bodies. The Almanac pages affected are A2, A3, A4, xxxiv, and xxxv. Except for the additional corrections for planets on page A2, these pages have been considered permanent pages that do not change from year to year. With this recalculation they are still considered permanent and are not expected to change again in the foreseeable future.

The changes on page A2 for the Sun, Stars and Planets are limited to 0.1' and because of the way the tables are arranged will be noticed in only a limited number of cases. Page A2 for altitudes 0°-10° has changes of up to 0.7' at 0° altitude but only spotty changes of 0.1' above 2° altitude. Page A4 for non-standard conditions has been redrawn and another column added to the table of corrections. This is where the majority of differences will be found. The changes to the moon corrections on pages xxxiv and xxxv are limited to altitudes below 4 degrees, and are 0.7' at 0° altitude. These changes have an insignificant effect on practical navigation, but may cause the values obtained to be slightly different than if the previous almanacs were used.

The effects on the JN and N courses are described below. Please make sure this gets to all instructors and students.

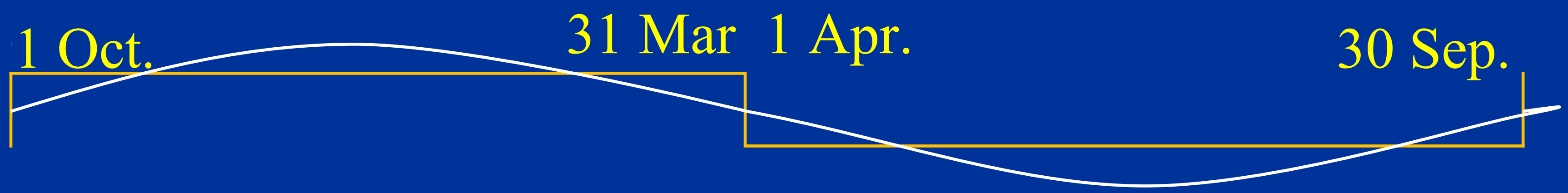
The course material including homework and exams were developed prior to these changes, and are based on the pre 2004 Altitude Corrections. The pre 2004 Altitude Correction pages, except for page A4, are included in the "Excerpts from the 199X Almanac" in both the JN and N course material. For those not having access to a pre 2004 Almanac, a PDF copy of page A4 (58KB) is available. These pages should be used to obtain values for Altitude Corrections for our courses.

Sight Folders should use the Altitude Corrections from the Nautical Almanac for the year in which the sight was taken. (16 Oct 05)

Sun Altitude Correction Issue

- Prior to V5.6.4, Celestial Tools often showed a sun altitude correction that disagreed with the Sun Altitude Correction Table by a couple of tenths of an arc-minute. If the Sun Altitude Correction Table 10º-90º (page A2) is a critical table, why didn't Celestial Tools (prior to V5.6.4) agree with its values?

For a given limb and apparent altitude, the sun correction table uses an average correction value over each of the six-month periods tabulated.



Do we really believe that the correction remains constant for six months, suddenly changes, then remains constant for another six months?

No! The actual correction looks something like this…

What's going on here? What is actually changing?

The Sun correction table includes refraction, parallax, and semi-diameter. Do any of these vary over the course of a year?

Yes. Because the distance from the Earth to the Sun changes, parallax and semi-diameter change, but refraction is independent of time of year. Parallax is also dependent on the altitude of the Sun.

The ranges of parallax and semi-diameter can be calculated using the following values:

Average radius of Earth 3959 miles
Minimum distance from Earth to Sun 91,400,000 miles
Maximum distance from Earth to Sun 94,400,000 miles
Radius of Sun 432,164 miles

Parallax of Sun

Minimum horizontal parallax = 0.144’

Maximum horizontal parallax = 0.149’

Difference during the year = 0.005’ or 0.3”

Conclusion: For a given altitude, parallax of Sun is essentially constant throughout the year.

Semi-diameter of Sun

Minimum semi-diameter of Sun = 15.74’

Maximum semi-diameter of Sun = 16.25’

(These values essentially agree with those at the bottom of the Sun column on the daily pages of the Nautical Almanac, which show values ranging from 15.8’ to 16.3’.)

Conclusion: The semi-diameter of the Sun changes by 0.51’ over the course of the year.

The Nautical Almanac table allows a year's worth of Sun altitude correction data, including refraction, parallax, semi-diameter, to occupy only one-third of a page, with no more than a few tenths of an arc-minute error.

Celestial Tools has two modes:

In the "SR form" mode, Celestial Tools tries to use a six-month average. Since V5.6.4. it will agree with the Nautical Almanac values on page A2 (apparent altitude greater than about 10º), but may be a couple of tenths of an arc-minute off for lower altitudes and non-standard temperatures and pressures.

In the "parameters" mode, Celestial Tools considers the actual date and time in its calculation, which could result in a discrepancy of up to 0.3' compared to the Nautical Almanac table.

1961

OCT.–MAR. **SUN** APR.–SEPT.

