Collegedunia NCERT Notes

The Ultimate NCERT Revision Guide for Class 10 Maths (Mathematics)

Chapter 9: Some Applications of Trigonometry

What this chapter covers: how we use the trigonometric ratios from the previous chapter to measure things we cannot reach, like the height of a tower, the width of a river, or the distance of a ship. You will meet three key ideas: the *line of sight*, the *angle of elevation*, and the *angle of depression*. Then you will learn a clean step-by-step method to turn a word problem into a right triangle and solve it. Everything here follows the rationalised NCERT 2026-27 syllabus and the CBSE board pattern.

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Also see for this chapter: NCERT Solutions | Formula Sheet | Exemplar Solutions

1 Line of Sight, Elevation, Depression

In Chapter 8 you learned the six trigonometric ratios of an acute angle in a right triangle. This chapter shows where those ratios are actually used. We often need to find a height or a distance that is hard to measure directly, like the height of a tall building, a hill, or a chimney. Trigonometry lets us find such values using just an angle and one known distance. This is why the chapter is called *Some Applications of Trigonometry*.

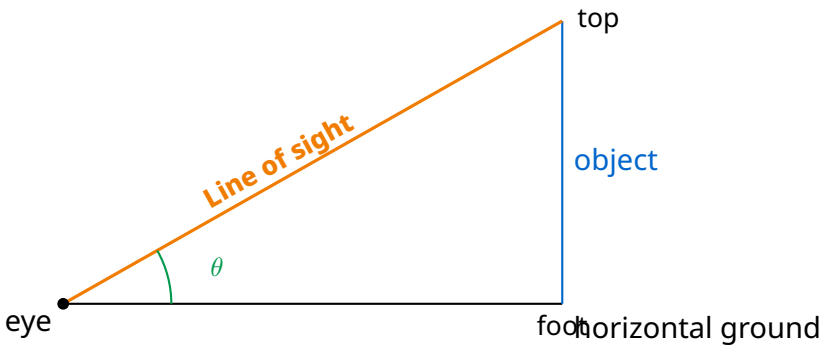
1.1 The line of sight

When you look at an object, an imaginary straight line runs from your eye to the object. This line is called the **line of sight**.

Line of Sight

The **line of sight** is the straight line drawn from the eye of an observer to the point on the object being viewed. Every height-and-distance problem in this chapter is built around this single line.

The line of sight, the horizontal level through the observer's eye, and the vertical object together form a **right triangle**. That right triangle is the engine that drives the whole chapter.



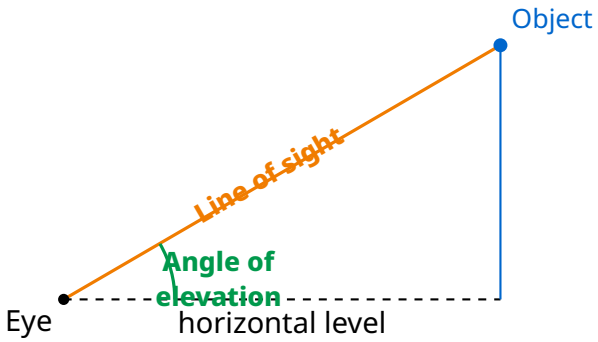
1.2 Angle of elevation

When the object is *above* the horizontal level of your eye, you have to raise your head to look at it. The angle between the line of sight and the horizontal is then called the **angle of elevation**.

Angle of Elevation

The **angle of elevation** of a point is the angle made by the line of sight with the horizontal when the point is *above* the horizontal level (you raise your head).

- It is measured from the horizontal *upwards* to the line of sight.
- The higher you must look, the larger this angle becomes.



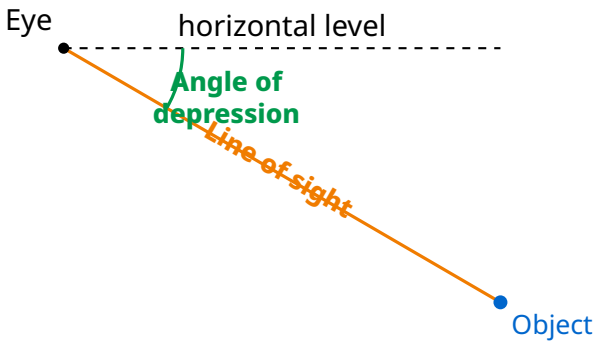
1.3 Angle of depression

When the object is *below* the horizontal level of your eye, you lower your head to look at it. The angle between the line of sight and the horizontal is then called the **angle of depression**.

