

# WORD PROBLEMS USING TRIGONOMETRY

## Learning Goal

- Practice drawing triangles to represent real life situations
- Solve using SohCahToa

### The Primary Trigonometric Ratios - Word Problems

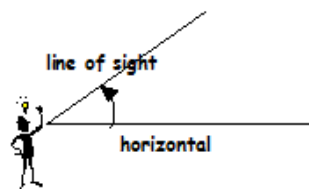
handout

#### A. Determining the measures of the sides and angles of right triangles using the primary ratios

When we want to measure the height of an "inaccessible" object like a tree, pole, building, or cliff, we can utilize the concepts of trigonometry.

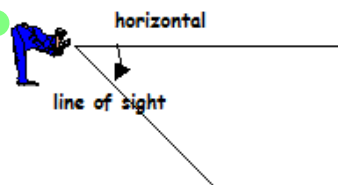
To solve such inaccessible heights or depths using trigonometry, the following angle definitions are necessary:

#### Angle of Elevation



The **Angle of Elevation** is the angle from the horizontal to your line of sight. (i.e. you are looking upwards at the object)

#### Angle of Depression



The **Angle of Depression** is the angle from the horizontal to the line of sight. (i.e. you are looking downwards at the object)

**SOLVING FOR AN UNKNOWN SIDE OR ANGLE**

Where Do I Begin...Where Does It End?

1. Sketch the triangle, if one has not been provided for you.
2. Label the given angle(s) and side(s). Include the variable for the unknown side or angle, where needed.
3. "Looking" from the given angle, label the opposite side, adjacent side, and hypotenuse.
4. Write the trig ratio (*sin*, *cos*, *tan*) that contains the given information and the unknown you want to find.
5. Substitute the given information, and solve for the unknown.

**Example 1**

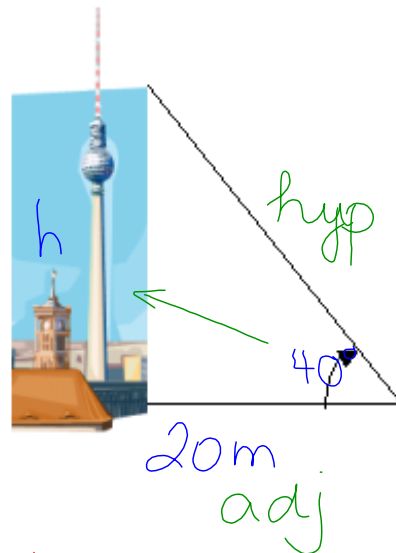
If your distance from the foot of the tower is 20 m and the angle of elevation is  $40^\circ$ , find the height of the tower.

$$\tan \theta = \frac{\text{opp}}{\text{adj}}$$

$$\tan 40^\circ = \frac{h}{20}$$

$$20 \cdot \tan 40^\circ = \frac{h}{\cancel{20}} (\cancel{20})$$

$$16.78 = h$$



$\therefore$  height is 16.78 m

**Example 2**

The angle of depression from the top of the Castle to boat is 25°. If the boat is 50 m from the base of the cliffs, how high is the top of the Castle in meters.



$$\tan \theta = \frac{\text{OPP}}{\text{adj}}$$

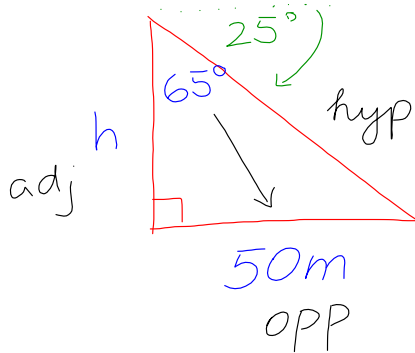
$$\tan 65^\circ = \frac{50}{h}$$

$$h \cdot \tan 65^\circ = 50$$

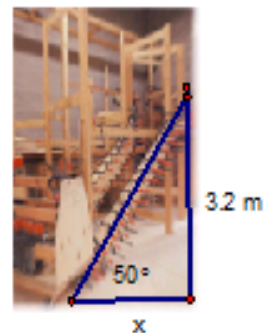
$$h = \frac{50}{\tan 65^\circ}$$

$$h = 23.31$$

∴ the height is 23.31 m

**On the Boards...**

The stringer, that supports the stairs, makes an angle of  $50^\circ$  with the floor. It reaches 3.2 m up the wall. How far is the base of the stringer from the wall?



$$\tan 50^\circ = \frac{3.2}{x}$$

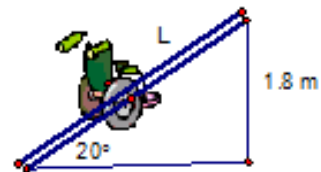
$$x \cdot \tan 50^\circ = 3.2$$

$$x = \frac{3.2}{\tan 50^\circ}$$

$$x = 2.685$$

## On the Boards...

A ramp has an angle of inclination of  $20^\circ$ . It has a vertical height of 1.8 m. What is the length,  $L$  metres, of the ramp?



