

Latitude by Ex-Meridian Altitude

This method is used to find only the latitude of the observer when the heavenly body is near the observer's meridian and where the local hour angle is small. It can be used either by Ex-Meridian tables, or by the formula.

Ex-Meridian Tables Table I: Enter latitude and declination to find quantity of "A". Value A can also be calculated by formula:

$$A = \frac{1.9635 \times \cos \text{Lat.} \times \cos \text{Dec.}}{\sin(\text{Lat.} \pm \text{Dec.})}$$

For denominator, the latitude and declination are:

- Subtracted if on upper meridian and same name;
- Added if on upper meridian and different name;
- Subtracted on lower meridian.

Table IV: Enter "A" and LHA "t" to check that the hour angle is within limit of table. From table IV, extract the time limit for hour angle; the hour angle for the body to travel must be within the time limit.

Table II: Enter "A" and LHA to get first correction;

Table III: Enter first correction and True Altitude to find 2nd correction.

$$1^{\text{st}} \text{ Correction} - 2^{\text{nd}} \text{ Correction} = \text{Reduction}$$

$$\text{TZD} - \text{Reduction} = \text{MZD}$$

Example 1 At 11^h54^m on 25th October 2008, DR position was 49°00'N 35°20'W; sextant altitude of the sun's lower limb near observer's meridian was 27°54.0'; index error 1.2' off the arc; height of eye 10 m. Chronometer showed 02^h40^m55^s with no error. Find direction of position line and latitude of observer:

LMT: 11^h54^m00^s Chronometer: 02^h40^m55^s
 Longitude: 2^h21^m20^s : 12^h00^m00^s
 UT: 14^h15^m20^s UT: 14^h40^m55^s

GHA 33°59.9' Declination 12°21.0' S
 Increment 10°13.8' d = 0.9' 0.6'
 GHA 44°13.7' 12°21.6' S
 Longitude (W) 35°20.0'
 LHA 8°53.7'

Sextant Alt.: 27°54.0' A: 1.4 (table I)
 Index Error: +1.2' Hour Angle: 52^m (table IV)
 Observer Alt.: 27°55.2' "Within Limit"
 Dip: -5.6'
 Apparent Alt.: 27°49.6' 1st Reduction: 1.0 21.1' (table II)
 Correction: +14.5' 0.4 8.4'
 True Alt.: 28°04.1' 1st Reduction: 29.5'
 TZD: 61°55.9' 2nd Reduction: 0.2' (table III)
 Reduction: 29.3' Total: 29.3'
 MZD: 61°26.6'
 Declination: 12°21.6' S
 Latitude: 49°05.0' N

$$Z = \tan^{-1} \left(\frac{\sin LHA}{\tan Dec. \cos Lat. - \cos LHA \sin Lat.} \right)$$

$$= \tan^{-1} \left(\frac{\sin 8^\circ 53.7'}{\tan 12^\circ 21.6' \cos 49^\circ 05.0' - \cos 8^\circ 53.7' \sin 49^\circ 05.0'} \right)$$

$$= S14.4^\circ W = 194.4^\circ T$$

Position Line: 104.4° / 284.4°

Example 2 At 11:50 on 15th April 2008, DR position 40°30'N 115°40'E., the sun's lower limb was observed near the observer's meridian by sextant altitude 59°38.6'; index error 3.0' on the arc; height of eye 15 m; chronometer 03^h48^m55^s; chronometer error 15^m35^s slow. Find direction of the position line and latitude which crosses the DR longitude:

LMT: 11^h50^m00^s
 Long. (E): 7^h42^m40^s
 UT: 4^h07^m20^s

Chronometer: 03^h48^m55^s
 Error(slow): 15^m35^s
 Chronometer: 04^h04^m30^s ∴ UT:04^h04^m30^s

GHA: 239°59.5' Declination: 9°53.1'N
 Increment: 1°07.5' d = 0.9 0.1'
 GHA: 241°07.0' 9°53.2'N
 Longitude (E): 115°40.0'
 LHA: 356°47.0'

Sextant Alt.:	59°38.6'	A:	2.89	(I)
Index Error:	<u>-3.0'</u>	Hour Angle:	33 ^m	(IV)
Observed Alt.:	59°35.6'	"Within Limit"		
Dip:	<u>-6.8'</u>	1st Reduction:	2.0 5.5'	(II)
Apparent Alt.:	59°28.8'		0.8 2.2'	
Correction:	<u>+15.4'</u>		0.09 <u>0.3'</u>	
True Alt.:	59°13.4'	1st Reduction:	8.0'	
TZD:	30°46.6'	2nd Reduction:	<u>0.0'</u>	(III)
Reduction:	<u>8.0'</u>	Total:	8.0'	
MZD:	30°38.6'			
Declination:	<u>9°53.2'</u> N			
Latitude:	40°31.8' N			

$$Z = \tan^{-1} \left(\frac{\sin LHA}{\tan Dec. \cos Lat. - \cos LHA \sin Lat.} \right)$$

$$= \tan^{-1} \left(\frac{\sin 356^\circ 47.0'}{\tan 9^\circ 53.2' \cos 40^\circ 31.8' - \cos 356^\circ 47' \sin 40^\circ 31.8'} \right)$$

$$= S6.2^\circ E = 173.8^\circ T$$

Position Line: 83.8° / 263.8°