

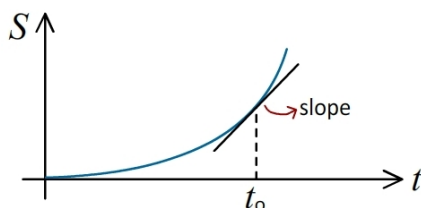
**Note :** Answers given below are intended only as a reference for the questions asked in board examinations. These answers are NOT an attempt at a detailed discussion related to the question.

### VSAQs

1. Define instantaneous velocity. How is it determined graphically?

Instantaneous velocity of a body is its velocity at a particular instant of time. It is given by the rate of change of its displacement w.r.t. time.  $\bar{v}_{inst} = \frac{d\bar{S}}{dt}$

Graphically it is given by the slope ( tangent ) of the displacement – time graph at that instant of time.



2. Differentiate between distance and displacement.

Distance	Displacement
It is the length of the path traversed by a body from the initial position to the final position.	It is the shortest line of path from the initial position to the final position.
It is a scalar quantity	It is a vector quantity
SI unit is m	SI unit is m

Observation from day to day life : Navigation apps like Google maps, Mappls ( by MapmyIndia ) etc. can measure distance and displacement ! Have you tried it out?

3. What is the difference between average speed and instantaneous speed?

Average speed is a measure of the speed at which the body should move uniformly so that the given distance is covered in a certain interval of time.

$$v_{avg} = \frac{S_{total}}{t_{total}}$$

Instantaneous speed is the speed of the body at a particular instant of time.

$$v_{inst} = \frac{dS}{dt}$$

Observation from day to day life : Our commute from house to college is with non-uniform speed. In such cases average speed is the speed calculated using the total distance and the total time taken for the commute. Instantaneous speed is the speed observed on the speedometer of the vehicle as we travel to the college. You may have observed that instantaneous speed may be more or less than the average speed of the body.

## Answers to text book questions      Motion in a straight line

4. A car moves with uniform acceleration. Write the relation among displacement, initial velocity, acceleration and time.

$$S = S_0 + ut + \frac{1}{2}at^2$$

where  $S_0$  is the initial displacement from the origin,  $u$  is the initial velocity,  $a$  is acceleration and  $t$  is time and  $S$  is the final displacement from the origin

5. What do you mean by rectilinear motion? Give one example.

Rectilinear motion is the motion of a body in a straight line. It is a one dimensional motion. Example : A freely falling body, or a vertically projected

6. Define average acceleration. What are its SI units?

Average acceleration is defined the total change in the velocity of the body divided by the time of travel.

$$a_{\text{avg}} = \frac{\Delta v}{\Delta t}$$

$$a_{\text{avg}} = \frac{v_f - v_i}{t_f - t_i}$$

Its SI unit is  $\text{ms}^{-2}$ .

7. What do you mean by free fall? Mention the value and direction of acceleration in this case.

A body dropped from a certain height and moving under the influence of only gravity, is called a freely falling body. Its acceleration is  $9.8 \text{ ms}^{-2}$ , in the downward direction.

8. Why is instantaneous speed equal to the magnitude of instantaneous velocity?

Instantaneous speed is equal to the magnitude of instantaneous velocity because the time interval in their measurement is infinitesimally small ( $dt$ ). During this small interval of time the length of path ( distance ) is identical to the displacement while the direction remains constant.

9. Explain how area under velocity – time graph gives displacement.

Velocity is defined as  $v = \frac{dS}{dt}$  therefore  $dS = v dt$ . This product implies that displacement is given by the area under velocity-time graph.

10. Can a body have zero velocity and non-zero acceleration at the same time? Explain.

Yes, a body can have zero velocity and non-zero acceleration.

Example : at the highest point of the trajectory of a vertically projected body, the velocity is momentarily zero where as its acceleration ( due to gravity ) is not zero

11. A car accelerates uniformly from  $10 \text{ ms}^{-1}$  to  $20 \text{ ms}^{-1}$  in 5 seconds. Calculate its acceleration.

Answers to text book questions      **Motion in a straight line**

$$v = u + at$$

$$a = \frac{v - u}{t}$$

$$a = \frac{20 - 10}{5}$$

$$a = 2 \text{ ms}^{-2}$$

- 12.** An object is thrown vertically upwards with a velocity of  $30\text{ms}^{-1}$ . What will be its velocity after 2 seconds? ( take  $g = 9.8 \text{ ms}^{-2}$  )

$$v = u + at$$

$$v = 30 - 9.8 \times 2$$

$$v = 10.4 \text{ ms}^{-2}$$

- 13.** A car moving at  $72\text{kmph}$  is brought to rest in 10 seconds. Find the distance it covers before stopping.

$$72 \text{ kmph} = 20 \text{ ms}^{-1} \quad \text{therefore}$$

$$v = u + at$$

$$0 = 20 + a \times 10$$

$$a = -2$$

$$\text{Using } v^2 - u^2 = 2aS$$

$$0^2 - 20^2 = 2(-2)S$$

$$S = 100\text{m}$$

- 14.** Velocity of a particle is given by  $v(t) = 3t^2$ . Find its acceleration at  $t = 2 \text{ s}$ .