Angle of Depression

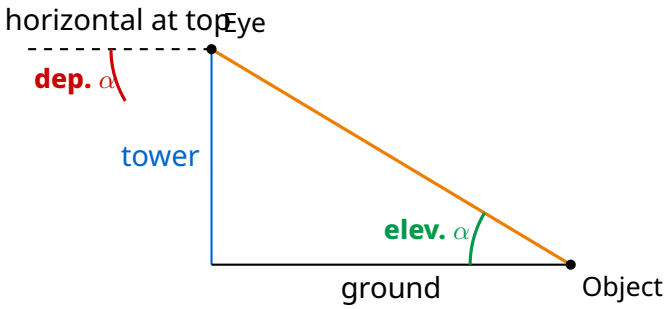
The **angle of depression** of a point is the angle made by the line of sight with the horizontal when the point is *below* the horizontal level (you lower your head).

- It is measured from the horizontal *downwards* to the line of sight.
- The observer is higher up; the object lies lower down.



Elevation and depression are equal (alternate angles)

If an observer at the top of a tower looks down at an object on the ground, the angle of depression of the object equals the angle of elevation of the observer as seen from the object. The horizontal at the top and the ground are parallel, so the line of sight is a transversal and the two angles are *alternate interior angles*.



Depression is measured from the horizontal, not the vertical

A very common slip is to mark the angle of depression from the *vertical* wall instead of from the *horizontal* line through the eye. Always draw the dashed horizontal line first, then measure the angle down from it. If you measure from the vertical you get the complement, and every answer goes wrong.

Where you meet these angles

A pilot landing a plane judges the runway by an angle of depression. A sur-

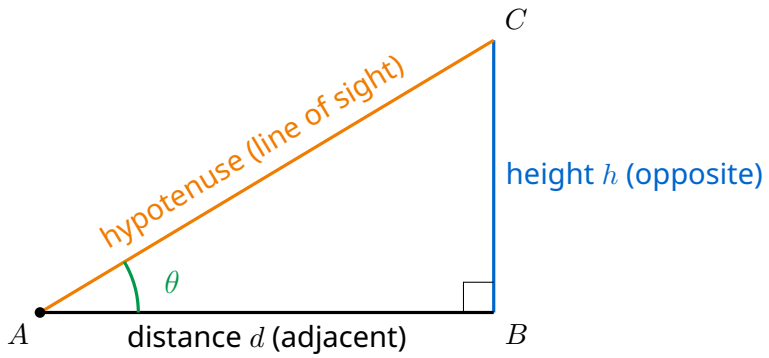
veyor measuring a hill uses an angle of elevation through a theodolite. Even your phone's level-app uses the same idea. The maths in this chapter is exactly what engineers, sailors, and architects use to measure the unreachable.

2 Setting Up a Heights Problem

Every problem in this chapter becomes easy once you draw the correct right triangle and pick the right ratio. This section gives a fixed method you can follow for any question.

2.1 The right triangle behind every problem

Look again at the standard picture below. The object stands vertically, the observer stands on the horizontal ground, and the line of sight closes the triangle. The vertical side is the *height* we usually want; the horizontal side is the *distance*; the slant side is the line of sight.



With the angle θ at the observer, the sides line up like this:

- the **opposite** side is the height h (the side facing θ),
- the **adjacent** side is the distance d (the side next to θ),
- the **hypotenuse** is the line of sight.

The three ratios you will use

For the angle θ in the right triangle above:

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}} = \frac{h}{d}, \qquad \sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}, \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}.$$

Here h is the height, d is the horizontal distance, and the hypotenuse is the line of sight. Choose the ratio that connects the side you *know* with the side you *want*.

2.2 Which ratio do I choose?

This is the one decision that solves the whole problem. Find the side you already know and the side you need, then pick the ratio that uses exactly those two.

You know	You want	Use this ratio
adjacent (distance)	opposite (height)	$\tan\theta = \frac{\text{opp}}{\text{adj}}$
opposite (height)	hypotenuse (sight line)	$\sin\theta = \frac{\text{opp}}{\text{hyp}}$
adjacent (distance)	hypotenuse (sight line)	$\cos\theta = \frac{\text{adj}}{\text{hyp}}$
opposite (height)	adjacent (distance)	$\tan\theta = \frac{\text{opp}}{\text{adj}}$

The two sides rule

Circle the two sides involved (one known, one unknown). The ratio that contains *both* of those sides is your ratio. Most board problems use $\tan\theta$, because height and ground distance are the two sides we deal with most.

