# Class 11th Physics Test Paper

## Chapter: Motion in a Straight Line

Time: 1 Hour M.M : 20

Section A - (1 mark each)

1. Define displacement and explain with an example how its magnitude can be less than the distance travelled.
2. A particle moves along the x-axis. Its position at time t is given by $x(t) = 4t^2 - 2t + 3$.
Find its instantaneous velocity at $t = 2$ s.
3. A particle is thrown vertically upward with a velocity u. Write the expression for the time taken to reach the highest point and derive it.
4. Under what conditions will the average velocity of a particle be zero over a time interval, even if the particle has non-zero speed throughout? Illustrate with an example.
5. A car is moving with uniform acceleration. Its velocity-time graph is a straight line inclined to the time axis. What does the area under this line represent? How can it be used to calculate displacement?
6. Write the equations of motion for a freely falling body using the sign convention.

Section B - (2 marks each)

7. Define instantaneous acceleration. How is it different from average acceleration? Illustrate with suitable graphs or examples.
8. A car travels the first half of a distance with a uniform speed of 60 km/h, and the second half with a uniform speed of 40 km/h. Find the average speed of the car over the entire journey.
9. A particle is moving in a straight line with a velocity given by

$$v(t) = 3t^2 + 2t + 1 \text{ m/s}.$$

Find the displacement of the particle between $t = 1$ s and $t = 2$ s

Section C - (3 marks each)

10. From the top of a tower of 100m height, a ball is dropped and

at the same time another ball is projected vertically upwards from the ground with a velocity of 25ms-1. Find when and where the two balls will meet. Take g = 9.8 ms-2.

11. A train starting from rest accelerates uniformly at 2 $m/s^2$ for 10 seconds. It then moves at constant speed for 20 seconds and finally decelerates at 1 $m/s^2$ to come to rest.

Find the total distance covered by the train during this entire journey.

Section D - Long Answer Type Questions (3 marks each)

12. Derive all three equations of motion using the calculus method. Also explain the physical significance of the slope of a velocity-time graph.

13. Derive all three equations of motion using the graphical method. Mention all assumptions and show clear labelled diagrams.



Answers:

Section A – (1 mark each)

1. Displacement is the shortest distance from initial to final position with direction.

Example: If a person walks 10 m east and then 10 m west, total distance = 20 m, but displacement = 0.

2. Given: $x(t) = 4t^2 - 2t + 3$

Instantaneous velocity $v = dx/dt = 8t - 2$

At t = 2 s, v = 8(2) - 2 = 16 - 2 = 14 m/s

3. At highest point, final velocity v = 0.

Using v = u - gt, we get 0 = u - gt → t = u/g

4. Average velocity is zero when total displacement is zero.

Example: If a ball is thrown up and returns to the starting point, net displacement = 0, so average velocity = 0.

5. The area under a velocity-time graph represents displacement.

For uniformly accelerated motion, the area under the v-t line (a trapezium or triangle) equals displacement.

6. Equations of motion for freely falling body (taking downward as positive):

$v = u + gt$

$h = ut + (1/2)gt^2$

$v^2 = u^2 + 2gh$

Section B – (2 marks each)

7.Average acceleration = (change in velocity)/(time interval) = $\Delta v/\Delta t$

Instantaneous acceleration = limit of

Av. acceleration as $\Delta t \rightarrow 0$, or $a = dv/dt$

Graphically, instantaneous acceleration is the slope of velocity-time curve at a point.

8.Let total distance = 2d.

Time for first half = d / 60

Time for second half = d / 40

Total time = (d/60 + d/40) = (2d + 3d)/120 = 5d/120

Average speed = total distance / total time = 2d / (5d/120) = (2 * 120)/5 = 48 km/h

9. $v(t) = 3t^2 + 2t + 1$

Displacement = $\int v(t)\,dt$ from t = 1 to 2

$= \int (3t^2 + 2t + 1)\,dt = [t^3 + t^2 + t]$ from 1 to 2

= (8 + 4 + 2) - (1 + 1 + 1) = 14 - 3 = 9 meters

Section C – (3 marks each)

10.Let A be the top of a tower and B be its foot. Two balls meet at point C after time t seconds. Let AC = x, so BC = 100 − x.

For the ball dropped from top (A to C):

Initial velocity u = 0, acceleration a = 9.8 $m/s^2$, displacement = x, time = t

Using equation: $S = ut + ½at^2$

$\Rightarrow x = 0 + ½ \times 9.8 \times t^2 = 4.9t^2$ ...(i)

For the ball thrown upward from bottom (B to C):
Initial velocity $u = 25$ m/s, acceleration $a = -9.8$ m/s²,
displacement = $100 - x$, time = $t$
Using equation: $S = ut + \frac{1}{2}at^2$
$\Rightarrow 100 - x = 25t + \frac{1}{2}(-9.8)t^2 = 25t - 4.9t^2$ ...(ii)
Adding (i) and (ii):
$x + (100 - x) = 4.9t^2 + (25t - 4.9t^2)$
$\Rightarrow 100 = 25t \Rightarrow t = 4$ s
Putting $t = 4$ in (i):
$x = 4.9 \times 16 = 78.4$ m
Final Answer: The two balls meet after 4 seconds at a distance of 78.4 m below the top of the tower.
11.Phase 1 (acceleration): $u = 0$, $a = 2$ m/s², $t = 10$ s
$v = u + at = 0 + 2*10 = 20$ m/s
$s1 = ut + (1/2)at^2 = 0 + (1/2)(2)(100) = 100$ m
Phase 2 (constant speed): $v = 20$ m/s, $t = 20$ s
$s2 = vt = 2020 = 400$ m
Phase 3 (deceleration): $u = 20$ m/s, $v = 0$, $a = -1$ m/s²
Using $v^2 = u^2 + 2as \rightarrow 0 = 400 + 2*(-1)*s \rightarrow s3 = 200$ m
Total distance = $s1 + s2 + s3 = 100 + 400 + 200 = 700$ m