



CHAPTER OVERVIEW & INDEX

Welcome to the ultimate Master Notes for **Class 10 CBSE Mathematics — Chapter 9: Some Applications of Trigonometry** (Heights and Distances). Designed with the *Concept → Connection → Trick → Hack → Practice → PYQ → Exam* methodology to guarantee 100% conceptual clarity and maximum marks in CBSE Board Exams!

Module #	Topic / Section Title	Key Focus Areas
01	Real-World Foundations & Terminology	Line of Sight, Angle of Elevation, Angle of Depression, Horizontal Level
02	Trigonometric Values & Standard Right Triangles	30°-60°-90° and 45°-45°-90° Triangle Shortcuts & Tinku Special Ratios
03	Question Identification System	"Question Dekho → Pattern Pehchano → Method Chuno" Matrix
04	Core Question Models & Visual Diagrams	Single Triangle, Double Triangle (Same/Opposite Side), Moving Objects, Speed/Time
05	CBSE Board PYQs (2023–2026) & Solutions	Verified Board Questions, Step-wise Marking, HOTS & Competency Case Studies
06	Concept-Wise Practice Set & Solutions	Basic → Moderate → Advanced → HOTS → Board Challenge
07	Visual Mind Map & One-Page Revision Sheet	2-Minute Chapter Recap & Last-Minute Exam Booster Sheet
08	Common Mistakes & Full Marks Strategy	CBSE Marking Scheme Secrets, Traps to Avoid & Top 10 Practice Questions

01. REAL-WORLD FOUNDATIONS & TERMINOLOGY

In Chapter 8, we studied Trigonometric Ratios in right-angled triangles. In this chapter, we use trigonometry to find the **heights of objects** (towers, trees, buildings, balloons) and the **distances between points** without actually measuring them!

1. Key Terms Defined

- ① **Line of Sight:** The straight line drawn from the eye of an observer to the point in the object viewed by the observer.
- ② **Horizontal Level:** The horizontal line passing through the eye of the observer parallel to the ground surface.



③ **Angle of Elevation:** The angle formed by the line of sight with the horizontal level when the object being viewed is **ABOVE** the horizontal level. (Head moves UP 🙙)

④ **Angle of Depression:** The angle formed by the line of sight with the horizontal level when the object being viewed is **BELOW** the horizontal level. (Head moves DOWN 🙘)

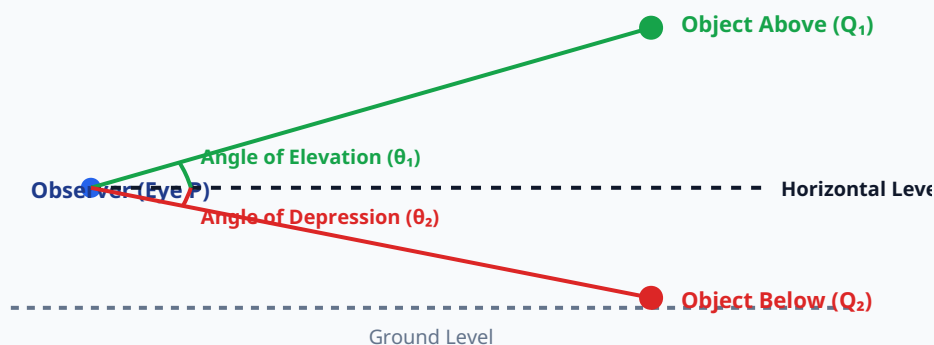


Figure 1.1: Visual Representation of Angle of Elevation and Angle of Depression

🔥 TINKU SIR TRICK #1: "Look Up = Elevation, Look Down = Depression"

- **Elevator goes UP:** When you look UP at a flying bird, balloon, or top of a tower, you form an **Angle of Elevation**.
- **Depressed person looks DOWN:** When you stand on a roof and look DOWN at a car on the road, you form an **Angle of Depression**.

🚀 ONEPATH HACK #1: The Alternate Interior Angles Secret

In problems involving **Angle of Depression**, ALWAYS convert it into an **Angle of Elevation** inside the right triangle immediately!

Since Horizontal Level is parallel to Ground Level, **Angle of Depression = Angle of Elevation** (Alternate Interior Angles).

Never try to solve the triangle using the angle outside the triangle — draw the Z-pattern (alternate interior angles) to bring the angle to the ground level inside $\triangle ABC$!

