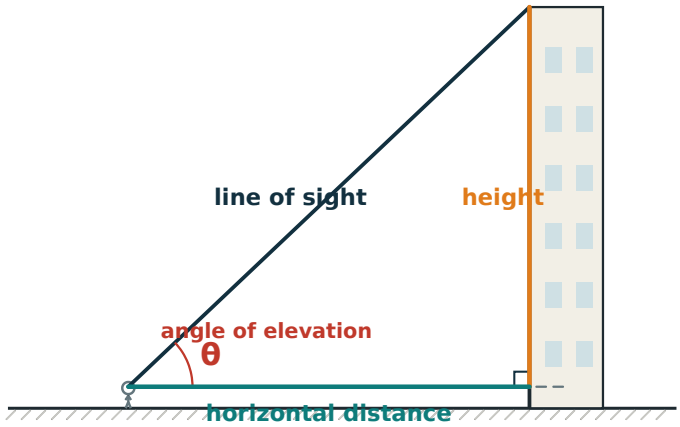
MATHS WITHOUT GUESSWORK

Some Applications of Trigonometry

Understand the Situation.
Draw the Diagram.
Solve Independently.

A guided problem-solving workbook · Heights and Distances
CBSE Class 10 Mathematics · Syllabus session 2026–27



tan θ = height ÷ horizontal distance

INSIDE THIS BOOK

Read the story
Draw the right triangle
Place the angle correctly
Choose sin, cos or tan
Solve and check

> Signature feature:
> **Word problem → correct diagram → correct ratio**

Core topics: angle of elevation · angle of depression · heights and distances with at most two right triangles · 30°, 45°, 60°

Original explanations, examples and questions. Not a substitute for the NCERT textbook or your teacher.

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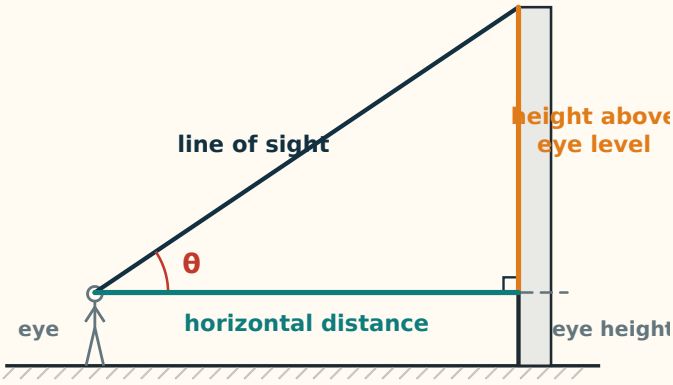
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Concept 2 · Height, horizontal distance, line of sight

CORE

Learning objective: Distinguish the three lengths in every problem and know their roles in the right triangle.

Every problem in this chapter talks about some of these quantities. Naming them correctly is the first half of the work.



θ = angle of elevation, between the dashed horizontal through the eye and the line of sight. Not to scale.

Quantity	What it is	In the right triangle
Height	vertical distance from the base (or from eye level) up to the top of the object	usually **opposite** the angle at the observer
Horizontal distance	distance along level ground (or along the eye-level horizontal) between observer and object	usually **adjacent** to the angle at the observer
Line of sight	straight line from the observer's eye to the point being looked at	always the **hypotenuse**
Eye height	height of the observer's eye above the ground	added to the height above eye level to get the full height

◆ UNDERSTAND

The three lengths form one right triangle. The horizontal and the vertical meet at 90°; the line of sight joins their ends. So line of sight² = height² + horizontal distance², and the line of sight is always the longest of the three.

⚠ COMMON TRAP

Using the line of sight as the ground distance. "The observer is 40 m from the tower" means the **horizontal** distance to the foot of the tower, unless the question says "40 m from the top" or gives a ladder/string length.

✓ CHECK YOURSELF

C2. A girl whose eyes are 1.5 m above the ground looks at the top of a 21.5 m pole. What is the height of the pole *above her eye level*? Which side of her right triangle is this?

