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**APPLIED CAVE
MATHEMATICS**

①

Question 1.

How close to it's Limit of Function is TonroeSouterrain working at in 2012?

Answer.

The Souterrain is operating to within 1.86 degrees (15.04 minus 13.18) or 35.1 mm (4450 minus 4414.9) of maximum function.

N.B.

All proofs for this at the end of the section.

3

Question 2.

Have we been left any clues as to how the Souterrain might have been designed?

Answer.

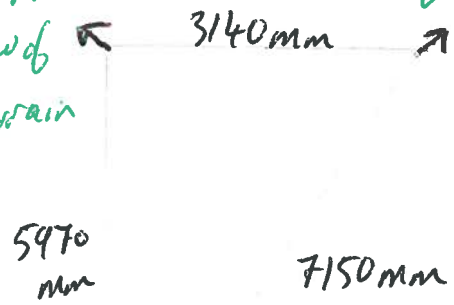
It appears that Square and Compass might have been used in the construction of TonroeSouterrain.

(14)

The first clue that the Souterrain might have been designed using squares came from analysis of this data.

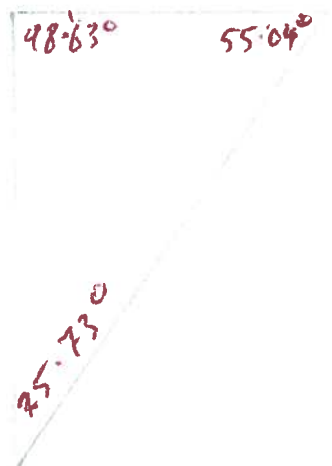
Person standing directly over external window of Souterrain

Person standing in line with apparent axis of northern section of cave as defined by the steps

