ANSWER KEY & MARKING SCHEME · CBSE CLASS 11

Motion in a Straight Line

Physics · Chapter 2 · 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 — 1 mark each

Q1. Define displacement. How is it different from distance? [1 mark]

Ans: Displacement is the straight-line vector from initial to final position (signed). Distance is the total path length (scalar, always positive). Displacement can be zero or negative; distance is always non-negative and >= |displacement|.

Q2. What does the slope of a velocity-time graph represent? [1 mark]

Ans: The slope of a v-t graph at any instant represents the instantaneous acceleration (a = dv/dt).

Q3. Can a body have zero velocity but non-zero acceleration? Give an example. [1 mark]

Ans: Yes. A ball thrown vertically upward at the highest point has v = 0 but a = g downward = 9.8 m/s^2.

Q4. Write the kinematic equation that does not involve time. [1 mark]

Ans: v^2 = u^2 + 2as.

Q5. State whether the following is True or False: 'If acceleration is zero, the body must be at rest.' [1 mark]

Ans: False. Zero acceleration means constant velocity; the body can be moving at any constant speed.

Q6. What is the SI unit of acceleration? [1 mark]

Ans: m/s^2 (metre per second squared).

Section B — 2 marks each

Q7. A person walks 30 m east, then 40 m north, then 30 m west. Find the total distance and the magnitude of displacement. [2 marks]

Ans: Distance = 30 + 40 + 30 = 100 m. Net east-west displacement = 30 - 30 = 0; net north displacement = 40 m. So displacement magnitude = 40 m (due north).

Q8. A car starts from rest and accelerates uniformly at 4 m/s^2. Find its velocity and distance covered after 6 s. [2 marks]

Ans: v = u + at = 0 + 4*6 = 24 m/s. s = ut + (1/2)at^2 = 0 + (1/2)(4)(36) = 72 m.

Q9. A v-t graph is a horizontal line at 15 m/s from t = 0 to t = 8 s. What is the displacement and acceleration? [2 marks]

Ans: Horizontal v-t line => acceleration = slope = 0. Displacement = area = 15*8 = 120 m.

Q10. Distinguish between average velocity and instantaneous velocity. [2 marks]

Ans: Average velocity = total displacement / total time over a finite interval. Instantaneous velocity = dx/dt at a single instant (limit of average velocity as Δt -> 0). The speedometer reads instantaneous speed.

Q11. Two trains move in opposite directions at 25 m/s and 15 m/s. Find the relative velocity of the first with respect to the second. [2 marks]

Ans: Opposite directions: take first +ve, second -ve. v_AB = 25 - (-15) = 40 m/s in the direction of the first train.

Q12. Distance covered in the 5th second by a body starting from rest with a = 4 m/s^2 is found how? Compute it. [2 marks]

Ans: Apply s_n = u + (a/2)(2n - 1) = 0 + (4/2)(2*5 - 1) = 2*9 = 18 m. This is the distance traversed during the 5th second.

Section C — 3 marks each

Q13. A ball is dropped from a 45 m tall building. Taking g = 9.8 m/s^2, find (a) the time taken to reach the ground, (b) velocity on impact, (c) distance covered in the last 1 second of fall. [3 marks]

> **Ans:** (a) Taking downward +ve: u=0, a=9.8, s=45. s = (1/2)at^2 => t^2 = 90/9.8 = 9.18 => t = 3.03 s. (b) v = u + at = 0 + 9.8(3.03) = 29.7 m/s downward. (c) Distance in last second = total distance - distance in (3.03-1) s = 45 - (1/2)(9.8)(2.03^2) = 45 - 20.18 = 24.82 m approx.

Q14. A ball is thrown vertically upward with u = 20 m/s. Take g = 9.8 m/s^2. Find (a) maximum height, (b) time to reach peak, (c) velocity 1 s after release. [3 marks]

> **Ans:** Take upward +ve, u=+20, a=-9.8. (a) At peak v=0: 0 = u^2 + 2(-9.8)s => s = 400/19.6 = 20.41 m. (b) v = u + at => 0 = 20 - 9.8t => t = 2.04 s. (c) v(1) = 20 - 9.8(1) = 10.2 m/s upward.

Q15. A car covers the first half of a journey at 40 km/h and the second half at 60 km/h. Find the average speed. Why is the simple mean (40+60)/2 = 50 km/h incorrect? [3 marks]

> **Ans:** Let total distance = 2d. t1 = d/40, t2 = d/60. Total time = d/40 + d/60 = (3d+2d)/120 = d/24. Average speed = 2d / (d/24) = 48 km/h. Arithmetic mean 50 km/h is wrong because the body spends MORE time at the slower speed (more time covering d at 40 than at 60), so the average is pulled toward 40. Correct formula = harmonic mean for equal distances = 2v1v2/(v1+v2) = 4800/100 = 48 km/h.

Q16. A particle moves along x-axis with position x = 3t^2 - 12t + 5 (m). Find (a) initial velocity, (b) time when velocity is zero, (c) position at that time. [3 marks]

> **Ans:** (a) v = dx/dt = 6t - 12. At t=0: v = -12 m/s (i.e. 12 m/s in -x direction). (b) v = 0 => 6t = 12 => t = 2 s. (c) x(2) = 3(4) - 24 + 5 = 12 - 24 + 5 = -7 m. The particle is at x = -7 m when momentarily at rest, before reversing direction.

★ TOPPER ANSWER TEMPLATES

5 TEMPLATES · MEMORISE THE FORMAT

★ TOPPER TEMPLATE — Free-fall numerical: object dropped from height H or thrown up with initial velocity u, find time/velocity/max-height.