🔴 COMMON MISTAKE: Eye Height vs. Ground Observer

- If the question specifies observer height (e.g., "A girl 1.5 m tall observes..."), you MUST subtract observer height from total building height ($h' = H - 1.5$).
- If observer height is **NOT given**, treat the observer as a point on the ground (height = 0).

02. STANDARD RATIOS & TINKU SPECIAL TRIANGLE SHORTCUTS

In 99% of CBSE Class 10 Heights & Distances problems, only three angles are tested: 30° , 45° , and 60° .

ESSENTIAL TRIGONOMETRIC RATIOS TABLE

Ratio \ Angle (°)	30°	45°	60°
$\sin \theta$ (Perpendicular / Hypotenuse)	$1/2$	$1/\sqrt{2}$	$\sqrt{3}/2$
$\cos \theta$ (Base / Hypotenuse)	$\sqrt{3}/2$	$1/\sqrt{2}$	$1/2$
$\tan \theta$ (Perpendicular / Base)	$1/\sqrt{3}$	1	$\sqrt{3}$

Standard values to remember: $\sqrt{3} \approx 1.732$, $\sqrt{2} \approx 1.414$.

2. Tinku Special Ratio Triangles (Mental Math Shortcuts)

Master these ratio figures to double-check your long board answers in 5 seconds!

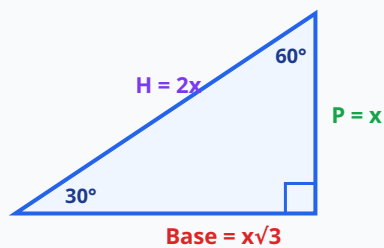


Figure 2.1: The 30°-60°-90° Special Triangle

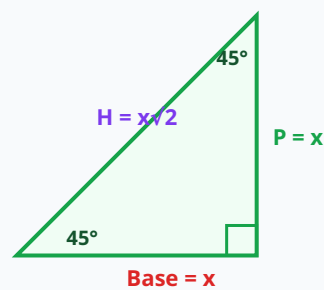


Figure 2.2: The 45°-45°-90° Isosceles Triangle

🔥 TINKU SIR TRICK #2: The Golden Ratio Summary

- In a 45°-45°-90° Triangle: **Perpendicular : Base : Hypotenuse = 1 : 1 : $\sqrt{2}$**

Meaning: Height and Distance are ALWAYS EQUAL! If height = 50 m, shadow/distance = 50 m.

- In a 30°-60°-90° Triangle: **Side opposite 30° : Side opposite 60° : Hypotenuse = 1 : $\sqrt{3}$: 2**

Meaning: Larger angle faces larger side! Side opposite 60° is always $\sqrt{3}$ times the side opposite 30°.

03. QUESTION IDENTIFICATION SYSTEM

Master the rule: "QUESTION DEKHO → TYPE PECHANO → METHOD CHUNO"

Question Clue / Text Keyword	Identified Pattern Type	Mathematical Strategy & Formula
"Height of tower given, find length of shadow when angle is θ "	Single Right Triangle	Draw 1 right triangle. Use $\tan \theta = h/d$ directly.
"Observer moves towards/away from tower; angle changes from 30° to 60°"	Double Triangle (Same Side)	Draw 2 nested right triangles sharing common vertical height h . Express bases in terms of h and subtract.

"Two points on opposite sides of a tower/river; angles of elevation are α and β "	Double Triangle (Opposite Sides)	Draw 2 triangles sharing height h on left and right. Total distance $D = d_1 + d_2 = h(\cot \alpha + \cot \beta)$.
"From top of a building, angles of depression of top and bottom of a tower..."	Two Vertical Structures (Building & Tower)	Draw 2 parallel vertical lines. Form horizontal rectangle at lower height. Work in upper and lower right triangles.
"Angle changes from 30° to 45° in 6 seconds; find speed of boat/car"	Speed, Distance & Time Integration	Calculate distance x using trigonometry. Use Speed = Distance / Time or Time = Distance / Speed .
"A broken tree bends such that its top touches ground making angle θ ..."	Broken Tree / Folding Pole	Total height $H = \text{Perpendicular} + \text{Hypotenuse} = x + y$. Use $\sin \theta$ and $\tan \theta$.

