**Clearing David C’s first Lunar using Cosine formula and Thompson Abbreviated method.**

**Sight 1. Cleared using observed apparent altitudes of moon and Venus. Sight taken using an Artificial horizon (AH)**

Date 5th Jan 2017. I.E. +0.5’

DR 41˚ 06.5’ S, 175˚ 05.2 E. (not required for these formulae)

Actual GMT of sight 08.23.07. (not required for these formulae )

Apparent Alt moon (ha) =69°11.0' + 0.5' = 69°11.5' / 2 = **34°35'45".**

Apparent Alt. Venus. 41˚ 40’ 40”+0.5’/2=**20˚50’35” Ha**

Lunar Distance (LDs) =36˚ 29.5’. + 0.5 I.E. + 0.24’ Augmentation =36˚ 30’14”. LDa, + 0˚15.9’ (SD)=**36˚ 46’ 8” LDsd**

**Venus.** No SD, use star alt correction from NA =-0˚2.2’**=Ho= 20˚50’ 20”**

**Moon** .AH therefore no SD correction.

Main correction with HP of 0˚58.4’ =0˚56.7’

Second correction , **use instructions for Bubble sextant in N**A = mean of ul and ll =0˚4.6’-

Lower Limb: 56.7' + 5.9' = 62.6'

Upper Limb: 56.7' + 4.1'  = 60.8'

Average: (62.6' + 60.8') / 2 = 61.7'

34°35.7' + 61.7' - 15' = **35°22.4'=ho**

**Clearance**

**Cosine method as per John Karl page 92**

**Cos RBA –(cosLDsd-sin Hsdx sin hsd/cos Hsdx cos cos hsd**

**Cos LDo = sin Ho x sin ho+cos Ho xcos hox cos RBA.**

I used Casio fx-3650P with these programmed in as one continuous formula..

Also easy to do with the App by Andre Ruiz. On smart phone , but I find the calculator much more sea worthy than smart phone.

**Result LDo= 36˚ 56’ 29” (Frank’s website 36˚ 57.5’)**

**Thompson method (Frank’s modified)**

I prefer this simplified method which is easier to perform on a slide rule than the cosine method.

P1=HP xsin Hsd/tan LDsd.

P2= HP x sin Hsd/sin LDsd

P=P1-P2

P + 3rd correction taken from Bowditch 1863 edition which also explains the method.

Result with 3rd correction of 0˚1.31’= **36˚57’7”**

**Update, correction on lunar clearnce.**

**Using conventional corrections (not the special AH ones), and  your observed readings I  now  get LDo 37˚0’' with the Karl Cosine and LDo 36°57’25'’ with the Thompson compared to Frank's 36°57.5'.**

**Ho = Ho= 20˚50’ 20” (No SD for planets)**

**hsd=34˚35’45”+ 0˚15.9’+0.24’=34˚51’53”**

**h main corrections 0˚56.7’+0˚5.9’ for LL.=1˚2’36”+ha=35˚38’21”**

**+0˚15.9’ (SD)+ Aug 0˚0.24’=35˚54’29”=ho**

**Result LDo 37˚0’.**

**Thompson gives 36°57’25”**

**So I think the anomaly relates mostly  to my use of the AH modified corrections.**

**Interestingly, the Thompson result is the same with either type of correction ,presumably because it does  not require Ho and especially ho, where most of the differences in corrections occur.**

**I assume that Frank's site calculator does not do this, so using normal corrections I get similar  results with cosine formula as Frank. (well 0.1' out)**

**So perhaps Frank could advise about how to deal with artifical horizons and lunar clearance?**

**Find the Time**

I generally take a pre-printed set of tables from Frank’s website which gives geocentric LDs for every 3 hours. This puts me in the same position as a 19th century navigator, since the NA included these till about 1912.

Alternatively, it is easy to calculate an LD for say the period +/- an hour from your approximate estimated time using the great circle equation, essentially the cosine formula for Hc, where Lat=dec of sun or body, dec= moon dec, LHA =GHA1-GHA2.

The resulting hc is subtracted from 90 to give the ZD which is the same as the LD1.

Then repeat for + 1 hour to get LD2. I often use the Bygrave to do this just for fun!

Date and Times are GMT.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 0:00 | 3:00 | 6:00 | 9:00 | 12:00 | 15:00 | 18:00 | 21:00 | 24:00 |
| *Moon's HP* | *58.22* | *58.29* | *58.37* | *58.44* | *58.52* | *58.59* | *58.66* | *58.73* | *58.8* |
| Geocentric Lunar Distances | | | | | | | | | |
| Venus | 32° 33.6' | 34° 08.1' | 35° 42.9' | 37° 17.9' | 38° 53.2' | 40° 28.8' | 42° 04.6' | 43° 40.7' | 45° 17.1' |

|  |  |
| --- | --- |
| Venus HP: | 0.2 |

-FER, Centennia Software, June 2004. Server moved November, 2008.

Just eyeballing the LDs, you know that even without clearance, the LDa of about 36˚ means your GMT is somewhere between 6 and 9 am.. I am not sure what the maximum correction would be at maximum HP but probably no more than an hour in time ?

To get the accurate time, it is a simple job of equating the LD difference ratios to the corresponding time differences.

**Cosine formula result**

LD1=35˚ 42.9’ at 6.00 GMT

LDo=’ **36˚ 56’ 29”**  at ? GMT

LD2= 37˚ 17.9’ at 9.00

LD2-LD1=1˚ 35’ over 180 minutes time

LDo-LD1= 1˚13’35” divide by 1˚ 35’=0˚46’28”

x 180=139˚25’16”/ 60=2˚19’25”

**GMT = ΔT=180x /60 =6.00 + 2hrs 19mins 25secs= 08 19 425(correct result is 8 23 07 )**

**Thompson result**

LDo=36˚57’7”-LD1=1˚14’13” /1˚ 35’ =0˚46’52’’

X180=140˚37’16”/60= 2˚20’37”

6.00+ 2hrs 22mins 21 secs = **08 20 37**

**Discussion**

The Cosine formula is usually more accurate than the abbreviated Thompson method which I use because it is easy and quick with my slide rule. (and in my experience, usually accurate).

In this case, it seems to be more accurate, perhaps because it does not involve the main correction for the moon, which in this situation of AH, involves some unusual features:

* No dip, No SD, use of bubble sextant instructions for 2nd correction.
* Possibly the Cosine formula does not perform so well with AH readings? I have no experience of AH. Perhaps Frank would know?
* Using the conventional corrections (not AH), gives much better results.