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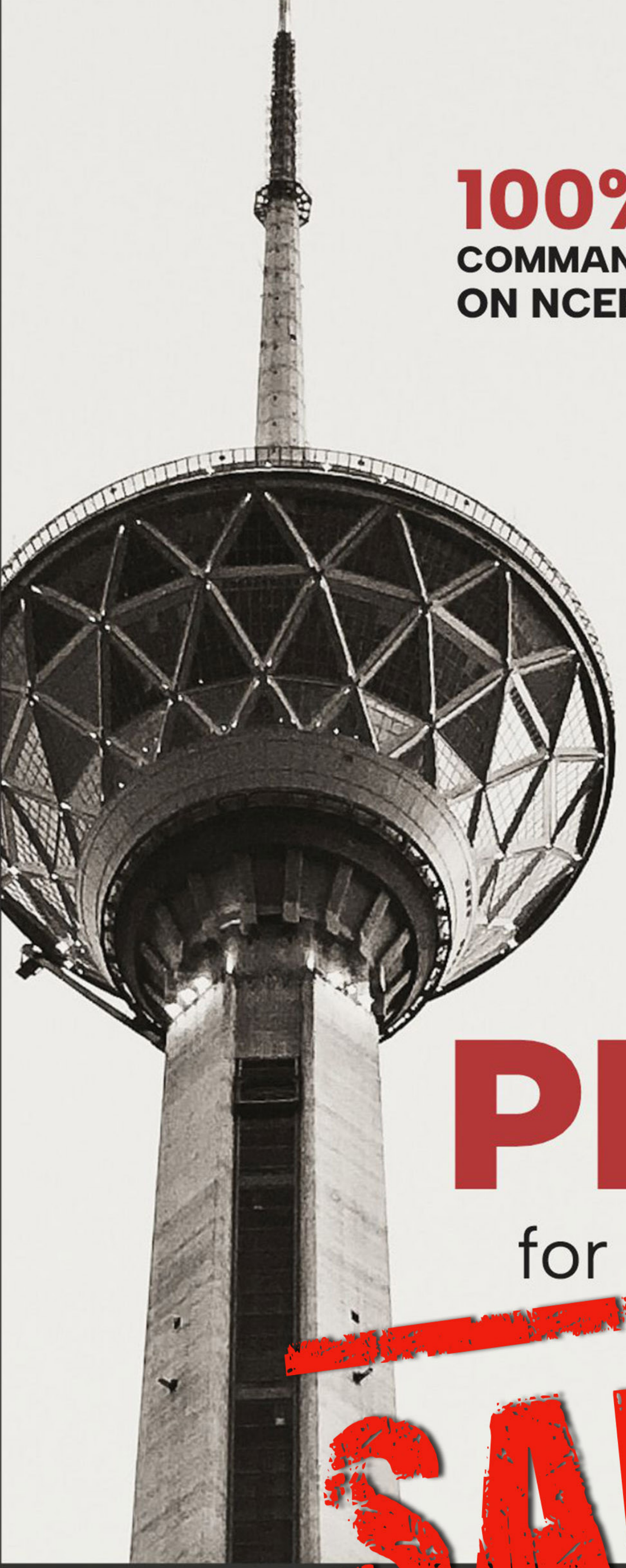

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Contents of Free Sample Book

Class XI

Hints & Solutions (Class 11th)

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Class XI **A1—A286**

Note : * The four Exercises in each of the chapters are :
- Exercise 1 : NCERT Based Topic-wise MCQs
- Exercise 2 : NCERT Exempler Past Years NEET & JEE Main
- Exercise 3 : Matching Statements & Assertion Reason Type
- Exercise 4 : Skill Enhancer MCQs
- Exercise 5 : Numeric Value Answer Questions

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Class XII B1—B302

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Mock Tests

Sample Chapter

CHAPTER-3

Motion in a Straight Line

Trend Analysis NEET & JEE Main

	NEET	JEE	Remarks
Number of Questions from 2022-16	8	5	Less important Chapter for JEE (M)
Weightage	2.5%	2.44%	

