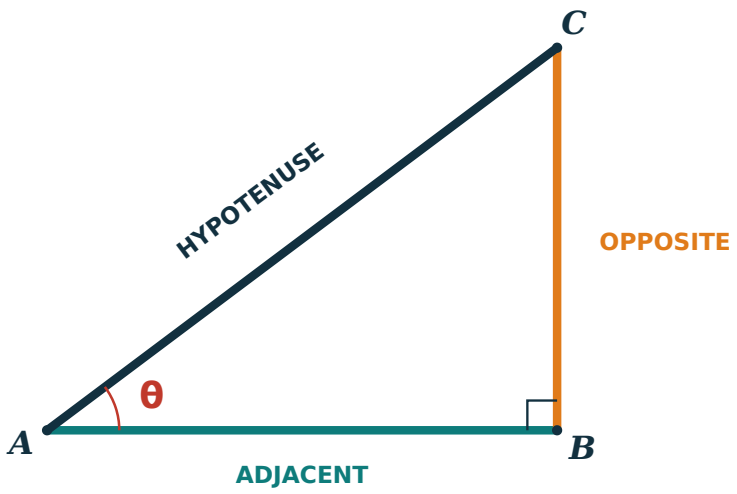
MATHS WITHOUT GUESSWORK

Introduction to Trigonometry

Understand the Triangle.
Choose the Ratio.
Solve Independently.

A guided problem-solving workbook

CBSE Class 10 Mathematics · Syllabus session 2026–27



For angle θ: sin θ = 3/5 · cos θ = 4/5 · tan θ = 3/4

INSIDE THIS BOOK

Name the sides from the angle
Choose sin, cos or tan
Derive the standard values
Use $\sin^2 A + \cos^2 A = 1$
Prove simple identities

> Signature feature:
> **Identify the sides before choosing the ratio**

Core topics: trigonometric ratios of acute angles · values at 0°, 30°, 45°, 60°, 90° · $\sin^2 A + \cos^2 A = 1$ and simple identities

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

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Opposite and adjacent depend on the angle

CORE

Learning objective: Name the opposite and adjacent sides relative to a chosen acute angle, and see why they swap.

Once the hypotenuse is fixed, the other two sides get their names **from the angle you are looking at**. Call that angle the **reference angle** (often θ, read “theta”).

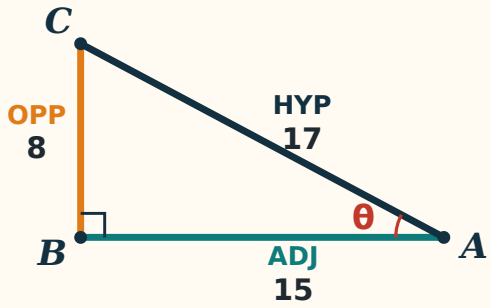
Opposite side

The side that **faces** the reference angle. It does **not touch** the angle’s corner.

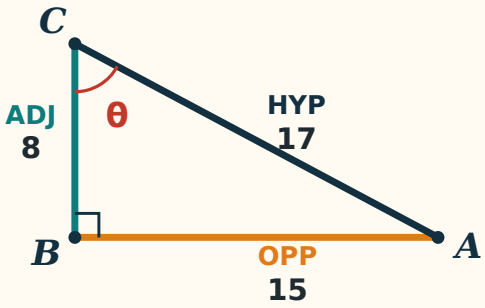
Adjacent side

The side that **touches** the reference angle and is **not** the hypotenuse. (“Adjacent” means “next to”.)

Same triangle, different angle



Reference angle A



Reference angle C

	From angle A	From angle C	Changes?
Hypotenuse	AC = 17	AC = 17	never: it is fixed by the right angle
Opposite	BC = 8	AB = 15	yes: swaps
Adjacent	AB = 15	BC = 8	yes: swaps

▲ IDENTIFY THE SIDES BEFORE CHOOSING THE RATIO — the three-question routine

Role	Side	How I know
Hypotenuse	**Q1**	Where is the right angle? The side across from it is the hypotenuse.
Opposite	**Q2**	Which side does the reference angle look across at (without touching)?
Adjacent	**Q3**	Which remaining side touches the reference angle?

