RELATIONS BETWEEN ALTITUDES

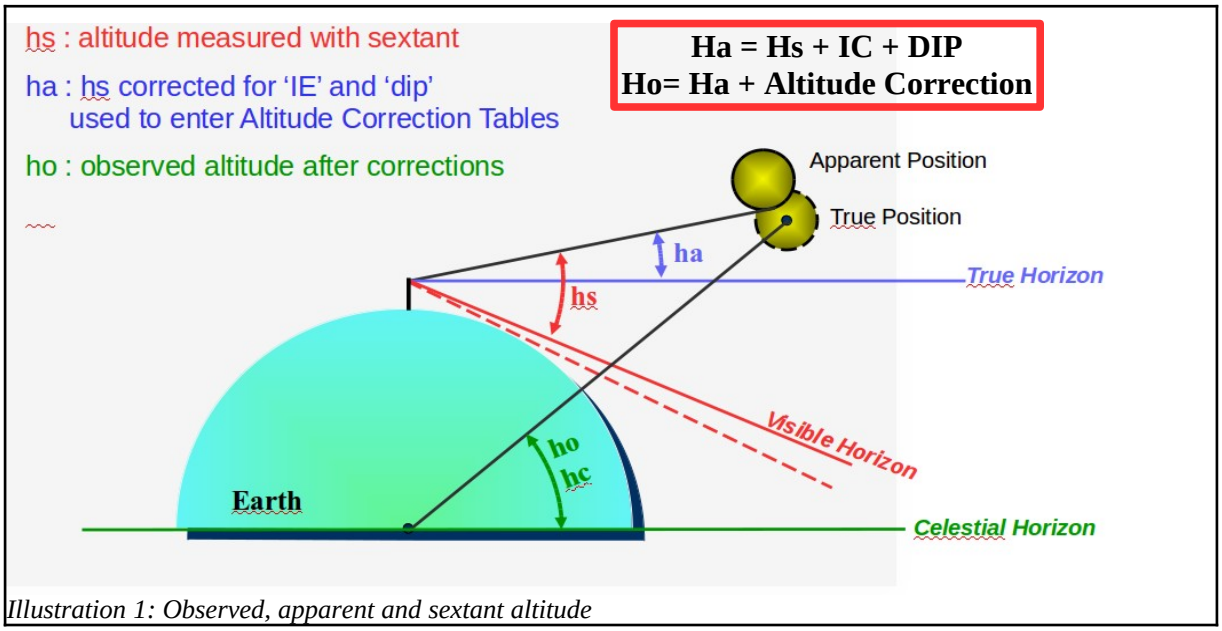


Illustration 1: Observed, apparent and sextant altitude

The Dip and altitude correction are read in Nautical Almanac
An error or a correction are told to be :

- **on the arc** when positive ;
- **off the arc** when negative.

Be carefull:
We will use the UK/USA definition of altitudes (as described on the illustration) ; the asian and french definitions differ a little from this.

THE CORRECTIONS TABLES IN NAUTICAL ALMANAC

Dip table (at the front of the NA)

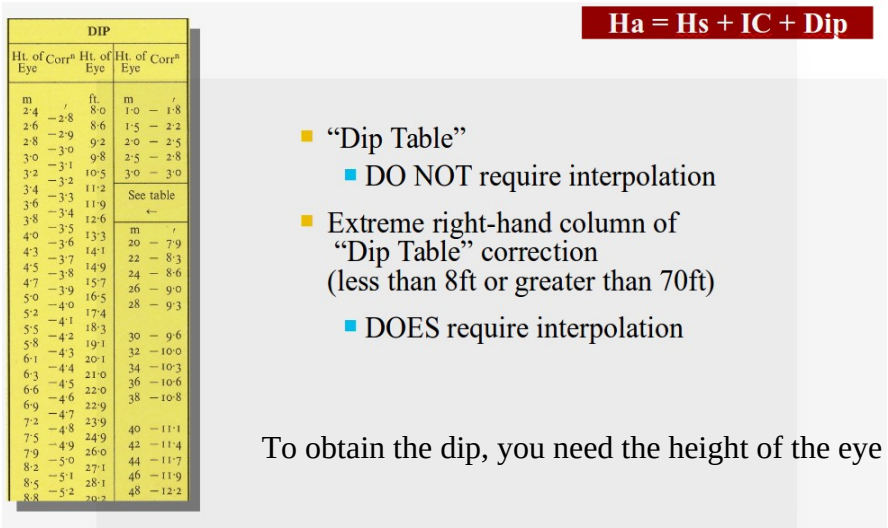


Illustration 2: Dip table

The main altitude correction tables

The Altitude Correction Tables in the Nautical Almanac give the combined correction for refraction, semi-diameter and parallax under standard atmosphere conditions, where atmospheric pressure is 1010mbs (29.5 ins) and temperature is 10 ℃ (50 ℉). So, additional correction is required for refraction if atmospheric conditions are different.

