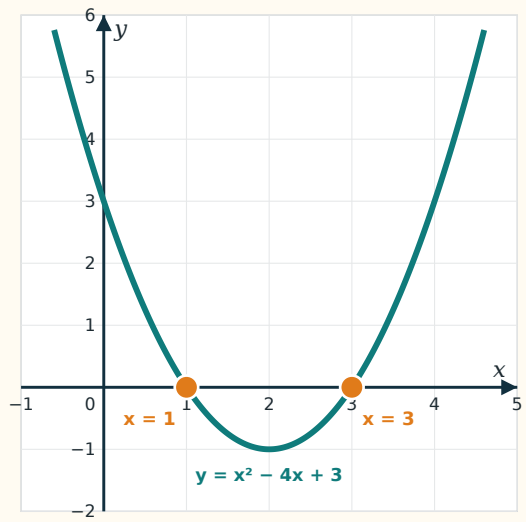
MATHS WITHOUT GUESSWORK

Quadratic Equations

Understand the Equation. Choose the Method. Solve Independently.

A step-by-step concept, problem-solving and board-exam practice workbook for Class 10 Mathematics

CBSE Class 10 Mathematics · Syllabus session 2026–27 · Volume 4



THREE QUESTIONS

1. **What am I** looking at?
2. **What should** I do next?
3. **How do I know** it is correct?

$x^2 - 4x + 3 = 0$

the curve crosses the x-axis at the roots: x = 1 and x = 3

Core topics: standard form · factorisation · quadratic formula · discriminant · word problems

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

Liked this? The full Quadratic Equations workbook is ₹99 →

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1 What am I looking at? | 2 What should I do next? | 3 How do I know it's correct? CORE

What makes an equation quadratic?

Learning objective: Tell an expression from an equation, and name the parts of a quadratic equation.

An **expression** such as $x^2 - 5x + 6$ is a bundle of terms. It has no "=" sign, so there is nothing to solve. An **equation** such as $x^2 - 5x + 6 = 0$ is a statement. It is true for some values of x and false for others. **Solving** means finding the values that make it true.

◆ UNDERSTAND

A **quadratic equation** in x can be written as $ax^2 + bx + c = 0$, where a, b, c are real numbers and **$a \neq 0$**. It has one unknown, and the highest power of that unknown is exactly 2. The word comes from the Latin *quadratus*, "square", because x^2 is a square.

VISUAL 1 · ANATOMY OF A QUADRATIC EQUATION

$$3x^2 - 5x + 2 = 0$$

$3x^2$	$-5x$	$+2$
a = 3	**b = −5**	**c = +2**
coefficient of x^2 (never 0)	coefficient of x (sign included)	constant term (no x at all)

One equation, three disguises. These all describe the same equation and have the same roots (2 and 3). You will often meet the second and third before the first.

Form	Written as	Standard form
Standard	$x^2 - 5x + 6 = 0$	$a = 1, b = -5, c = 6$
Terms on both sides	$x^2 = 5x - 6$	move every term to one side first
Factors in view	$x(x - 5) = -6$	expand, then move: $x^2 - 5x + 6 = 0$

★ SPOT THE CLUE

How a story becomes a quadratic equation. A garden is x metres wide and (x + 3) metres long. Its area is 40 m². Area = length × breadth, so $x(x + 3) = 40$, which becomes $x^2 + 3x - 40 = 0$. Here $a = 1$, $b = 3$, $c = -40$. The clue: a length times a length gave x^2, so the highest power is 2. (Check: $x = 5$ gives $5 \times 8 = 40$ ✓.)

⚠ COMMON TRAP

"It has x^2 in it, so it is quadratic." Not always. $x^2 + 3x = x^2 + 5$ has x^2 on both sides, and they cancel to $3x = 5$, a linear equation. Decide only after you simplify (page 7).