Ask the three questions **in this order**. Naming the hypotenuse first stops you calling it “adjacent”, because the hypotenuse also touches the reference angle.

⚠ COMMON TRAP

Calling the hypotenuse “adjacent” because it touches the angle. Both AC and AB touch angle A, but AC is already the hypotenuse, so the adjacent side is AB.

✔ CHECK YOURSELF

C2. In ΔPQR, right-angled at R, name the hypotenuse, and the opposite and adjacent sides (a) for angle P, (b) for angle Q. What do you notice?

Concept 2 · sine, cosine and tangent

CORE

Learning objective: Define sin, cos and tan as pairs of named sides, and use them on a labelled triangle.

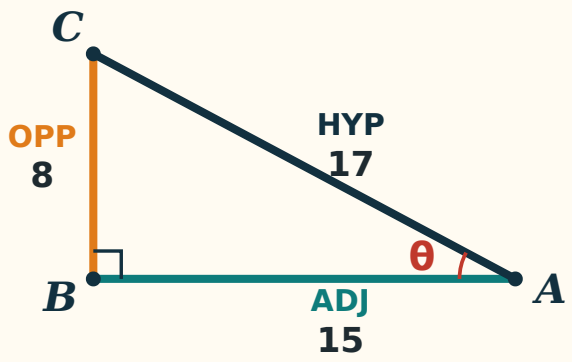
For an acute angle θ in a right triangle, three ratios compare the three pairs of sides. Each ratio is named by the **pair of sides** it uses, measured from θ.

sine	cosine	tangent
$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

What they mean. sin θ: how much of the slope is "rise". cos θ: how much of the slope is "run". tan θ: rise per unit of run, the steepness. Because the hypotenuse is the longest side, **sin θ and cos θ are less than 1** for an acute angle; tan θ can be any positive number.

Memory aid (after you understand it): SOH sine = opposite/hypotenuse · **CAH** cosine = adjacent/hypotenuse · **TOA** tangent = opposite/adjacent. The mnemonic only works if the sides were named correctly first.

Worked example 1 · all three sides known



ΔABC, right angle at B.

Question. In ΔABC, right-angled at B, AB = 15 cm, BC = 8 cm and AC = 17 cm. Find sin A, cos A and tan A.

What do I notice first? The right angle is at B, so AC is the hypotenuse.

Solution. sin A = BC/AC = **8/17**; cos A = AB/AC = **15/17**; tan A = BC/AB = **8/15**.

Check: $8^2 + 15^2 = 64 + 225 = 289 = 17^2$ ✓; sin and cos are below 1 ✓.

▲ IDENTIFY THE SIDES BEFORE CHOOSING THE RATIO — angle A in ΔABC

Role	Side	How I know
Hypotenuse	**AC = 17**	opposite the right angle at B
Opposite	**BC = 8**	faces angle A; does not touch A
Adjacent	**AB = 15**	touches A; it is not the hypotenuse

Why these ratios? sin uses OPP & HYP → 8/17 · cos uses ADJ & HYP → 15/17 · tan uses OPP & ADJ → 8/15.

✓ CHECK YOURSELF

Explain it in your own words. Why is the hypotenuse never the *top* of a sine or cosine fraction? (Think about the answer being bigger than 1.)

✓ EXAM TIP

In your answer, write the ratio in words before numbers, e.g. "sin A = BC/AC = 8/17". The letters show the examiner you named the sides.

✎ YOUR TURN

T1 (transfer). In the same triangle, find sin C, cos C and tan C. Name the sides from angle C first. What do you notice when you compare with sin A and cos A?

