

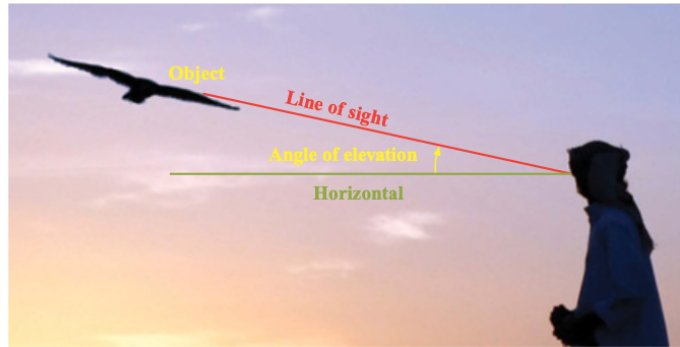
Worded problems using trigonometry

WALT apply the angle of elevation and the angle of depression to solve trig problems
 Success Criteria I know my trig ratios, I can draw a diagram and determine the sides and the ratio.

[Watch the video](#)

[How to make and use a clinometer](#)

The **angle of elevation** of an object from an observer is the angle between the horizontal and the line of sight *up* to the object.



The **angle of depression** of an object from an observer is the angle between the horizontal and the line of sight *down* to the object.



EXAMPLE 1

The angle of elevation of the top of a flagpole, as observed from a point 15 m from its base, is 63° . Draw a diagram and find the height of the flagpole.

Solve	Think	Apply
$\tan 63^\circ = \frac{x}{15}$ $x = 15 \tan 63^\circ$ ≈ 29.4 <p>The flagpole is about 29 m high.</p>		<p>Elevation means looking upwards. The angle is at ground level.</p>

EXAMPLE 2

The angle of depression from the top of a vertical cliff, 150 m above sea level, to a boat below is 50° . Draw a diagram and find the distance of the boat from the base of the cliff.

We assume that the angle between the ground (or sea) and a building (or cliff) is always 90° .



Solve	Think	Apply
$\tan 40^\circ = \frac{x}{150}$ $x = 150 \tan 40^\circ$ ≈ 125.86 <p>The boat is about 126 m out from the base of the cliff.</p>		<p>Depression means looking downwards. Either subtract from 90° to find the angle in the triangle or use parallel line properties to label the angle at the bottom as equal.</p>

EXAMPLE 3

A kite is flying at a height of 45 m above the ground at the end of a string of length 70 m. Find, to the nearest minute, the angle of elevation from the ground to the string.

Solve	Think	Apply
$\sin \theta = \frac{45}{70}$ $\therefore \theta = 40.005\dots^\circ$ $= 40^\circ 0' 19''$ <p>The angle of elevation is $40^\circ 0'$.</p>		<p>Determine the sides required and select the correct ratio.</p>

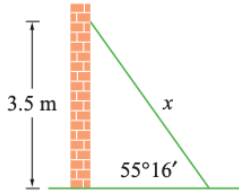
Draw a diagram for each of the following and find the unknown. For questions 1 to 5 give your answer to the nearest metre where necessary.

- The angle of elevation of the top of a flagpole from the ground, as observed from a point 50 m from its base, is 38° . Find the height of the flagpole.
- The angle of depression from the top of a cliff, 100 m above sea level, to a boat is 65° . Find the distance of the boat from the base of the cliff.
- From a point 35 m from the base of a vertical cliff, the angle of elevation to the top of the cliff is 72° . Find the height of the cliff.
- When looking down from the top of a building to a person standing in a park 150 m from the base of the building, the angle of depression is 28° . Find the height of the building.
- The top of a tree, when viewed 40 m from the base of the tree, has an angle of elevation of 37° . Find the height of the tree.
- A person is standing 200 m from a vertical cliff 265 m high. Find the angle of elevation to the top of the cliff to the nearest minute.

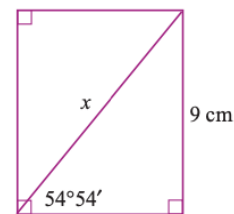


EXAMPLE 4

A ladder leaning against a vertical wall reaches 3.5 m up the wall and makes an angle of $55^{\circ}16'$ with the ground. Determine the length of the ladder.

Solve	Think	Apply
$\sin 55^{\circ}16' = \frac{3.5}{x}$ $\therefore x \sin 55^{\circ}16' = 3.5$ $x = \frac{3.5}{\sin 55^{\circ}16'}$ $= 4.25\dots$ ≈ 4.3 <p>The ladder is 4.3 m long.</p>	<p>Use the opposite side and hypotenuse.</p>  <p>3.5 \div \sin 55 DMS 16 DMS $=$</p>	<p>Identify the sides required and select the correct ratio.</p>

- 7 A rectangle has a longer side of 9 cm. The angle between the diagonal and the shorter side is $54^{\circ}54'$. Find the length of the diagonal.



- 8 A seesaw is 6.3 m long. When one end is resting on the ground it makes an angle of $23^{\circ}35'$ with the ground. Find the height of the other end above ground level.



- 9 A rally driver travels 210 km on a bearing of 145°T . How far east of the starting position would the rally driver be now?



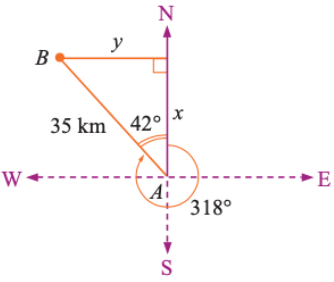
- 10 An isosceles triangle has height 13 cm and base 20 cm. Find the value of the base angles to the nearest minute.
- 11 A right-angled triangle has non-hypotenuse sides of length 12 cm and 17 cm. Find the value of the other angles in degrees and minutes.
- 12 An isosceles triangle has a base of length 12 cm and a vertical angle of 70° . Find the lengths of the equal sides.



