ANSWER KEY & MARKING SCHEME · CBSE CLASS 11

Numbers, Quantification and Numerical Applications

Applied 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 — Short calculation (2 × 4 = 8 marks)

Q1. Convert the decimal number 45 into a binary number, showing your division steps. [2 marks]

Ans: 45÷2 = 22 r 1; 22÷2 = 11 r 0; 11÷2 = 5 r 1; 5÷2 = 2 r 1; 2÷2 = 1 r 0; 1÷2 = 0 r 1. Reading remainders bottom-to-top: 45 = 101101_2. Check: 32+8+4+1 = 45. ✓

Q2. Evaluate log 8 + log 25 − log 2 (base 10), stating the laws you use. [2 marks]

Ans: By the product and quotient laws: log((8×25)/2) = log(200/2) = log 100. Since 100 = 10^2, log 100 = 2 log 10 = 2 (as $\log_{10} 10 = 1$). Answer = 2.

Q3. If today is Friday, what day of the week will it be 75 days from now? Show your modular reasoning. [2 marks]

Ans: 75 = 7×10 + 5, so 75 ≡ 5 (mod 7). Count 5 days forward from Friday: Sat(1), Sun(2), Mon(3), Tue(4), Wed(5). Answer = WEDNESDAY.

Q4. Given log 2 = 0.3010, find log 5 (base 10). [2 marks]

Ans: log 5 = log(10/2) = log 10 − log 2 = 1 − 0.3010 = 0.6990 (quotient law, with $\log_{10} 10 = 1$).

Section B — Word problem with full working (3 × 4 = 12 marks)

Q5. Two grades of coffee costing Rs 240/kg and Rs 360/kg are mixed to obtain a blend costing Rs 300/kg. In what ratio should the two grades be mixed? Verify your answer with the weighted-average check. [3 marks]

Ans: C = 240, D = 360, M = 300 (240 < 300 < 360 ✓). Ratio (cheaper:dearer) = (D−M):(M−C) = (360−300):(300−240) = 60:60 = 1:1. Check: 1 kg at 240 + 1 kg at 360 = Rs 600 for 2 kg = Rs 300/kg ✓. Answer = 1 : 1.

Q6. A boat goes 45 km downstream in 3 hours and the same distance upstream in 5 hours. Find the speed of the boat in still water and the speed of the stream. [3 marks]

Ans: Downstream = 45/3 = 15 km/h; upstream = 45/5 = 9 km/h. Boat speed b = (15+9)/2 = 12 km/h; stream speed s = (15−9)/2 = 3 km/h. Check: 12+3 = 15 ✓, 12−3 = 9 ✓.

Q7. Pipe A fills a tank in 5 hours; pipe B (a leak) empties it in 20 hours. With both open, find the time to fill the tank. [3 marks]

Ans: Rates: A = +1/5, leak = −1/20 per hour. Combined = 1/5 − 1/20 = 4/20 − 1/20 = 3/20 per hour. Time = 1 ÷ (3/20) = 20/3 hours = 6 hours 40 minutes.

Q8. Express the recurring requirement as a modulo problem: find the smallest positive integer x such that x ≡ 4 (mod 9) and 30 < x < 40. [3 marks]

Ans: x ≡ 4 (mod 9) means x = 4 + 9k. For k = 0: 4; k = 1: 13; k = 2: 22; k = 3: 31; k = 4: 40. The only value strictly between 30 and 40 is x = 31. (31 − 4 = 27 = 9×3 ✓.) Answer = 31.

Section C — Long-answer, multi-step (5 × 2 = 10 marks)

Q9. A cask is full of 50 litres of pure milk. 10 litres are drawn out and replaced with water; the same operation is then repeated a second time. (a) Find the quantity of pure milk left after the two operations. (b) Find the ratio of milk to water in the final mixture. [5 marks]

Ans: (a) Pure milk left = $V\cdot(1 - x/V)^k = 50\cdot(1 - 10/50)^2 = 50\cdot(1 - 1/5)^2 = 50\cdot(4/5)^2 = 50\cdot(16/25) = 32$ litres. (b) Total volume stays 50 L, so water = 50 − 32 = 18 L. Milk : water = 32 : 18 = 16 : 9.

Q10. (a) Given log 2 = 0.3010 and log 3 = 0.4771, evaluate log 6, log 12 and log 1.5 (base 10). (b) Convert the binary number 110110_2 to decimal, and convert your decimal answer back to binary to verify. **[5 marks]**

Ans: (a) log 6 = log(2×3) = 0.3010 + 0.4771 = 0.7781. log 12 = log(2^2×3) = 2 log 2 + log 3 = 0.6020 + 0.4771 = 1.0791. log 1.5 = log(3/2) = log 3 − log 2 = 0.4771 − 0.3010 = 0.1761. (b) 110110_2 = 32 + 16 + 0 + 4 + 2 + 0 = 54. Back-convert 54: 54÷2=27 r0, 27÷2=13 r1, 13÷2=6 r1, 6÷2=3 r0, 3÷2=1 r1, 1÷2=0 r1 → 110110_2 ✓.