Annual

Step 1 [1 mark]	**Set up axis + sign convention + list u, a, s**	Taking downward as positive. Given: u = 0 m/s (dropped), a = g = 9.8 m/s^2, s = 45 m. To find: time of fall t, velocity on hitting ground v.
Step 2 [1 mark]	**Pick the right kinematic equation and substitute**	Using s = ut + (1/2)at^2: 45 = 0*t + (1/2)(9.8)t^2 => t^2 = 45/4.9 = 9.18 => t = 3.03 s.
Step 3 [1 mark]	**Find the second quantity + state both with units and direction**	Using v = u + at: v = 0 + 9.8*3.03 = 29.7 m/s downward. Answer: t = 3.03 s, v = 29.7 m/s directed downward.

COMMON LOSS OF MARKS:

- Not stating the sign convention up-front (loses 0.5 mark — examiner cannot verify your signs).
- Writing the final answer without units or direction (vector quantity → -0.5).
- Using g = 10 m/s^2 when the question states 9.8 (or vice versa) — read the question carefully.

★ TOPPER TEMPLATE — Distance vs displacement: object moves A->B->C with B->C being a partial back-track. Find distance and displacement.

Annual

Step 1 [1 mark]	**Lay out the motion on a number line with positions**	Let A = 0 m, B = +60 m (forward 60 m), C = +20 m (back 40 m). Person moves A->B->C.
Step 2 [1 mark]	**Distance = sum of path lengths (scalar)**	Distance = |AB| + |BC| = 60 + 40 = 100 m.
Step 3 [1 mark]	**Displacement = final - initial position (signed)**	Displacement = x_C - x_A = 20 - 0 = +20 m, i.e. 20 m in the forward direction. Note: distance != displacement here.

COMMON LOSS OF MARKS:

- Reporting displacement as 100 m (i.e. adding both legs instead of subtracting) — full mark loss for that step.
- Forgetting to mention direction of displacement — it is a vector, so 20 m alone is incomplete.
- Not drawing the number line — the examiner has to guess your setup.

★ TOPPER TEMPLATE — Find average velocity of a multi-stage journey (e.g. half the distance at v1, other half at v2).
Common

Step 1 [1 mark]	**Write definition + assign variables**	Average velocity = total displacement / total time. Let total distance = 2d (so each half is d). Speed in first half = v1 = 40 m/s, second half = v2 = 60 m/s.
Step 2 [1 mark]	**Compute time for each segment**	t1 = d/v1 = d/40, t2 = d/v2 = d/60. Total time t = d/40 + d/60 = (3d + 2d)/120 = 5d/120 = d/24.
Step 3 [1 mark]	**Compute average velocity (= harmonic mean here, since equal distances)**	Average velocity = 2d / (d/24) = 48 m/s. Note: arithmetic mean (40+60)/2 = 50 m/s is WRONG for equal-distance segments.

COMMON LOSS OF MARKS:
- Taking simple average (v1+v2)/2 — this is valid only for equal-time segments. Loss: 2 of 3 marks.
- Mixing displacement and distance — if motion is back-and-forth, average velocity differs from average speed.
- Not stating units of the answer.

★ TOPPER TEMPLATE — Read a velocity-time graph: find displacement, acceleration, and distinguish from distance.
Common

Step 1 [1 mark]	**Identify slopes for each segment (slope = acceleration)**	From t=0 to t=4 s, v rises from 0 to 20 m/s => a1 = 20/4 = 5 m/s^2. From t=4 to t=8 s, v stays at 20 m/s => a2 = 0. From t=8 to t=10 s, v drops 20 to 0 => a3 = -10 m/s^2.
Step 2 [1 mark]	**Displacement = signed area under v-t curve**	Triangle 1 (0-4 s) area = (1/2)*4*20 = 40 m. Rectangle (4-8 s) = 4*20 = 80 m. Triangle 2 (8-10 s) = (1/2)*2*20 = 20 m. Total displacement = 40 + 80 + 20 = 140 m.
Step 3 [1 mark]	**State distance and average velocity**	Since v >= 0 throughout, distance = displacement = 140 m. Total time = 10 s. Average velocity = 140/10 = 14 m/s.

COMMON LOSS OF MARKS:
- Forgetting to use signed areas when v dips below the axis (distance and displacement diverge then).
- Mixing slope of x-t (= velocity) with slope of v-t (= acceleration).
- Not labelling segments before computing — confuses the examiner.

★ TOPPER TEMPLATE — Distance covered in the nth second — use s_n = u + (a/2)(2n - 1).
Common

Step 1 [1 mark]	**Write the formula + identify u, a, n**	s_n = u + (a/2)(2n - 1) gives distance in the nth second. Given: u = 2 m/s, a = 4 m/s^2, n = 5.
Step 2 [1 mark]	**Substitute and simplify**	s_5 = 2 + (4/2)(2*5 - 1) = 2 + 2*9 = 2 + 18 = 20 m.
Step 3 [1 mark]	**Interpret + state units**	The body covers 20 m during the 5th second (i.e. between t=4 s and t=5 s). Answer: s_5 = 20 m.

COMMON LOSS OF MARKS:
- Computing s in 5 seconds (s = ut + (1/2)at^2) instead of s in the 5th second — full step loss.
- Using (2n + 1) instead of (2n - 1) — sign error worth -1 mark.
- Missing the units 'm' on the final answer.

MARKING SCHEME — GENERAL NOTES
- 1 mark for stating the sign convention up-front in any numerical.
- 1 mark for picking the correct kinematic equation and substituting given quantities.
- 1 mark for the final answer with correct units AND direction (for vector quantities).
- Half-mark deduction for missing units in the final answer.
- Half-mark deduction for missing direction on a vector quantity (displacement, velocity, acceleration).
- Full credit if the alternative kinematic equation is used and yields the same answer.
- No credit for the final number alone without working — show all steps.