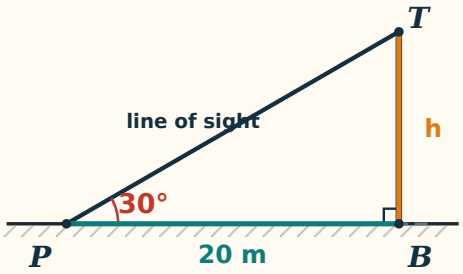
Method 1 · Height from a distance and an angle

CORE

Learning objective: Find a vertical height when the horizontal distance and the angle of elevation are known.

When to use: the horizontal distance to the object and the angle of elevation are known; the height is wanted.

Question. From a point P on level ground, 20 m from the foot B of a vertical pole BT, the angle of elevation of the top T is 30°. Find the height of the pole.



Not to scale.

▤ READ THE SITUATION

What is happening in the story? A person at P looks **up** at the top of a pole 20 m away. The ground is level and the pole is vertical, so the pole meets the ground at 90°.

What do I know?

- PB = 20 m (horizontal)
- ∠TPB = 30° (elevation)
- ∠TBP = 90° (vertical pole on level ground)

What must I find?

BT = h (vertical height)

▲ WORD PROBLEM → CORRECT DIAGRAM → CORRECT RATIO Method 1

Role	The words say…	…so in the diagram
OBJECT	*"a vertical pole BT"*	vertical line BT; right angle at B
ADJACENT	*"20 m from the foot B"*	horizontal PB = 20 m
ANGLE	*"the angle of elevation of the top T is 30°"*	∠TPB = 30°, at P, between PB (horizontal) and PT (sight)
UNKNOWN	*"find the height of the pole"*	BT = h, opposite the 30° angle

Correct ratio: BT is **opposite** 30°, PB is **adjacent**; PT is not given or wanted → **tan 30° = BT/PB**.

Solve. $\tan 30° = h/20 \Rightarrow \frac{1}{\sqrt{3}} = \frac{h}{20} \Rightarrow h = \frac{20}{\sqrt{3}} = \frac{20\sqrt{3}}{3}$ m $\approx \frac{20 \times 1.732}{3} \approx$ **11.55 m**.

✓ CHECK YOURSELF

Check whether the answer makes sense. At 30° (less than 45°) the height must be **less** than the horizontal distance: 11.55 m < 20 m ✓. At 45° they would be equal; above 45° the height is bigger.

? WHY THIS STEP?

Why tan and not sin? sin 30° = opposite/hypotenuse needs PT, the line of sight, which is neither given nor asked. tan uses exactly the two sides in the problem: the known PB and the wanted BT.

✎ YOUR TURN

T1. From a point on the ground 40 m from the foot of a flagpole, the angle of elevation of its top is 30°. Draw the diagram, then find the height of the flagpole (√3 ≈ 1.732).

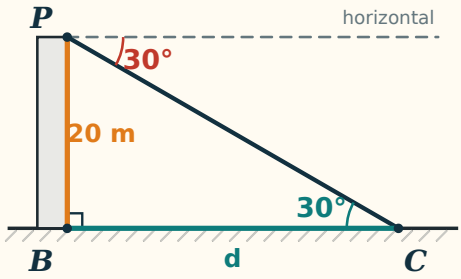
Method 4 · Problems with an angle of depression

CORE

Learning objective: Place the angle of depression correctly and move it inside the triangle with alternate angles.

When to use: the observer is high up (top of a building, cliff, tower, balloon) looking **down**. The depression angle is outside the triangle; alternate angles bring it inside.

Question. From the top P of a 20 m high building, the angle of depression of a scooter C on the road is 30°. Find the distance of the scooter from the foot B of the building.



Horizontal at P ∥ road BC.