04. CORE QUESTION MODELS WITH STEP-BY-STEP SOLUTIONS

Model A: Broken Tree Problem (Classic NCERT Pattern)

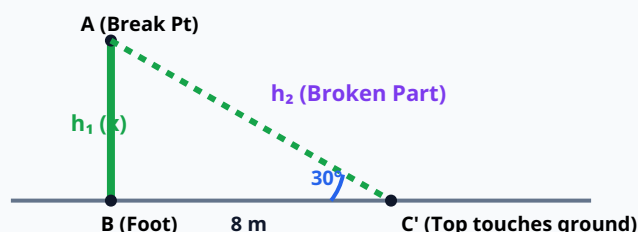


Figure 4.1: Broken Tree Diagram — Total Height = Standing Part (x) + Broken Part (y)

VERIFIED NCERT / CBSE CLASSIC

Example 1: A tree breaks due to a storm and the broken part bends so that the top of the tree touches the ground making an angle of 30° with it. The distance between the foot of the tree to the point where the top touches the ground is 8 m . Find the total height of the tree.

Concept Identification: Right triangle with given base (8 m) and angle (30°). Total height = Perpendicular + Hypotenuse.

Given: Base distance $BC = 8 \text{ m}$, Angle of elevation $\theta = 30^\circ$.

To Find: Total height of tree $H = AB + AC$.

Step-by-Step Solution:

Let $AB = x$ (standing part) and $AC = y$ (broken part).

In right $\triangle ABC$:

1) Finding x using $\tan 30^\circ$:

$$\tan 30^\circ = AB / BC \Rightarrow 1/\sqrt{3} = x / 8 \Rightarrow x = 8 / \sqrt{3} \text{ ext}\{ m\}$$

2) Finding y using $\cos 30^\circ$:

$$\cos 30^\circ = BC / AC \Rightarrow \sqrt{3}/2 = 8 / y \Rightarrow y = 16 / \sqrt{3} \text{ ext}\{ m\}$$

3) Calculating Total Height H :

$$H = x + y = 8/\sqrt{3} + 16/\sqrt{3} = 24 / \sqrt{3}$$

Rationalizing denominator:

$$H = (24 \times \sqrt{3}) / (\sqrt{3} \times \sqrt{3}) = 24\sqrt{3} / 3 = 8\sqrt{3} \text{ ext}\{ m\}$$

If $\sqrt{3} = 1.732$, $H = 8 \times 1.732 = 13.856 \text{ ext}\{ m\}$.

✅ **Final Answer:** Total height of tree is $8\sqrt{3} \text{ ext}\{ m\}$ (or $13.86 \text{ ext}\{ m\}$).

🚀 ONEPATH HACK #2: The Broken Tree Shortcut Formula

For any broken tree making angle θ with ground at base distance d :

$$\text{Total Height } H = d \times [(1 + \sin \theta) / \cos \theta] = d \times \tan(45^\circ + \theta/2)$$

For $\theta = 30^\circ$ and $d = 8$: $H = 8 \times [(1 + 0.5) / (\sqrt{3}/2)] = 8 \times (1.5 / (\sqrt{3}/2)) = 8 \times (3 / \sqrt{3}) = 8\sqrt{3} \text{ ext}\{ m\}$! Verified in 3 seconds!

Model B: Double Triangle on Same Side (Approach / Distance Change)

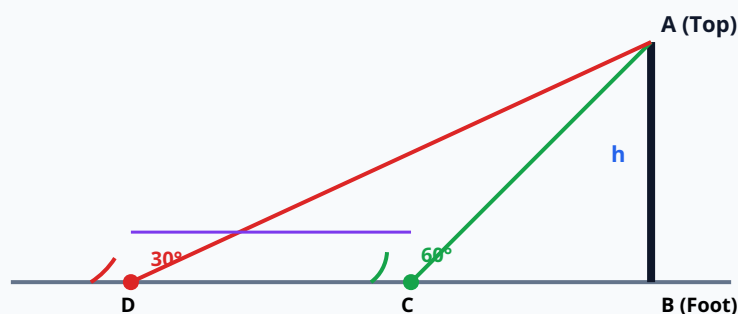


Figure 4.2: Double Right Triangle on Same Side (Angles 30° and 60°)

🟢 CBSE 2024 VERIFIED PYQ [3 MARKS]

Example 2: A statue $1.6 \text{ ext}\{ m\}$ tall stands on top of a pedestal. From a point on the ground, the angle of elevation of top of statue is 60° and from same point angle of elevation of top of pedestal is 45° . Find the height of the pedestal.

 **Given:** Height of statue $AD = 1.6 \text{ ext{ m}}$. Angle to top of pedestal BC is 45° , angle to top of statue AC is 60° .

 **To Find:** Height of pedestal $h = AB$.

 **Step-by-Step Solution:**

Let height of pedestal $AB = h$ metres and distance of point on ground C from base be $BC = x$ metres.