Year	Topic Name	Concept Used	NEET No. of Ques.	NEET Difficulty Level	JEE No. of Ques.	JEE Difficulty Level
2022	Displacement versus time graph, motion under gravity	V = Slope of displacement time graph = tan θ; $S_n = u + \frac{a}{2}(2n-1)$; $h = \frac{u^2}{2g}, s = ut + \frac{1}{2}gt^2$	2	Easy Average	1	Difficult
2021	Uniform acceleration	Equation of motion	1	Average	1	Average
2020	Motion under Gravity	Equations of motion	1	Average	0	
2019	Relative velocity in one dimension	River-Man problem	1	Average	1	Average
2018	Average speed and velocity	Average speed & velocity; kine-matic equations of uniformly acce-lerated motion	1	Average	1	Average
	Position/Distance/ Velocity versus time graph	Graphical analysis				
2017	Relative velocity; Graphical, analysis	Relative velocity; Different cases of velocity-time graph	1	Average	1	Average
2016	Non-uniform Motion	Integration and differentiation	1	Easy	0	

NCERT ONE-LINERS
(Important Points to Remember)

3.1 Introduction

- Motion is change in position of an object with time.
- Motion of objects along a straight line, is known as **rectilinear motion.**
- In **kinematics** we study ways to describe motion without going into the causes of motion.

3.2 Position, Path Length and Displacement

Position

- In order to specify position, we need to use a reference point and a set of axes.
- A rectangular coordinate system consisting of three mutually perpenducular axes, labelled X-, Y-, and Z- axes. The point of intersection of these three axes is called origin (O) reference point. The coordinates (x, y. z) of an object describe the position of the object. This coordinate system along with a clock constitutes a **frame of reference.**
- For describing motion in one dimension, we need only one axis. To describe motion in two/three dimensions, we need a set of two/three axes.
- To describe motion along a straight line, choose an axis, say X-axis, so that it coincides with the path of the object. We then measure the position of the object with reference to a chosen origin, say O, as shown in Fig. Positions to the right of O are taken as positive and to the left of O, as negative.

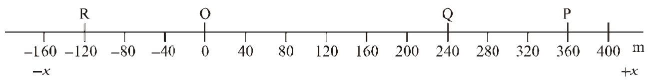


Fig.: x-axis, origin and positions of a car at different times.

- The position of point P and Q in Fig. are +360 m and +240 m. Similarly, the position of point R is –120 m.

Path Length

- Consider the motion of a car along the x-axis, the car was at x = 0 at t = 0.
- Consider two cases of motion. First the car moves from O to P. The distance moved by the car is OP = +360 m. This distance is called the path length.
- Second case, the car moves from O to P and then moves back from P to Q. Path length is OP + PQ = + 360 m + (+120 m) = + 480 m. Path length is a scalar quantity & equals to total length of path.

Displacement

- Displacement is the change in position. Let x_1 and x_2 be the positions of an object at time t_1 and t_2. Then its displacement, denoted by Δx is given by the difference between the final and initial positions :

$$\Delta x = x_2 - x_1$$ **JEE M 2022**

Delta (Δ) denote change in a quantity.

- Displacement of the car in moving from O to P is:
$\Delta x = x_2 - x_1 = (+360 \text{ m}) - 0 \text{ m} = +360 \text{ m}$
- The displacement of the car from P to Q is 240 m – 360 m = – 120 m. Negative sign indicates the direction of displacement.
- The magnitude of displacement may or may not be equal to the path length traversed by an object. Consider the motion of the car from O to P and back to Q. In this case, the path length = (+360 m) + (+120 m) = + 480 m. The displacement = (+240 m) – (0 m) = + 240 m.
- The magnitude of the displacement for a course of motion may be zero but the corresponding path length is not zero. If the car starts from O, goes to P and then returns to O, the displacement is zero. However, the path length of this journey is OP + PO = 360 m + 360 m = 720 m.
- A car is standing still at x = 40 m. The position-time graph for this car is a straight line parallel to the time axis.

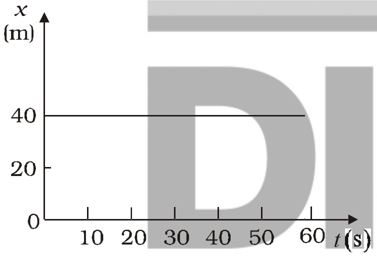


Fig.: Stationary Object

- If an object moving along the straight line covers equal distances in equal intervals of time, it is said to be in **uniform motion.** Fig. shows the position-time graph of such a motion.

