Motion in a Straight Line — CBSE Pattern Test 1

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

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General Instructions: (1) This paper has four sections — Section A (1 × 10), Section B (2 × 4), Section C (3 × 4) and Section D (5 × 2) — total 40 marks. Time allowed: 90 minutes.
(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.
(3) For MCQ questions choose the single correct option; for VSA answers write a single line.
(4) Take g = 10 m/s^2. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA (10 × 1 = 10 marks)

1. A car travelling at 72 km/h is moving with a speed of

(A) 20 m/s

(B) 10 m/s

(C) 25 m/s

(D) 40 m/s

2. Two cars heading toward each other on a straight road have speeds 20 m/s and 30 m/s. The speed with which they approach each other is

(A) 50 m/s

(B) 10 m/s

(C) 25 m/s

(D) 35 m/s

3. The position–time graph of a body moving with constant acceleration is

(A) a parabola

(B) a straight line

(C) a horizontal line

(D) a vertical line

4. A ball dropped from rest (g = 10 m/s^2) covers a distance of 35 m

(A) in the 4th second

(B) in the 2nd second

(C) in the 3rd second

(D) in the 1st second

5. A car covers the first half of its journey at 40 km/h and the second half at 60 km/h. Its average speed for the whole journey is

(A) 48 km/h

(B) 50 km/h

(C) 45 km/h

(D) 52 km/h

6. A particle moves from A to B along a semicircular path of radius R. The ratio of the distance travelled to the magnitude of its displacement is

(A) π : 2

(B) 2 : π

(C) π : 1

(D) 1 : π

7. Define average velocity.

8. State the three equations of motion for a uniformly accelerated body.

9. What does the slope of a velocity–time graph represent?

10. When does the formula $s_n = u + (a/2)(2n - 1)$ give the true distance travelled in the nth second?

Section B — Short Answer I (4 × 2 = 8 marks)

11. A train moving at 54 km/h is brought to rest by applying brakes uniformly in 18 s. Find the acceleration and the distance covered before stopping.

12. Distinguish between the average speed and the average velocity of a body that returns to its starting point.

13. A stone is dropped from the top of a tower 45 m high. Taking $g = 10\ m/s^2$, find the time taken to reach the ground and the velocity of impact.

14. A swimmer aims perpendicular to a 150 m wide river at 3 m/s in still water, while the current flows at 4 m/s. Find the time to cross and the drift.

Section C — Short Answer II (4 × 3 = 12 marks)

15. A balloon is ascending at 5 m/s at a height of 300 m above the ground when a stone is dropped from it. Taking $g = 10\ m/s^2$, find the time taken by the stone to reach the ground and the speed with which it strikes the ground.

16. Balls are released from the top of a tower, one after the other, at intervals of 1 s. When the 4th ball is just released, find the separation between the 1st and 2nd balls and between the 2nd and 3rd balls.

17. A body initially at rest accelerates uniformly at $2\ m/s^2$ for 5 s, then moves with constant velocity for 4 s, and finally retards uniformly to rest in 3 s. Draw the velocity–time graph and find the total distance covered.

18. A ball thrown vertically upward returns to its starting point in 6 s. Taking $g = 10\ m/s^2$, find (i) its initial velocity and (ii) the maximum height reached.

Section D — Long Answers (2 × 5 = 10 marks)

19. (a) Derive the three equations of motion for a body moving with uniform acceleration using calculus. (b) A car moving at 72 km/h is brought to rest with uniform retardation in 5 s. Find the retardation and the distance covered before it stops.

20. (a) What do the slope and the area under a velocity–time graph represent? (b) Draw the x–t, v–t and a–t graphs for a ball thrown vertically upward until it returns to the thrower (air resistance neglected).

Answer Key (Marking Scheme)

Q1 — (A) 20 m/s. Q2 — (A) 50 m/s. Q3 — (A) parabola. Q4 — (A) in the 4th second ($s_x = \frac{1}{2}g(4^2 - 3^2) = 35$ m).

Q5 — (A) 48 km/h (2·40·60/100). Q6 — (A) π : 2. Q7 — Average velocity = total displacement ÷ total time taken; a vector quantity.

Q8 — $v = u + at$, $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$. Q9 — Instantaneous acceleration (slope at that instant).

Q10 — When the motion is unidirectional during that second, so that displacement equals the path length.

Q11 — $a = (0 - 15)/18 = -0.83\ m/s^2$ (retardation $0.83\ m/s^2$); $s = \frac{1}{2}(15)(18) = 135$ m.

Q12 — Return trip: displacement = 0 so average velocity = 0, while average speed > 0 (it equals total path length / total time).

Q13 — $t = \sqrt{(2h/g)} = 3$ s; $v = gt = 30$ m/s. Q14 — $t = d/u = 150/3 = 50$ s; drift = $w \cdot t = 4 \times 50 = 200$ m.

Q15 — Time ↑: $300 = -5t + 5t^2 \rightarrow 5t^2 - 5t - 300 = 0 \rightarrow t = (1 + \sqrt{241})/2 \approx 8.26$ s ≈ 8.3 s; impact speed $v = -5 + 10t \approx 77.6$ m/s.

Q16 — 1st–2nd: $\frac{1}{2}g(3^2 - 2^2) = 25$ m; 2nd–3rd: $\frac{1}{2}g(2^2 - 1^2) = 15$ m.

Q17 — v–t graph: triangle 0–5 s (slope 2), rectangle 5–9 s (v = 10), triangle 9–12 s (slope −10/3); total distance = 25 + 40 + 15 = 80 m.

Q18 — $u = gT/2 = 30$ m/s; $H = u^2/2g = 45$ m.

Q19 — (a) $v = u + at$ ⇒ $dv = \int a\,dt$; $s = ut + \frac{1}{2}at^2$ ⇒ $dx = \int (u + at)\,dt$; $v^2 = u^2 + 2as$ ⇒ $a = v\,dv/ds$. (b) 72 km/h = 20 m/s; $a = -20/5 = -4$ m/s² (retardation 4 m/s²); $s = \frac{1}{2}(20)(5) = 100$ m.

Q20 — (a) Slope of v–t graph = instantaneous acceleration; area under v–t graph = displacement. (b) x–t: upward parabola to maximum then returning; v–t: straight line of slope −g crossing zero at the top; a–t: horizontal line at −g.