2.3 Standard angle values to memorise

Almost every board question uses one of three angles: $30°$, $45°$, or $60°$. Knowing their exact values by heart saves time.

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

A neat way to remember sine

Write $0, 1, 2, 3, 4$ under $0°, 30°, 45°, 60°, 90°$. Take the square root of each and divide by 2:

$$\sin\theta = \frac{\sqrt{0}}{2}, \frac{\sqrt{1}}{2}, \frac{\sqrt{2}}{2}, \frac{\sqrt{3}}{2}, \frac{\sqrt{4}}{2}.$$

For cosine, just read the same list *backwards*. This rebuilds the whole table in seconds.

2.4 The five-step method

Five steps for any height-and-distance question

1. **Draw** a clean diagram: a vertical object, a horizontal ground, and the line of sight.
2. **Mark** the right angle, the given angle, and every known length.
3. **Name** the side you want (call it h or x).
4. **Choose** the ratio that connects the known side with the unknown side.
5. **Solve**: write the ratio, substitute the values, then do the arithmetic.

Always draw first

Never try to solve a heights problem in your head. A correct, labelled diagram is half the marks in a board exam and stops almost every sign or side error.

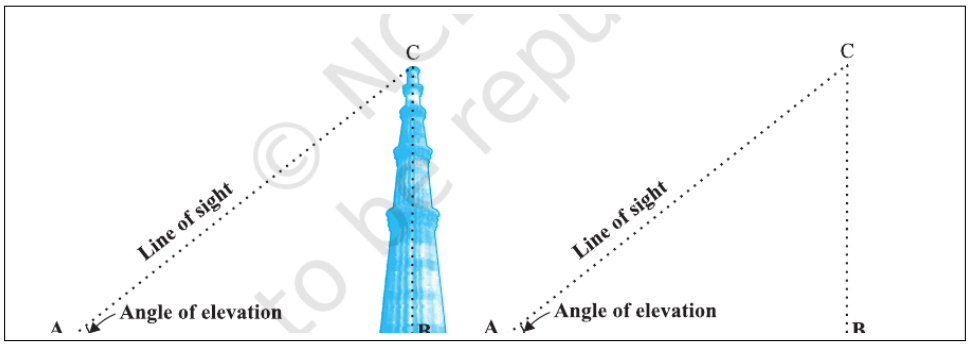


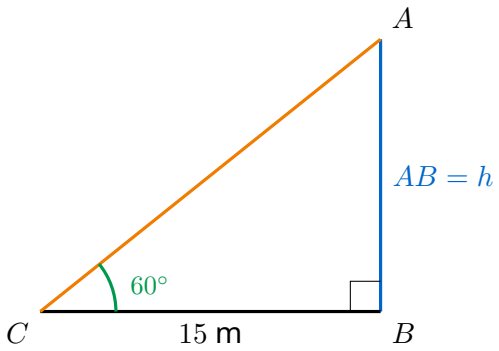
Fig. 9.1 (NCERT): line of sight, angle of elevation, and the right triangle that models a tower or minar.

3 Worked Examples: Elevation

Now we use the five-step method on the classic NCERT elevation problems. Watch how each line shows the formula, then the substitution, then the arithmetic, kept on separate lines.

3.1 Height of a tower from the ground

A tower stands vertically on the ground. From a point on the ground, 15 m away from the foot of the tower, the angle of elevation of the top is 60°. Find the height of the tower.



Solution. Let the height be $AB = h$. The known side is the distance $BC = 15$ m (adjacent), and we want the height AB (opposite). The ratio that links opposite and adjacent is tan.

$$\tan 60^\circ = AB/BC$$

$$\sqrt{3} = \frac{h}{15}$$

$$h = 15\sqrt{3}$$

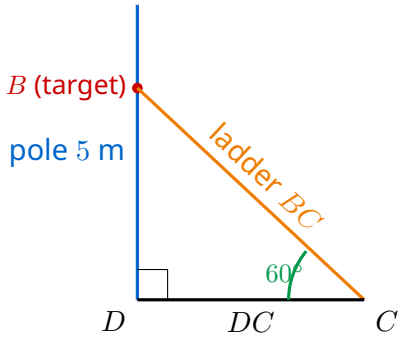
$$h = 15 \times 1.732$$

$$h = 25.98 \text{ m (approx.)}$$

So the height of the tower is $15\sqrt{3} \approx 25.98$ m.