READ THE SITUATION

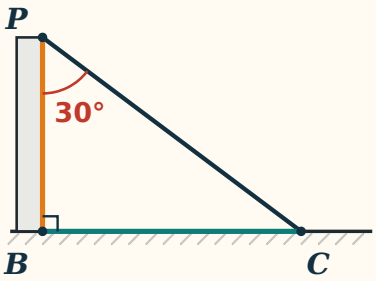
What is happening? Someone on the roof looks **down** at a scooter. Their eye line starts horizontal (parallel to the road) and tilts down 30°.

WORD PROBLEM → CORRECT DIAGRAM → CORRECT RATIO — Method 4

Role	The words say…	…so in the diagram
OBSERVER	*"from the top P of a 20 m high building"*	vertical PB = 20 m; draw a horizontal through P
ANGLE	*"the angle of depression of a scooter is 30°"*	between the horizontal at P and the sight line PC
PARALLEL	*"(horizontal at P ∥ road)"*	alternate angles: ∠PCB = 30° inside ΔPBC
UNKNOWN	*"distance of the scooter from the foot"*	BC = d, adjacent to the 30° at C

Correct ratio: From C: PB **opposite**, BC **adjacent** → **tan 30° = PB/BC**: $1/\sqrt{3} = 20/d$, $d = 20\sqrt{3} \approx$ **34.64 m**.

Spot the wrong diagram



A student's diagram.

COMMON TRAP

What is wrong? The student marked 30° at P **between the building and the line of sight**. That is the angle from the vertical, which equals 90° − 30° = 60°. With this wrong angle the student writes tan 30° = BC/20 and gets BC = $20/\sqrt{3} \approx 11.55$ m, which is far too short. The depression angle is measured from the **horizontal**.

SPOT THE CLUE

Words that signal depression: "from the top of", "looks down at", "angle of depression of", "observed from a balloon / aeroplane / cliff". The observer is **above** the object.

YOUR TURN

T6. From the top of a 45 m cliff, the angle of depression of a boat is 60°. Draw the diagram (mark both the depression angle and the alternate angle), then find the distance of the boat from the foot of the cliff.

Doubts 1 and 2

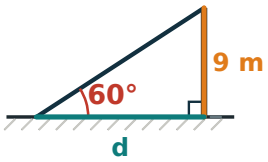
DOUBT 1 — *"There's no diagram in the question. How do I even start drawing?"*

✗ WHY THIS CONFUSION HAPPENS
Students try to picture the whole scene at once, with buildings, people and sky, instead of the few lines that matter.

◆ UNDERSTAND
You only need three lines: the **vertical object**, the **horizontal ground (or eye level)**, and the **line of sight**. They always make one right triangle.

★ SPOT THE CLUE
Nouns tell you the objects (tower, pole, tree = vertical); "from a point on the ground" tells you where the observer is; "angle of elevation/depression" tells you where the angle goes.

✎ DRAW AND LABEL
Draw the ground, stand the object up on it, put the observer on the ground, draw the sight line to the top, mark 90° at the foot and the angle at the observer.



➤ CHOOSE THE RATIO
Pole (opposite) and ground distance (adjacent) → **tan**.

✦ SOLVED EXAMPLE
"A 9 m pole; from a point on the ground the angle of elevation of its top is 60°. How far is the point from the pole?" $\tan 60° = 9/d \Rightarrow d = 9/\sqrt{3} = 3\sqrt{3} \approx$ **5.20 m**.

? WHY THIS STEP?
Drawing first shows that 9 m is opposite 60° and d is adjacent, before any formula is written.

⚠ COMMON TRAP
Writing $\tan 60° = d/9$ because 9 was mentioned first. Position in the sentence means nothing; position in the diagram decides.

✎ YOUR TURN DB1
From a point 25 m from the foot of a tree, the angle of elevation of its top is 45°. Draw, then find the height.

✓ CHECK YOURSELF
At 45° the height and distance are equal.

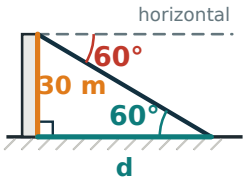
DOUBT 2 — *"What exactly is the difference between elevation and depression?"*

✗ WHY THIS CONFUSION HAPPENS
Both are "the angle with the line of sight", so students mix them up.