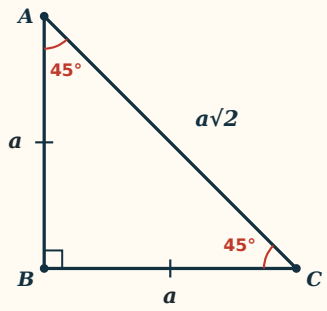
Concept 5 · Standard values from two triangles

CORE

Learning objective: Derive the ratios of 30°, 45° and 60° from the half-square and half-equilateral triangles.

The values for 30°, 45° and 60° are not things to memorise blindly. Each comes from one simple triangle you can redraw in ten seconds.

45°: half a square



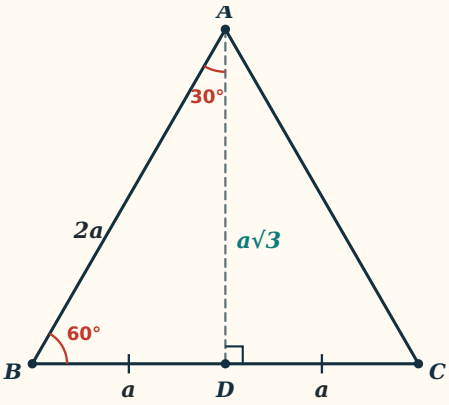
Isosceles right triangle.

In ΔABC right-angled at B with ∠A = ∠C = 45°, the two legs are equal (equal angles face equal sides): AB = BC = a. Pythagoras: AC = √(a² + a²) = a√2.

From 45° (either angle): opposite = a, adjacent = a, hypotenuse = a√2.

$$\sin 45° = \frac{a}{a\sqrt{2}} = \frac{1}{\sqrt{2}} \cdot \cos 45° = \frac{1}{\sqrt{2}} \cdot \tan 45° = \frac{a}{a} = 1$$

30° and 60°: half an equilateral triangle



Equilateral ABC, AD ⊥ BC.

Take equilateral ΔABC with side 2a; every angle is 60°. Drop AD ⊥ BC. Triangles ABD and ACD are congruent (RHS), so BD = a and ∠BAD = 30°. In right ΔABD: AD = √((2a)² − a²) = a√3.

From **30°** (at A): opp BD = a, adj AD = a√3, hyp AB = 2a. From **60°** (at B): opp AD = a√3, adj BD = a, hyp 2a.

$$\sin 30° = \frac{1}{2} \cdot \cos 30° = \frac{\sqrt{3}}{2} \cdot \tan 30° = \frac{1}{\sqrt{3}} \quad \sin 60° = \frac{\sqrt{3}}{2} \cdot \cos 60° = \frac{1}{2} \cdot \tan 60° = \sqrt{3}$$

▲ IDENTIFY THE SIDES BEFORE CHOOSING THE RATIO — ΔABD, the 30°–60°–90° triangle

Role	Side	How I know
Hypotenuse	**AB = 2a**	opposite the right angle at D, for both acute angles
Opposite	**30°: BD = a · 60°: AD = a√3**	the side each angle faces
Adjacent	**30°: AD = a√3 · 60°: BD = a**	the side each angle touches (not AB)

The same two legs swap roles between 30° and 60°. That is why sin 30° = cos 60° = 1/2 and cos 30° = sin 60° = √3/2.

⚠ COMMON TRAP

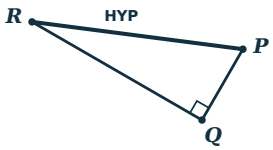
Thinking the shortest side is opposite 60°. The shortest side (a) is opposite the **smallest** angle, 30°. Bigger angle, bigger opposite side.

✓ CHECK YOURSELF

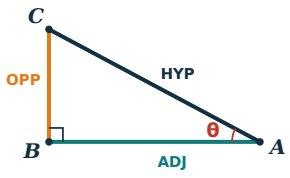
C10. Without the table, derive cosec 60°, sec 30° and cot 45° from the triangles above. Rationalise where needed.