In right $\triangle ABC$ (smaller triangle with 45°):

$$\tan 45^\circ = AB / BC \Rightarrow 1 = h / x \Rightarrow x = h \quad \text{--- (Equation 1)}$$

In right $\triangle DBC$ (larger triangle with 60°):

$$\tan 60^\circ = DB / BC \Rightarrow \sqrt{3} = (h + 1.6) / x$$

Substituting $x = h$ from Eq (1):

$$\sqrt{3} = (h + 1.6) / h \Rightarrow h\sqrt{3} = h + 1.6 \Rightarrow h(\sqrt{3} - 1) = 1.6$$

$$h = 1.6 / (\sqrt{3} - 1)$$

Rationalizing denominator multiplying by $(\sqrt{3} + 1)$:

$$h = [1.6(\sqrt{3} + 1)] / [(\sqrt{3} - 1)(\sqrt{3} + 1)] = [1.6(\sqrt{3} + 1)] / (3 - 1) = 0.8(\sqrt{3} + 1) \text{ ext{ m}}$$

If $\sqrt{3} = 1.732$: $h = 0.8 \times 2.732 = 2.1856 \text{ ext{ m}}$.

 **Final Answer:** Height of pedestal is $0.8(\sqrt{3} + 1) \text{ ext{ m}}$ (or $2.186 \text{ ext{ m}}$).

TINKU SIR TRICK #3: The Standard 30° - 60° Distance Formula

When an observer moves a distance d on the ground changing angle from 30° to 60° towards a vertical tower of height h :

$$d = 2h / \sqrt{3} \quad \text{and} \quad h = (\sqrt{3} / 2) \times d$$

Example: If $d = 40 \text{ ext{ m}}$, height $h = (\sqrt{3} / 2) \times 40 = 20\sqrt{3} \text{ ext{ m}}$! Zero lengthy steps for rough checking!

Model C: Moving Objects, Speed & Time Problems

 CBSE 2025 VERIFIED HIGH-YIELD PYQ [5 MARKS]

Example 3: A straight highway leads to the foot of a tower. A man standing at the top of the tower observes a car at an angle of depression of 30° , which is approaching the foot of the tower with a uniform speed. Six seconds later, the angle of depression of the car is found to be 60° . Find the time taken by the car to reach the foot of the tower from this point.

Step-by-Step Solution:

Let height of tower $AB = h$. Let initial position of car be D (angle 30°) and position after 6 seconds be C (angle 60°).

1) In right $\triangle ABC$:

$$\tan 60^\circ = AB / BC \Rightarrow \sqrt{3} = h / BC \Rightarrow BC = h / \sqrt{3}$$

2) In right $\triangle ABD$:

$$\tan 30^\circ = AB / BD \Rightarrow 1/\sqrt{3} = h / BD \Rightarrow BD = h\sqrt{3}$$

3) Distance travelled in 6 seconds (CD):

$$CD = BD - BC = h\sqrt{3} - h/\sqrt{3} = (3h - h) / \sqrt{3} = 2h / \sqrt{3}$$

4) Time taken to cover distance CD ($2h/\sqrt{3}$) = 6 *seconds*.

Therefore, Speed of car $v = \text{Distance} / \text{Time} = (2h / \sqrt{3}) / 6 = h / (3\sqrt{3})$ *units/sec*.

5) Time required to cover remaining distance BC ($h/\sqrt{3}$):

$$\text{Time} = \text{Distance} / \text{Speed} = (h / \sqrt{3}) / [h / (3\sqrt{3})] = (h / \sqrt{3}) \times (3\sqrt{3} / h) = 3 \text{ seconds}.$$

✓ **Final Answer:** The car will take **3 seconds** more to reach the foot of the tower.

ONEPATH HACK #3: The $30^\circ \rightarrow 60^\circ$ Half-Time Magic Rule

When an object moves at uniform speed towards a tower and its angle of elevation/depression changes from 30° to 60° :

$$\text{Time to reach base from } 60^\circ \text{ point} = \frac{1}{2} \text{ times (Time taken from } 30^\circ \text{ to } 60^\circ)$$

If time from 30° to 60° is 6 *s*, remaining time is $6 / 2 = 3$ *s*! If time given is 10 *min*, remaining time is 5 *min*!

