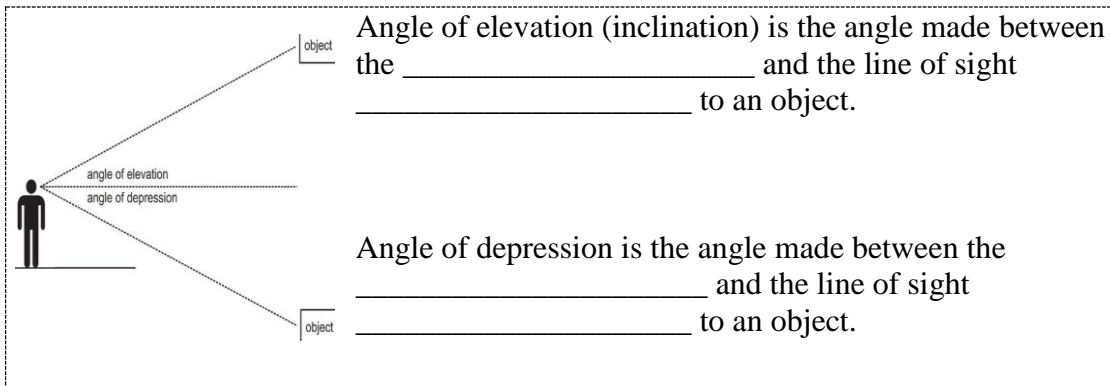


ANGLES OF ELEVATION & DEPRESSION



KEY WORDS

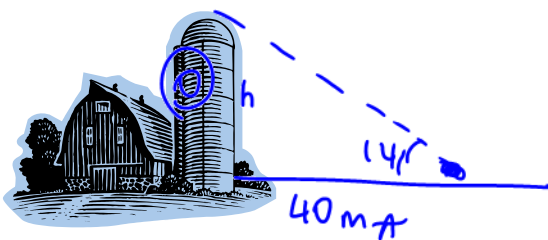
- Horizontal line
- Upward
- Horizontal line
- Downward
- Identify, angle, side
- Model, right
- Angle
- Write, trig
- Known
- Therefore

APPLICATION PROBLEMS

Steps to solving problems using trigonometric ratios

- 1) _____ what needs to be calculated (_____ or _____)
- 2) _____ the problem with a _____ triangle (draw a picture)
- 3) Label the relevant sides associated with the _____
- 4) _____ an equation using the _____ ratios
- 5) Substitute _____ values
- 6) Solve for the unknown measure, and write _____ statement.

Example 1: While walking to school you pass a barn with a silo. Looking up to the top of the silo you estimate the angle of elevation to be about 14° . You continue walking and find that you were 40 m from the silo. Using this information and our knowledge of trigonometric ratios, calculate the height of the silo. (10m)



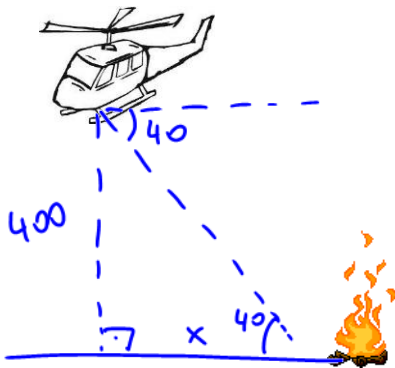
$$\tan 14 = \frac{h}{40}$$

$$h = 40 \cdot \tan 14$$

$$h = 10 \text{ m}$$

\therefore The silo is 10m tall

Example 2: A helicopter sights a campfire at an angle of 40° from the horizontal. The helicopter is hovering 400 m above the ground. What is the horizontal distance between the helicopter and the campfire? (476.7m)



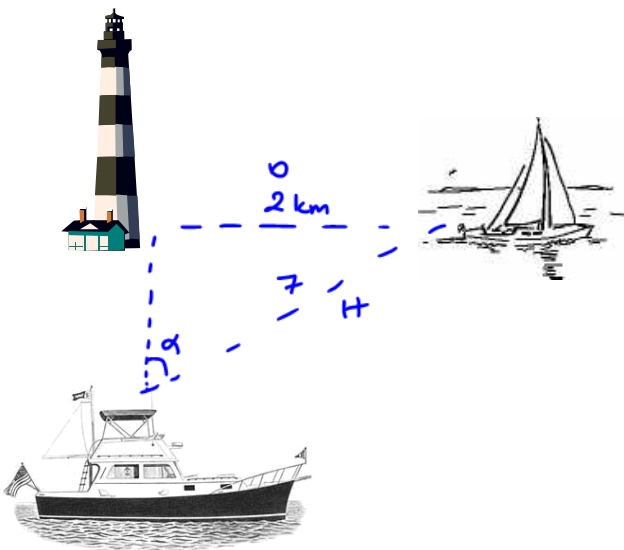
$$\tan 40 = \frac{400}{x}$$

$$x = \frac{400}{\tan 40}$$

$$x \approx 476.7 \text{ m}$$

\therefore The horizontal distance between the chopper and campfire is 476.7m.