✎ YOUR TURN

C1 (guided) Which of these are quadratic equations? For each one, write a, b and c. (a) $3x^2 - 2x + 1 = 0$ (b) $2x - 5 = 0$ (c) $x^3 + x = 2$ (d) $5 - x^2 = 0$ (e) $y^2 = 16$

1 What am I looking at? 2 What should I do next? 3 How do I know it's correct? CORE

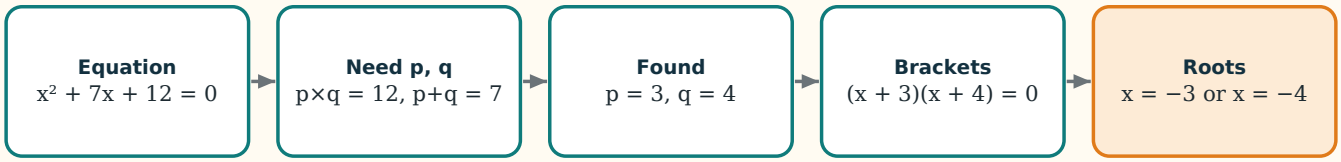
Splitting the middle term: when a = 1

Learning objective: Find the two brackets of $x^2 + bx + c$ using a product-and-sum search.

◆ UNDERSTAND

Why product and sum? Expand $(x + p)(x + q)$: you get $x^2 + (p + q)x + pq$. So to factorise $x^2 + bx + c$ we look for two numbers **p and q with p × q = c and p + q = b**. Then the brackets are $(x + p)(x + q)$.

VISUAL 4 · FACTORISATION WALKTHROUGH



Pairs with product 12 and their sums: 1 + 12 = 13, 2 + 6 = 8, **3 + 4 = 7** ✓. Only the last pair has sum 7.

Worked example (moderate). Solve $x^2 - 2x - 15 = 0$ by splitting the middle term.

Q	Working	Why this step?
① LOOK	$x^2 - 2x - 15 = 0$: quadratic. a = 1, b = −2, c = −15.	Question 1: identify the type; read a, b, c with signs.
② DO	Find two numbers with product ac = 1×(−15) = −15 and sum b = −2: 3 and −5.	Check: 3 + (−5) = −2 ✓; 3 × (−5) = −15 ✓.
	$x^2 + 3x - 5x - 15 = 0$ $x(x + 3) - 5(x + 3) = 0$ $(x - 5)(x + 3) = 0$	Split, group, then take out the common bracket.
	$x - 5 = 0$ or $x + 3 = 0$ so $x = 5$ or $x = -3$.	A product is zero only if a factor is zero.
③ VERIFY	$x = -3$: $(-3)^2 - 2(-3) - 15 = 9 + 6 - 15 = 0$ ✓ $x = 5$: $5^2 - 2 \cdot 5 - 15 = 25 - 10 - 15 = 0$ ✓	Substitute each root into the original equation.

★ SPOT THE CLUE

Sign clue. Look at c first. If **c is positive**, p and q have the *same* sign (both positive if b is positive, both negative if b is negative). If **c is negative**, they have *opposite* signs, and the larger one takes the sign of b. Here c = −15, so one number is positive and one negative; b = −2 means the larger is negative: −5 and +3.

⚠ COMMON TRAP

Right numbers, wrong signs. For $x^2 - 2x - 15$ a student picks 5 and −3 (product −15 ✓, sum +2 ✗). That gives $(x + 5)(x - 3) = x^2 + 2x - 15$, not the original. *Check by expanding:* the sum of the two numbers must equal b **with its sign**. Correct pair: −5 and 3 (sum −2).

✎ YOUR TURN

C8 (part-guided) Solve by factorisation: (a) $x^2 - 9x + 20 = 0$ (b) $x^2 + 3x - 28 = 0$. For each, write the product and sum you need, then check both roots in the original equation.

1 What am I looking at? 2 What should I do next? 3 How do I know it's correct? CORE

The quadratic formula: surd roots and checking

Learning objective: Simplify roots that contain square roots and check them with sum and product.

◆ UNDERSTAND

When D is not a perfect square, the roots contain a square root (a **surd**). They are exact and perfectly correct. Simplify √D by taking out square factors (√20 = √4 × √5 = 2√5), then divide **every** term of the numerator by the common factor.

Example 1. Solve $x^2 - 4x - 1 = 0$.

