# TRIGONOMETRY

## 3D TRIGONOMETRY (X)

Contents include:

- Unpacking a 3D Trig Problem

- Unpacking a 3D Trig Problem

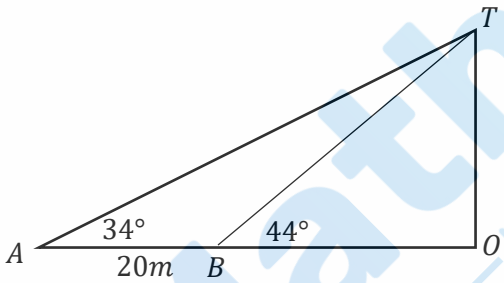
There is technically no more additional theory that needs to be learnt up to this point. Instead, these types of questions are more about the practical applications of our Trigonometry knowledge. This can include cosine rule, sine rule, trig ratios, etc. Thus, practice is key!

When presented with a 3D trig problem, it may initially seem confronting, but we should remember:

$$Sketch\ 2D\ trig\ diagrams\ of\ all\ possible\ triangles!$$

This will help break down the question much easier

**Example 1:** OT is a tower on horizontal group. $\Delta OTA$ is a right – angle triangle at $\angle AOT$. Two straight cables, $AT$ and $BT$ connect the top of the tower to the ground.




AT and BT make angles with the ground of 34° and 44° respectively. BT is 20m closer to the base of the tower compared to AT. What is the length of the cable AT, correct to 2 significant figures? [2 marks]

Solution:

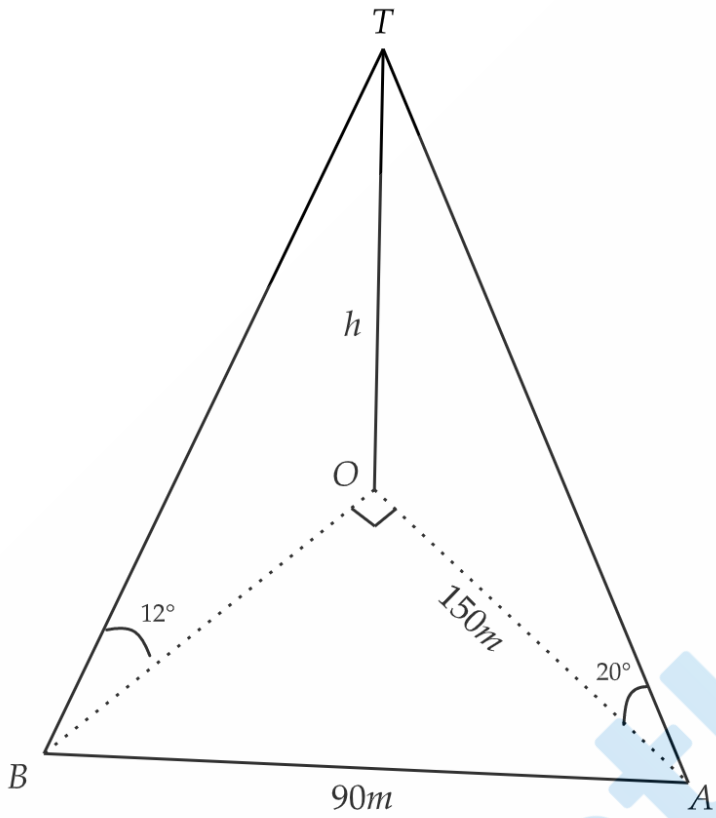
$$\angle ABT = 180° - 44°$$
$$= 136°$$

$$\therefore \angle ATB = 180° - 34° - 136°\ [interior\ angle\ sum\ of\ triangle]$$
$$= 10°$$

Therefore, considering sine rule:

$$\frac{AT}{\sin 136°} = \frac{AB}{\sin 10°}$$
$$AT = \frac{20}{\sin 10°} \times \sin 136°$$
$$\therefore AT \approx 80m\ [2\ sig\ figs]$$

**Example 2:** Alberto stands at a point A, 150m east of the tower OT which stands at a height of $h$ metres. The angle of elevation of T from point A is 20°. Ben stands at point B, due south of the tower OT. The angle of elevation to the top of the tower from B is 12°.