Extension

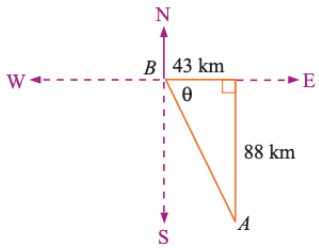
Example 5

A ship sails 35 km from a port A on a bearing of 318°T to a buoy B . Find how far the ship is north and west of A .

Solve	Think	Apply
$\cos 42^\circ = \frac{\text{adjacent}}{\text{hypotenuse}}$ $= \frac{x}{35}$ $\therefore x = 35 \cos 42^\circ$ $\approx 26.01 \text{ (2 decimal places)}$ <p>The ship is 26 km north of A.</p> $\sin 42^\circ = \frac{\text{opposite}}{\text{hypotenuse}}$ $= \frac{y}{35}$ $\therefore y = 35 \sin 42^\circ$ $\approx 23.42 \text{ (2 decimal places)}$ <p>The ship is 23 km west of A.</p>	<p>$\angle NAB = 360^\circ - 318^\circ = 42^\circ$ Let x be the distance north and y be the distance west.</p> 	<p>Always draw a diagram with north in the vertical direction of the page. Locate all the other bearings or distances.</p>

EXAMPLE 6

Town A is 43 km east and 88 km south of town B . Find the bearing of A from B .

Solve	Think	Apply
$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$ $= \frac{88}{43}$ $\therefore \theta \approx 64^\circ$ <p>The bearing of A from B is $90 + 64 = 154^\circ\text{T}$.</p>		<p>Draw a diagram showing all the information, then isolate the right-angled triangle.</p>

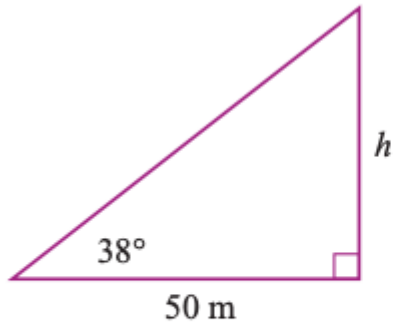
- 13 A ship sails 58 km from a port A on a bearing of 262°T to a buoy B . Find how far the ship is west and south of A .
- 14 A ship sails 83 km from a port O on a bearing of 131° to another boat X . Find how far the ship is east and south of O .
- 15 A ship sails from a port P . It travels 55 km west then 30 km south to an atoll A . Find the bearing of A from P .
- 16 Town X is 185 km west and 260 km north of town Y .
 - a Find the bearing of Y from X .
 - b Find the bearing of X from Y .
- 17 A plane flies 800 km north and 1250 km west. Find the bearing and distance of the plane from its starting point.
- 18 A is 40 km due north of B and C is 100 km due east of B . Find the distance and bearing of C from A .
- 19 A kayaker paddles due west for 1.5 km, then turns due south and covers a further 800 m. How far and in what direction to the nearest degree must she travel to return to her starting point?



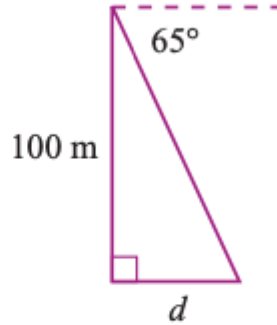
Remember Pythagoras. !

Check your answers

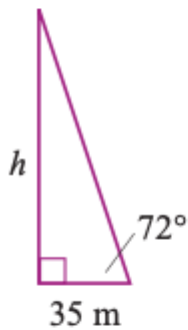
1 $h = 39 \text{ m}$



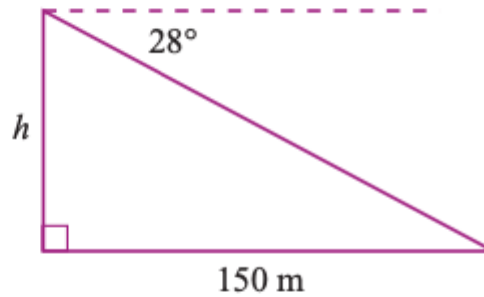
2 $d = 47 \text{ m}$



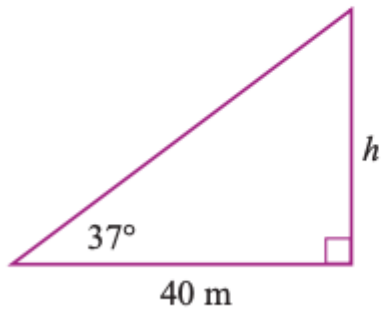
3 $h = 108 \text{ m}$



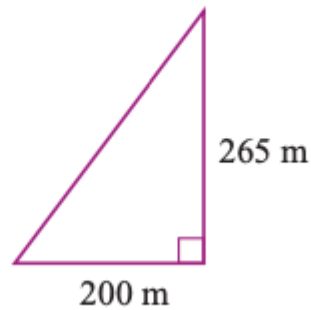
4 $h = 80 \text{ m}$



5 $h = 30 \text{ m}$



6 $52^\circ 27'$



7 11 cm

9 120 km

11 $35^\circ 13'$ and $54^\circ 47'$

13 $57 \text{ km W}, 8 \text{ km S}$

15 241°T

16 a 145°T

17 $302^\circ 37' \text{T}, 1484 \text{ km}$

19 $1.7 \text{ km}, 062^\circ \text{T}$

8 2.5 m

10 $52^\circ 26'$

12 10.5 cm

14 $63 \text{ km E}, 54 \text{ km S}$

b 325°T

18 $111^\circ 48' \text{T}, 108 \text{ km}$