ANSWER KEY & MARKING SCHEME · CBSE CLASS 9

Number Systems

Mathematics · Chapter 1 · Use this with the Board Paper · Companion to Quick Drill

HOW TO USE

Attempt the Board Paper first (closed-book, full time). Then come here. For 2-mark+ questions, compare your answer to the model. For 3-4 mark questions, also consult the **Topper Templates** below — these show the exact step-by-step structure that scores full marks per CBSE marking-scheme conventions.

MODEL ANSWERS · BOARD PAPER

Section A — Very Short Answer (1 mark each, 4 Qs)

Q1. Is 0.bar(7) (i.e. 0.7777...) a rational or an irrational number? Give a reason. **[1 mark]**

Ans: Rational — it is a non-terminating but RECURRING decimal, and every recurring decimal can be written as p/q (here 0.bar(7) = 7/9).

Q2. Write the rationalising factor (conjugate) of $(2 + \sqrt{5})$. **[1 mark]**

Ans: $(2 - \sqrt{5})$. Multiplying gives $(2)^2 - (\sqrt{5})^2 = 4 - 5 = -1$, a rational number.

Q3. Find the value of (16)^(1/2). **[1 mark]**

Ans: (16)^(1/2) = $\sqrt{16}$ = 4.

Q4. State whether $\sqrt{(-4)}$ has a value in the real number system. **[1 mark]**

Ans: No. No real number squared gives a negative, so $\sqrt{(-4)}$ is not defined among the real numbers (it belongs to the complex-number system studied later).

Section B — Short Answer I (2 marks each, 3 Qs)

Q5. Express 0.bar(6) in the form p/q, where p and q are integers and q ≠ 0. **[2 marks]**

Ans: Let x = 0.6666... Then 10x = 6.6666... Subtracting, 10x – x = 6, so 9x = 6 ⇒ x = 6/9 = 2/3. Hence 0.bar(6) = 2/3.

Q6. Find one rational and one irrational number between 2 and 3. **[2 marks]**

Ans: Rational: 5/2 = 2.5 (or 2.4, 2.7, etc.). Irrational: any non-terminating non-recurring decimal in the range, e.g. 2.101001000100001... (or $\sqrt{5} \approx 2.236$). State clearly which is which.

Q7. Simplify: 2^(2/3) × 2^(1/3) × 2^(0). Give the answer as a power of 2 and as a number. **[2 marks]**

Ans: Add the exponents (same base, multiplication): 2/3 + 1/3 + 0 = 1. So the expression = 2^1 = 2. (Recall 2^0 = 1, so it does not change the product.)

Section C — Short Answer II (3 marks each, 3 Qs)

Q8. Rationalise the denominator of $1/(3 + \sqrt{2})$ and state whether the result is rational or irrational. **[3 marks]**

Ans: Multiply numerator and denominator by the conjugate $(3 - \sqrt{2})$: $1/(3+\sqrt{2}) \times (3-\sqrt{2})/(3-\sqrt{2}) = (3-\sqrt{2})/((3)^2-(\sqrt{2})^2) = (3-\sqrt{2})/(9-2) = (3-\sqrt{2})/7$. The result $(3 - \sqrt{2})/7$ is IRRATIONAL, because it still contains $\sqrt{2}$ (an irrational), and a non-zero rational combined with an irrational stays irrational.

Q9. Represent $\sqrt{5}$ on the number line, showing all construction steps. **[3 marks]**

Ans: Step 1: On the number line mark O at 0 and A at 2 (since $5 = 2^2 + 1^2$). Step 2: At A, draw AB perpendicular to the line with AB = 1 unit. By Pythagoras, $OB = \sqrt{(OA^2 + AB^2)} = \sqrt{(2^2 + 1^2)} = \sqrt{5}$. Step 3: With O as centre and radius OB, draw an arc cutting the number line at P. Then OP = $\sqrt{5}$; mark P as $\sqrt{5}$. (Construction with compass arc is mandatory — estimation earns no marks.)