Q	Working	Why this step?
① LOOK	$x^2 - 4x - 1 = 0$: quadratic, already in standard form. a = 1, b = −4, c = −1.	Read the signs carefully: b is the number with its sign.
② DO	Discriminant: $b^2 - 4ac = (-4)^2 - 4(1)(-1) = 16 - (-4) = 20$. Since D > 0, there are two distinct real roots.	Compute D first, with brackets; it tells you what to expect.
	Substitute: $x = (-(-4) \pm \sqrt{20}) / (2\times1)$	−b = −(−4) = 4; 2a = 2. Brackets stop sign errors.
	$\sqrt{20} = 2\sqrt{5}$ (simplified) $x = (4 \pm 2\sqrt{5}) / 2$ $x = 2 - \sqrt{5}$ or $x = 2 + \sqrt{5}$	Take out the largest square factor, then divide **every** term of the top by the common factor.
③ VERIFY	Sum of roots = 4 = −b/a = 4 ✓; product = −1 = c/a ✓. Decimals: −0.236 and 4.236.	Substitute rational roots; for surd roots use sum = −b/a and product = c/a.

Example 2 (needs cancelling). Solve $3x^2 - 8x + 2 = 0$.

Q	Working	Why this step?
① LOOK	$3x^2 - 8x + 2 = 0$: a = 3, b = −8, c = 2	Standard form; signs read.
② DO	$b^2 - 4ac = (-8)^2 - 4(3)(2) = 64 - 24 = 40$: D = 40 is not a perfect square, so factorising is unlikely.	D tells us roots exist but are not rational.
	$x = (8 \pm \sqrt{40}) / 6 = (8 \pm 2\sqrt{10}) / 6 = (4 \pm \sqrt{10}) / 3$	√40 = 2√10; then divide top and bottom by 2.
③ VERIFY	Sum of roots = 8/3 = −b/a = 8/3 ✓; product = 2/3 = c/a ✓. Decimals: 0.279 and 2.387.	Sum 8/3 = −b/a; product 2/3 = c/a; and decimals look sensible.

⚠ COMMON TRAP

Cancelling only one term. $(4 \pm 2\sqrt{5})/2$ is **not** $4 \pm \sqrt{5}$. The 2 in the denominator must divide both 4 and 2√5: $2 \pm \sqrt{5}$. *Check:* 2 + √5 ≈ 4.236 and $x^2 - 4x - 1$ at 4.236 is ≈ 0 ✓, whereas 4 + √5 ≈ 6.236 gives 38.9 − 24.9 − 1 ≈ 13 ✗.

✎ YOUR TURN

C12 (part-guided) Solve $2x^2 - 6x + 3 = 0$ by the formula. Leave the answer in surd form and check with sum and product.
T2 (transfer) Solve $x^2 + 6x + 4 = 0$ and give each root to 2 decimal places (use √5 ≈ 2.236).

1 What am I looking at? | 2 What should I do next? | 3 How do I know it's correct?

Doubts 1 and 2: type and sign slips

DOUBT 1 *"How do I know whether an equation is quadratic?"* Q1

✗ WHY IT HAPPENS	I look at the equation and decide by eye. If there is an x^2 I say "quadratic", even when other terms hide or cancel it.
◆ SIMPLE EXPLANATION	Simplify the equation completely first. Then look at the **highest power of x** that is left: 2 means quadratic, 1 means linear.
★ SPOT THE CLUE	Brackets multiplying each other, squares or cubes of brackets, and the same power on both sides (which can cancel).
▦ WORKED EXAMPLE	(a) $x^2 + 5x = (x + 1)^2 + 3 \rightarrow x^2 + 5x = x^2 + 2x + 4 \rightarrow 3x - 4 = 0$: **linear**. (b) $(2x - 1)(x + 3) = 6 - x \rightarrow 2x^2 + 5x - 3 = 6 - x \rightarrow 2x^2 + 6x - 9 = 0$: **quadratic**.
? WHY THIS STEP?	Expanding makes hidden x^2 terms appear or cancel. You can only know the degree once everything is on one side and simplified.
⚠ COMMON TRAP	Calling (a) quadratic because it began with x^2. The two x^2 terms cancelled.
✎ YOUR TURN DB1	**DB1** Simplify and decide: (a) $x(x + 3) = x^2 - 4$ (b) $(x - 2)(x + 5) = 2x^2 - 1$ (c) $(x + 2)^3 = x^3 + 8$. Write a, b, c for each quadratic.
✓ QUICK CHECK	After simplifying, the highest power of x tells you the type.