App. Alt.	Lower Limb	Upper Limb	App. Alt.	Lower Limb	Upper Limb
° ′	′	′	° ′	′	′
9 34	+10.8	-22.7	9 39	+10.6	-22.4
9 45	+10.9	-22.6	9 51	+10.7	-22.3
9 56	+11.0	-22.5	10 03	+10.8	-22.2
10 08	+11.1	-22.4	10 15	+10.9	-22.1
10 21	+11.2	-22.3	10 27	+11.0	-22.0
10 34	+11.3	-22.2	10 40	+11.1	-21.9
10 47	+11.4	-22.1	10 54	+11.2	-21.8
11 01	+11.5	-22.0	11 08	+11.3	-21.7
11 15	+11.6	-21.9	11 23	+11.4	-21.6
11 30	+11.7	-21.8	11 38	+11.5	-21.5
11 46	+11.8	-21.7	11 54	+11.6	-21.4
12 02	+11.9	-21.6	12 10	+11.7	-21.3
12 19	+12.0	-21.5	12 28	+11.8	-21.2
12 37	+12.1	-21.4	12 46	+11.9	-21.1
12 55	+12.2	-21.3	13 05	+12.0	-21.0
13 14	+12.3	-21.2	13 24	+12.1	-20.9
13 35	+12.4	-21.1	13 45	+12.2	-20.8
13 56	+12.5	-21.0	14•07	+12.3	-20.7
14 18	+12.6	-20.9	14 30	+12.4	-20.6
14 42	+12.7	-20.8	14 54	+12.5	-20.5
15 06	+12.8	-20.7	15 19	+12.6	-20.4
15 32	+12.9	-20.6	15 46	+12.7	-20.3
15 59	+13.0	-20.5	16 14	+12.8	-20.2
16 28	+13.1	-20.4	16 44	+12.9	-20.1
16 59	+13.2	-20.3	17 15	+13.0	-20.0
17 32	+13.3	-20.2	17 48	+13.1	-19.9
18 06	+13.4	-20.1	18 24	+13.2	-19.8
18 42	+13.5	-20.0	19 01	+13.3	-19.7
19 21	+13.6	-19.9	19 42	+13.4	-19.6
20 03	+13.7	-19.8	20 25	+13.5	-19.5
20 48	+13.8	-19.7	21 11	+13.6	-19.4
21 35	+13.9	-19.6	22 00	+13.7	-19.3
22 26	+14.0	-19.5	22 54	+13.8	-19.2
23 22	+14.1	-19.4	23 51	+13.9	-19.1
24 21	+14.2	-19.3	24 53	+14.0	-19.0
25 26	+14.3	-19.2	26 00	+14.1	-18.9
26 36	+14.4	-19.1	27 13	+14.2	-18.8
27 52	+14.5	-19.0	28 33	+14.3	-18.7
29 15	+14.6	-18.9	30 00	+14.4	-18.6
30 46	+14.7	-18.8	31 35	+14.5	-18.5
32 26	+14.8	-18.7	33 20	+14.6	-18.4
34 17	+14.9	-18.6	35 17	+14.7	-18.3
36 20	+15.0	-18.5	37 26	+14.8	-18.2
38 36	+15.1	-18.4	39 50	+14.9	-18.1
41 08	+15.2	-18.3	42 31	+15.0	-18.0
43 59	+15.3	-18.2	45 31	+15.1	-17.9
47 10	+15.4	-18.1	48 55	+15.2	-17.8
50 46	+15.5	-18.0	52 44	+15.3	-17.7
54 49	+15.6	-17.9	57 02	+15.4	-17.6
59 23	+15.7	-17.8	61 51	+15.5	-17.5
64 30	+15.8	-17.7	67 17	+15.6	-17.4
70 12	+15.9	-17.6	73 16	+15.7	-17.3
76 26	+16.0	-17.5	79 43	+15.8	-17.2
83 05	+16.1	-17.4	86 32	+15.9	-17.1
90 00			90 00		

2003

OCT.—MAR. **SUN** APR.—SEPT.

App. Alt.	Lower Limb	Upper Limb	App. Alt.	Lower Limb	Upper Limb
° ′	′	′	° ′	′	′
9 34	+10.8	-21.5	9 39	+10.6	-21.2
9 45	+10.9	-21.4	9 51	+10.7	-21.1
9 56	+11.0	-21.3	10 03	+10.8	-21.0
10 08	+11.1	-21.2	10 15	+10.9	-20.9
10 21	+11.2	-21.1	10 27	+11.0	-20.8
10 34	+11.3	-21.0	10 40	+11.1	-20.7
10 47	+11.4	-20.9	10 54	+11.2	-20.6
11 01	+11.5	-20.8	11 08	+11.3	-20.5
11 15	+11.6	-20.7	11 23	+11.4	-20.4
11 30	+11.7	-20.6	11 38	+11.5	-20.3
11 46	+11.8	-20.5	11 54	+11.6	-20.2
12 02	+11.9	-20.4	12 10	+11.7	-20.1
12 19	+12.0	-20.3	12 28	+11.8	-20.0
12 37	+12.1	-20.2	12 46	+11.9	-19.9
12 55	+12.2	-20.1	13 05	+12.0	-19.8
13 14	+12.3	-20.0	13 24	+12.1	-19.7
13 35	+12.4	-19.9	13 45	+12.2	-19.6
13 56	+12.5	-19.8	14 07	+12.3	-19.5
14 18	+12.6	-19.7	14 30	+12.4	-19.4
14 42	+12.7	-19.6	14 54	+12.5	-19.3
15 06	+12.8	-19.5	15 19	+12.6	-19.2
15 32	+12.9	-19.4	15 46	+12.7	-19.1
15 59	+13.0	-19.3	16 14	+12.8	-19.0
16 28	+13.1	-19.2	16 44	+12.9	-18.9
16 59	+13.2	-19.1	17 15	+13.0	-18.8
17 32	+13.3	-19.0	17 48	+13.1	-18.7
18 06	+13.4	-18.9	18 24	+13.2	-18.6
18 42	+13.5	-18.8	19 01	+13.3	-18.5
19 21	+13.6	-18.7	19 42	+13.4	-18.4
20 03	+13.7	-18.6	20 25	+13.5	-18.3
20 48	+13.8	-18.5	21 11	+13.6	-18.2
21 35	+13.9	-18.4	22 00	+13.7	-18.1
22 26	+14.0	-18.3	22 54	+13.8	-18.0
23 22	+14.1	-18.2	23 51	+13.9	-17.9
24 21	+14.2	-18.1	24 53	+14.0	-17.8
25 26	+14.3	-18.0	26 00	+14.1	-17.7
26 36	+14.4	-17.9	27 13	+14.2	-17.6
27 52	+14.5	-17.8	28 33	+14.3	-17.5
29 15	+14.6	-17.7	30 00	+14.4	-17.4
30 46	+14.7	-17.6	31 35	+14.5	-17.3
32 26	+14.8	-17.5	33 20	+14.6	-17.2
34 17	+14.9	-17.4	35 17	+14.7	-17.1
36 20	+15.0	-17.3	37 26	+14.8	-17.0
38 36	+15.1	-17.2	39 50	+14.9	-16.9
41 08	+15.2	-17.1	42 31	+15.0	-16.8
43 59	+15.3	-17.0	45 31	+15.1	-16.7
47 10	+15.4	-16.9	48 55	+15.2	-16.6
50 46	+15.5	-16.8	52 44	+15.3	-16.5
54 49	+15.6	-16.7	57 02	+15.4	-16.4
59 23	+15.7	-16.6	61 51	+15.5	-16.3
64 30	+15.8	-16.5	67 17	+15.6	-16.2
70 12	+15.9	-16.4	73 16	+15.7	-16.1
76 26	+16.0	-16.3	79 43	+15.8	-16.0
83 05	+16.1	-16.2	86 32	+15.9	-15.9
90 00			90 00		

What is significantly different about these two Sun altitude correction tables?