◆ UNDERSTAND
Both are measured from the **horizontal through the observer's eye**. **Elevation**: the object is above, you look up. **Depression**: the object is below, you look down.

★ SPOT THE CLUE
Where is the observer compared with the object? Below → elevation. Above (on a roof, cliff, tower) → depression.

✎ DRAW AND LABEL
For depression, draw the horizontal at the top, mark the angle under it, then copy it to the ground point (alternate angles).



➤ CHOOSE THE RATIO
Height (opposite) and ground distance (adjacent) → **tan**.

✦ SOLVED EXAMPLE
From the top of a 30 m tower, the angle of depression of a car is 60°. $\tan 60° = 30/d \Rightarrow d = 30/\sqrt{3} = 10\sqrt{3} \approx$ **17.32 m**.

? WHY THIS STEP?
The depression angle at the top equals the elevation angle at the car, so the same triangle works.

⚠ COMMON TRAP
Putting 60° at the top *inside* the triangle (between the tower and the sight line). That angle is 30°.

✎ YOUR TURN DB2
A bird on top of a 15 m pole sees a worm on the ground at an angle of depression of 30°. How far is the worm from the pole?

✓ CHECK YOURSELF
Draw the horizontal at the bird first.

Guide 4 · From words to equations

Learning objective: Follow one word problem through five stages: words, known, unknown, equation, answer.

Here is one word problem carried all the way to an answer. Each stage uses only what the previous stage produced.

1 · WORDS
"A man 1.5 m tall stands 25√3 m from a tower. The angle of elevation of the top of the tower from his eyes is 30°. Find the height of the tower."

2 · KNOWN
eye height 1.5 m · horizontal DE = 25√3 m · ∠ADE = 30°

3 · UNKNOWN
AE (above eye level), then AB = AE + 1.5

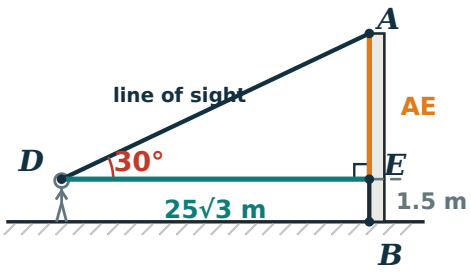
4 · EQUATION
tan 30° = AE/DE ⇒ 1/√3 = AE/(25√3)

5 · ANSWER
AE = 25√3/√3 = 25 m ⇒ AB = 25 + 1.5 = **26.5 m**

▲ WORD PROBLEM → CORRECT DIAGRAM → CORRECT RATIO

words → diagram

Role	The words say…	…so in the diagram
OBSERVER	*"a man 1.5 m tall … from his eyes"*	eye D, 1.5 m up; horizontal DE
ADJACENT	*"stands 25√3 m from a tower"*	DE = 25√3 m
ANGLE	*"angle of elevation … is 30°"*	∠ADE = 30° at the eye
UNKNOWN	*"height of the tower"*	AB = AE + 1.5



Correct ratio: AE **opposite**, DE **adjacent** → **tan 30°**.

◇ FIND THE MISSING LINK

A student wrote stages 1, 2, 4 and 5 but skipped stage 3. Their answer was "25 m". What did skipping the "unknown" stage cost them? (They forgot that the triangle's height is only the part above eye level, so 1.5 m was never added.)

A second run-through: looking down

1 · WORDS
"From the top of a 60 m building, the angle of depression of a car is 60°. How far is the car?"

2 · KNOWN
height 60 m; depression 60° ⇒ angle at car 60° (alternate)

3 · UNKNOWN
horizontal distance d (adjacent to 60° at the car)

4 · EQUATION
tan 60° = 60/d

5 · ANSWER
d = 60/√3 = 20√3 ≈ **34.64 m**

✓ EXAM TIP

In the exam, write stages 2 and 3 as two short lines: "Given: …" and "To find: …". It takes seconds, shows the examiner your reading of the question, and stops you from answering the wrong unknown.