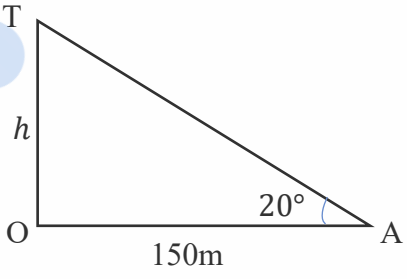

i. Show that the height of the tower is $x$ metres correct to 3 significant figures [1 mark]

ii. Find how far Ben is from the bottom of the tower, giving your answer correct to 3 significant figures [1 mark]

iii. What is the bearing of Ben from Alberto? Give your answer to the nearest minute [2 marks]

Solutions:

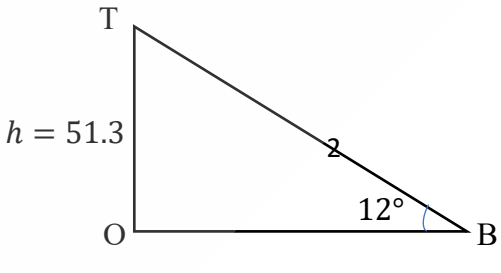
i. Considering $\Delta ATO$:




Since $\sin 20° = \frac{h}{150}$:

$$\therefore h = 150 \times \sin 20°$$
$$\approx 51.3m$$

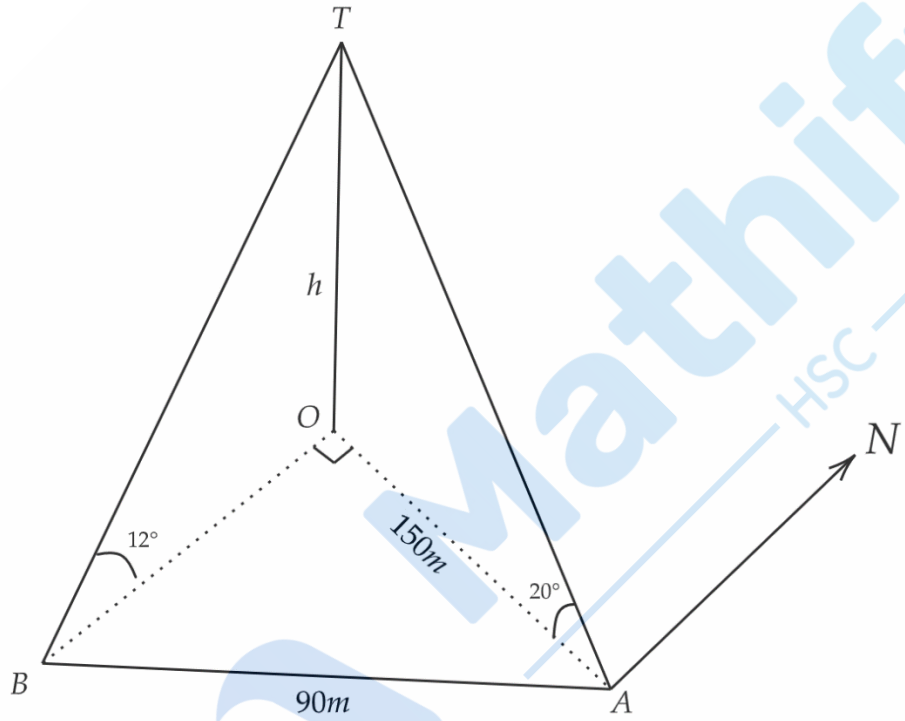
ii. Now knowing that $h = 51.3$, considering $\Delta BTO$:



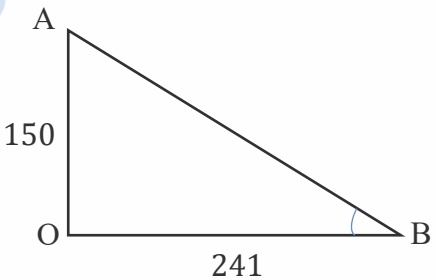
Since $\tan 12° = \frac{51.3}{BO}$:

$$\therefore BO = \frac{51.3}{\tan 12°}$$
$$\approx 241m$$

iii. Drawing line AN to represent the North direction on the diagram:




Now consider $\Delta\, ABO$:




To find $\angle ABO$:

$$\tan \angle ABO = \frac{150}{241}$$
$$\therefore \angle ABO \approx 31°54'$$

Hence, since BO and AN are parallel lines:

$$\begin{aligned} \angle BAN &= 180° - \angle ABO \\ &= 180° - 31°54' \\ &= 148°6' \end{aligned}$$

Therefore, the bearing of point B from A will be:

$$360° - 148°6 = 211°54'\ T$$