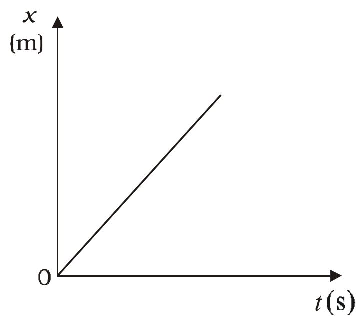


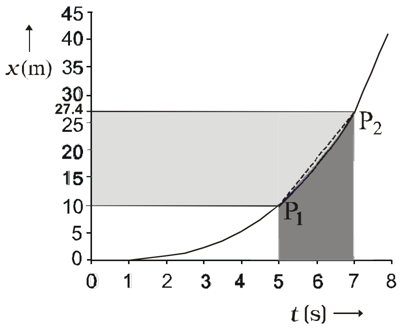
Fig. : An object in uniform motion

3.3 Average Velocity and Average Speed

- How fast is the position changing with time and in what direction? To describe this, define the quantity average velocity. **Average velocity** is defined as the change in position or displacement (Δx) divided by the time intervals (Δt), in which the displacement occurs:

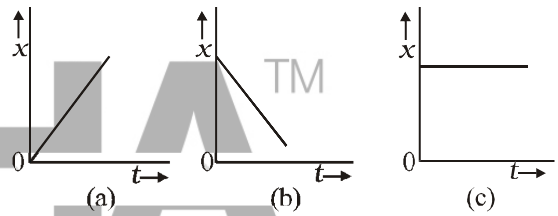
$$v = \frac{x_2 - x_1}{t_2 - t_1} = \frac{\Delta x}{\Delta t}$$

where x_2 and x_1 are the positions of the object at time t_2 and t_1, respectively. Like displacement, average velocity is also a vector quantity. As seen from the plot, the average velocity of the car between time t = 5 s and t = 7 s is :



$$\bar{v} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{(27.4 - 10.0) \text{ m}}{(7-5) \text{ s}} = 8.7 \text{ ms}^{-1}$$

The x-t graphs for an object, moving with positive velocity, moving with negative velocity (Fig.) and at rest.



- Average speed is defined as the total path length travelled divided by the total time.

$$\text{Average speed} = \frac{\text{Total path length}}{\text{Total time interval}}$$ **NEET 2007, 2011, 2018**

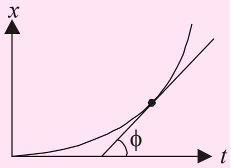
- If the motion of an object is along a straight line and in the **same direction**, the magnitude of displacement is equal to the total path length. The magnitude of average velocity is equal to the average speed. This is not always the case, speed is, in general, greater than the magnitude of the velocity.
Speed $\geq$ |velocity|

3.4 Instantaneous Velocity and Speed

Instantaneous Velocity

- The velocity at an instant is defined as the limit of the average velocity as the time interval Δt becomes infinitesimally small.

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$ **NEET 2013**



- Displacement $= \int V dt$ NEET 2016
- Slope of tangent on displacement time graph gives velocity at that instant $\frac{dx}{dt} = \tan\phi$ NEET 2022
- For uniform motion, velocity is the same as the average velocity at all instants.
- Instantaneous speed or simply speed is the magnitude of velocity. For example, a velocity of + 24.0 m s^{-1} and a velocity of –24.0 m s^{-1} — both have speed of 24.0 m s^{-1}.
- Instantaneous speed at an instant is equal to the magnitude of the instantaneous velocity at that point.

3.5 Acceleration

- The **average acceleration** $\bar{a}$ over a time interval is defined as the change of velocity divided by the time interval :

$$\bar{a} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$$

- **Instantaneous acceleration** is defined as $a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$. NEET 2015
- The acceleration at an instant is the slope of the tangent to the v–t curve at that instant. NEET 2021
- Acceleration of particle as a function of x, $a = v\frac{dv}{dx}$ NEET 2015
- Velocity is a quantity having both magnitude and direction, a change in velocity may involve change in either or both of these factors. Acceleration, therefore, may result from a change in speed (magnitude), a change in direction or changes in both.
- Position-time graphs for motion with positive, negative and zero acceleration are shown in Figs. (a), (b) and (c), respectively.

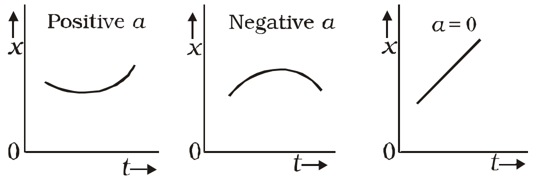


Fig.: Position-time graph for motion with (a) positive acceleration; (b) negative acceleration, and (c) zero acceleration.

