MATHEMATICS · GRADES 10-12

Angles of elevation and depression

Difficulty level: Advanced

Mathematics: Grades 10-12

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Overview of the concept

This is how you work out the height of a tree, a building, or a cliff by looking up at its top from the ground. The angle your eyes make with the flat ground is all you need, plus how far away you are standing. It works the other way too, like working out how far away a boat is when you look down at it from a lighthouse.

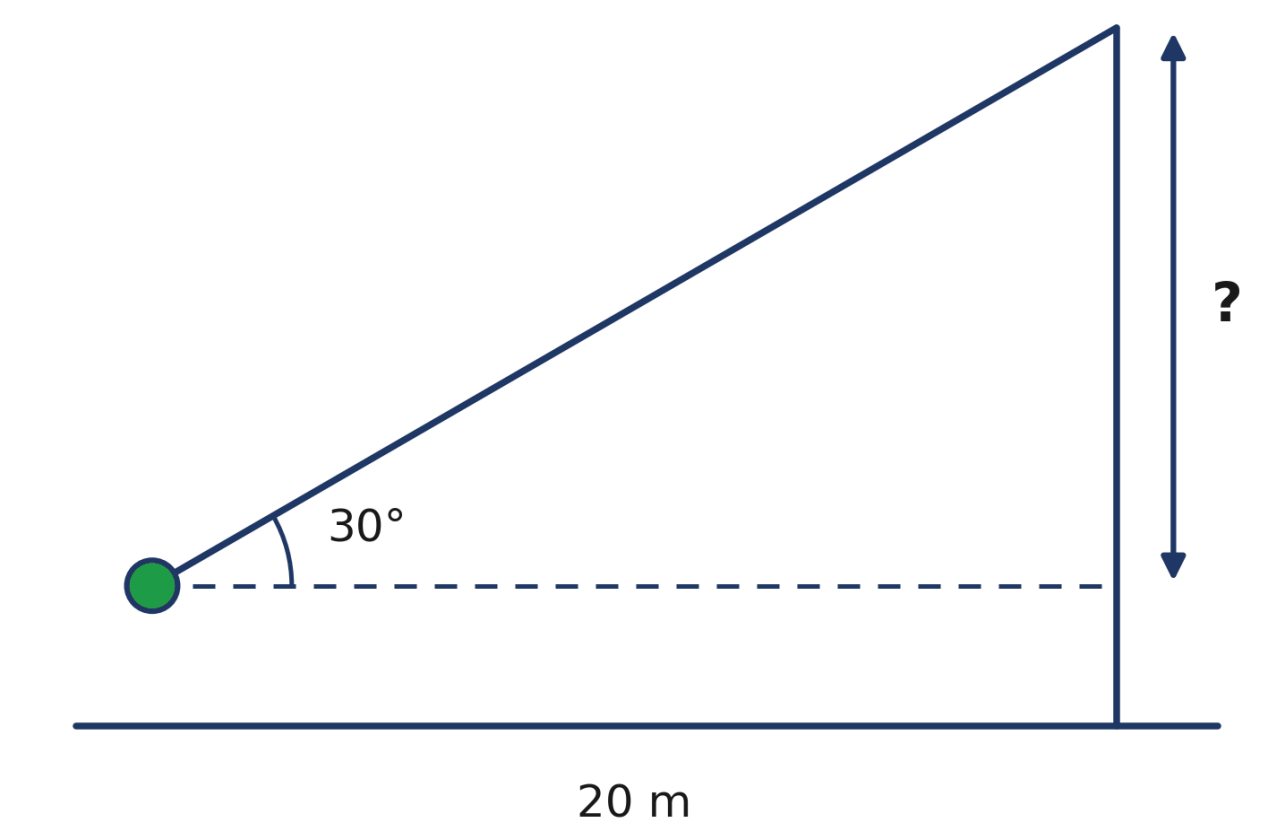


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Worked examples

EXAMPLE 1

Q You look up at the top of a building. The angle of elevation is 30 degrees and you stand 20 metres away. Find the height above eye level.



SOLUTION

Tan of the elevation angle = $\frac{\text{height}}{\text{distance}}$, so tan 30 degrees = $\frac{\text{height}}{20}$

Tan 30 degrees is about 0.577, so height = 20 × 0.577

Height above eye level is about 11.55 metres.