Doubts 1–2: hypotenuse, opposite, adjacent

DOUBT 1 *"In a tilted triangle I can't tell which side is the hypotenuse."*

✗ WHY THIS CONFUSION HAPPENS	Students learn the hypotenuse as "the slanting side", which only works when the triangle sits on a flat base.
◆ UNDERSTAND	The hypotenuse is the side **opposite the right angle**, and it is always the longest side. Find the small square first; the side not touching that corner is the hypotenuse.
★ SPOT THE CLUE	The right-angle mark, or the words "right-angled at Q".
➤ CHOOSE THE RATIO / IDENTITY	No ratio yet. Naming the hypotenuse comes before every ratio.
✦ SOLVED EXAMPLE	ΔPQR is right-angled at Q, drawn tilted. The side not touching Q is PR, so PR is the hypotenuse, even though it is drawn vertically and looks "straight". 
? WHY THIS STEP?	If the hypotenuse is wrong, every ratio built on it is wrong.
⚠ COMMON TRAP	Picking the longest-looking or most slanted line. Figures are not drawn to scale.
✎ YOUR TURN DB1	ΔKLM is right-angled at L. Name the hypotenuse. If KL = 9 and LM = 12, find its length.
✔ CHECK YOURSELF	Your answer must be longer than both 9 and 12.

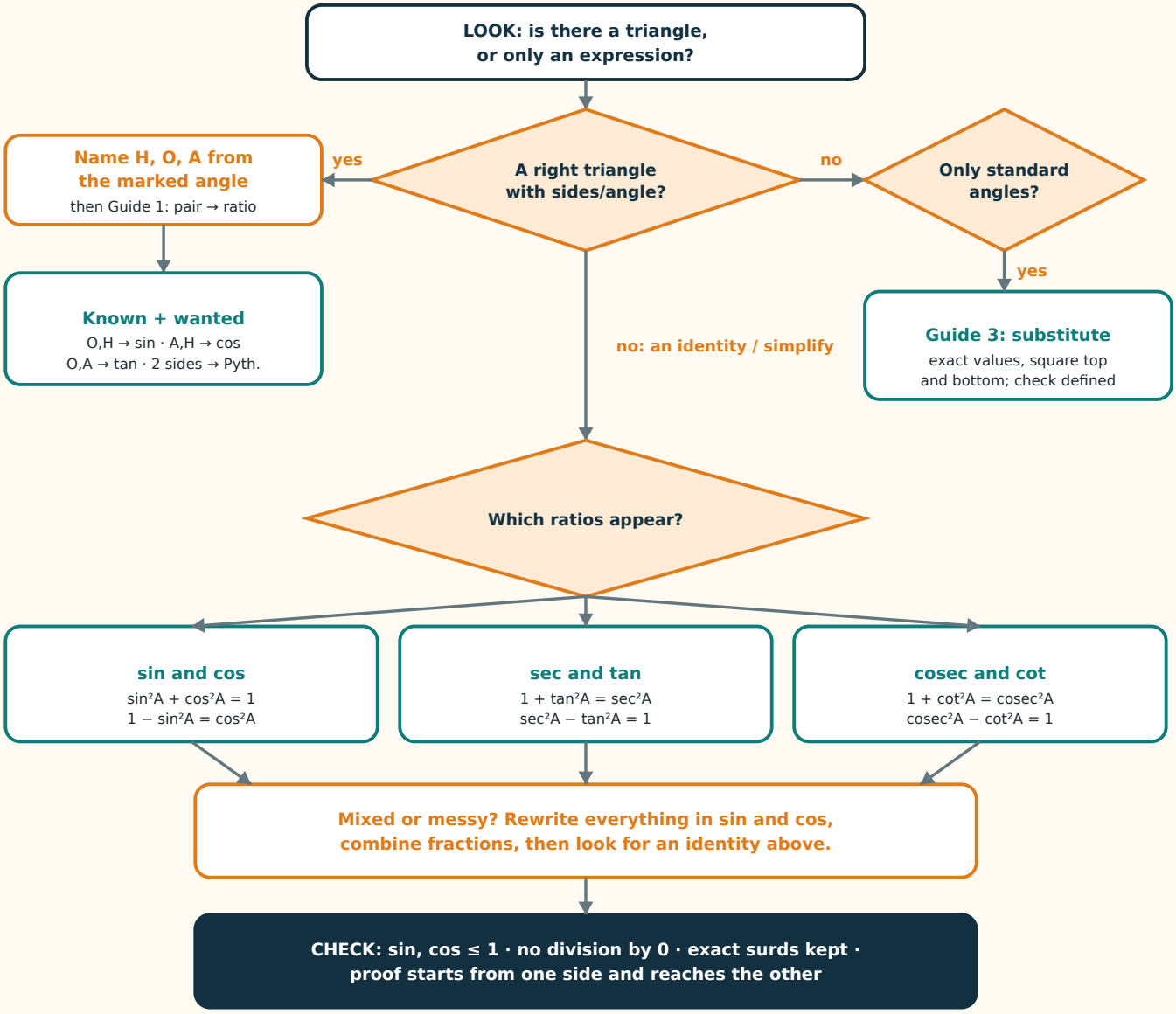
DOUBT 2 *"How do I tell the opposite side from the adjacent side?"*