ALTITUDE CORRECTION TABLES 10°-90°—SUN,STARS,PLANETS

SUN

OCT.—MAR. App. Alt.	Lower Limb	Upper Limb	APR.—SEPT. App. Alt.	Lower Limb	Upper Limb
° ′	′	′	° ′	′	′
9 33	+10·8	−21·5	9 39	+10·6	−21·2
9 45	+10·9	−21·4	9 50	+10·7	−21·1
9 56	+11·0	−21·3	10 02	+10·8	−21·0
10 08	+11·1	−21·2	10 14	+10·9	−20·9
10 20	+11·2	−21·1	10 27	+11·0	−20·8
10 33	+11·3	−21·0	10 40	+11·1	−20·7
10 46	+11·4	−20·9	10 53	+11·2	−20·6
11 00	+11·5	−20·8	11 07	+11·3	−20·5
11 15	+11·6	−20·7	11 22	+11·4	−20·4
11 30	+11·7	−20·6	11 37	+11·5	−20·3
11 45	+11·8	−20·5	11 53	+11·6	−20·2
12 01	+11·9	−20·4	12 10	+11·7	−20·1
12 18	+12·0	−20·3	12 27	+11·8	−20·0
12 36	+12·1	−20·2	12 45	+11·9	−19·9
12 54	+12·2	−20·1	13 04	+12·0	−19·8
13 14	+12·3	−20·0	13 24	+12·1	−19·7
13 34	+12·4	−19·9	13 44	+12·2	−19·6
13 55	+12·5	−19·8	14 06	+12·3	−19·5
14 17	+12·6	−19·7	14 29	+12·4	−19·4
14 41	+12·7	−19·6	14 53	+12·5	−19·3
15 05	+12·8	−19·5	15 18	+12·6	−19·2
15 31	+12·9	−19·4	15 45	+12·7	−19·1
15 59	+13·0	−19·3	16 13	+12·8	−19·0
16 27	+13·1	−19·2	16 43	+12·9	−18·9
16 58	+13·2	−19·1	17 14	+13·0	−18·8
17 30			17 47		

STARS AND PLANETS

App. Alt.	Corrⁿ
° ′	′
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	

App. Alt.	Additional Corrⁿ
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	

DIP

Ht. of Eye	Corrⁿ	Ht. of Eye
m	′	ft.
2·4	−2·8	8·0
2·6	−2·9	8·6
2·8	−3·0	9·2
3·0	−3·1	9·8
3·2	−3·2	10·5
3·4	−3·3	11·2
3·6	−3·4	11·9
3·8	−3·5	12·6
4·0	−3·6	13·3
4·3	−3·7	14·1
4·5	−3·8	14·9
4·7	−3·9	15·7
5·0	−4·0	16·5
5·2	−4·1	17·4
5·5	−4·2	18·3
5·8	−4·3	19·1
6·1	−4·4	20·1
6·3	−4·5	21·0
6·6	−4·6	22·0
6·9	−4·7	22·9
7·2	−4·8	23·9
7·5	−4·9	24·9
7·9	−5·0	26·0
8·2	−5·1	27·1
8·5	−5·2	28·1
8·8		29·2

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

Illustration 3: Altitude correction tables for Sun, stars & planets - Dip table

For the sun

The correction is a combination of refraction, semi-diameter and parallax.