Q10. Express 1.2bar(7) (i.e. 1.27777...) in the form p/q. **[3 marks]**

Ans: Let y = 1.27777... Then 10y = 12.7777... and 100y = 127.7777... Subtract the first from the second: 100y – 10y = 127.7777... – 12.7777... ⇒ 90y = 115 ⇒ y = 115/90 = 23/18. Hence 1.2bar(7) = 23/18.

Section D — Long Answer / Case Study (4-5 marks each, 2 Qs)

Q11. **(a) Rationalise the denominator of $(5 + \sqrt{3})/(5 - \sqrt{3})$. (b) Hence state whether the simplified result is rational or irrational. (c) Verify your conjugate step by computing $(5 - \sqrt{3})(5 + \sqrt{3})$.** **[5 marks]**

> **Ans:** (a) Multiply numerator and denominator by the conjugate $(5 + \sqrt{3})$: $[(5+\sqrt{3})(5+\sqrt{3})]/[(5-\sqrt{3})(5+\sqrt{3})] = (5+\sqrt{3})^2/(25 - 3) = (25 + 10\sqrt{3} + 3)/22 = (28 + 10\sqrt{3})/22 = (14 + 5\sqrt{3})/11$. (b) The result $(14 + 5\sqrt{3})/11$ is IRRATIONAL because it contains $\sqrt{3}$. (c) $(5 - \sqrt{3})(5 + \sqrt{3}) = 5^2 - (\sqrt{3})^2 = 25 - 3 = 22$, confirming the rational denominator obtained in (a).

Q12. **Read the passage and answer: Riya is sorting numbers into two boxes — 'Rational' and 'Irrational'. Her cards read: A = 0.bar(45), B = $\sqrt{11}$, C = 3.141141114... (the gaps between 1s keep growing), D = $\sqrt{49}$, and E = 22/7. (a) Sort each card into the correct box with a one-line reason. (b) Riya claims 'the product of any two irrational numbers is irrational'. Give a counter-example to prove her wrong. (c) Between cards' values, name one irrational number that lies between 3 and 4.** **[6 marks]**

> **Ans:** (a) A = 0.bar(45) → RATIONAL (recurring decimal, = 45/99 = 5/11). B = $\sqrt{11}$ → IRRATIONAL (root of a non-perfect square). C = 3.141141114... → IRRATIONAL (non-terminating and non-recurring, since the gaps grow). D = $\sqrt{49} = 7$ → RATIONAL (it is an integer). E = 22/7 → RATIONAL (it is a fraction p/q; note it only APPROXIMATES π). (b) Counter-example: $\sqrt{2} \times \sqrt{2} = 2$, which is rational — so the product of two irrationals need not be irrational. (Also $\sqrt{3} \times \sqrt{3} = 3$.) (c) Any non-terminating non-recurring decimal in the range, e.g. 3.101001000... or $\sqrt{11} \approx 3.317$ (since $\sqrt{11}$ lies between 3 and 4).

★ TOPPER ANSWER TEMPLATES

3 TEMPLATES · MEMORISE THE FORMAT

★ TOPPER TEMPLATE — 2-3 mark question: 'Represent $\sqrt{x}$ (e.g. $\sqrt{5}$ or $\sqrt{9.3}$) on the number line.'

Annual Pattern 2021, 2022, 2023

Step 1 [1 mark]	**Set up the right triangle (or semicircle for $\sqrt{9.3}$)**	For a perfect-of-sum like $\sqrt{5}$: mark O at 0 and A at 2 on the number line (since $5 = 2^2 + 1^2$). Draw AB ⊥ to the line with AB = 1 unit. State clearly: 'OA = 2, AB = 1.' For $\sqrt{9.3}$ use the semicircle method: mark distance 9.3 then 1 unit further, draw a semicircle on the 10.3-unit diameter.
Step 2 [1 mark]	**Apply Pythagoras / the geometric mean**	By Pythagoras, $OB = \sqrt{(OA^2 + AB^2)} = \sqrt{(2^2 + 1^2)} = \sqrt{5}$. Show this line of working — the examiner wants to see WHY OB equals $\sqrt{5}$, not just a labelled figure.
Step 3 [1 mark]	**Transfer the length with a compass arc**	With O (or the appropriate centre) as centre and radius OB, draw an arc that cuts the number line at point P. Then $OP = \sqrt{5}$. Label P as $\sqrt{5}$ on the number line. A neat compass arc is mandatory for the final mark.