The upper limb corrections differ by a constant.

Irradiation – "When a bright surface is observed adjacent to a darker one, a physiological effect in the eye causes the brighter area to appear to be larger than is actually the case; conversely, the darker area appears smaller. Thus, since the sun is considerably brighter than the sky background, the sun appears larger than it really is; and when the sky is considerably brighter than the water, the horizon appears slightly depressed. The effects on the horizon and lower limb are in the same direction and tend to cancel each other while the effect on the upper limb of the sun is in the opposite direction to that on the horizon and tends to magnify the effect." (Bowditch, 1977)

"From 1958-1970 a correction of 1.2' was included…for the upper limb of the sun as an average correction for the effect of irradiation." (Bowditch, 1977) (According to the 1978 Dutton's, irradiation was dropped after 1969.) This effect is also a function of telescope magnification. 1.2' was chosen based on the 3X scope typically used in that period.

The irradiation correction was dropped because it was found that the magnitude of the effect depended on the individual observer, the size of the ocular, the altitude of the sun, and other variables.

STARS AND PLANETS (1997)

App. Alt.	Corrⁿ
° ′	′
9 56	
	−5·3
10 08	
	−5·2
10 20	
	−5·1
10 33	
	−5·0
10 46	
	−4·9
11 00	
	−4·8
11 14	
	−4·7
11 29	
	−4·6
11 45	
	−4·5
12 01	
	−4·4
12 18	
	−4·3
12 35	
	−4·2
12 54	
	−4·1
13 13	
	−4·0
13 33	
	−3·9
13 54	
	−3·8
14 16	
	−3·7
14 40	
	−3·6
15 04	
	−3·5
15 30	
	−3·4
15 57	
	−3·3
16 26	
	−3·2
16 56	
	−3·1
17 28	
	−3·0
18 02	
	−2·9
18 38	
	−2·8
19 17	
	−2·7
19 58	
	−2·6
20 42	
	−2·5
21 28	
	−2·4
22 19	
	−2·3
23 13	
	−2·2
24 11	
	−2·1
25 14	
	−2·0
26 22	
	−1·9
27 36	
	−1·8
28 56	
	−1·7
30 24	
	−1·6
32 00	
	−1·5
33 45	
	−1·4
35 40	
	−1·3
37 48	
	−1·2
40 08	
	−1·1
42 44	
	−1·0
45 36	
	−0·9
48 47	
	−0·8
52 18	
	−0·7
56 11	
	−0·6
60 28	
	−0·5
65 08	
	−0·4
70 11	
	−0·3
75 34	
	−0·2
81 13	
	−0·1
87 03	
	0·0
90 00	

App. Alt. — Additional Corrⁿ

1997

VENUS

Jan. 1–Sept. 26
° ′
0
+0·1
60

Sept. 27–Nov. 16
0
+0·2
41
+0·1
76

Nov. 17–Dec. 10
0
+0·3
34
+0·2
60
+0·1
80

Dec. 11–Dec. 25
0
+0·4
29
+0·3
51
+0·2
68
+0·1
83

Dec. 26–Dec. 31
0
+0·5
26
+0·4
46
+0·3
60
+0·2
73
+0·1
84

MARS

Jan. 1–Jan. 20
May 25–Dec. 31
0
+0·1
60

Jan. 21–May 24
0
+0·2
41
+0·1
76

STARS AND PLANETS (1982)

App. Alt.	Corrⁿ
° ′	′
9 56	
	−5·3
10 08	
	−5·2
10 20	
	−5·1
10 33	
	−5·0
10 46	
	−4·9
11 00	
	−4·8
11 14	
	−4·7
11 29	
	−4·6
11 45	
	−4·5
12 01	
	−4·4
12 18	
	−4·3
12 35	
	−4·2
12 54	
	−4·1
13 13	
	−4·0
13 33	
	−3·9
13 54	
	−3·8
14 16	
	−3·7
14 40	
	−3·6
15 04	
	−3·5
15 30	
	−3·4
15 57	
	−3·3
16 26	
	−3·2
16 56	
	−3·1
17 28	
	−3·0
18 02	
	−2·9
18 38	
	−2·8
19 17	
	−2·7
19 58	
	−2·6
20 42	
	−2·5
21 28	
	−2·4
22 19	
	−2·3
23 13	
	−2·2
24 11	
	−2·1
25 14	
	−2·0
26 22	
	−1·9
27 36	
	−1·8
28 56	
	−1·7
30 24	
	−1·6
32 00	
	−1·5
33 45	
	−1·4
35 40	
	−1·3
37 48	
	−1·2
40 08	
	−1·1
42 44	
	−1·0
45 36	
	−0·9
48 47	
	−0·8
52 18	
	−0·7
56 11	
	−0·6
60 28	
	−0·5
65 08	
	−0·4
70 11	
	−0·3
75 34	
	−0·2
81 13	
	0·1
87 03	
	0·0
90 00	

App. Alt. — Additional Corrⁿ

1982

VENUS

Jan. 1–Jan. 3
° ′
0
+ 0·5
6
+ 0·6
20
+ 0·7
31

Jan. 4–Feb. 7
0
+ 0·6
4
+ 0·7
12
+ 0·8
22

Feb. 8–Feb. 14
0
+ 0·5
6
+ 0·6
20
+ 0·7
31

Feb. 15–Mar. 2
0
+ 0·4
11
+ 0·5
41

Mar. 3–Mar. 28
0
+ 0·3
46

Mar. 29–May 12
0
+ 0·2
47

May 13–Dec. 31
0
+ 0·1
42

MARS

Jan. 1–Jan. 30
0
+ 0·1
60

Jan. 31–June 18
0
+ 0·2
41
+ 0·1
75

June 19–Dec. 31
0
+ 0·1
60

What appears to be wrong with this table from the 1982 Almanac?