★ TOPPER ANSWER TEMPLATES

3 TEMPLATES · MEMORISE THE FORMAT

★ TOPPER TEMPLATE — 3 marks: 'If today is Monday, what day of the week will it be after 80 days? Show your modular reasoning.'

Annual + SQP

Step 1 **[1 mark]**	**Translate to modular form**	A week has 7 days, so the day repeats with period 7. The day after N days is found by computing N mod 7 and counting that many days forward from today. Here we need 80 mod 7.
Step 2 **[1 mark]**	**Compute the remainder**	Divide 80 by 7: 7 × 11 = 77, remainder = 80 − 77 = 3. Hence 80 ≡ 3 (mod 7). After 80 days the day is 3 weekdays beyond Monday. Showing the division and remainder explicitly is what earns this mark.
Step 3 **[1 mark]**	**State the answer in words**	Count 3 days forward from Monday: Tuesday (1), Wednesday (2), Thursday (3). Therefore, after 80 days, the day will be THURSDAY. (If the question asked for 80 days BEFORE Monday, count backward instead: Sunday, Saturday, Friday.)

COMMON LOSS OF MARKS:

- Computing 80 ÷ 7 = 11.43 and answering '11.43 weeks' — the answer must be a named day.
- Counting from Monday as 'day 0' versus 'day 1' inconsistently — fix one convention and apply it cleanly.
- Not showing the remainder step 80 = 7 × 11 + 3 — examiners want the modular working visible.

★ TOPPER TEMPLATE — 4 marks: 'A shopkeeper mixes two varieties of tea costing Rs 350/kg and Rs 500/kg to obtain a mixture costing Rs 430/kg. In what ratio should they be mixed?'

Annual

Step 1 **[1 mark]**	**Identify cheaper, dearer and mean**	Cheaper price C = Rs 350/kg. Dearer price D = Rs 500/kg. Mean price M = Rs 430/kg. Confirm M lies between C and D: 350 < 430 < 500 ✓. (If M were outside this range, no positive mixture would exist.)
Step 2 **[1 mark]**	**Apply the alligation rule**	Alligation rule: (quantity of cheaper) : (quantity of dearer) = (D − M) : (M − C). Substitute: (500 − 430) : (430 − 350) = 70 : 80 = 7 : 8.
Step 3 **[1 mark]**	**Verify with a weighted-average check**	Take 7 kg cheaper (cost = 7 × 350 = Rs 2,450) + 8 kg dearer (cost = 8 × 500 = Rs 4,000). Total = 15 kg costing Rs 6,450. Per kg = 6,450 ÷ 15 = Rs 430. ✓ Matches the stated mean, so the ratio is correct.
Step 4 **[1 mark]**	**State the answer with units**	The two varieties must be mixed in the ratio 7 : 8 (cheaper : dearer). For every 7 kg of Rs 350 tea the shopkeeper adds 8 kg of Rs 500 tea to obtain a mixture costing Rs 430/kg.

COMMON LOSS OF MARKS:

- Putting the differences on the wrong sides — (D − M) goes on the CHEAPER side, (M − C) on the dearer side. The differences exchange.
- Skipping the verification step (worth 1 mark; it catches sign errors).
- Dropping units (kg) in the final ratio statement.

★ TOPPER TEMPLATE — 3 marks: 'Evaluate log 8 + log 25 − log 2 (base 10), using the laws of logarithms.'

Almost every annual paper + SQP

Step 1 **[1 mark]**	**Combine using the product and quotient laws**	By log a + log b = log(ab) and log a – log b = log(a/b): log 8 + log 25 – log 2 = log((8 × 25) / 2) = log(200 / 2) = log 100. State the laws being applied explicitly.
Step 2 **[1 mark]**	**Express the argument as a power of 10**	$100 = 10^2$. So log 100 = log 10^2 = 2 log 10 (power law). Since the base is 10, $\log_{10} 10 = 1$.
Step 3 **[1 mark]**	**State the final value**	Therefore log 8 + log 25 – log 2 = 2 × 1 = 2. CHECK: 8 × 25 ÷ 2 = 100 and $\log_{10} 100 = 2$ because $10^2 = 100$. ✓

COMMON LOSS OF MARKS:

- Writing log(8 + 25 – 2) — addition/subtraction of arguments does NOT correspond to addition/subtraction of logs; only product/quotient does.
- Forgetting $\log_{10} 10 = 1$, leaving the answer as 'log 100' instead of the number 2.
- Not naming the law used at each step — marking schemes award method marks for stating product/quotient/power laws.

MARKING SCHEME — GENERAL NOTES

- Binary: show the division ladder (decimal→binary) or the place-value sum (binary→decimal); a back-check earns the final accuracy mark.
- Logarithms: NAME the law used at each step (product/quotient/power) — method marks are awarded for the law, not just the number. Never write log(a + b) = log a + log b.
- Modulo: always show the remainder calculation explicitly (e.g. '75 = 7×10 + 5') before naming the day.
- Alligation: verify with the weighted-average check; it recovers the last mark on sign errors.
- Boats: state both consistency checks (down + up = 2b, down – up = 2s). Pipes: convert to RATES first, never average times; leaks are NEGATIVE rates; invert the combined rate at the end.