COMMON LOSS OF MARKS:

- Marking $\sqrt{5}$ by eye/estimation instead of the compass construction (–1 mark).
- Not writing the Pythagoras step $OB = \sqrt{(2^2+1^2)} = \sqrt{5}$ (–0.5 mark — figure alone is not enough).
- Perpendicular AB not drawn at a right angle / not labelled 1 unit.

★ TOPPER TEMPLATE — 2-3 mark question: 'Rationalise the denominator of $1/(a + b\sqrt{x})$ and simplify.'

Almost every annual paper + SQP 2022, 2023, 2024

Step 1 [1 mark]	**Write and multiply by the conjugate**	Identify the conjugate of the denominator: for $(3 + \sqrt{2})$ it is $(3 - \sqrt{2})$. Multiply BOTH numerator and denominator by this conjugate: $1/(3+\sqrt{2}) \times (3-\sqrt{2})/(3-\sqrt{2})$. State explicitly 'multiplying numerator and denominator by the conjugate $(3 - \sqrt{2})$'.
Step 2 [1 mark]	**Apply $(a+b)(a-b) = a^2 - b^2$ to the denominator**	Denominator = $(3 + \sqrt{2})(3 - \sqrt{2}) = 3^2 - (\sqrt{2})^2 = 9 - 2 = 7$. Show the identity being used — this is where the surd is removed and the marks live.
Step 3 [1 mark]	**Write the simplified rational-denominator result**	Result = $(3 - \sqrt{2})/7$. Leave the answer with an integer (rational) denominator. If asked, state whether the result is rational or irrational: $(3 - \sqrt{2})/7$ is irrational because $\sqrt{2}$ is irrational.

COMMON LOSS OF MARKS:

- Multiplying by the surd ($\sqrt{2}$) instead of the conjugate $(3 - \sqrt{2})$ — denominator still irrational (–1 mark).
- Sign error in the conjugate: using $(3 + \sqrt{2})$ again instead of flipping the sign (–1 mark).
- Not simplifying 9 – 2 to 7 / leaving the answer un-reduced.

★ TOPPER TEMPLATE — 2-3 mark question: 'Express the recurring decimal 0.bar(d) (e.g. 0.bar(3) or 1.2bar(7)) in the form p/q.'

SQP 2023, Annual Pattern 2022, 2024

Step 1 **[1 mark]**	**Let x = the decimal; multiply to shift the repeating block**	Let x = 0.3333... Since one digit repeats, multiply by 10: 10x = 3.3333... Clearly state how many places you shift (one digit → ×10, two digits → ×100).
Step 2 **[1 mark]**	**Subtract to eliminate the recurring part**	Subtract the original from the shifted: 10x – x = 3.3333... – 0.3333... ⇒ 9x = 3. The repeating tails cancel exactly — this is the key idea examiners look for.
Step 3 **[1 mark]**	**Solve for x and reduce to lowest terms**	9x = 3 ⇒ x = 3/9 = 1/3. Always reduce p/q to its lowest form. State the conclusion: 'Hence 0.bar(3) = 1/3, which is rational.'

COMMON LOSS OF MARKS:

- Multiplying by the wrong power of 10 for the length of the repeating block (–1 mark).
- Forgetting to reduce p/q to lowest terms (–0.5 mark).
- Not aligning the decimals when subtracting, so the tails don't cancel.

MARKING SCHEME — GENERAL NOTES

- Recurring-to-p/q questions: full marks require the 'let x = ⋯, multiply, subtract' method shown; a bare answer without working earns at most half marks.
- Rationalisation: the conjugate-multiplication step must be visible; multiplying by the surd alone (not the conjugate) earns 0 for the method even if a later step is right.
- Number-line construction: the Pythagoras line OB = $\sqrt{(a^2+b^2)}$ and the compass arc are each worth a mark; estimation by eye earns no construction mark.
- Exponent simplification: adding exponents when multiplying (and multiplying when raising a power to a power) must be applied correctly — a single rule-swap caps the question at half marks.
- Final answers must be in lowest terms and, for fractions, with a rationalised denominator unless the question states otherwise.