For stars and planets

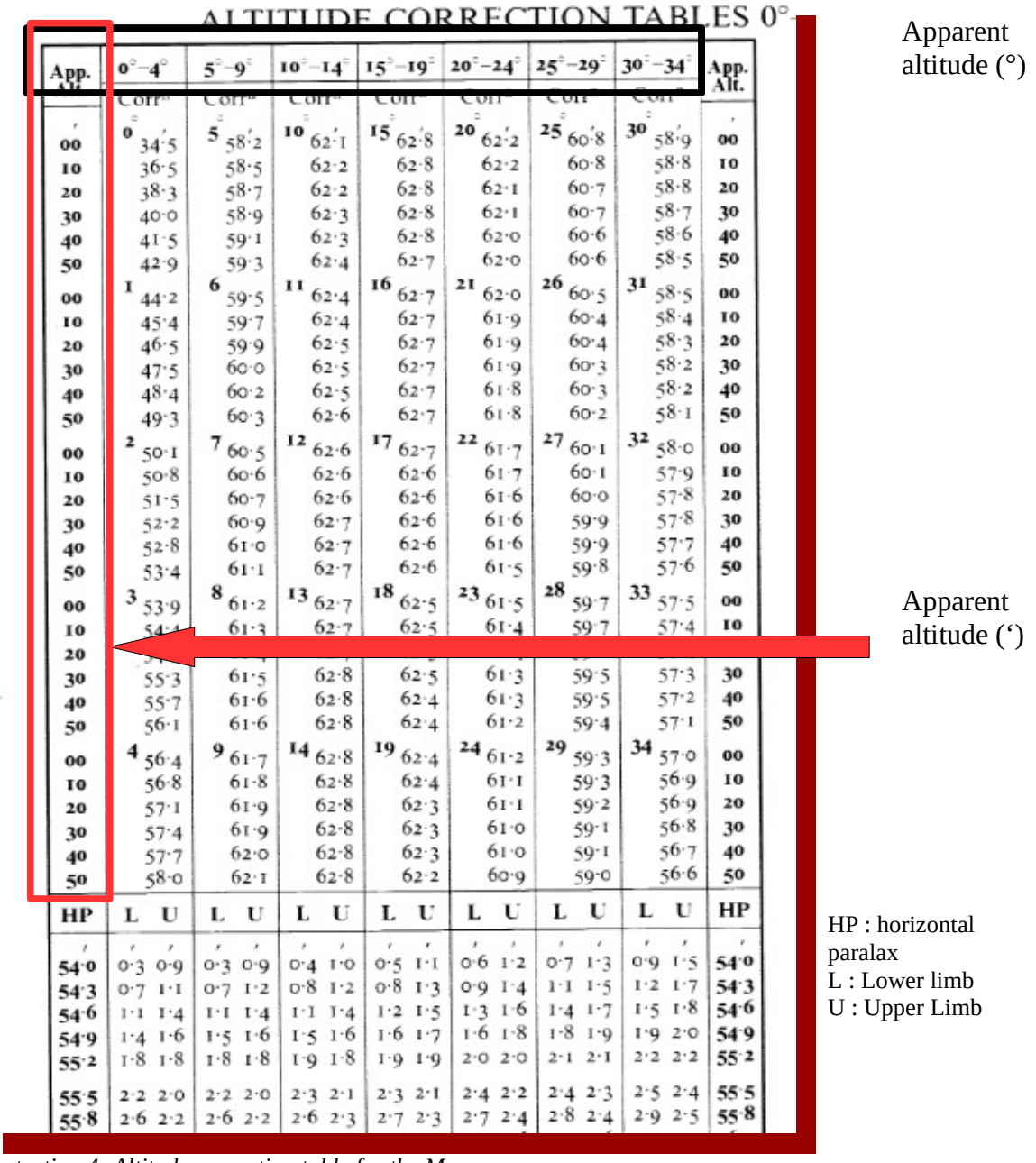
Basically, the correction is the refraction correction, and depending on the date, additional corrections might be required for Venus and Mars for parallax and phase.

For the moon

The tables are divided two parts.

- **The first part** is a tabulated correction, which is the combination of refraction, semi-diameter and parallax for the lower limb, so if the altitude of the moon is taken from the upper limb, then 30′ must be subtracted.