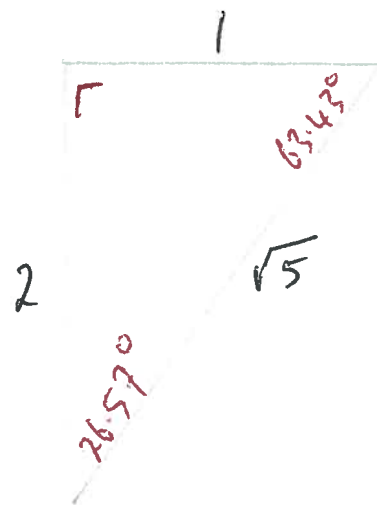


Person standing over middle of lintels in Creep Passage

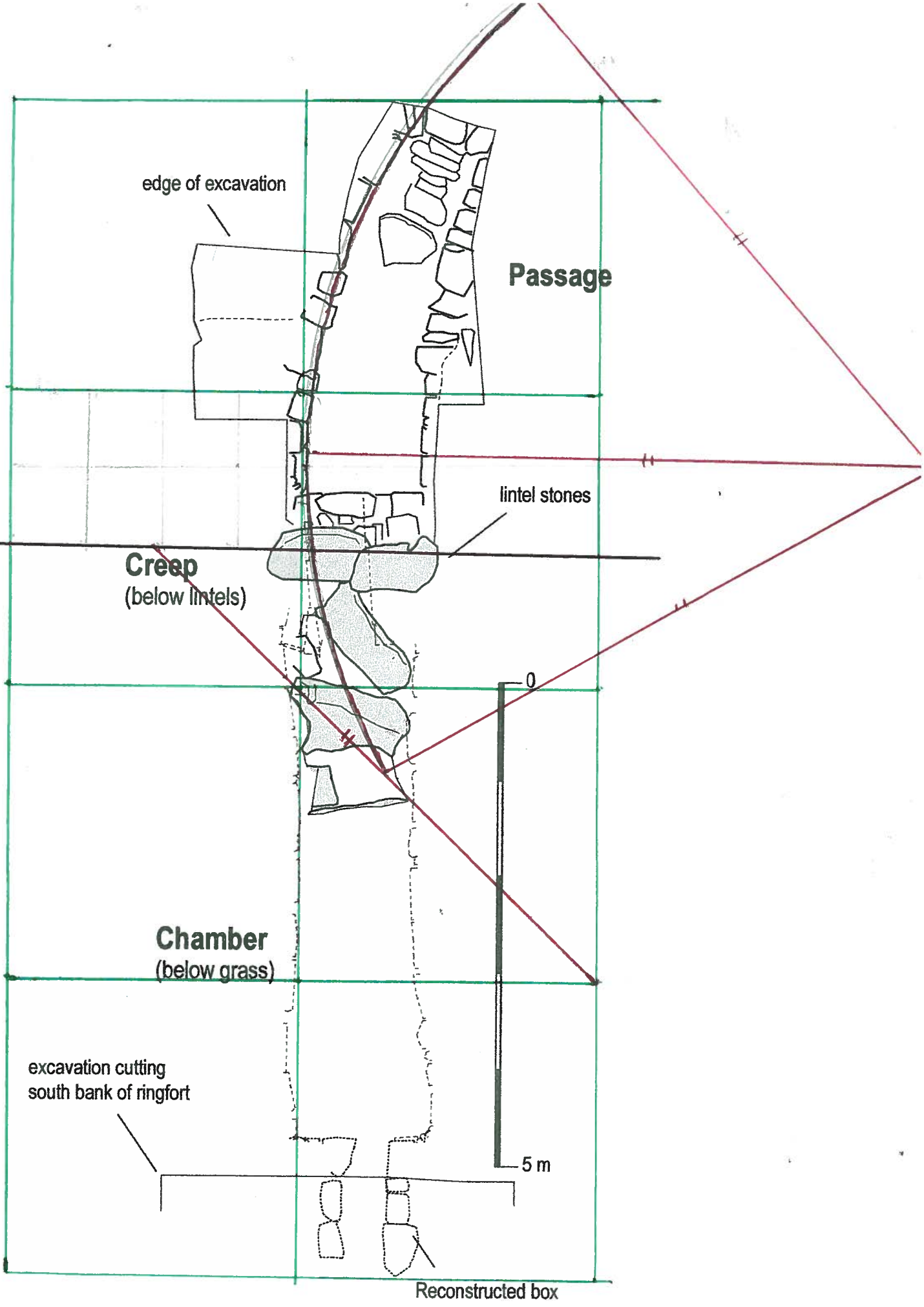
The Acute angle of this triangle 25.73° is tantalizingly close to the 26.57° acute angle of a double square.



However these measurements were taken on top of the finished mound and would be slightly at variance with planning on the level field before building.



5



(b)

Question 3.

Given the following co-ordinates does Tonroe have any alignment with important sites in other countries?

Answer.

No. However Newgrange in The Boyne Valley, Co Meath is aligned with:

Stonehenge in Wiltshire,

Vatican State,

The Great Pyramid at Giza, and

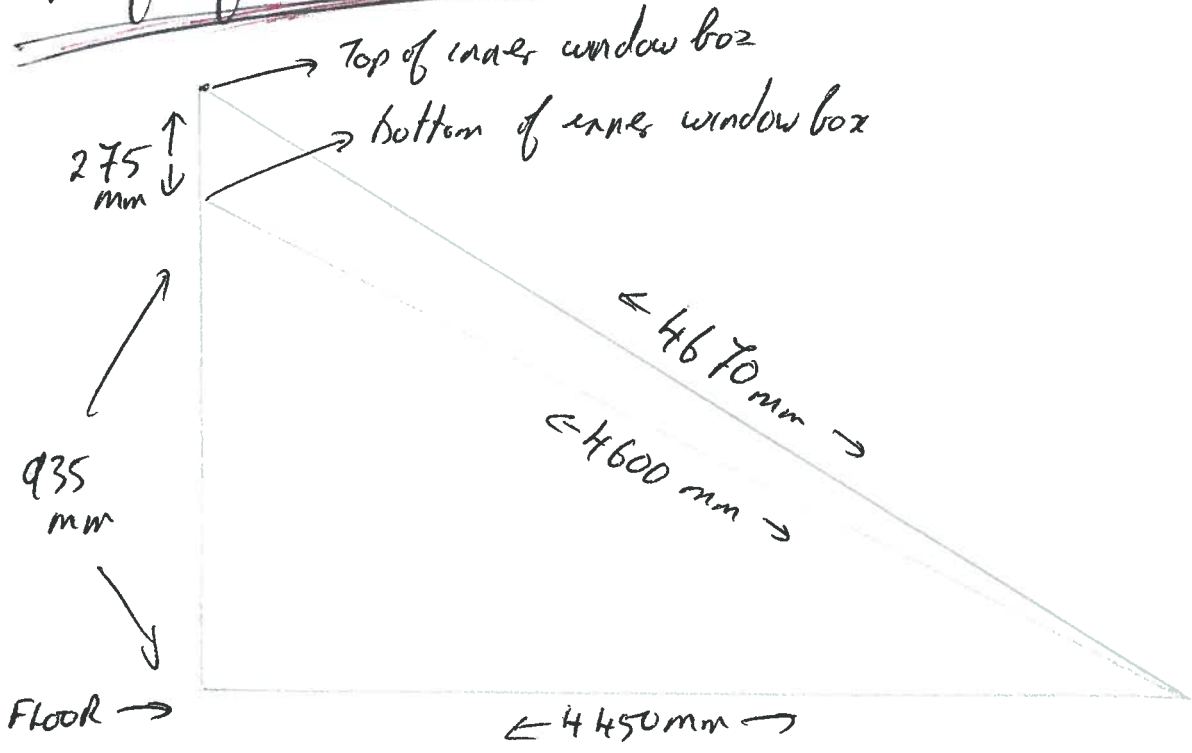
The Holy City of Medina.