Compare it to this table from the 1997 Almanac.

We are taught that the additional altitude correction for Venus and Mars is for parallax.

We are also taught that parallax is maximum when the body is on the horizon and decreases as the altitude of the body increases, reaching zero at the zenith.

The correction for Venus is <u>increasing</u> with increasing altitude!

Venus exhibits phases like the Moon. From 1952 to 1984 the additional correction for Venus allowed for parallax <u>and phase</u>, because the tabulated position was for the center of disk, not the center of light.

For several reasons, some of which were discussed in several NavList messages, this method was not retained. The tabulated positions are now for center of light.

Dots show perceived center of light.

Provided by Frank Reed

Stan, you quoted the old explanation section from the NA:
"The corrections given on page A2, and on the bookmark, are mean values applicable in the case of Venus only when the Sun is below the horizon. For daylight observations of Venus the observed values of H and theta should be used to calculate the correction directly; the term - k cos (theta) is positive when the Sun is lower than Venus, zero when they have the same altitude, and negative when the Sun is higher."
I am convinced now that their former system was nonsense. The idea that you could have a "general" value for the phase correction for normal sights is ridiculous. Further, in the directions for daylight observations, the claim that k·cos(theta) is zero when the Sun and Venus have the same altitude is simply false. This is a case of the sort of "muddled" thinking that used to screw up discussions of star-star distances. I'm sure some of you remember the old tale claiming that the angular distance between two stars is unaffected by refraction when they are at the same altitude. Oh yeah?? What if both stars are 45° high and on opposite azimuths? And that's only the most extreme case. The same problem applies to the phase correction. Clearly, the simplest solution to this error (and that's what it was --an error on the part of the almanac offices) was to replace the true position of Venus with the phase-adjusted position of Venus in the daily GHA and Dec data (which, we now know, thanks to Catherine Hohenkerk, happened thirty long years ago...). Personally, I think they should have admitted the error and dropped the phase correction entirely. Even the USNO online nautical almanac data skips the phase adjustment. That's a better choice. The official Nautical Almanac is inferior in this case.
It's all minor, of course. If we're to believe some claims (which Gary LaPook re-posted recently), the standard deviation of celestial altitude observations is 1.5 minutes of arc, in which case the phase of Venus would *always* be lost in the noise. I consider those claims over-blown, and in good "normal" conditions, the errors in celestial altitudes are +/-0.5' or so (in the 1 s.d. sense) and in excellent conditions a little better. Naturally when conditions are anything but good, the phase of Venus is completely irrelevant. If your height of eye is varying in an unpredictable way from 25 to 36 feet (unpleasant but not uncommon), then you automatically get an additional random error of a minute of arc.
Frank Reed

From 2004 Nautical Almanac

TIME

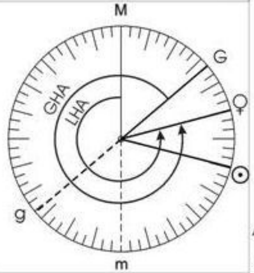
Date	29 June 20XX
WT	05-20-14
WE (S+) (F-) (+)	00-07
ZT	05-20-21
ZD (W+) (E-) (+)	3
UT	08-20-21
G Day/Mo	29 June

ALMANAC --- LHA

SHA★	
GHA ♀	
08 hr	329° 08.5'
20 m 21 s	5° 05.3'
v (+) 2.4'	
v corr (+)	0.8'
Tot GHA	334° 14.6'
DR Lo (-)	49° 31.2' W
LHA	284° 43.4'

SIGHT DATA

Sight No.	2
Body	Venus
DR L	22° 25.7' N
DR Lo	49° 31.2' W



ALMANAC --- DEC

Dec 08 hr	17° 57.6' N
d (-) 0.2'	
d corr (-)	0.1'
Dec	17° 57.5' N

ALTITUDE

	(+)	(-)
Ht of eye	9.0 ft	
hs	20° 02.6'	
IC	0.5'	
Dip		2.9'
Total	0.5'	2.9'
Corr	(-) 2.4'	
ha	20° 00.2'	
HP ☾		
Main		2.6'
Add'l ☾, Pl	0.4'	
UL☾ -30.00'		
Add'l Ref		
Total	0.4'	2.6'
Corr	(-) 2.2'	
Ho	19° 58.0'	

From US Naval Observatory web site

Celestial Navigation Data for 2004 Jun 29 at 8:20:21 UT

For Assumed Position: Latitude N 22 25.7, Longitude W 49 31.2

Object	GHA (° ')	Dec (° ')	Hc (° ')	Zn (°)	Refr (')	SD (')	PA (')	Sum (')
	Almanac Data				Altitude Corrections			
SUN	304 13.0	N23 12.2	- 4 14.4	62.7	---	---	---	---
VENUS	334 14.9	N17 57.4	+19 56.9	78.2	-2.7	0.4	0.4	-1.9

Celestial Navigation Data for 2004 Jun 29 at 8:00:00 UT

For Assumed Position: Latitude N 22 25.7, Longitude W 49 31.2

Object	GHA (° ')	Dec (° ')	Hc (° ')	Zn (°)	Refr (')	SD (')	PA (')	Sum (')
	Almanac Data				Altitude Corrections			
SUN	299 07.7	N23 12.3	- 8 22.6	60.6	---	---	---	---
VENUS	329 08.8	N17 57.5	+15 20.9	76.5	-3.5	0.4	0.4	-2.7