$$a = \frac{dv}{dt}$$

$$a = 6t$$

At  $t = 2$  seconds

$$a = 12 \text{ ms}^{-2}$$

- 15.** A train starts from rest and attains a velocity of  $36 \text{ kmph}$  in  $10\text{s}$ . Assuming uniform acceleration, calculate acceleration and the distance covered in this time.

$$36 \text{ kmph} = 10 \text{ ms}^{-1}, \text{ therefore}$$

$$10 = 0 + a \times 10$$

$$a = 1 \text{ ms}^{-2}$$

$$\text{Using } v^2 - u^2 = 2aS$$

$$10^2 - 0^2 = 2(1)S$$

$$S = 50\text{m}$$

Answers to text book questions **Motion in a straight line**

- 16.** A ball is dropped from a height of 20m. Find the time it takes to reach the ground. ( $g = 10 \text{ ms}^{-2}$ ).

$$TOD = \sqrt{\frac{2H}{g}}$$

$$TOD = \sqrt{\frac{2 \times 20}{10}}$$

$$TOD = 2 \text{ s}$$

- 17.** A man walks 2 km in 30 minutes and returns in 20 minutes. What is the average speed for the entire journey?

Total distance = 4 km

$$S = 4000 \text{ m}$$

Total time = 50 minutes

$$t = 3000 \text{ s}$$

$$v = \frac{S}{t}$$

$$v = \frac{4000}{3000}$$

$$S = 1.33 \text{ ms}^{-1}$$

- 18.** An object moves with uniform acceleration and covers 100 m in 5 seconds. If the initial velocity is  $4 \text{ ms}^{-1}$ , find the acceleration.

$$S = 100 \text{ m}$$

$$t = 5 \text{ s}$$

$$u = 4 \text{ ms}^{-1}$$

$$\text{Using } S = ut + \frac{1}{2}at^2$$

$$100 = 4 \times 5 + \frac{1}{2}a 4^2$$

$$a = 10 \text{ ms}^{-2}$$

- 19.** A bullet is fired horizontally from a police van moving at 30 kmph. If the muzzle speed is  $150 \text{ ms}^{-1}$ , find the speed of the bullet relative to the thief's car moving ahead at 192 kmph.

$$v_{PC} = 30 \times \frac{5}{18} \text{ ms}^{-1} = \frac{25}{3} \text{ ms}^{-1}$$

$$v_B = 150 \text{ ms}^{-1}$$

$$v_{BG} = \left( \frac{25}{3} + 150 \right) \text{ ms}^{-1} = \frac{475}{3} \text{ ms}^{-1}$$

$$v_T = 192 \times \frac{5}{18} \text{ ms}^{-1} = \frac{160}{3} \text{ ms}^{-1}$$

$$v_{BT} = v_B - v_T$$

$$v_{BT} = \frac{475}{3} - \frac{160}{3}$$

$$v_{BT} = \frac{475}{3} - \frac{160}{3}$$

$$v_{BT} = 105 \text{ ms}^{-1}$$

20. A ruler falls freely and travels 20 cm before being caught. Estimate the reaction time of the person. ( use  $g = 10 \text{ ms}^{-2}$  )

Time taken (  $t_R$  ) by the person to catch the ruler is equal to the time of fall ( TOD ) of the ruler.

$$t_R = \sqrt{\frac{2H}{g}}$$

$$t_R = \sqrt{\frac{2 \times 0.2}{10}}$$

$$t_R = 0.2 \text{ s}$$

## SAQs

1. Derive the relation  $v = u + at$  using calculus.

Refer to notes ([click here](#))

2. Derive the expression for displacement of uniformly accelerated motion using velocity-time graph.

Refer to notes ([click here](#))

3. Derive the kinematic equation of motion  $v^2 = v_o^2 + 2ax$ .

Refer to notes ([click here](#))

4. A ball is thrown vertically upwards with a velocity of  $20 \text{ ms}^{-1}$  from a height 25m. Calculate the time taken to reach the ground.

Total displacement of the ball is  $-25 \text{ m}$

$$\text{Using } S = ut + \frac{1}{2}at^2$$

$$-25 = 20t + \frac{1}{2}(-10)t^2$$

$$10t^2 - 40t - 50 = 0$$

Solving the above equation we get  $t = 5 \text{ s}$ .

5. Explain Galileo's law of odd numbers with a suitable example.

## Answers to text book questions    Motion in a straight line

Refer to notes ([click here](#))

6. A man walks 2.5 km to the market at a speed of 5 kmph and returns at 7.5 kmph. Find his average speed and average velocity.

Total distance (  $S$  ) = 5 km

Time taken to go to the market is

$$t_1 = \frac{2.5}{5} = \frac{1}{2}$$

Time taken to return is

$$t_2 = \frac{2.5}{7.5} = \frac{1}{3}$$

Average speed is

$$v_{\text{avg}} = \frac{2.5}{t_1 + t_2}$$

$$v_{\text{avg}} = 3 \text{ kmph}$$

7. Plot position versus time graph for a body moving with constant acceleration. Explain how to find velocity from it.

Refer to notes ([click here](#))

8. Explain with example why instantaneous acceleration may be non-zero even when instantaneous velocity is zero.

Refer to notes ([click here](#))

9. Define reaction time. Describe an experiment to measure it using a ruler.

Refer to notes ([click here](#))