3.2 Length of a ladder against a pole

An electrician must reach a point 1.3 m below the top of a 5 m pole to repair a fault. The ladder leans at 60° to the horizontal. Find the length of the ladder and how far from the foot of the pole she should place it. (Take $\sqrt{3} = 1.73$.)



Solution. The point B is 1.3 m below the top, so

$$BD = AD - AB = (5 - 1.3) = 3.7 \text{ m}.$$

Here $BD = 3.7$ m is the opposite side and BC (the ladder) is the hypotenuse, so

use sin.

$$\sin 60^\circ = BD/BC$$
$$\frac{\sqrt{3}}{2} = \frac{3.7}{BC}$$
$$BC = \frac{3.7 \times 2}{\sqrt{3}}$$
$$BC = \frac{7.4}{1.73}$$
$$BC = 4.28 \text{ m (approx.)}$$

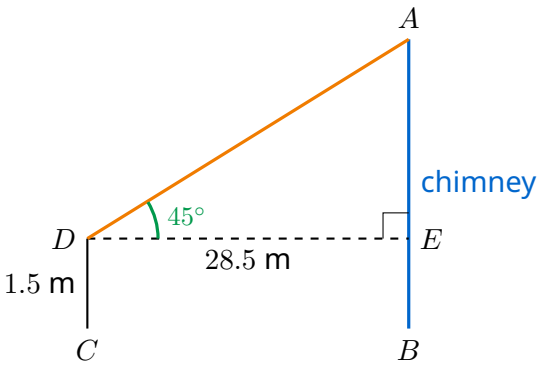
Now the foot of the ladder DC is the adjacent side, so use cot (or tan):

$$DC/BD = \cot 60^\circ = 1/\sqrt{3}$$
$$DC = \frac{3.7}{\sqrt{3}}$$
$$DC = \frac{3.7}{1.73}$$
$$DC = 2.14 \text{ m (approx.)}$$

So the ladder is about 4.28 m long and its foot is about 2.14 m from the pole.

3.3 Adding the observer's height: a chimney

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



Solution. Let AE be the part of the chimney above eye level. The horizontal $DE = CB = 28.5$ m. Use tan in triangle ADE:

$$\tan 45^\circ = AE/DE$$
$$1 = \frac{AE}{28.5}$$
$$AE = 28.5 \text{ m}$$

The full height adds the observer's height $BE = 1.5$ m:

$$AB = AE + BE$$
$$AB = 28.5 + 1.5$$
$$AB = 30 \text{ m}$$

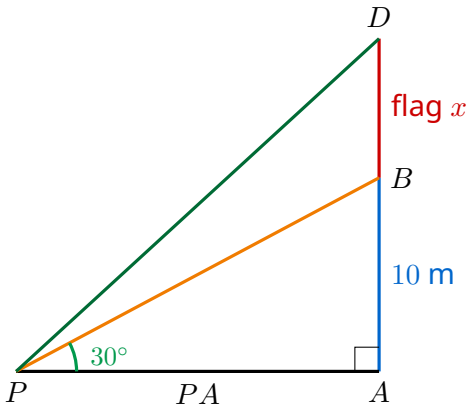
So the chimney is 30 m tall.

Do not forget the observer's height

When the angle is measured "from her eyes" or "from the eye level," the triangle gives only the part of the object *above eye level*. You must add the observer's own height to get the full height. Skipping this last addition is the single most common board-exam error in this chapter.

3.4 Two triangles: building and flagstaff

From a point P on the ground the angle of elevation of the top of a 10 m tall building is $30°$. A flag on top of the building makes an angle of elevation of $45°$ from P. Find the length of the flagstaff and the distance of the building from P. (Take $\sqrt{3} = 1.732$.)