Example 3: A sailboat that is 2 km due East of a lighthouse sends a signal to the lighthouse that it is in distress. The lighthouse quickly signals the coast guard that is due South of the lighthouse and 7 km Southwest of the sailboat. What heading from due north should the coast guard take in order to intercept the troubled sailboat? (16.6°)



$$\sin d = \frac{2}{7}$$

$$\sin^{-1}\left(\frac{2}{7}\right) = d$$

$$d = 16.6^\circ \text{ NE}$$

\therefore The coastguard should head 16.6° NE to intercept the sailboat

Example 4: Safety by-laws state that for a ladder to be stable, the angle the base of the ladder makes with the ground should be between 70° and 80° . A safety inspector at a construction site notices a painter on a 10 m ladder that is leaning against a wall. The base of the ladder is 1.5 m away from the wall. Does the inspector have cause to be concerned? Explain. (81.4°)



$$\cos \alpha = \frac{1.5}{10}$$

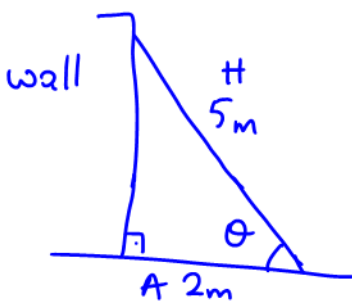
$$\cos^{-1}\left(\frac{1.5}{10}\right) = \alpha$$

$$\alpha \approx 81.4$$

\therefore Yes, the inspector has cause to be concerned because the angle is greater than 80° .

Primary Trigonometry Ratio Application Practice

- 1) A 5-m ladder is resting against a wall. The base of the ladder is 2 m along the ground from the base of the wall. What angle does the base of the ladder make with the ground? Express your answer to the nearest tenth of a degree.



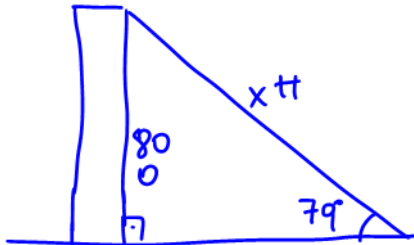
$$\cos \theta = \frac{2}{5}$$

$$\cos^{-1}\left(\frac{2}{5}\right) = \theta$$

$$\theta = 66.4^\circ$$

\therefore The angle between the ladder and the ground is 66.4°

- 2) An 80-m tower is supported by a guy wire attached to the top of the tower. If the wire forms an angle of elevation of 79° , how long is it? Express your answer to the nearest tenth of a metre.



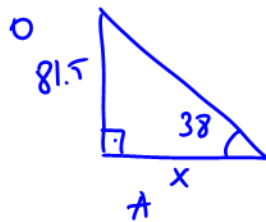
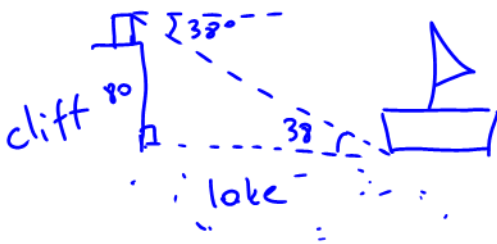
$$\sin 79^\circ = \frac{80}{x}$$

$$x = \frac{80}{\sin 79^\circ}$$

$$x = 81.5$$

\therefore The guy wire is 81.5 m long.

- 3) The highest point along a cliff is 80 m above the lakeshore. A surveyor stands on the top of the cliff, looking through a 1.5 m tall transit instrument. He spots a boat out on the lake, at an angle of depression of 38° . How far, to the nearest tenth of a metre, is it from the boat to the base of the cliff?



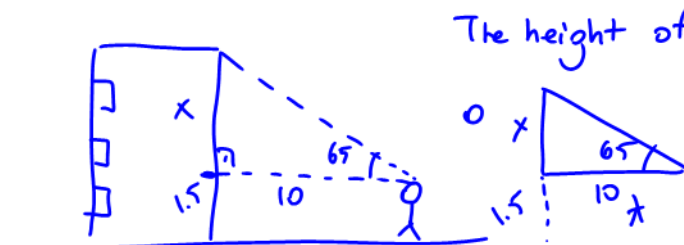
$$\tan 38^\circ = \frac{81.5}{x}$$

$$x = \frac{81.5}{\tan 38}$$

$$x = 104.3 \text{ m}$$

\therefore The boat is 104.3 m away.

- 4) Michael stands 10.0 m from the base of a building. He measures the angle of elevation to the top of the building to be 65° . Michael's measurement was made from 1.5 m above the ground. Determine the height of the building to the nearest metre.



The height of the building is $x + 1.5$

$$\tan 65 = \frac{x}{10}$$

$$x = 10 \tan 65$$

$$x = 21.4$$

\therefore The height is $21.4 + 1.5$
 $22.9 \approx 23 \text{ m}$

5) Two buildings are 60 m apart. The angle of depression from the top of the taller building to the top of the shorter building is 15° . The height of the shorter building is 30.4 m. What is the height of taller building? Express your answer to the nearest tenth of a metre.

6) From the top of a 150 m high cliff, the angles of depression of two boats on the water are 20° and 25° . How far apart are the boats?

7) Two buildings are 20 m apart. The angle from the top of the shorter building to the top of the taller building is 20° . The angle from the top of the shorter building to the base of the taller building is 45° . What is the height of the taller building?

8) The CN Tower is 553.33 m high. Lina looks up at the top of the tower at a 15° angle of elevation. She calculates the distance, d , from the base of the tower as follows:

$$\frac{d}{553.33} = \tan 15^\circ$$
$$d = 553.33 \times \tan 15^\circ$$
$$d \cong 149$$

Explain why Lina's solution is incorrect.
Write a correct solution