DOUBT 2 *"Terms are on both sides and I keep making sign mistakes when moving them."* Q1

✗ WHY IT HAPPENS	I treat "moving" as a rule to memorise ("change the sign") instead of an action on both sides, so I forget a term or flip the wrong sign.
◆ SIMPLE EXPLANATION	Moving a term means doing the same operation to both sides: to remove $2x^2$ from the right, **subtract $2x^2$** from both sides. The sign changes because you subtracted.
★ SPOT THE CLUE	Quadratic terms or numbers on *both* sides of "=". Aim for the form *expression* = *0*.
▦ WORKED EXAMPLE	$3x^2 - 2x = 2x^2 + 5x - 6$. Subtract $2x^2$: $x^2 - 2x = 5x - 6$. Subtract $5x$: $x^2 - 7x = -6$. Add 6: $x^2 - 7x + 6 = 0$. So $a = 1$, $b = -7$, $c = 6$. Roots: $(x - 1)(x - 6) = 0$, $x = 1$ or 6. *Check $x = 1$ in the original:* $3 - 2 = 1$ and $2 + 5 - 6 = 1$ ✓.
? WHY THIS STEP?	Doing it as three small subtractions or additions keeps every sign tied to an operation.
⚠ COMMON TRAP	Writing $x^2 - 2x + 2x^2 + 5x$ ..., that is, adding instead of subtracting the right side.
✎ YOUR TURN DB2	**DB2** Write in standard form and give a, b, c: (a) $4x^2 + 3 = 5x - 2x^2$ (b) $7 - x^2 = 2(x - 4)$.
✓ QUICK CHECK	Test your standard form with a number: it should hold when the original holds.

1 What am I looking at? | 2 What should I do next? | 3 How do I know it's correct?

CORE

Decision tree: from the equation to the first step

Learning objective: Follow the questions from the top; stop at the first "yes".

VISUAL 8 · METHOD-SELECTION DECISION TREE

Q1. Is it a story in words?
- yes → Define x and form the equation (pp. 19–20); then ask the next questions about that equation.
- no ↓

Q2. Simplify. Is the highest power of x equal to 2?
- no → **No:** it is not quadratic (linear if the highest power is 1). Stop.
- yes ↓

Q3. Is it written as $ax^2 + bx + c = 0$ with a, b, c known?
- no → **No:** expand, move all terms to one side, collect (page 7).
- yes ↓

Q4. Does it ask only for nature of roots, real roots, or a value of k?
- yes → **Yes:** find $D = b^2 - 4ac$ only (pp. 17–18). The roots are not needed.
- no ↓

Q5. Is b = 0 or c = 0?
- yes → **b = 0:** x^2 = number, take $\pm\sqrt{}$. **c = 0:** take x out as a common factor (p. 14).
- no ↓

Q6. Is D a perfect square, or are the numbers small?
- yes → **Yes:** factorise by splitting the middle term (pp. 11–14).

Otherwise (D not a perfect square, messy numbers) → **Use the quadratic formula** (pp. 15–16): a, b, c with brackets, then D, then the roots.

Always, at the end (Question 3): substitute each root (or use sum = −b/a and product = c/a); in a word problem, test each root against the story.

◆ UNDERSTAND

The tree is a guide, not a law. If you can see the factors at once, use them even if the tree says "formula". And a recommended method is never the only valid method: the roots are the same whichever method finds them (see page 31).

✎ YOUR TURN

C18 (guided) Walk each equation through the tree and write the branch: (a) $x^2 - 5x = 0$ (b) $2x^2 - 3x + 7 = 0$ (is it worth solving?) (c) $(x + 2)^2 = 9$ (d) $x^2 - 6x + 7 = 0$

1 What am I looking at? 2 What should I do next? 3 How do I know it's correct?

Mistake clinic (1 of 3)

MISTAKE 1 Rearranging with sign errors

✗ STUDENT'S WORK	Solve $x^2 = 7x - 12$. The student writes $x^2 + 7x - 12 = 0$, so a = 1, b = 7, c = −12.
✗ WHERE IT FAILS	The original has root x = 3 ($9 = 21 - 12$ ✓), but the student's equation gives $9 + 21 - 12 = 18 \neq 0$ ✗. The equation has changed.
? WHY IT TEMPTS	"The terms were already there, so I just copy them across." Moving a term across "=" changes its sign.
✓ CORRECTED	Subtract 7x and add 12 on both sides: $x^2 - 7x + 12 = 0$. So a = 1, b = −7, c = 12. Roots 3 and 4 (check $9 - 21 + 12 = 0$ ✓).
★ PREVENTION RULE	Moving = the same operation on both sides. Test the new equation with a known root.
✎ FIX IT E1	**E1** A student rewrites $2x^2 = 5x - 3$ as $2x^2 + 5x - 3 = 0$. Find the error, correct it and solve.