✗ WHY THIS CONFUSION HAPPENS	Both shorter sides "touch" the triangle; the words feel vague.
◆ UNDERSTAND	From the reference angle: the **opposite** side is the one it faces and does **not touch**; the **adjacent** side touches it. The hypotenuse also touches it, so name the hypotenuse first and exclude it.
★ SPOT THE CLUE	The marked angle (θ or a letter). Put your finger on that corner.
➤ CHOOSE THE RATIO / IDENTITY	Once O and A are named, the ratio follows from the pair needed.
✦ SOLVED EXAMPLE	Right angle at B, angle A marked, AB = 15, BC = 8, AC = 17. A touches AB and AC; AC is the hypotenuse, so **adjacent = AB**. A does not touch BC, so **opposite = BC**. 
? WHY THIS STEP?	Excluding the hypotenuse first leaves exactly one touching side: the adjacent.
⚠ COMMON TRAP	Calling AC adjacent because it touches A.
✎ YOUR TURN DB2	In ΔXYZ right-angled at Z with angle X marked, name the opposite and adjacent sides.
✔ CHECK YOURSELF	The opposite side never contains the letter of the reference angle.

Ratio and identity flowchart

Learning objective: Follow a decision path from the question to the first correct step.

Start at the top. Each diamond is a question about the problem in front of you; each box is an action you already know. A question can pass through two branches, so look again after the first step.



Trace two questions through the chart

Question	Path
Right ΔABC, ∠B = 90°, ∠A = 30°, BC = 4. Find AC.	triangle → name sides: BC opp, AC hyp → O,H → sin: AC = 4 ÷ ½ = 8
Evaluate $\tan^2 60° - \sec^2 60°$.	no triangle → standard angles → substitute: 3 − 4 = −1 (also the identity 1 + tan² = sec² gives −1 ✓)

✓ CHECK YOURSELF

Try the chart. “Simplify $(1 + \tan^2 A)\cos^2 A$.” Which boxes do you pass through? (Answer: no triangle → not standard angles → sec and tan → $1 + \tan^2 A = \sec^2 A$, then $\sec^2 A \cos^2 A = 1$.)

Mistake clinic (1 of 3)

MISTAKE 1 · Wrong hypotenuse

✗ STUDENT'S WORK	*"Right angle at B, AB = 3, BC = 4, AC = 5. sin A = AC/BC = 5/4."*
⚠ WHERE IT FAILS	AC is the hypotenuse and belongs on the bottom of a sine. A sine above 1 is impossible.
? WHY TEMPTING	AC is the longest number, and the student wrote the biggest number first.
✓ CORRECTED	sin A = opp/hyp = BC/AC = 4/5.
➤ PREVENTION RULE	**Find the right angle; the side across from it is the hypotenuse.**
✎ FIX IT E1	A student writes cos C = 13/12 in a 5-12-13 triangle. Explain the error and correct it.