- **The second part** is the correction for variations in semi-diameter and parallax, depending on the horizontal parallax



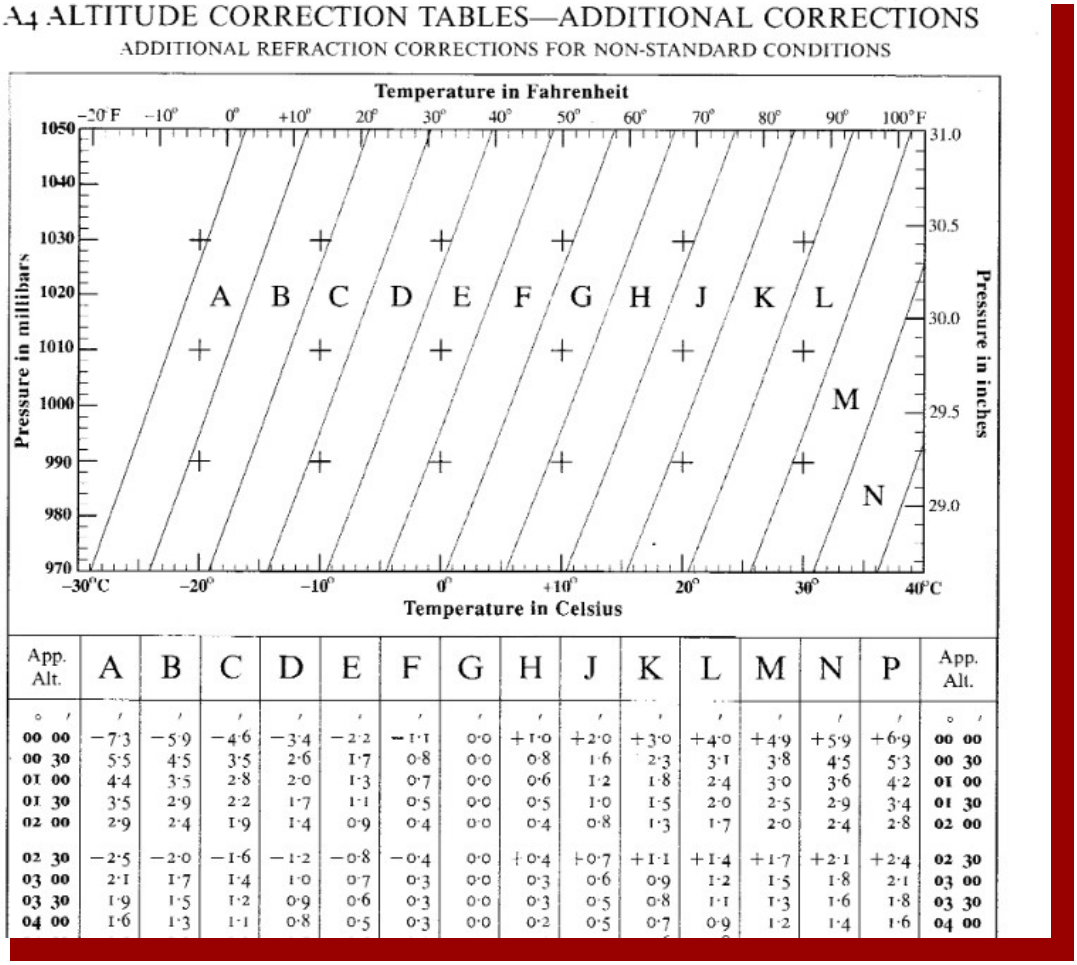
App. Alt.	0°–4° Corr	5°–9° Corr	10°–14° Corr	15°–19° Corr	20°–24° Corr	25°–29° Corr	30°–34° Corr	App. Alt.
′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	′
00	0 34·5	5 58·2	10 62·1	15 62·8	20 62·2	25 60·8	30 58·9	00
10	36·5	58·5	62·2	62·8	62·2	60·8	58·8	10
20	38·3	58·7	62·2	62·8	62·1	60·7	58·8	20
30	40·0	58·9	62·3	62·8	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								
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

Illustration 4: Altitude correction table for the Moon

You find HP (horizontal parralax) in the daily page at the selected time in Moon part.