MISTAKE 2 Misreading a, b, c

✗ STUDENT'S WORK	For $3 - 4x + x^2 = 0$ the student takes a = 3, b = −4, c = 1 and finds roots $(4 \pm 2)/6 = 1, 1/3$.
✗ WHERE IT FAILS	Put x = 1/3 back: $3 - 4/3 + 1/9 \neq 0$ ✗. Only x = 1 works; the other root is wrong because a and c were swapped.
? WHY IT TEMPTS	Reading the numbers from left to right. The first number is not always a.
✓ CORRECTED	a is the coefficient of x^2: $x^2 - 4x + 3 = 0$ gives a = 1, b = −4, c = 3, and roots 1 and 3 (check $9 - 12 + 3 = 0$ ✓).
★ PREVENTION RULE	Rewrite in the order $ax^2 + bx + c = 0$ before reading a, b, c.
✎ FIX IT E2	**E2** Write a, b, c for $4 - 7x + 2x^2 = 0$ and say which value a student would wrongly take as a.

MISTAKE 3 Losing the sign when solving brackets

✗ STUDENT'S WORK	$(2x - 3)(x + 4) = 0$. The student writes x = −3/2 and x = 4 (copying the numbers with their sign).
✗ WHERE IT FAILS	Test x = 4: $(2 \cdot 4 - 3)(4 + 4) = 5 \times 8 = 40 \neq 0$ ✗.
? WHY IT TEMPTS	The bracket shows −3 and +4, so it feels natural to copy them as roots.
✓ CORRECTED	Solve each bracket: $2x - 3 = 0$ gives x = 3/2; $x + 4 = 0$ gives x = −4. (Check x = −4: second bracket is 0 ✓.)
★ PREVENTION RULE	Write "bracket = 0" and solve it; never copy signs.
✎ FIX IT E3	**E3** Find the roots of $(3x + 1)(x - 6) = 0$ and check both.

MISTAKE 4 Wrong factorisation

✗ STUDENT'S WORK	For $2x^2 + 7x + 3 = 0$ the student writes $(2x + 3)(x + 1) = 0$, so x = −3/2 or −1.
✗ WHERE IT FAILS	Expand: $(2x + 3)(x + 1) = 2x^2 + 5x + 3$, not $2x^2 + 7x + 3$. The middle term is wrong.
? WHY IT TEMPTS	Using 2 × 1 for $2x^2$ and 3 × 1 for 3 without checking the middle term.
✓ CORRECTED	ac = 6; numbers with sum 7: 1 and 6. $2x^2 + x + 6x + 3 = (2x + 1)(x + 3)$, so x = −1/2 or −3.
★ PREVENTION RULE	Always expand your factors to see whether you get the original expression.
✎ FIX IT E4	**E4** A student factorises $x^2 + x - 12$ as $(x + 6)(x - 2)$. Check by expanding, then solve correctly.

1 What am I looking at? 2 What should I do next? 3 How do I know it's correct?

Recognise and set up

Learning objective: Question 1 of the ebook: What am I looking at?

1 Guided 2 Part-guided 3 Independent 4 Unfamiliar Guided to part-guided: decide, rewrite, test.

P1 Simplify each equation. Decide whether it is quadratic and, if so, write a, b, c. (a) $2x^2 - 3x + 1 = 0$ (b) $x(x + 3) = x^2 - 5$ (c) $(x + 1)^2 = 2x - 3$ (d) $x^3 - x^2 = 2$

Purpose: Look before you solve **Foundation** ★☆☆

Hint (not the solution): Expand brackets first; compare the highest power.

Working space

P2 Write in the form $ax^2 + bx + c = 0$ with a, b, c. (a) $3x^2 = 5x - 2$ (b) $(x + 2)(x - 3) = 2x$ (c) $5 - x^2 = 4x$ (make a positive)

Purpose: Standard form **Foundation** ★☆☆

Hint (not the solution): Move every term to one side, then collect like terms.

