**Sight reduction of the Navigational Triangle using Mini Fuller 2 and Bygrave cylindrical slide rules**

**Example of a sight reduction**

GHA 304˚ 22.6’

Dec 22˚ 59.5’N

LHA 298˚ 49.8’ (360˚-298˚49.8’=61˚10’)

LAT 50˚ 06’.8 N

Hc (computer) 35˚ 45.6’

Az (computer ) 96˚

**Formulas**

Sin Alt(Hc) = (cos LHA x cos Lat x cos Dec) +/- (sin Lat x sin Dec.)

Sin Az =sin LHA(cos Dec/cos alt).

**Calculator.**

**Hc**

Sin Hc=(cos 298˚49.8’xcos 50˚ 6.8’xcos 22˚ 59.5’)=(0.4822x0.6412x0.9205)=**0.2846**

=/- (sin 50˚6.8’xsin 22˚59.5’)=0.7673x0.3905=**0.2996**

0.2846+0.2996=**0.58423= 35˚ 45’=Hc**

**Az.**

Sin Az =sin LHA(cosdec/cos Hc

=sin 298˚49.8’=-0.8760.

(cos dec 22˚59.5’=0.92056/cos Hc=0.81157)=1.134

1.134x-.8760=-0.9934, =**sin Az=-83˚24’. Zn according to rules = 180˚ - 83˚ 24’ =96˚36’**

**Mini Fuller 2 worksheet.**

Basic moves. Curser move = divide. Inner tube move =multiply

* 2x4. S>2, top 0>L, L>4, read 8 at S
* 4/2. S>4, 2>L, L>0, read 2 at S
* Sine 30˚ ,
* . S>0, 30˚>L, L> red, read 0.5 at S
* Sine 15> half way between red and black. Sine 10> black
* Sin 30 x sin 30 . S>0, 30˚>L,L>red,30˚>L ,L>red, read 0.25 at S
* Sine 30/sin 50 **division**. Direct on sine. S>0, 30˚>L, L>50˚, read 0.6527 at S. (can do divison sines direct.)
* **Combined multiplication and division** direct on sine scale. Sin20xsin 30/sin 50x sin 25. Can do direct. S>0,20>L, L>50, 30>L, L>25, read 0.5283 at S **or** red >L,S>0, read 31˚53’

1. Convert cosines to sines ; (new version will have cosines scales going other way to avoid this step 1)

Cos LHA 298˚ 49.8’= sine 28˚49’ 48’’

Cos LAT 50˚ 06.8’= sine 39˚ 53’.

Cos DEC 22˚ 59.5’N= sine 67˚

2)Cos LHA x cos lat xcos dec)S>0, 28˚49’ inner tube to L. L>red, read 0.4822 at S

3) 39˚53’>L, L>red (0.3091 at S)

4)67˚>L. L>red, read **0.2846 at S Record (**2-4 are multiply actions direct on the sine scale)

5)Sin LAT x sin DEC

S>0, 50˚6’48”>L. L>red, read 0.7673 at S

6) 22˚59’>L.L>red **read 0.2997 at S, record**

**7) 0.2846 + 0.2997= ).58423=sin Hc record**

8) 0.58423 to S, red>L, S>0, **read 35˚45’ at L=Hc**

**Azimuth.**

1. Convert cosines to sines ; (new version will have cosines scales going other way to avoid this step 1)

Cos DEC 22˚ 59.5’N= sine 67˚

Cos Hc 35˚45’=sin 54˚15’=0.8115.

Sin LHA S>0, **360˚-298˚49.8=61˚10’ >L** .L>red **=0.8760. record**

1. Cos dec/cos Hc S>0, 67˚>L,.L>red**, read 0.9205 at S**

S>0, 54˚15’ >L, L>red , **read 0.8115 at S**

1. **Direct sin 61˚10’x(sin 67˚/sin 54˚15’(Divide)**  **S>top 0, 67˚>L,L>54˚15’, 61˚10’>L,S> top 0 read 83˚ 24’ at L**=**sin Az=-83˚24’. Zn according to rules = 180˚ - 83˚ 24’ =96˚36’**

**The Bygrave sight reduction process.**

The instructions are printed on the curser and cylinders.

EQ 1. 1/cot dec=cosLHA/cot y (or w)

EQ2 Cos y(W)/cot LHA= cosy/cot Az

EQ3 cos Az/cot Y= i/cot Hc

1. Find “H”, or hour angle, rules depending on size of LHA. LHA >270 therefore =( 360˚-LHA )= 360˚ -298˚ 49.8’ =**61˚ 10.2’**
2. Find co-latitude= 90˚ - 50˚ 06.8’ =**39˚ 53.2’**
3. Eq 1 Set S (cos scale) to 0 , set inner (co-tan) scale (L) to Dec (**22˚ 59.5’)**
4. Set S to H (61˚ 10.2’) read “y” = **41˚ 19’**
5. Eq 2 Set S to y (41˚ 19’), set H on L
6. Set Y (Y=co-lat +y,) = **81˚ 12’**
7. **Read Az on L=83˚ 36’, Zn according to rules = 180˚ - 83˚ 36’ =96˚ 24’**
8. Eq 3 Set S to Az (83˚ 36’), set Y (81˚ 12’) to L
9. Set S to 0, **read Hc at L =** **35˚ 45.5’** (can be read to 0.5’ at this part of the scale.)