MISTAKE 2 · Sides not renamed for a new angle

✗ STUDENT'S WORK	*"From A: opp = BC, adj = AB. So tan C = BC/AB too."*
⚠ WHERE IT FAILS	From C, the sides swap: opposite is AB and adjacent is BC.
? WHY TEMPTING	The same triangle is still on the page, so the old labels feel valid.
✓ CORRECTED	tan C = AB/BC.
➤ PREVENTION RULE	**New angle → new O and A. Only H stays.**
✎ FIX IT E2	In ΔPQR (right angle at Q), a student uses sin R = QR/PR. Is that right? Which ratio of R is QR/PR?

MISTAKE 3 · Ratio chosen from a pattern

✗ STUDENT'S WORK	*"∠A = 30°, hypotenuse 10, want the adjacent side. tan 30° = adj/10."*
⚠ WHERE IT FAILS	tan uses opposite and adjacent; the hypotenuse is not in tan at all.
? WHY TEMPTING	The previous example used tan, so the student repeated it.
✓ CORRECTED	Adjacent and hypotenuse → cos: cos 30° = adj/10, adj = 10 × √3/2 = 5√3.
➤ PREVENTION RULE	**Name the two sides involved, then pick the ratio with exactly that pair.**
✎ FIX IT E3	∠P = 60°, opposite side 9 cm, want hypotenuse. A student uses cos. Choose correctly and solve.

MISTAKE 4 · Mixing up sin and cos values

✗ STUDENT'S WORK	*"sin 60° = 1/2."*
⚠ WHERE IT FAILS	In the 30-60-90 triangle, 60° faces the longer leg √3, so sin 60° = √3/2. The value 1/2 is sin 30° (= cos 60°).
? WHY TEMPTING	The two values 1/2 and √3/2 are swapped in memory.
✓ CORRECTED	sin 60° = √3/2; cos 60° = 1/2.
➤ PREVENTION RULE	**Sketch the 1-√3-2 triangle: the shortest side faces the smallest angle.**
✎ FIX IT E4	Write sin 30°, cos 30°, sin 60°, cos 60° from the triangle, not from memory.

Practice 1 · Recognise

Learning objective: Identify sides, match ratios, recognise standard values and identities.

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

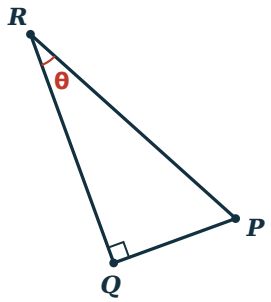
Answers: Section H

P1 In ΔABC, right-angled at C, the hypotenuse is
(A) AB (B) BC (C) AC (D) it depends on the marked angle

Purpose: Find the hypotenuse from the right angle. **easy** ★☆☆

Working space (use separate paper if needed)

P2 In the figure, the right angle is at Q and angle R is marked. Name the hypotenuse, the side opposite R and the side adjacent to R. Then name the side opposite P.



Purpose: Name sides relative to an angle. **easy** ★☆☆

Working space (use separate paper if needed)

P3 Which ratio equals hypotenuse ÷ adjacent?
(A) sin θ (B) cosec θ (C) sec θ (D) cot θ

Purpose: Match a ratio to its sides. **easy** ★☆☆

Working space (use separate paper if needed)

P4 Which of these equals ½?
(A) sin 60° (B) cos 60° (C) tan 45° (D) sin 45°

Purpose: Recognise a standard value. **easy** ★☆☆

Working space (use separate paper if needed)

P5 True or false? Give a reason. (a) tan A is always less than 1. (b) sec A = 12/5 for some acute angle A. (c) cos A is short for the cosecant of A. (d) sin θ = 4/3 for some angle θ.