Solution. First, triangle PAB with the building only ($AB = 10$ m, angle $30°$):

$$\tan 30° = AB/PA$$
$$\frac{1}{\sqrt{3}} = \frac{10}{PA}$$
$$PA = 10\sqrt{3}$$
$$PA = 10 \times 1.732$$
$$PA = 17.32 \text{ m}$$

So the building is 17.32 m from P. Next, triangle PAD with the flag on top (angle

$45°$, total height $AD = 10 + x$):

$$\tan 45° = AD/PA$$
$$1 = \frac{10 + x}{10\sqrt{3}}$$
$$10 + x = 10\sqrt{3}$$
$$x = 10\sqrt{3} - 10$$
$$x = 10(1.732 - 1)$$
$$x = 7.32 \text{ m}$$

So the flagstaff is 7.32 m long.

Why two triangles matter

A surveyor finding the height of a flag, an antenna, or a water tank *above* a building uses exactly this two-triangle idea: one angle to the base of the upper object, one to its top. Subtracting the two heights gives the part you cannot reach directly.

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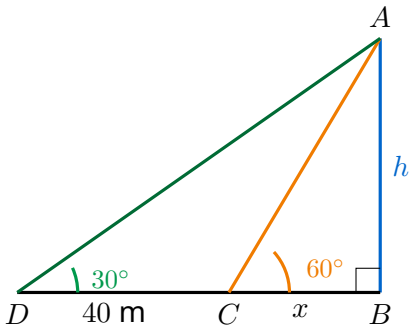
4 Worked Examples: Depression and Combined

Depression problems are solved exactly like elevation problems, once you use the alternate-angle idea to move the angle down to the ground. Combined problems use two angles together.

4.1 Shadow of a tower

The shadow of a tower on level ground is 40 m longer when the Sun's altitude is $30°$ than when it is $60°$. Find the height of the tower.



Solution. Let the height be $AB = h$ and the shorter shadow $BC = x$. Then the longer shadow is $BD = x + 40$. In triangle ABC (angle $60°$):

$$\tan 60° = AB/BC$$
$$\sqrt{3} = \frac{h}{x}$$
$$h = x\sqrt{3} \tag{1}$$

In triangle ABD (angle $30°$):

$$\tan 30° = AB/BD$$
$$\frac{1}{\sqrt{3}} = \frac{h}{x+40} \tag{2}$$

Put $h = x\sqrt{3}$ from (1) into (2):

$$\frac{1}{\sqrt{3}} = \frac{x\sqrt{3}}{x+40}$$
$$x + 40 = x\sqrt{3} \cdot \sqrt{3}$$
$$x + 40 = 3x$$
$$2x = 40$$
$$x = 20$$

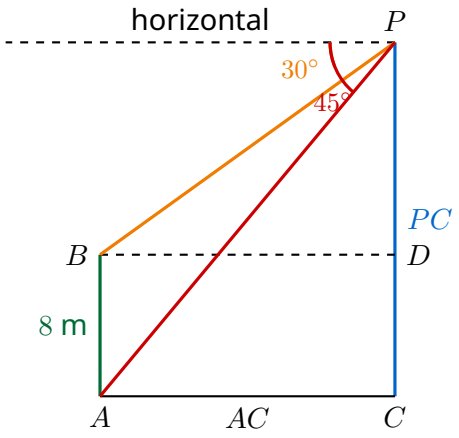
Then from (1):

$$h = x\sqrt{3}$$
$$h = 20\sqrt{3} \text{ m}$$

So the tower is $20\sqrt{3} \approx 34.64$ m tall.

4.2 Angles of depression: a multi-storeyed building

From the top of a multi-storeyed building, the angles of depression of the top and the bottom of an 8 m tall building are $30°$ and $45°$. Find the height of the taller building and the distance between the two buildings.



Solution. By alternate angles, $\angle PBD = 30^\circ$ and $\angle PAC = 45^\circ$. Let $AC = BD = d$ and $PC = H$. In triangle PAC (angle 45°):

$$\tan 45^\circ = PC/AC$$
$$1 = \frac{H}{d}$$
$$H = d \tag{1}$$

In triangle PBD, the height above B is $PD = H - 8$, and angle 30°:

$$\tan 30^\circ = PD/BD$$
$$\frac{1}{\sqrt{3}} = \frac{H-8}{d}$$

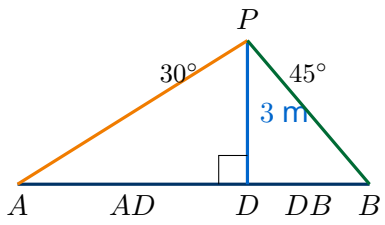
Replace d by H from (1):

$$\frac{1}{\sqrt{3}} = \frac{H-8}{H}$$
$$H = \sqrt{3}\,(H-8)$$
$$H = \sqrt{3}\,H - 8\sqrt{3}$$
$$8\sqrt{3} = \sqrt{3}\,H - H$$
$$8\sqrt{3} = H(\sqrt{3}-1)$$
$$H = \frac{8\sqrt{3}}{\sqrt{3}-1} = 4(3+\sqrt{3}) \text{ m}$$

So the taller building is $4(3+\sqrt{3})$ m high, and the distance between them is $d = H = 4(3+\sqrt{3})$ m as well.