- Fig. shows velocity-time graph for motion with constant acceleration for the following cases :
  - (a) An object is moving in a positive direction with a positive acceleration,
  - (b) An object is moving in positive direction with a negative acceleration.
  - (c) An object is moving in negative direction with a negative acceleration.
  - (d) An object is moving in positive direction till time t_1, and then turns back with the same negative acceleration.

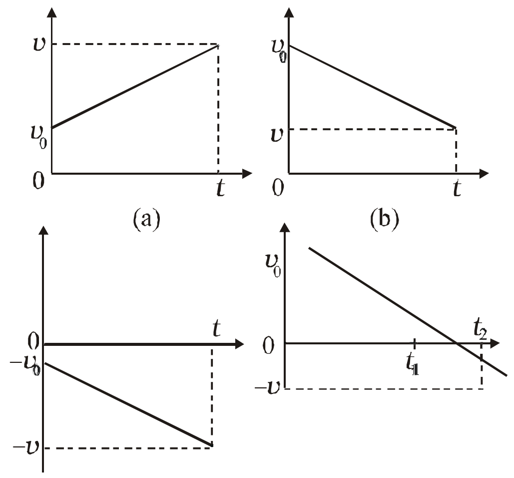


Fig.: Velocity–time graph for motions with constant acceleration. (a) motion in positive direction; direction with positive acceleration, (b) Motion in positive direction with negative acceleration, (c) Motion in negative direction with negative acceleration, (d) Motion of an object with negative acceleration that changes direction at time t_1. Between times 0 to t_1, it moves in positive x-direction and between t_1 and 2 it moves in the opposite direction.

- The area under the velocity time curve represents the displacement over a given time interval. JEE M 2020

3.6 Kinematic Equations for Uniformly Accelerated Motion

- For uniformly accelerated motion, we can derive some simple equations that relate displacement (x), time taken (t), initial velocity (v_0), final velocity (v) and acceleration (a).
  - (i) $v = v_0 + at$
  - (ii) $x = v_0 t + \frac{1}{2}at^2$
  - (iii) $v^2 = v_0^2 + 2ax$ NEET 2020
  - (iv) $x_{nth} = V_0 + \frac{a}{2}(2n-1)$ NEET 2021
- When a body is moving up or downward under the influence of force of gravity. $a = g = 9.8 \text{ ms}^{-2}$
- The ratio of the distance travelled by a freely falling body in 1st, 2nd, 3rd and 4th second is 1 : 3 : 5 : 7 NEET 2022

3.7 Relative Velocity

- Consider two objects A and B moving uniformly with velocities v_A and v_B in one dimension, along x-axis. If $x_A(0)$ and x_B (0) are positions of objects A and B, respectively at time $t = 0$, their positions $x_A(t)$ and $x_B(t)$ at time t are given by:

$$x_A(t) = x_A(0) + v_A t$$
$$x_B(t) = x_B(0) + v_B t$$

- The displacement from object A to object B is given by

$$x_{BA}(t) = x_B(t) - X_A(t)$$
$$= [x_B(0) - x_A(0)] + (v_B - v_A)t$$

Equation tells us that as seen from object A, object B has a velocity $v_B - v_A$:

- Velocity of object B relative to object A is

$$v_{BA} = v_B - v_A$$

Similarly, velocity of object A relative to object B is:

$$v_{AB} = v_A - v_B$$

- Angle swimmer makes with perpendicular to river flow to reach across river is

$$\sin\theta = \frac{\text{Velocity of river}}{V_{man}\,\text{w.r.t. river}}$$ **NEET 2019**

Relative velocity of a person w.r.t ground on the moving escalator $v = v_1 + v_2$

$$\Rightarrow \frac{d}{t} = \frac{d}{t_1} + \frac{d}{t_2} \Rightarrow \frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2} \Rightarrow t = \frac{t_1 t_2}{t_1 + t_2}$$ **NEET 2017**

Here t_1 = time taken to travel up the stationary escalator, t_2 = time taken to travel up when person stands on the moving escalator, t = time taken to walk up on the moving escalator.

- Some special cases :
  (a) If $v_B = v_A$, $v_B - v_A = 0$. the two objects stay at a constant distance, position–time graphs are straight lines parallel to each other as shown in Fig.