05. VERIFIED CBSE BOARD PYQs (2023 – 2026)

VERIFIED CBSE 2023 [4 MARKS CASE STUDY]

Question 1 (Case Study): A group of students of Class 10 visited India Gate on an educational trip. The teacher asked the students to calculate the height of India Gate without measuring it directly. One student, Radhika, stands at a distance of 42 *m* away from the base of India Gate and observes the top at an angle of elevation of 45° . Another student, Rahul, stands behind Radhika such that the angle of elevation of top of India Gate from Rahul is 30° .

(i) Find the height of India Gate.

(ii) Find the distance between Radhika and Rahul.

Solution:

(i) Let height of India Gate be $h = AB$. Radhika is at point C , $BC = 42 \text{ m}$.

In $\triangle ABC$, $\tan 45^\circ = AB / BC \Rightarrow 1 = h / 42 \Rightarrow h = 42 \text{ m}$.

(ii) Rahul is at point D . In $\triangle ABD$, $\tan 30^\circ = AB / BD \Rightarrow 1/\sqrt{3} = 42 / BD \Rightarrow BD = 42\sqrt{3} \text{ m}$.

Distance between Radhika & Rahul $CD = BD - BC = 42\sqrt{3} - 42 = 42(\sqrt{3} - 1) \text{ m} = 42(1.732 - 1) = 42 \times 0.732 = 30.744 \text{ m}$.

VERIFIED CBSE 2026 BOARD PATTERN [5 MARKS]

Question 2 (Two Objects on Opposite Sides): Two poles of equal heights are standing opposite each other on either side of the road, which is 80 m wide. From a point between them on the road, the angles of elevation of the top of the poles are 60° and 30° , respectively. Find the height of the poles and the distances of the point from the poles.

Solution:

Let height of equal poles be $AB = CD = h$. Road width $BD = 80 \text{ m}$.

Let point on road be P . Let $BP = x$, so $PD = 80 - x$.

In $\triangle ABP$ (angle 60°): $\tan 60^\circ = h / x \Rightarrow h = x\sqrt{3}$ *quad* (1)

In $\triangle CDP$ (angle 30°): $\tan 30^\circ = h / (80 - x) \Rightarrow 1/\sqrt{3} = h / (80 - x) \Rightarrow h = (80 - x) / \sqrt{3}$ *quad* (2)

Equating (1) and (2): $x\sqrt{3} = (80 - x) / \sqrt{3} \Rightarrow 3x = 80 - x \Rightarrow 4x = 80 \Rightarrow x = 20 \text{ m}$.

So, $BP = 20 \text{ m}$ and $PD = 80 - 20 = 60 \text{ m}$.

Height of poles $h = x\sqrt{3} = 20\sqrt{3} \text{ m}$ *pprox* 34.64 m .

Final Answer: Height = $20\sqrt{3} \text{ m}$; Distances from poles = 20 m and 60 m .

06. CONCEPT-WISE PRACTICE SET

LEVEL 1 — BASIC (1-2 Marks)

1. If a tower 30 m high casts a shadow $10\sqrt{3} \text{ m}$ long on the ground, find the angle of elevation of the Sun.

Ans: $\tan \theta = 30 / (10\sqrt{3}) = 3/\sqrt{3} = \sqrt{3} \Rightarrow \theta = 60^\circ$.

2. A ladder leaning against a wall makes an angle of 60° with the horizontal. If the foot of ladder is 9.5 m away from wall, find length of ladder.

Ans: $\cos 60^\circ = 9.5 / L \Rightarrow 1/2 = 9.5 / L \Rightarrow L = 19 \text{ m}$.

LEVEL 2 — APPLICATION (3 Marks)

3. An observer 1.5 m tall is 28.5 m away from a chimney. The angle of elevation of the top of the chimney from her eyes is 45° . What is the height of the chimney?

Ans: $\tan 45^\circ = h' / 28.5 \Rightarrow h' = 28.5 \text{ m}$. Total height $H = 28.5 + 1.5 = 30 \text{ m}$.

LEVEL 3 — ADVANCED & HOTS (5 Marks)

4. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is 60° and the angle of depression of its foot is 45° . Determine the height of the tower.

Ans: In lower triangle with 45° : distance $d = 7 \text{ ext{ m}}$. In upper triangle with 60° : upper height $h' = d \tan 60^\circ = 7\sqrt{3} \text{ ext{ m}}$.
Total Height $H = 7 + 7\sqrt{3} = 7(\sqrt{3} + 1) \text{ ext{ m}}$ approx $19.12 \text{ ext{ m}}$.