From Celestial Tools "Accurate vals. of v/d" mode

TIME

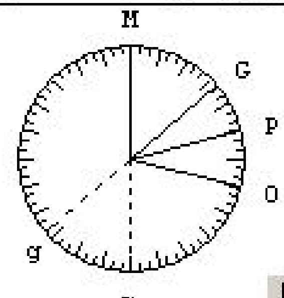
Date	29 Jun 2004
WT	05-20-14
WE (+)	-07
ZT	05-20-21
ZD (+)	3
UT (GMT)	08-20-21
G Day/Mo/Yr	29 Jun 2004

ALMANAC - LHA

SHA *	
GHA Venus	
08 hr	329°08.7'
20 m 21 s	5°05.3'
v (+) 2.5'	
v corr (+)	0.9'
Tot GHA	334°14.9'
DR Lo (-)	49°31.2'W
LHA	284°43.7'

SIGHT DATA

Sight No. 2	
Body	Venus
DR L	22°25.7'N
DR Lo	49°31.2'W



EqT

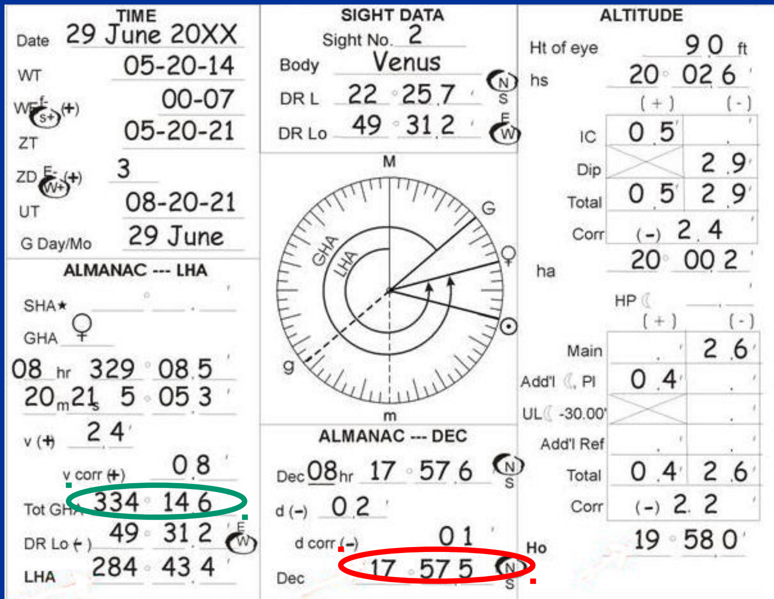
ALMANAC - Dec

Dec 08 hr	17°57.5'N
d (-) 0.3'	
d corr (-)	0.1'
Dec	17°57.4'N

ALTITUDE

Ht of eye	9.0 ft	
hs		20°02.6'
IC	(+) 0°00.5'	
Dip	(-) 2.9'	
Corr	(-) 0°02.4'	
ha		20°00.2'
HP Moon		
Main	(-) 02.6'	
Add'l (, Pl	(+) 00.4'	
UL (-30.0'		
Add'l Ref		
Corr	(-) 2.2'	
Ho		19°58.0'

From 2004 Nautical Almanac



From US Naval Observatory web site

Celestial Navigation Data for 2004 Jun 29 at 8:20:21 UT

For Assumed Position: Latitude N 22 25.7
Longitude W 49 31.2

	Almanac Data				Altitude Corrections			
Object	GHA	Dec	Hc	Zn	Refr	SD	PA	Sum
	o '	o '	o '	o	'	'	'	'
SUN	[illegible]	[illegible]	- 4 14.4	62.7	---	---	---	---
VENUS	334 14.9	N17 57.4	+19 56.9	78.2	-2.7	0.4	0.4	-1.9

Celestial Navigation Data for 2004 Jun 29 at 8:00:00 UT

For Assumed Position: Latitude N 22 25.7
Longitude W 49 31.2

	Almanac Data				Altitude Corrections			
Object	GHA	Dec	Hc	Zn	Refr	SD	PA	Sum
	o '	o '	o '	o	'	'	'	'
SUN	299 07.7	N23 12.3	- 8 22.6	60.6	---	---	---	---
VENUS	329 08.8	N17 57.5	+15 20.9	76.5	-3.5	0.4	0.4	-2.7

From Celestial Tools "Accurate vals. of v/d" mode

TIME

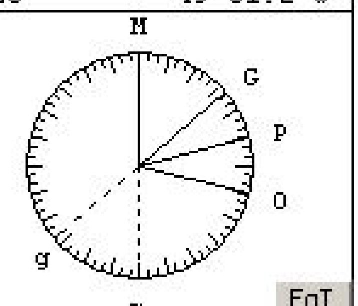
Date 29 Jun 2004
WT 05-20-14
WE (+) -07
ZT 05-20-21
ZD (+) 3
UT (GMT) 08-20-21
G Day/Mo/Yr 29 Jun 2004

ALMANAC - LHA

SHA *
GHA Venus
08 hr 329°08.7'
20 m 21 s 5°05.3'
v (+) 2.5'
v corr (+) 0.9'
Tot GHA 334°14.9'
DR Lo (-) 49°31.2'W
LHA 284°43.7'

SIGHT DATA

Sight No. 2
Body Venus
DR L 22°25.7'N
DR Lo 49°31.2'W



ALMANAC - Dec

Dec 08 hr 17°57.5'N
d (-) 0.3'
d corr (-) 0.1'
Dec 17°57.4'N

ALTITUDE

Ht of eye 9.0 ft
hs 20°02.6'
IC (+) 0°00.5'
Dip (-) 2.9'
Corr (-) 0°02.4'
ha 20°00.2'
HP Moon
Main (-) 02.6'
Add'l (, Pl (+) 00.4'
UL (-30.0'
Add'l Ref
Corr (-) 2.2'
Ho 19°58.0'

From 2004 Nautical Almanac

TIME

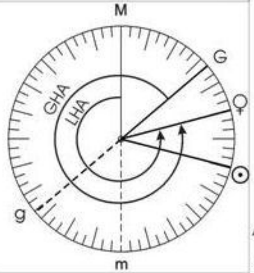
Date 29 June 20XX
WT 05-20-14
WE (S+) (+) 00-07
ZT 05-20-21
ZD (W+) (+) 3
UT 08-20-21
G Day/Mo 29 June