These sites are on the same straight line which is a 52.5 kilometer wide band which continues through Western Australia and Tasmania.

$\tan 0^{\circ}18' = 0.052 \times 5000 \text{ km} = 26 \text{ km}$
 $\times 2 = 52 \text{ km}$

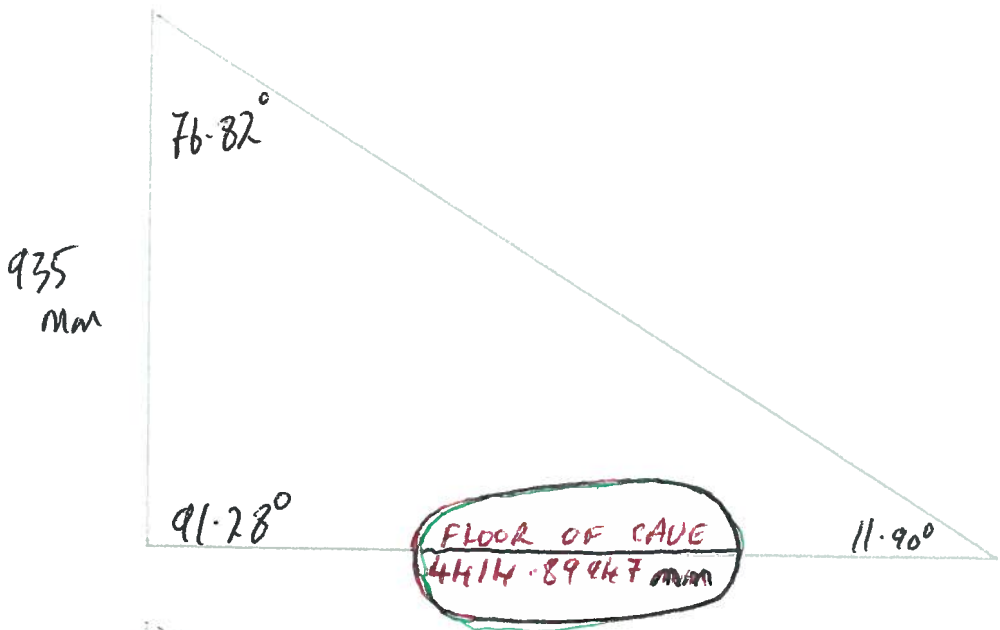
	NEWBAMBE	STONEHENGE	VATICAN	BIZA	MEDINA	MECCA	TOWROE	GASTONBURY
	53.695N	51.1788W	41.90N	29.9792W	24.45W	21.415W	53.780W	51.144N
	6.475W	1.8262W	12.45E	31.1342E	39.60E	39.815E	8.316E	2.7W
NEWBAMBE	28°25'	31°50'	32°14'	32°24'	34°54'	20°38'	34°03'	RED 32°32' +18'
STONEHENGE	28°25'	33°01'	32°45'	32°50'	35°33'	21°50'	-2°16'	GREEN 32°32' +42'
VATICAN	31°50'	33°01'	32°32'	32°44'	36°43'	29°47'	31°29'	
BIZA	32°14'	32°45'	32°32'	32°30'	44°37'	31°06'	32°01'	
MEONA	32°24'	32°50'	32°44'	32°30'	86°	31°29'	32°15'	
MECCA	34°54'	35°33'	36°43'	44°37'	86°	33°55'	34°58'	
TOWROE	20°38'	21°50'	29°47'	31°06'	33°55'	25°08'	25°08'	
GASTONBURY	34°03'	-2°16'	31°29'	32°15'	34°58'	25°08'	25°08'	