07. CHAPTER VISUAL MIND MAP

APPLICATIONS OF TRIGONOMETRY (HEIGHTS & DISTANCES) | — 1. CORE TERMINOLOGY | — Line of Sight (Eye to Object) | — Horizontal Level (Parallel to ground) | — Angle of Elevation (Looking UP 🙌) | — Angle of Depression (Looking DOWN 🙇 -> Convert via Z-pattern Alternate Angles) | — 2. SPECIAL TRIANGLE RATIOS (TINKU SHORTCUTS) | — 45° - 45° - 90° Triangle -> Sides Ratio = $1 : 1 : \sqrt{2}$ (Height = Shadow) | — 30° - 60° - 90° Triangle -> Sides Ratio = $1 : \sqrt{3} : 2$ (Opposite $60^\circ = \sqrt{3} \times$ Opposite 30°) | — 3. CORE QUESTION TYPES | — Single Triangle ($\tan \theta = P/B$) | — Broken Tree / Pole (Total Height = Perpendicular + Hypotenuse) | — Double Triangle - Same Side (Change in angle as observer moves) | — Double Triangle - Opposite Sides (Two objects or middle observer) | — Speed, Distance & Time (30° to 60° angle takes time T -> remaining time = $T/2$) | — 4. CBSE EXAM TRAPS & CHECKS | — Always add observer height if specified in question! | — Rationalize denominators containing $\sqrt{3}$ or $\sqrt{2}$! | — Write correct final units (metres, seconds, km/h)!

🚀 ONEPATH ONE-PAGE LAST-MINUTE REVISION SHEET

📌 MUST-REMEMBER FORMULAS & VALUES

- $\tan 30^\circ = 1/\sqrt{3} \approx 0.577$ | $\tan 45^\circ = 1$ | $\tan 60^\circ = \sqrt{3} \approx 1.732$
- $\sin 30^\circ = 1/2$ | $\sin 45^\circ = 1/\sqrt{2}$ | $\sin 60^\circ = \sqrt{3}/2$
- $\sqrt{2} = 1.414$ | $\sqrt{3} = 1.732$
- **Broken Tree Formula:** $H = d \times \tan(45^\circ + \theta/2)$
- **Speed-Time Rule ($30^\circ \rightarrow 60^\circ$):** Remaining Time = Given Time / 2

08. COMMON MISTAKES & FULL MARKS STRATEGY

⚠️ TOP 5 MISTAKES STUDENTS MAKE IN BOARD EXAMS

1. **Forgetting Alternate Angles for Angle of Depression:** Marking angle of depression with vertical instead of horizontal line.
2. **Ignoring Observer Height:** Writing $H = h$ instead of $H = h + h_{\text{ext{observer}}}$.
3. **Unrationalized Denominators:** Leaving answers as $24/\sqrt{3}$ instead of $8\sqrt{3}$. (Costs 1/2 mark!).
4. **Missing Diagram:** Drawing no diagram or an unlabelled diagram. (CBSE board guidelines mandate 1 mark deduction if diagram is missing in 3/5 mark questions!).
5. **Unit Omission:** Forgetting to write 'm', 'cm', or 'seconds' in the final line.

🏆 HOW TO PRESENT YOUR ANSWER FOR FULL MARKS

Follow this exact 5-Step CBSE Marking Scheme Layout:

Step 1: Draw a neat, labelled diagram using ruler and pencil.

Step 2: State given values clearly (e.g., Let AB be tower height = h , BC be distance = x).

Step 3: Name the right triangle explicitly before applying ratio (e.g., "In right-angled $\triangle ABC$, angle $B = 90^\circ$...").

Step 4: Show step-by-step algebraic substitution and rationalization.

Step 5: Highlight final answer in a box with correct units!

TOP 10 BOARD PRACTICE QUESTIONS CHECKLIST

- ☐ 1. Broken tree problem with 30° angle and 8m base.
- ☐ 2. Statue on top of pedestal (angle 45° and 60°).
- ☐ 3. Highway tower car speed problem (30° to 60° in 6 sec).
- ☐ 4. 7m building and cable tower (angle 60° elevation, 45° depression).
- ☐ 5. Two poles of equal height on either side of 80m road.
- ☐ 6. Cloud reflection in lake (HOTS pattern with elevation θ_1 and depression θ_2).
- ☐ 7. Two ships observed from lighthouse top (opposite sides vs same side).
- ☐ 8. Balloon moving horizontally at constant height with changing angle.
- ☐ 9. Girl 1.2m tall spotting balloon flying at height 88.2m.
- ☐ 10. Multi-structure shadow comparison when Sun's altitude changes from 30° to 45° .