

Heights and Distances — Class 10 Maths

NCERT Chapter 9, Section 9.2 (Exercise 9.1) · CBSE Unit V, Trigonometry — 12 of 80 marks

$$h = d \times \tan \theta \quad \cdot \quad d = h / \tan \theta \quad \cdot \quad h = L \times \sin \theta$$

One picture behind every question

A vertical object stands at right angles to level ground, so the situation is always a **right-angled triangle**. The **height** is opposite the angle, the **horizontal distance** is adjacent to it, and the **line of sight** is the hypotenuse.

Angle of elevation — measured up from the horizontal to the line of sight.

Angle of depression — measured down from the horizontal to the line of sight.

Equal-angle rule — a depression angle at the top equals the elevation angle at the bottom (alternate angles), so copy it down before solving.

Which ratio? Match the two sides you have

The two sides involved	Ratio	Rearranged
Height and ground distance	$\tan \theta = \text{opposite} / \text{adjacent}$	$h = d \tan \theta, d = h / \tan \theta$
Height and slant length	$\sin \theta = \text{opposite} / \text{hypotenuse}$	$h = L \sin \theta, L = h / \sin \theta$
Ground distance and slant length	$\cos \theta = \text{adjacent} / \text{hypotenuse}$	$d = L \cos \theta, L = d / \cos \theta$

Slant length means a ladder, rope, kite string or the broken part of a tree — that is the only signal to leave $\tan$ behind.

The 4-step method, and the values it ends in

1. Draw and label the right triangle — the figure carries method marks on its own. **2. Mark the angle** at the correct vertex, copying a depression angle down. **3. Choose the ratio** that links the side you have to the side you want. **4. Solve, then adjust** — if the angle was taken from the eyes, **add the observer's height**.

θ	30°	45°	60°
$\sin \theta$	$1/2$	$1/\sqrt{2}$	$\sqrt{3}/2$
$\cos \theta$	$\sqrt{3}/2$	$1/\sqrt{2}$	$1/2$
$\tan \theta$	$1/\sqrt{3}$	1	$\sqrt{3}$

What NCERT and CBSE actually ask for

Source: NCERT Chapter 9, *Some Applications of Trigonometry*. Section 9.1 is the introduction; **Section 9.2, "Heights and Distances"**, holds all 7 worked examples and the chapter's only exercise. The topic is Section 9.2 but the exercise is **Exercise 9.1**, 16 questions — there is no Exercise 9.2.

Scope written into the syllabus: problems "should not involve more than two right triangles"; and angles of elevation or depression are "only 30° , 45° and 60° ". A third triangle or an odd angle means you have taken a wrong turn.

Reading the words into the figure

The question says	What it means in your figure
"from a point on the ground"	Angle sits at ground level — nothing to add
"from her eyes", "from the top of"	Triangle starts there — add that height back
"angle of depression of a boat"	Copy it down as an equal angle of elevation
"the kite string is 100 m"	That is the hypotenuse — use $\sin$ or $\cos$

Key takeaways

- Every problem is one right triangle: height opposite, ground distance adjacent, line of sight hypotenuse.
- **tan** for height with ground distance; **sin** or **cos** the moment a slant length appears.
- Copy a **depression** angle down as the equal angle of elevation before you solve.
- **Add the observer's height** when the angle was measured from the eyes, not the ground.
- NCERT Ch. 9 §9.2 / Exercise 9.1; CBSE Unit V, 12 of 80 marks; angles only 30° , 45° , 60° .

Three questions that cover the whole chapter

Write the figure first. The diagram earns marks even when the arithmetic slips.

THE EYE-LEVEL TRAP

An observer 1.5 m tall stands 28.5 m from a chimney. The angle of elevation of the top, from her eyes, is 45° . Find the height of the chimney.

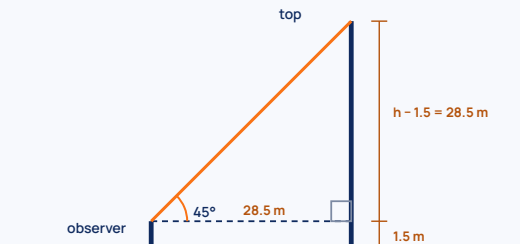


Figure not to scale – the observer's height is drawn larger so the two parts of the chimney are visible.

Step 1–2. The right triangle starts at her **eyes**, not her feet, so its vertical side is the height *above eye level*, and 28.5 m is the adjacent side.

Step 3. Opposite and adjacent $\rightarrow \tan$. $\tan 45^\circ = (h - 1.5) / 28.5$

Step 4. $h - 1.5 = 28.5 \times 1 = 28.5$, so **$h = 28.5 + 1.5 = 30$ m.**

Check: at 45° the two sides of the triangle must be equal – 28.5 and 28.5. ✓ The 1.5 m is added *after* the triangle is solved, never inside it.

WHEN TAN IS NOT ENOUGH

A tree breaks and the top touches the ground 8 m from the foot, making 30° with the ground. Find the original height.

The broken part is a slant length, so this question needs two ratios, not one.

Standing part = $8 \tan 30^\circ = 8/\sqrt{3} = 8\sqrt{3}/3 \approx 4.62$ m

Broken part (hypotenuse) = $8 / \cos 30^\circ = 16/\sqrt{3} = 16\sqrt{3}/3 \approx 9.24$ m

Original height = $8\sqrt{3}/3 + 16\sqrt{3}/3 = 24/\sqrt{3} = 8\sqrt{3} \approx 13.86$ m

Check: the two parts are in the ratio 1 : 2, which is what 30° forces (the side opposite 30° is half the hypotenuse). ✓

TWO TRIANGLES – THE SYLLABUS MAXIMUM

A 20 m building and a tower stand on level ground. From the foot of the tower the elevation of the top of the building is 30° ; from the foot of the building the elevation of the top of the tower is 60° . Find the height of the tower.

The two triangles share the ground distance d – find it from the easy one, then use it in the other.

Triangle 1: $\tan 30^\circ = 20 / d \rightarrow d = 20\sqrt{3} \approx 34.64$ m

Triangle 2: $\tan 60^\circ = H / d \rightarrow H = 20\sqrt{3} \times \sqrt{3} = 60$ m

Check: the shared distance is the whole method. Solve the triangle with two known quantities first, every time.

WHERE THE MARKS ACTUALLY GO

No figure drawn, so opposite and adjacent get swapped – the marks for the set-up are gone before any working starts. · The observer's height is left out, or worse, added inside the triangle. · A depression angle is used where it stands instead of being copied down. · $\tan 30^\circ$ written as $\sqrt{3}$ – it is $1/\sqrt{3}$. · The final line has no unit, or a surd is decimalised when the question wanted the exact value.

NOW TRY THIS ONE

From the top of a 60 m lighthouse the angles of depression of two ships on the same side are 45° and 30° . How far apart are the ships? (Copy both angles down; $d_1 = 60$, $d_2 = 60\sqrt{3}$, so the gap is $60(\sqrt{3} - 1) \approx 43.92$ m.)

Turn the method into marks on examfront

- **Chapter 1 is free** – start practising today, no payment needed.
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- **Anytime tests** whenever you have twenty spare minutes.
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