ALMANAC --- LHA

SHA★
GHA ♀
08 hr 329° 08.5'
20 m 21 s 5° 05.3'
v (+) 2.4'
v corr (+) 0.8'
Tot GHA 334° 14.6'
DR Lo (-) 49° 31.2' (W)
LHA 284° 43.4'

SIGHT DATA

Sight No. 2
Body Venus
DR L 22° 25.7' (N)
DR Lo 49° 31.2' (W)



ALMANAC --- DEC

Dec 08 hr 17° 57.6' (N)
d (-) 0.2'
d corr (-) 0.1'
Dec 17° 57.5' (N)

ALTITUDE

Ht of eye 9.0 ft
hs 20° 02.6'

	(+)	(-)
IC	0.5'	
Dip		2.9'
Total	0.5'	2.9'
Corr	(-) 2.4'	

ha 20° 00.2'

HP ☾

	(+)	(-)
Main		2.6'
Add'l ☾, Pl	0.4'	
UL ☾ -30.00'		
Add'l Ref		
Total	0.4'	2.6'
Corr	(-) 2.2'	

Ho 19° 58.0'

From US Naval Observatory web site

Celestial Navigation Data for 2004 Jun 29 at 8:20:21 UT

For Assumed Position: Latitude N 22 25.7
Longitude W 49 31.2

	Almanac Data				Altitude Corrections			
Object	GHA	Dec	Hc	Zn	Refr	SD	PA	Sum
	° '	° '	° '	°	'	'	'	'
SUN	304 13.0	N23 12.2	- 4 14.4	62.7	---	---	---	---
VENUS	334 14.9	N17 57.4	+19 56.9	78.2	-2.7	0.4	0.4	-1.9

Celestial Navigation Data for 2004 Jun 29 at 8:00:00 UT

For Assumed Position: Latitude N 22 25.7
Longitude W 49 31.2

	Almanac Data				Altitude Corrections			
Object	GHA	Dec	Hc	Zn	Refr	SD	PA	Sum
	° '	° '	° '	°	'	'	'	'
SUN	299 07.7	N23 12.3	- 8 22.6	60.6	---	---	---	---
VENUS	329 08.8	N17 57.5	+15 20.9	76.5	-3.5	0.4	0.4	-2.7

From Celestial Tools "Accurate vals. of v/d" mode

TIME

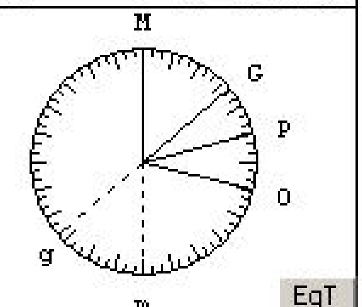
Date 29 Jun 2004
WT 05-20-14
WE (+) -07
ZT 05-20-21
ZD (+) 3
UT (GMT) 08-20-21
G Day/Mo/Yr 29 Jun 2004

ALMANAC - LHA

SHA *
GHA Venus
08 hr 329°08.7'
20 m 21 s 5°05.3'
v (+) 2.5'
v corr (+) 0.9'
Tot GHA 334°14.9'
DR Lo (-) 49°31.2'W
LHA 284°43.7'

SIGHT DATA

Sight No. 2
Body Venus
DR L 22°25.7'N
DR Lo 49°31.2'W



ALMANAC - Dec

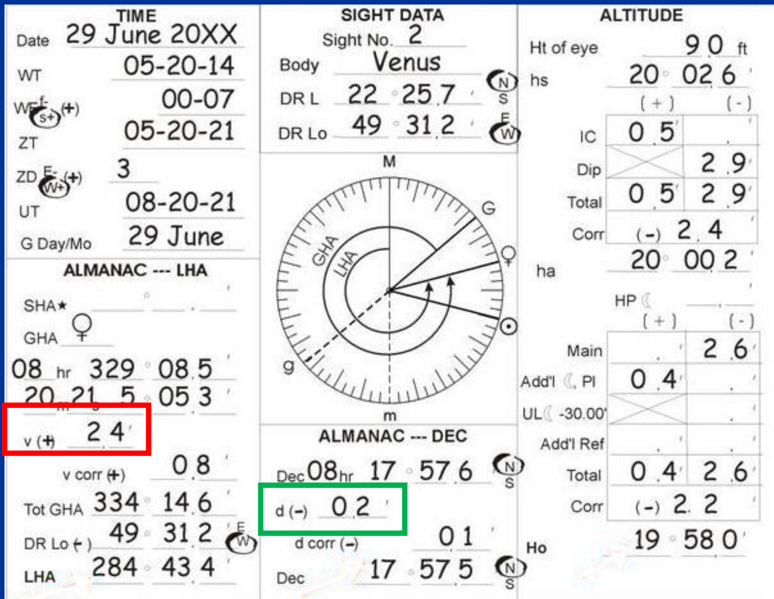
Dec 08 hr 17°57.5'N
d (-) 0.3'
d corr (-) 0.1'
Dec 17°57.4'N

ALTITUDE

Ht of eye 9.0 ft
hs 20°02.6'
IC (+) 0°00.5'
Dip (-) 2.9'
Corr (-) 0°02.4'
ha 20°00.2'
HP Moon
Main (-) 02.6'
Add'l (, Pl (+) 00.4'
UL (-30.0'
Add'l Ref
Corr (-) 2.2'
Ho 19°58.0'

The Nautical Almanac now builds a phase correction into the values of GHA and Dec of Venus. Celestial Tools and other sources consider the center of disk, not the center of light.