(8) Proof of Question 7

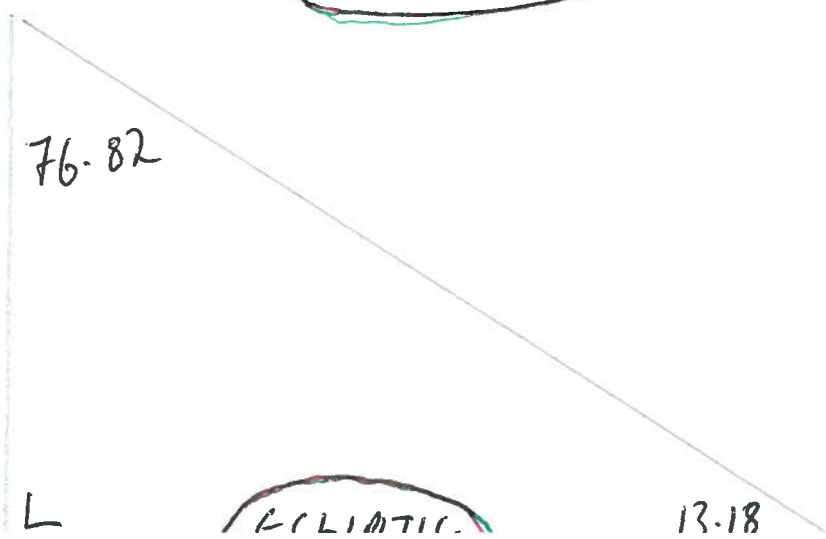


From basic Plane Mathematics Q.5

(i)



(ii)



(a)
(i)

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{a}{\sin 76.82^\circ} = \frac{b}{\sin 19.28} = \frac{935 \text{ mm}}{\sin 11.90}$$

$$\frac{a}{0.973658553} = \frac{b}{0.999750467} = \frac{935}{0.206204185}$$

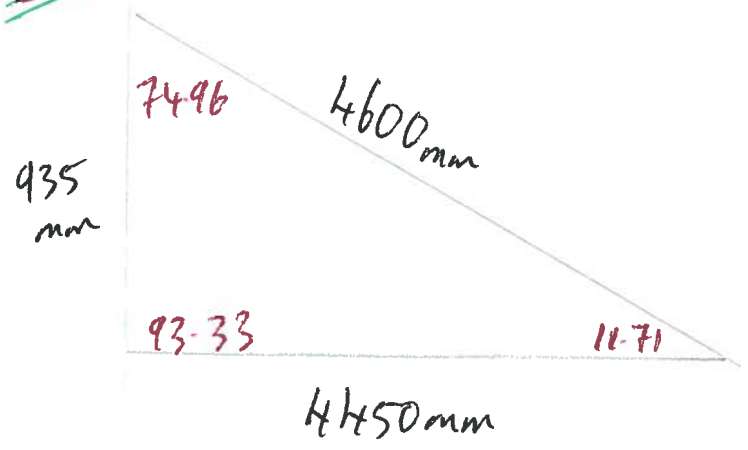
$$a = 4414.89947$$

re When the Sun is at its highest point allowed by the window-box for a beam of light to enter the cave the resultant Sunspot would be

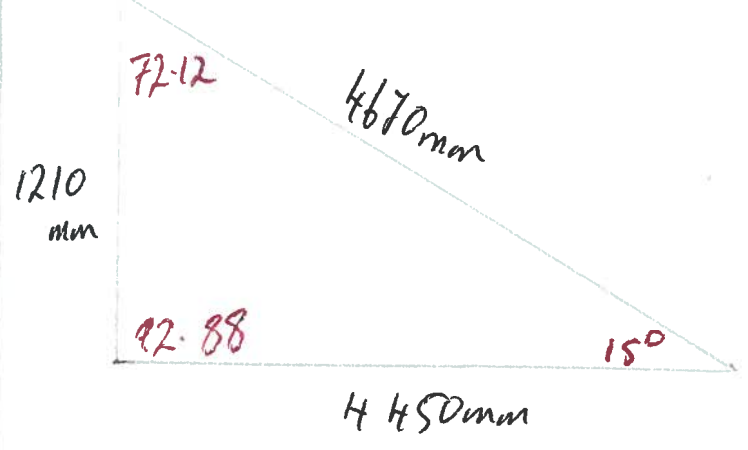
4414.9 mm

from the front (Southern end) of the cave.