✓ CHECK YOURSELF

Try it. Carry this problem through all five stages on rough paper: "From a point 20 m from the foot of a tower, the angle of elevation of its top is 60°. Find the length of the line of sight to the top." (Answer: 40 m, using cos 60° = 20/l.)

Mistake clinic (1 of 3)

MISTAKE 1 · Angle measured from the vertical

✗ STUDENT'S WORK	*"The line of sight makes 60° with the tower, so the angle of elevation is 60°."*
⚠ WHERE IT FAILS	Angles of elevation and depression are measured from the **horizontal**. The angle with the vertical tower is the complement.
? WHY TEMPTING	The tower is drawn clearly and the horizontal is not.
✓ CORRECTED	Angle of elevation = 90° − 60° = 30°.
➤ PREVENTION RULE	**Measure from the horizontal through the eye.**
✎ FIX IT E1	The line of sight to a pole's top makes 60° with the vertical pole. The observer is 15 m from the pole. Find the height.

MISTAKE 2 · Elevation drawn at the wrong vertex

✗ STUDENT'S WORK	*"30° elevation of a 20 m tower's top: tan 30° = d/20." (30° marked at the top of the tower)*
⚠ WHERE IT FAILS	The angle of elevation is at the **observer**, not at the top of the object. At the top the angle is 60°.
? WHY TEMPTING	The angle is "of the top", so it feels like it belongs at the top.
✓ CORRECTED	At the observer: tan 30° = 20/d ⇒ d = 20√3 ≈ 34.64 m.
➤ PREVENTION RULE	**The vertex of the angle is always the observer's eye.**
✎ FIX IT E2	Redo it correctly. What does the student's 20/√3 actually represent?

MISTAKE 3 · Depression put inside the triangle at the top

✗ STUDENT'S WORK	*"From a 35 m building, depression 60°: tan 60° = d/35."*
⚠ WHERE IT FAILS	60° is between the horizontal and the sight line, **outside** the triangle. Inside, at the top, the angle is 30°.
? WHY TEMPTING	The top is where the observer stands, so the student puts the angle there, inside.
✓ CORRECTED	Alternate angle 60° at the object: tan 60° = 35/d ⇒ d = 35/√3 ≈ 20.21 m.
➤ PREVENTION RULE	**Depression → draw the horizontal at the top → move the angle to the object.**
✎ FIX IT E3	From the top of a 45 m building, the angle of depression of a car is 30°. A student writes d = 45 tan 30°. Correct it.

MISTAKE 4 · Height confused with line of sight

✗ STUDENT'S WORK	*"Kite string 50 m at 30° to the ground, so the height is 50 tan 30°."*
⚠ WHERE IT FAILS	50 m is the **string** (hypotenuse), not the ground distance. tan needs opposite and adjacent.
? WHY TEMPTING	"Heights use tan" is applied without checking the sides.
✓ CORRECTED	Height = 50 sin 30° = 25 m.
➤ PREVENTION RULE	**A slanting length is the hypotenuse: use sin or cos.**
✎ FIX IT E4	A 24 m wire from the top of a pole makes 60° with the ground. A student writes h = 24 tan 60°. Correct it.

Practice 1 · Recognise

Learning objective: Identify angles, lengths and ratios, and match words with diagrams.

1 Recognise | 2 Apply | 3 Connect | 4 Board-style

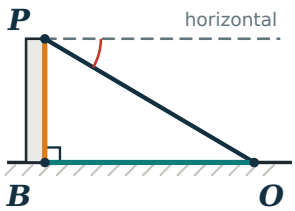
Answers: Section H

P1 The angle of elevation is the angle between
(A) the object and the line of sight (B) the horizontal and the line of sight
(C) the ground and the object (D) the line of sight and the object's top

Purpose: Recall the definition. **easy ★☆☆**

Working space (use separate paper if needed)

P2 In the figure, P is the top of a building and O is a car. Name (a) the angle of depression, (b) the height, (c) the horizontal distance, (d) the line of sight, (e) the angle inside ΔPBO equal to the angle of depression, with a reason.