$$\sin 20^\circ = \frac{1.8}{L}$$

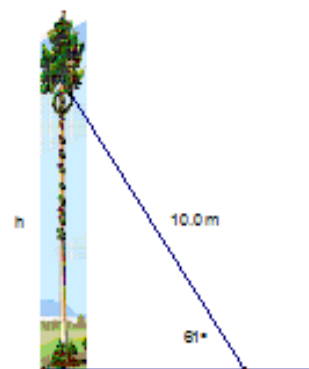
$$L \cdot \sin 20^\circ = 1.8$$

$$L = \frac{1.8}{\sin 20^\circ}$$

$$L = 5.26$$

## On the Boards...

A damaged tree is supported by a guy wire 10.0 m long. The wire makes an angle of  $61^\circ$  with the ground. Calculate the height at which the guy wire is attached to the tree.

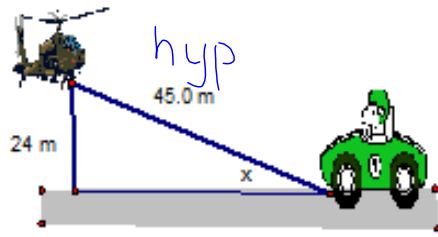


$$\sin 61^\circ = \frac{h}{10}$$

$$8.75 = h$$

**On the Boards...**

A helicopter is hovering above a road at an altitude of 24 m. At a certain time, the distance between the helicopter and a car on the road is 45.0 m. Calculate the angle of elevation of the helicopter from the car.



$$\sin \theta = \frac{\text{opp}}{\text{hyp}}$$

$$\sin x = \frac{24}{45}$$

$$\sin x = 0.53$$

$$\sin^{-1} \quad x = 32^\circ$$

# Homework

# Handout

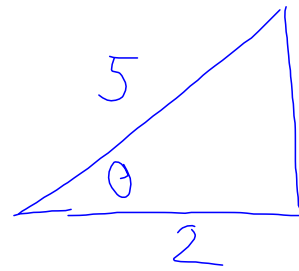
- 1) A 5-m ladder is resting against a wall. The base of the ladder is 2 m along the ground from the base of the wall. What angle does the base of the ladder make with the ground? Express your answer to the nearest tenth of a degree.

$$\cos \theta = \frac{\text{adj}}{\text{hyp}}$$

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

$$\cos \theta = 0.4$$

$$\theta = 66^\circ$$



- 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  $79^\circ$ , how long is it? Express your answer to the nearest tenth of a metre.

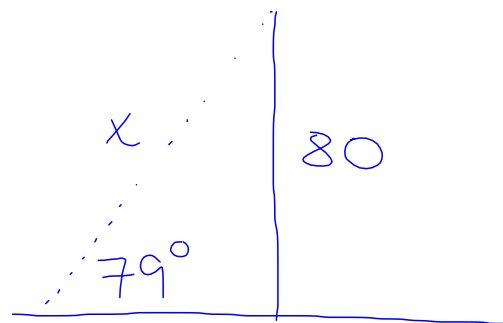
$$\sin \theta = \frac{\text{opp}}{\text{hyp}}$$

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

$$x \cdot \sin 79^\circ = 80$$

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

$$x = 81.5$$



- 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  $38^\circ$ . How far, to the nearest tenth of a metre, is it from the boat to the base of the cliff?

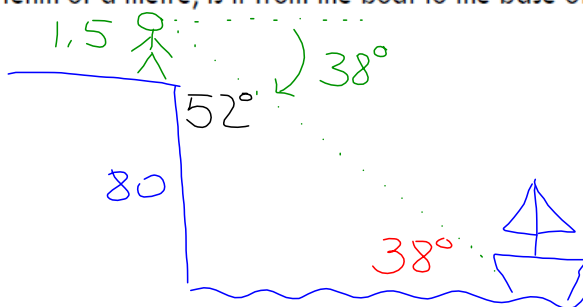
$$\tan 38^\circ = \frac{81.5}{x}$$

$$x \cdot \tan 38^\circ = 81.5$$

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

$$x = 104.3$$

$\therefore 104.3$  m away



$$\tan 52^\circ = \frac{x}{80}$$

$$80 \cdot \tan 52^\circ = x$$

$$104.3 = x$$

- 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  $65^\circ$ . Michael's measurement was made from 1.5 m above the ground. Determine the height of the building to the nearest metre.

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

$$10 \cdot \tan 65^\circ = x$$

$$21.44 = x$$

total height is  
 $21.44 + 1.5$   
 $= 22.94$

$$\therefore 22.94 \text{ m}$$