4.3 Width of a river from a bridge

From a point P on a bridge, the angles of depression of the banks on opposite sides of a river are 30° and 45°. The bridge is 3 m above the banks. Find the width of the river.



Solution. By alternate angles, $\angle PAD = 30^\circ$ and $\angle PBD = 45^\circ$, with $PD = 3$ m. In triangle APD:

$$\tan 30^\circ = PD/AD$$
$$\frac{1}{\sqrt{3}} = \frac{3}{AD}$$
$$AD = 3\sqrt{3} \text{ m}$$

In triangle PBD:

$$\tan 45^\circ = PD/BD$$
$$1 = \frac{3}{BD}$$
$$BD = 3 \text{ m}$$

The width of the river is

$$AB = AD + BD$$
$$AB = 3\sqrt{3} + 3$$
$$AB = 3(\sqrt{3} + 1) \text{ m}$$

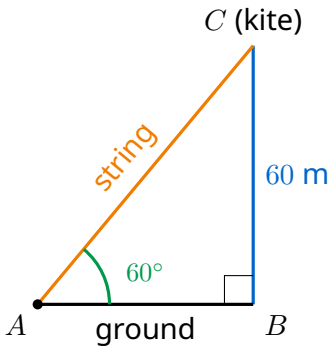
So the river is $3(\sqrt{3} + 1) \approx 8.20$ m wide.

Two angles, two triangles, one common side

In every "two-angle" problem the two right triangles share one common side, usually the vertical height or the line between the feet. Write each tan equation, then either substitute one into the other or add the two horizontal pieces. This single idea solves the tower-shadow, two-building, and river-width problems alike.

4.4 Length of a kite string

A kite is flying at a height of 60 m above the ground. The string makes an angle of 60° with the ground, and there is no slack in the string. Find the length of the string.



Solution. The height $BC = 60$ m is opposite the 60° angle, and the string AC is

the hypotenuse, so use sin.

$$\sin 60^\circ = BC/AC$$
$$\frac{\sqrt{3}}{2} = \frac{60}{AC}$$
$$AC = \frac{60 \times 2}{\sqrt{3}}$$
$$AC = \frac{120}{\sqrt{3}}$$
$$AC = 40\sqrt{3}\ \text{m}$$

So the string is $40\sqrt{3} \approx 69.28$ m long.

Up means raise, down means lower

Elevation $\rightarrow$ **E**yes go **up** (object is higher than you). **D**epression $\rightarrow$ look **down** (object is lower than you). Pair the first letter of the word with the direction your head moves, and you will never swap the two angles in a problem.

5 Exam Practice and Quick Revision

This last section pulls the chapter together: the exercise question types, a board-style solved table, and a one-page recap.

5.1 Types of questions in Exercise 9.1

Situation	Angle type	Ratio usually used
Rope of a circus artist to a pole top	elevation 30°	$\sin\theta$ (height vs rope)
Broken tree bent to the ground	elevation 30°	tan then cos
Slide for children at a park	elevation $30^\circ/60^\circ$	$\sin\theta$ (height vs slide)
Kite string at given height	elevation 60°	$\sin\theta$ (height vs string)
Two poles across an 80 m road	elevation $30^\circ/60^\circ$	tan twice
Tower on a canal bank	elevation $30^\circ/60^\circ$	tan twice
Ships seen from a lighthouse	depression $30^\circ/45^\circ$	tan twice

5.2 Board-style solved example

A circus artist climbs a 20 m long rope tied from the top of a vertical pole to the ground. The rope makes 30° with the ground. Find the height of the pole.

Solution. The rope $AC = 20$ m is the hypotenuse and the pole $AB = h$ is opposite the 30° angle. Use sin.

$$\sin 30^\circ = AB/AC$$
$$\frac{1}{2} = \frac{h}{20}$$
$$h = \frac{20}{2}$$
$$h = 10 \text{ m}$$

So the pole is 10 m high.