Additional correction for refraction



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

Illustration 5: Additional altitude correction table

Altitude correction / methodology

hs	
+ IC	
+ Dip	
ha	
+Alt. Main correction	
-30’ for upper limb(Moon)	
+U,L, correction for Moon	
+Additionnal correction for Planet	
+Additional refraction correction (non standard Temp/pression)	
ho	

} *Only for the moon*

} *Only for planet*

EXAMPLES

Example 1 - Sun altitude

The sextant altitudes were taken October 26, 1981; index error 1.2´ on the arc; height of eye 15.0 meters ; temperature 29°; pressure 980 mb; and Sun's lower limb altitude 40°25.0 '.
Find the observed altitude of the sun.

hs	**40° 25,0'**	
+ IC	-1,2'	(on the arc)
+ Dip	-6,8	(h.e.15m)
ha	**40° 17,0'**	
+Alt. Main correction	+15,1'	
-30' for upper limb (Moon)		
+U,L, correction for Moon		
+Additionnal correction for Venus		
+Additional refraction correction (non standard Temp/pression)	+0,1'	(temp. 29°C, pressure 980mb)
ho	**40° 32,2'**	

Example 2 : Moon altitude

The sextant altitudes 30°09.5´ of the moon's upper limb were taken at 1100 UT on October 23, 1981 in latitude 50°N; index error 1.8´on the arc ; height of eye 18 meters; temperature 15°C ; pressure 960mb.
Find the observed altitude of the moon.

hs	**30°09,5'**	
+ IC	-1,8'	(on the arc)
+ Dip	-7,5'	(h.e.18m)
ha	**30°00,2'**	
+Alt. Main correction	+ 58,9'	
-30' for upper limb (Moon)	- 30,0'	(Upper limb)
+U,L, correction for Moon	+ 2,7	(Upper limb, HP 56,1' read in daily pages October 23 at 11 :00 for the moon)
+Additionnal correction for Venus		
+Additional refraction correction (non standard Temp/pression)	+0,1'	(temp. 15°C, pressure 960mb)
ho	**30°31,9'**	

Example 3 : Moon altitude

The sextant altitude of the moon's lower limb were taken at 1700 UT on 15th July 1981 in latitude 42°N ; index error 1.3´off the arc; height of eye 20 meters ; temperature 25°C ; pressure 1020 mb. Sextant altitude is 15°28´.
Find the true altitude of the moon

hs	**15°28,0''**	
+ IC	+ 1,3'	(off the arc)
+ Dip	- 7,9'	(h.e.20 m)
ha	**15°21,4'**	
+Alt. Main correction	+ 62,8'	
-30' for upper limb (Moon)		(lower limb)
+U,L, correction for Moon	+ 1,9'	(Lower limb, HP 55,2')
+Additionnal correction for Venus		
+Additional refraction correction (non standard Temp/pression)	+ 0,2'	(temp. 29°C, pressure 980mb)
ho	**16° 26,3'**	

Example 4 : Star altitude

The sextant altitude 45°27.4´ of Star Bellatrix was taken October 26, 1981; index error 1.2´ on the arc; height of eye 15.0 meters ; standard atmospheric conditions.
Find the true altitude of Bellatrix

hs	**45°27.4'**	
+ IC	- 1,2'	(on the arc)
+ Dip	- 6,8'	(h.e.15m)
ha	**45°19,4'**	
+Alt. Main correction	- 1,0'	
-30' for upper limb (Moon)		
+U,L, correction for Moon		
+Additionnal correction for Venus		
+Additional refraction correction (non standard Temp/pression)	0'	(standard pression & temperature)
ho	**45° 18,4'**	

Example 5 : Venus altitude

On 15th April 1981, the sextant altitude of Venus 37°46.8´was taken ; index error 1.5 ´on the arc ; height of eye 15.0 meters ; standard atmospheric conditions.
Find the true altitude of Venus.

hs	**37°46,8'**	
+ IC	- 1,5'	
+ Dip	- 6,8'	(h.e.15m)
ha	**37°38,5'**	
+Alt. Main correction	- 1,3'	
-30' for upper limb (Moon)		
+U,L, correction for Moon		
+Additionnal correction for Venus	+ 0,1'	
+Additional refraction correction (non standard Temp/pression)	0'	(standard atmospheric condition
	37°37,3'	

RESSOURCES

Sources

http://shipofficer.com/so/wp-content/uploads/2015/02/17.-Altitude.pdf

Illustrations

ILLUSTRATION	
Illustration 1: Observed, apparent and sextant altitude	Extract from power point US power squadrons – Junior Na vigation – chapter 4 slide show
Illustration 2: Dip table	Nautical Almanac
Illustration 3: Altitude correction tables for Sun, stars & planets - Dip table	Nautical Almanac
Illustration 4: Altitude correction table for the Moon	Nautical Almanac
Illustration 5: Additional altitude correction table	Nautical Almanc