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EXAMPLE 2

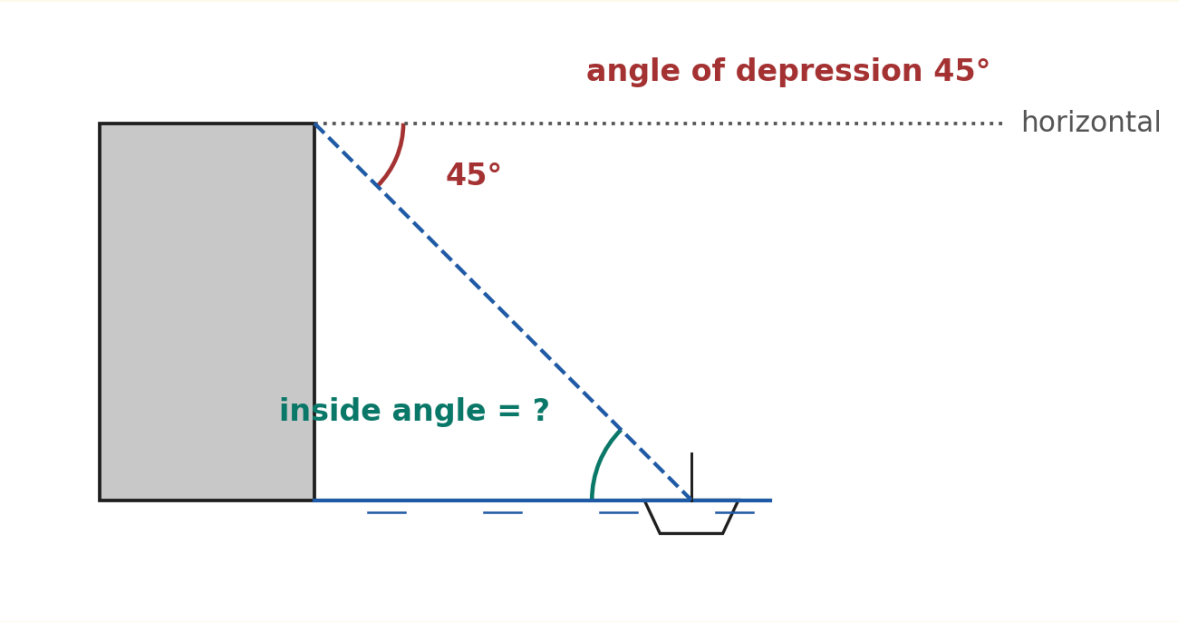
Q From a cliff top, the angle of depression to a boat is 45 degrees. What is the matching angle inside the triangle?

SOLUTION

The angle of depression is measured down from the horizontal.

Alternate interior angles make the angle inside the triangle equal to it.

The inside angle is also 45 degrees.



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Practice questions

1. A surveyor stands 24 metres from a building and looks up at its top. The angle of elevation is 35 degrees. Find the height of the building above eye level, to two decimal places.

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2. From the top of a 60 metre lighthouse, the angle of depression to a boat is 25 degrees. How far is the boat from the base of the lighthouse, to two decimal places?

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3. A kite is 25 metres above eye level and 30 metres away horizontally from the person holding the string. What is the angle of elevation to the kite, to the nearest degree?

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4 A hiker looks up at the top of a tree at an angle of elevation of 50 degrees. The tree is 14.30 metres above eye level. How far is the hiker from the base of the tree, to two decimal places?

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5 A drone hovers above a field and its camera looks down at a car. The angle of depression is 55 degrees. What is the matching angle inside the triangle formed by the drone, the car, and the point on the ground below the drone?

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6 From a cliff 45 metres above the sea, a walker sees a boat 77.94 metres from the base of the cliff. What is the angle of depression to the boat, to the nearest degree?

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7 A drone hovers above a field. Its camera looks down at a car 40 metres away horizontally at an angle of depression of 35 degrees. How high is the drone above the ground, to two decimal places?

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8 A lifeguard on a tower looks down at a swimmer. Is the angle of depression equal to the angle inside the triangle at the swimmer? Explain why.

- **A** No, the angle of depression is always bigger than the angle inside the triangle
- **B** Yes, they are corresponding angles on the same side
- **C** Yes, they are alternate interior angles between parallel horizontal lines
- **D** No, the angle inside the triangle is always 90 degrees

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9 The angle of elevation to the top of a tower is 28 degrees from 40 metres away, and the tower is 21.27 metres above eye level. A second observer stands 20 metres from the tower. What is the angle of elevation from the second observer, to the nearest degree?

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10 **Two observers look at the top of the same flagpole. One stands 18 metres away and sees an angle of elevation of 45 degrees. The other stands further away from the flagpole. Is the second observer's angle of elevation bigger or smaller than 45 degrees?**

A Bigger, because the flagpole looks taller from further away

B Smaller, because the angle gets smaller as you move further away

C The same, because the flagpole does not change height

D Bigger, because the distance is larger

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ANSWER KEY

1. 16.80 metres

2. 128.67 metres

3. 40 degrees

4. 12.00 metres

5. 55 degrees

6. 30 degrees

7. 28.01 metres

8. Yes, they are alternate interior angles between parallel horizontal lines

9. 47 degrees

10. Smaller, because the angle gets smaller as you move further away

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