5.3 Common errors to avoid

Mixing up the sides

Putting the height as the adjacent side, or the distance as the opposite side, flips the whole ratio. Re-check: the side *facing* the angle is opposite; the side *touching* the angle (other than the hypotenuse) is adjacent.

Forgetting to rationalise

An answer like $\frac{3}{\sqrt{3}}$ is not in final form. Multiply top and bottom by $\sqrt{3}$ to get $\sqrt{3}$. Board exams expect the surd in simplest form, and unrationalised answers can lose a mark.

5.4 Real-life uses recap

Trigonometry around you

Heights and distances are measured this way for tall structures like the Qutub Minar, for hills and lighthouses, for the height a kite reaches, and for the depth a ship is from a coastguard tower. Surveying instruments, navigation, and even astronomy all rest on the same right-triangle idea you used in this chapter.

5.5 Standard results worth memorising

A few results come up again and again in board papers. Keeping them ready saves time in the exam.

Quick results for the common angles

For a vertical object of height h and horizontal distance d from the observer:

- Angle $45°$: height equals distance, so $h = d$ (since $\tan 45° = 1$).
- Angle $30°$: distance is $\sqrt{3}$ times the height, so $d = h\sqrt{3}$.
- Angle $60°$: height is $\sqrt{3}$ times the distance, so $h = d\sqrt{3}$.

For the two-angle "shadow" setup with angles $60°$ and $30°$ on the same object, the longer shadow is exactly 3 times the shorter shadow.

Reading a word problem into a triangle

- "Tall tower / building / pole" $\Rightarrow$ a *vertical* side.
- "Distance from the foot" / "how far" $\Rightarrow$ a *horizontal* side.
- "Rope / ladder / string / line of sight" $\Rightarrow$ the *hypotenuse*.
- "From his eyes" / "observer is h m tall" $\Rightarrow$ remember to *add* the observer's height at the end.
- "Angle of depression" $\Rightarrow$ shift it to the ground as an equal *angle of elevation* using alternate angles.

5.6 Practice these yourself

Try the following on your own; the expected ratio and answer are given so you can check your work.

Problem	Ratio	Answer
Tower 30 m away, elevation $30°$. Find height.	$\tan 30°$	$10\sqrt{3} \approx 17.32$ m
A 1.6 m statue on a pedestal; elevation of statue top $60°$, pedestal top $45°$. Find pedestal height.	tan twice	$0.8(\sqrt{3}+1)$ m
Two equal poles across an 80 m road; elevations $60°$ and $30°$ from a point between them. Find pole height.	tan twice	$20\sqrt{3} \approx 34.64$ m
Cable tower seen from a 7 m building: elevation of top $60°$, depression of foot $45°$. Find tower height.	tan twice	$7(\sqrt{3}+1)$ m
Lighthouse 75 m high; two ships at depressions $30°$ and $45°$ on the same side. Find the distance between them.	tan twice	$75(\sqrt{3}-1)$ m

Make your own measurement

You can measure the height of your school flagpole without climbing it. Walk a known distance from its base, use a protractor and a straw to read the angle of elevation of the top, and then apply $h = d\tan\theta$. Add your own eye height. This is exactly how surveyors worked before laser tools existed.

5.7 One-page recap

Everything in this chapter in five lines

- **Line of sight:** eye to object. **Elevation:** object above eye. **Depression:** object below eye.
- Elevation at the ground equals depression at the top (alternate angles).
- Every problem is a right triangle: height (opposite), distance (adjacent), line of sight (hypotenuse).
- Choose the ratio that links the known side and the unknown side; mostly tan.
- Two angles give two triangles sharing one side; substitute or add to finish.

Exam-day check

Before you write the final answer, ask: did I add the observer's height where needed? Is the surd rationalised? Is the angle measured from the horizontal? These three checks catch almost every lost mark in this chapter.

Related Collegedunia Resources

Same chapter, other resources:
- NCERT Solutions
- Formula Sheet
- NCERT Book PDF
- Exemplar Book PDF
- Exemplar Solutions
- Handwritten Notes

Continue learning:
- Ch 8: Introduction to Trigonometry
- Ch 10: Circles
- Class 10 Maths - All Chapters

Best of luck with your board preparation!

Draw the triangle, pick the ratio, and trust your steps.