From 2004 Nautical Almanac



From 2004 Nautical Almanac

29 June	GHA	Dec
08h	329º08.5’	N17º57.6’
09h	344º11.0’	N17º57.3’

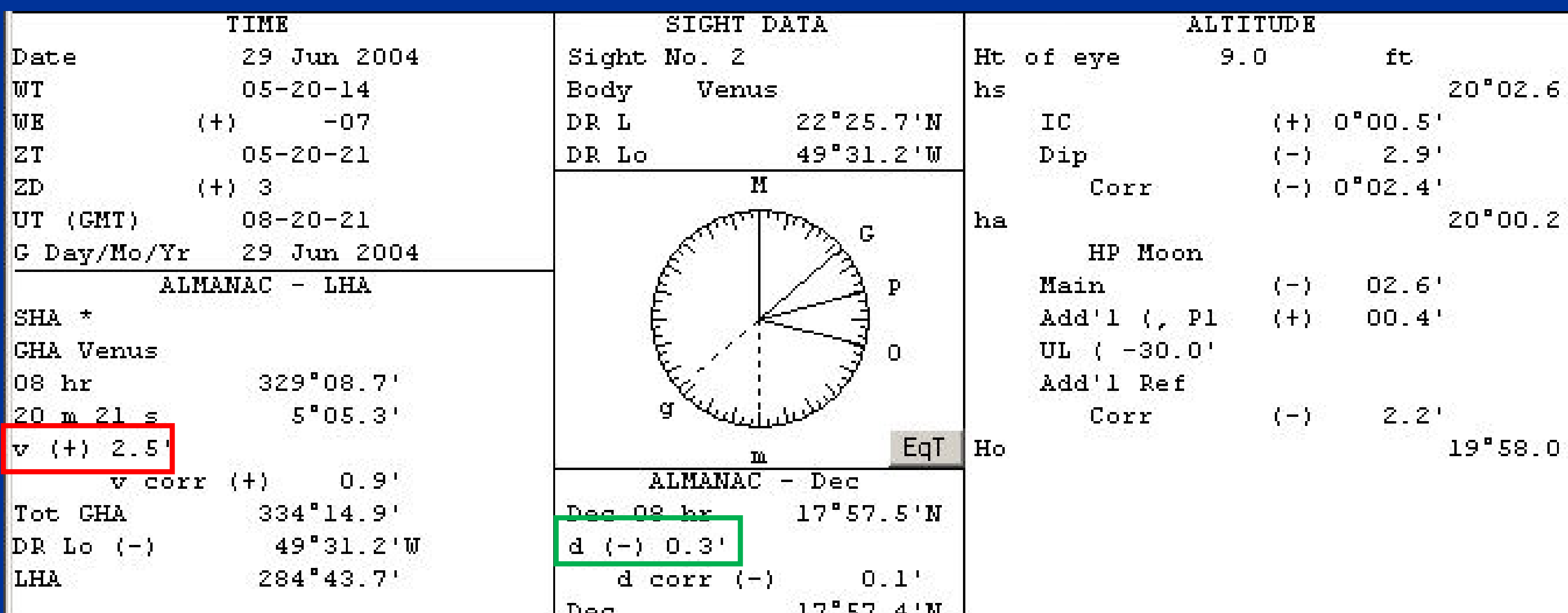
v = 344º11.0’ - 329º08.5’ = 15º02.5’ – 15º = $\boxed{+2.5’}$

d = 17º57.3’ - 17º57.6’ = $\boxed{-0.3’}$

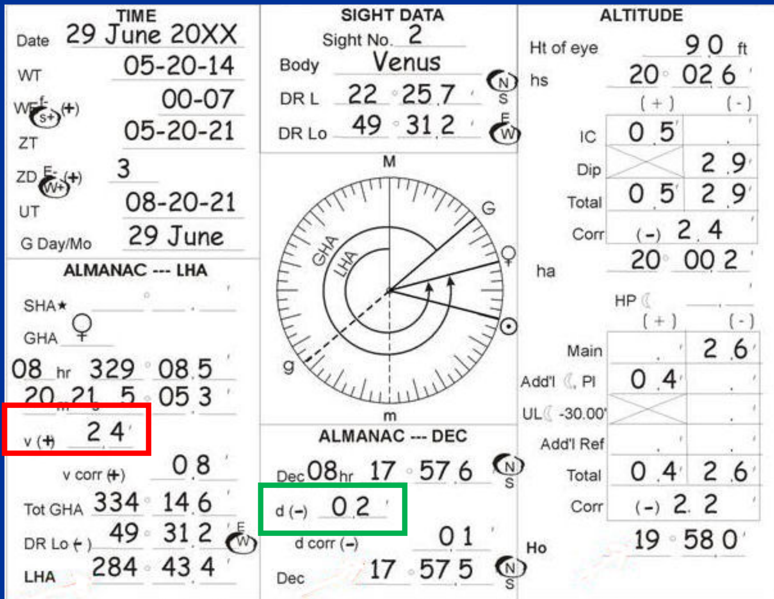
These values agree with Celestial Tools “Accurate vals. Of v/d” mode but not with the Nautical Almanac. Why?

Because the values of v and d in the Nautical Almanac are for the average value for the middle day of the page. In the “Accurate vals. of v/d” mode, Celestial Tools calculates values for the date and time of the sight.

From Celestial Tools “Accurate vals. of v/d” mode



From 2004 Nautical Almanac



From 2004 Nautical Almanac

	GHA	Dec	
30 June 00h	209°47.8'	N17°53.6'	(middle day of page)
1 July 00h	210°44.8'	N17°48.4'	