Working space

P3 Is the given number a root? (a) $x = 2$ in $x^2 - 3x + 2 = 0$ (b) $x = -3$ in $x^2 + x - 6 = 0$ (c) $x = 1/2$ in $2x^2 - x - 1 = 0$

Purpose: Test, do not solve **Foundation** ★☆☆

Hint (not the solution): Substitute and see whether the left side becomes 0.

Working space

P4 For what value of k is $(k - 2)x^2 + 3x - 5 = 0$ not a quadratic equation? Then write a, b, c when $k = 5$.

Purpose: Why $a \neq 0$ **Standard** ★★☆

Working space

P5 True or false, with a reason: (a) Every quadratic equation has exactly two real roots. (b) In a quadratic equation a can be 0. (c) If $x = 3$ is a root, then $(x - 3)$ is a factor.

Purpose: Concept check **Standard** ★★☆

Working space

P6 $x = 2$ is a root of $x^2 + kx + 6 = 0$. Find k, then find the other root and verify it.

Purpose: Use a root **Standard** ★★☆

Hint (not the solution): Substitute $x = 2$ to get an equation in k.

Working space

1 What am I looking at? 2 What should I do next? 3 How do I know it's correct?

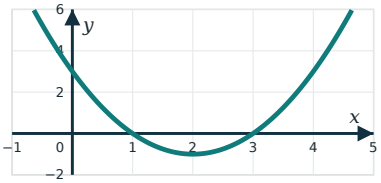
Revision map

Learning objective: Recall the three questions, the methods, the discriminant and the checking habit on one page.

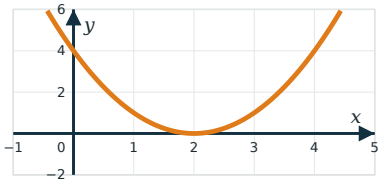
◆ UNDERSTAND

Quadratic equation: $ax^2 + bx + c = 0$, $a \neq 0$, after simplifying. A root is a number that makes the left side 0. It has at most two real roots.
Formula: $x = (-b \pm \sqrt{(b^2 - 4ac)})/(2a)$, with **$D = b^2 - 4ac$**. Put b in brackets; roots come from the formula, D alone is not a root.

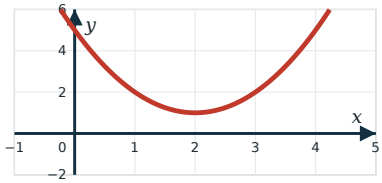
D > 0 · two distinct real roots
cuts x-axis twice



D = 0 · two equal real roots
touches x-axis once



D < 0 · no real roots
misses the x-axis



Question	Your routine
1 What am I looking at?	Simplify; is the highest power 2? Write $ax^2 + bx + c = 0$; read a, b, c with signs.
2 What should I do next?	Special form (c = 0, b = 0) → direct. Nice integer factors → split the middle term. Otherwise → formula. Only the nature asked → D.
3 How do I know it is correct?	Substitute each root (or check sum = −b/a, product = c/a). In a story: reject impossible roots, answer in words with units.

Method	When and how	Code
Special form	$x^2 = k$: $x = \pm\sqrt{k}$ · $ax^2 + bx = 0$: $x(ax + b) = 0$	S
Factorise	Find two numbers with product ac and sum b; split, group, set each bracket to 0	F
Formula	Works for every quadratic; best when D is not a perfect square	Q
Discriminant only	"nature of roots", "is it possible", find k for equal or real roots	D
Root check	"is x = … a root?": substitute, see whether you get 0	R

⚠ COMMON TRAP

Final error checklist. ☐ moved terms with the sign changed (E1) ☐ a, b, c read after standard form (E2) ☐ solved each bracket, not copied signs (E3) ☐ expanded factors to test (E4) ☐ b in brackets in D (E5) ☐ both ± values (E6) ☐ factorised instead of dividing by x (E7) ☐ D is not a root (E8) ☐ D = 0 still has a root (E9) ☐ tested roots against the story (E10)

✓ CHECK YOURSELF

Checking habit. Substitute every root in the *original* equation. For surd roots check the sum and product. Then ask: does the answer make sense for the question?

Progress: Section I ✓ (revision). Next: page 50, record where you stand and plan what to practise.

MATHS WITHOUT GUESSWORK

Liked this? Get the full Quadratic Equations workbook for ₹99

You have just read 10 sample pages. The full workbook is 50 pages + cover.

What is in the full workbook

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