(10)
(ii) A



(ii) B



$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$935^2 = 4450^2 + 4600^2 - 2 \cdot 4450 \cdot 4600 \cdot \cos A$$

$$874225 = 19802500 + 21160000 - 40940000 \cos A$$

$$\cos A = 0.979195774$$

$$A = 11.70763642$$

$$\frac{a}{\sin a} = \frac{b}{\sin b} = \frac{c}{\sin c}$$

$$\frac{935}{\sin 11.70763642} = \frac{4450}{\sin b} = \frac{4600}{\sin c}$$

$$\sin b = 0.965758537$$

$$b = 74.96301111$$

$$\sin c = 0.998312195$$

$$c = 93.32935246$$

$$\text{or } 86.67064754$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$1210^2 = 4450^2 + 4670^2 - 2 \cdot 4450 \cdot 4670 \cos A$$

$$1464100 = 19802500 + 21808900 - 41563000 \cos A$$

$$\cos A = 0.965938454$$

$$A = 14.99720411$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\frac{1210}{\sin 14.99720411} = \frac{4450}{\sin B} = \frac{4670}{\sin C}$$

$$\sin B = 0.951681817$$

$$B = 72.11630239$$

$$\sin C = 0.998731256$$

$$C = 92.88649339$$

$$\text{or } 87.11350661$$

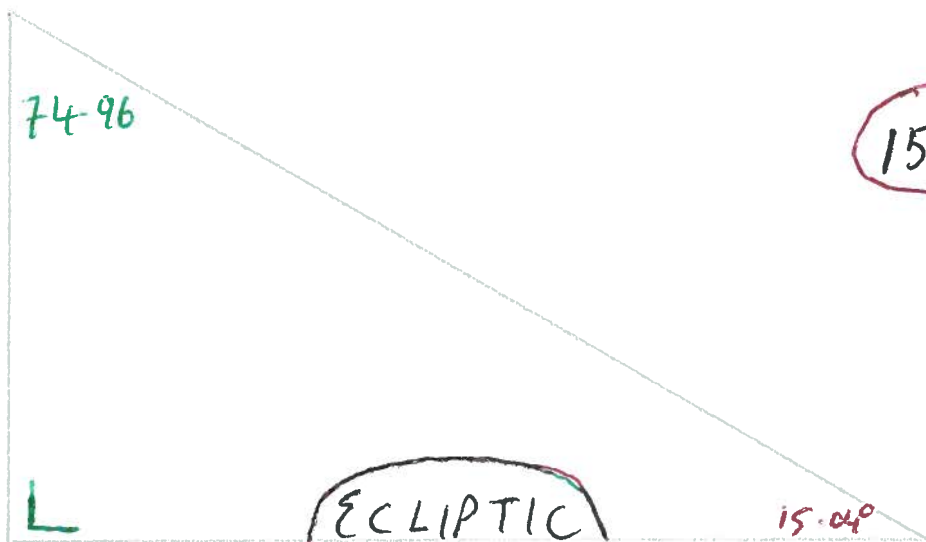
③ Composite Triangle from (ii) A and (ii) B



74.96° is the lowest possible declination of the Sun in 2012 and is taken directly from (ii) A

$$93.11^\circ = \frac{93.33 + 92.88}{2}$$

$$11.93^\circ = 180 - (93.11 + 74.96)$$



$$15.04^\circ - 13.18^\circ = 1.86^\circ$$

ii)
Proof of Question 2

$$a^2 = b^2 + c^2 - 2bc \cos A$$

$$3140^2 = 5970^2 + 7150^2 + 2 \cdot 5970 \cdot 7150 \cos A$$

$$9859600 = 35640900 + 51122500 - 85371000 \cos A$$

$$\cos A = 0.900818779$$

$$A = 25.73409831$$

$$\frac{A}{\sin a} = \frac{B}{\sin b} = \frac{C}{\sin c}$$

$$\frac{3140}{0.434195263} = \frac{7150}{\sin b} = \frac{5970}{\sin c}$$

$$\sin b = 0.988693036$$

$$b = 81.37576298$$

$$\sin c = 0.825524114$$

$$c = 55.64166454$$