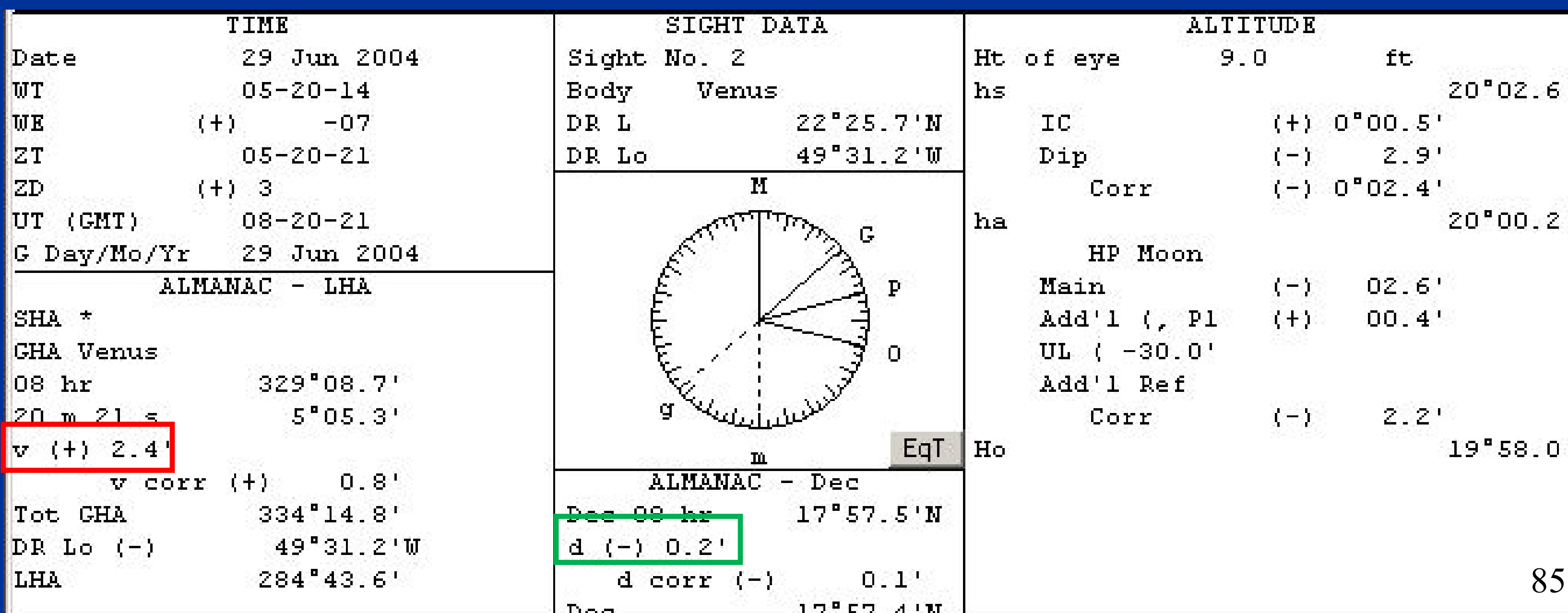
v = 210°44.8' - 209°47.8' = 52.0' / 24 = +2.375 -> $\boxed{+2.4'}$

d = 17°48.4' - 17°53.6' = -5.2'/24 = -0.217' -> $\boxed{-0.2}$

(The GHAs and Decs are unrounded values in the actual Almanac calculation.)

With the new (as of V5.1.0) "NA vals. of v/d" mode, Celestial Tools calculates the v and d values for the average value for the middle day of the page.

From Celestial Tools "NA vals. of v/d" mode (as of V5.1.0)



USPS NASR Auxiliary Table

Front Cover

UNITED STATES POWER SQUADRONS

ADVANCED GRADES DIVISION

ALTITUDE CORRECTION TABLE

for

The Nautical Almanac Sight Reduction Table

(Explanation and example on back cover)

Back Cover

ALTITUDE CORRECTION TABLE: Explanation

This table is a revision of the *Auxiliary Table* in *The Nautical Almanac*, used to find the two altitude corrections required by the *Nautical Almanac Sight Reduction Table*. The purpose of the revision is to simplify the determination of the signs of the corrections. The sign of Corr. 1 is found in the upper left corner adjacent to the heading **F'** and adjacent to the row of minutes arguments to which it applies. The sign of Corr. 2 is found in the upper right corner adjacent to the heading **A'** and adjacent to the row of minutes arguments to which the sign applies. Thus, the signs are taken directly from the table, with a single exception: when $F > 90°$, the sign taken from the table for Corr. 1 must be reversed.

The magnitude of the corrections is found just as before, the value for Corr. 1 in the column below the value for F' and the row for P°, the value for Corr. 2 in the column below the value for A' and the row for Z_2°.

EXAMPLE

Corr. 1 for F 103°37', P 27°

Enter the table with F' 37'. This value is found in the second row of arguments at top of the table. To the *left* of this row, next to the heading **F'** is the sign for Corr. 1, (-). *In this example, as F is greater than 90°, reverse the sign to* (+).

The magnitude of the correction is found in the body of the table in the column beneath F' (37') and in the row for P° (27°) and is found to be 10'.

Corr. 1 (+) 10'

Corr. 2 for A 28°05', Z_2 (-) 30.5°

Enter the table with A' 5'. This value is found in the top row of arguments at the top of the table. To the *right* of this row, next to the heading **A'** is the sign for Corr. 2, (-).

The magnitude of the correction is found in the body of the table in the column beneath A' (5') and in the row for Z_2° (31°) and is 4'.

Corr. 2 (-) 4'

Note: This table was originally designed so the tabulated values (for F' sin P° and A' cos Z_2°) could be reproduced by calculator. The single row that did not conform to this design in the *Auxiliary Table* (the values for P 30° and Z_2 60°) has been corrected.

From the Celestial Tools Help:

In the late 1990s, USPS produced its own version of the Auxiliary Table, called the "ALTITUDE CORRECTION TABLE for The Nautical Almanac Sight Reduction Table". Its purpose was twofold. It had a revised format which made it easier to determine the signs of the corrections, and it "corrected" the tabulated values of corr1 and corr2 to match what would be derived from using a calculator and applying standard rounding techniques. (The single row that did not conform to this design in the Auxiliary Table was the values for P 30° and Z2 60°. The Auxiliary Table values for corr1 are one less than the USPS version values when P° is 30 and F' is odd. The Auxiliary Table values for corr2 are one less than the USPS version values when Z2° is 60 and A' is odd.) This table was well-received, and replaced the original Auxiliary Table starting with the 1999 Nautical Almanac. However, starting in 2005, the Nautical Almanac maintained the improved format of the USPS version, but went back to the "uncorrected" values of corr1 and corr2.

Celestial Tools lets the user select which table to use.

True or False –
This presentation is over.

If you didn't find this useful I hope you at least found it interesting.

Questions?