Purpose: Test the size of each ratio. **moderate** ★★☆

Working space (use separate paper if needed)

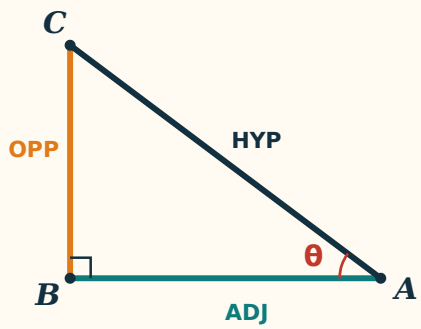
P6 Match each expression with a single ratio, naming the identity: (a) $1 - \sin^2 A$ (b) $\sec^2 A - 1$ (c) $\operatorname{cosec}^2 A - \cot^2 A$.

Purpose: Recognise identities. **easy** ★☆☆

Working space (use separate paper if needed)

One-page revision sheet

Learning objective: Recall every ratio, the standard values, the identities and the side-naming habit on one page.



Ratio	Sides from θ	Ratio	Sides from θ
sin	O/H	cosec = 1/sin	H/O
cos	A/H	sec = 1/cos	H/A
tan	O/A	cot = 1/tan	A/O

tan = sin/cos · cot = cos/sin · sin, cos ≤ 1 · sec, cosec ≥ 1

∠A	0°	30°	45°	60°	90°
sin	0	1/2	1/√2	√3/2	1
cos	1	√3/2	1/√2	1/2	0
tan	0	1/√3	1	√3	n.d.
cosec	n.d.	2	√2	2/√3	1
sec	1	2/√3	√2	2	n.d.
cot	n.d.	√3	1	1/√3	0

n.d. = not defined (division by 0). Rebuild 30°/60° from the 1-√3-2 triangle and 45° from 1-1-√2.

◆ UNDERSTAND

Identities (from Pythagoras):

$\sin^2 A + \cos^2 A = 1$

$1 + \tan^2 A = \sec^2 A \quad (0° \le A < 90°)$

$1 + \cot^2 A = \operatorname{cosec}^2 A \quad (0° < A \le 90°)$

Enrichment only: $\sin(90° - A) = \cos A$, $\cos(90° - A) = \sin A$, $\tan(90° - A) = \cot A$.

▲ IDENTIFY THE SIDES BEFORE CHOOSING THE RATIO — the habit to keep

Role	Side	How I know
Hypotenuse	1st	the side across from the right angle (longest)
Opposite	2nd	the side the marked angle faces (does not touch)
Adjacent	3rd	the side the marked angle touches, not the hypotenuse

Then choose: O + H → sin · A + H → cos · O + A → tan · unknown on the bottom → use the reciprocal · two sides, no angle → Pythagoras.

★ SPOT THE CLUE

Evaluating: identify → substitute in brackets → square top and bottom → common denominators → check for 1/0. **Proving:** start from the harder side, rewrite in sin and cos, combine fractions, apply an identity, cancel only factors, end with "= RHS".

⚠ COMMON TRAP

Final error checklist. ☐ wrong hypotenuse (E1) ☐ sides not renamed (E2) ☐ ratio by habit (E3) ☐ sin/cos values swapped (E4) ☐ ratio vs reciprocal (E5) ☐ $\sin^2 A$ misread (E6) ☐ half-squared fraction (E7) ☐ root/fraction slip (E8) ☐ value for "not defined" (E9) ☐ sin(A + B) split (E10) ☐ cancelled a term (E11) ☐ assumed the result (E12)

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- **Foundation.** Concept explanations that build the ideas the chapter depends on.
- **Core concepts.** Worked examples with a reason for every step, and quick checks to try.
- **Doubt Bank.** 14 common doubts answered clearly, each followed by a question to try.
- **Ratio and identity selection.** Clue tables, decision charts and look-alike questions that train you to choose the method.
- **Mistake Clinic.** 12 common mistakes: the wrong work, why it is tempting, and the fix.

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