Purpose: Read a diagram. **easy ★☆☆**

Working space (use separate paper if needed)

P3 In a kite problem, the string is the
(A) height (B) horizontal distance (C) hypotenuse (D) angle of elevation

Purpose: Identify the slant. **easy ★☆☆**

Working space (use separate paper if needed)

P4 Without calculating, name the ratio: (a) height of a tower and distance from it; (b) kite string and kite height; (c) ladder length and distance of its foot from the wall.

Purpose: Choose the ratio. **easy ★☆☆**

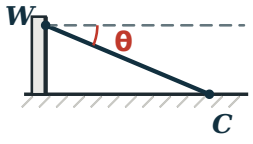
Working space (use separate paper if needed)

P5 From the top of a cliff, the angle of depression of a boat is 30°. The angle of elevation of the top of the cliff from the boat is
(A) 60° (B) 30° (C) 90° (D) 45°

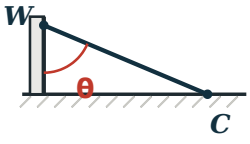
Purpose: Alternate angles. **easy ★☆☆**

Working space (use separate paper if needed)

P6 Which diagram shows "from a window W 8 m above the ground, the angle of depression of a car C is θ" correctly? Explain.



(i)



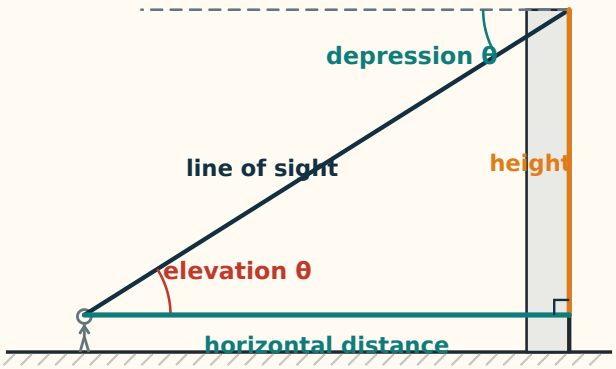
(ii)

Purpose: Spot the wrong diagram. **easy ★☆☆**

Working space (use separate paper if needed)

One-page revision sheet

Learning objective: Recall the definitions, the reference diagram, the ratios, the routine and the assumptions on one page.



Both angles are measured from a horizontal line. For the same line of sight they are equal (alternate angles). Not to scale.

Term	Meaning
Line of sight	eye → point viewed; the hypotenuse
Angle of elevation	horizontal → line of sight, object above the eye
Angle of depression	horizontal → line of sight, object below the eye
Height	vertical; usually opposite
Horizontal distance	along level ground; usually adjacent

Sides	Ratio	30°	45°	60°
O & A	**tan**	1/√3	1	√3
O & H	**sin**	1/2	1/√2	√3/2
A & H	**cos**	√3/2	1/√2	1/2

◆ UNDERSTAND

Routine: READ → VISUALISE → DRAW → LABEL → CHOOSE → SOLVE → CHECK.
Assumptions: level ground; vertical objects; straight lines of sight; observer height ignored unless given; one vertical plane.

★ SPOT THE CLUE

Two triangles? Find the shared side: height (two positions) or horizontal distance (object on top; up and down from a roof). Same side → subtract distances; opposite sides → add.

⚠ COMMON TRAP

Final error checklist. ☐ angle from the vertical (E1) ☐ angle at the wrong vertex (E2) ☐ depression inside the triangle (E3) ☐ slant used as height (E4) ☐ ground as hypotenuse (E5) ☐ ratio before labelling (E6) ☐ unjustified equal angles (E7) ☐ eye height forgotten (E8) ☐ same/opposite side ignored (E9) ☐ rearranging (E10) ☐ early rounding (E11) ☐ no unit / impossible answer (E12)

MATHS WITHOUT GUESSWORK

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