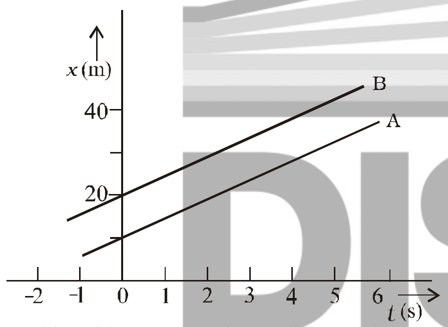


Fig.: Position-time graphs of two objects with equal velocities.

(b) If $v_A > v_B$, $v_B - v_A$ is negative.

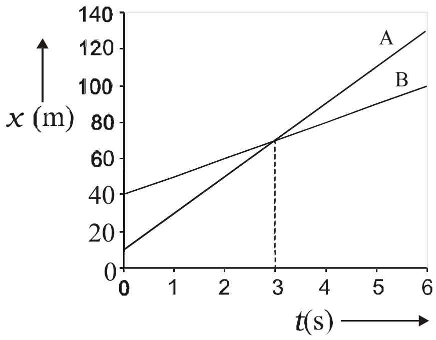


Fig.: Position-time graphs of two objects with unequal velocities, showing the time of meeting.

(c) Suppose v_A and v_B are of opposite signs. The velocity of B relative to A,

$v_{BA} = -v_{AB}$.

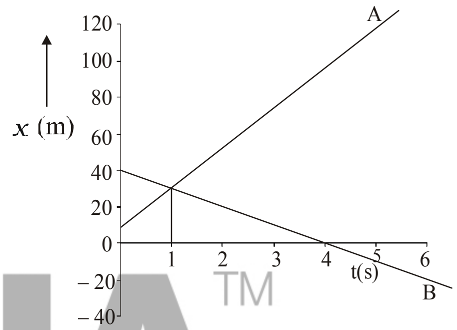


Fig.: Position-time graphs of two objects with velocities in opposite directions, showing the time of meeting.

Tips/Tricks/Techniques ONE-LINERS
(Exam Special)

- An object is said to be point object if its mass is very small as compared to its velocity.
- The angle between acceleration and velocity is either 0° or 180° in one dimensional motion and it does not change with time.
- The speed of the particle increases when the angle between $\vec{a}$ and $\vec{v}$ lies between 0° and 90°.
- The speed of the particle decreases, when the angle between $\vec{a}$ and $\vec{v}$ lies between +90° and 180°.
- The speed of the particle remains constant when the angle between $\vec{a}$ and $\vec{v}$ is equal to 90°.
- The ratio of distance and displacement is equal or greater than 1.
- Displacement of a particle gives no information regarding the nature of the path followed by the particle.
- Average speed of a body is equal or greater than the magnitude of the average velocity of the body.
- The average speed of a body is equal to its instantaneous speed if the body moves with a constant speed.
- Speedometer in a vehicle measures its instantaneous speed.
- The acceleration of the falling bodies is independent of the mass of the body.
- If two bodies are allowed to fall from the same height, they will reach the ground in the same time and with the same velocity.
- If a body is thrown upwards with velocity u from the top of a tower and another body is dropped downward from the same point and with the same velocity, then both reach the ground with the same speed.
- The velocity and acceleration of the body may have different directions.
- The value of velocity and acceleration of a body may not be zero simultaneously.

- If a particle travels with speed v_1 for first half time of its total motion and with speed v_2 for next half time then $v_{av} = \frac{v_1 + v_2}{2}$.
- When a particle covers first half of a distance with speed v_1 and another half with speed v_2 then $v_{av} = \frac{2v_1v_2}{v_1 + v_2}$.
- When a particle covers first one-third distance with speed v_1, next one third with speed v_2 and last one third with speed v_3, then $v_{av} = \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$
- If displacement time graph of two particles moving with velocities v_1 and v_2 are straight line with slopes θ_1 and θ_2 then $\frac{v_1}{v_2} = \frac{\tan\theta_1}{\tan\theta_2}$.
- Area enclosed by $v - t$ graph = displacement of the particle.
- Slope of velocity-time graph = acceleration.
- If a particle travels for a time t_1 with acceleration a_1 and for time t_2 with acceleration a_2 then average acceleration is $a_{av} = \frac{a_1t_1 + a_2t_2}{t_1 + t_2}$
- If a body is starting from rest and is moving with uniform acceleration then distance travelled by the body in t second is proportional to t^2 (*i.e.*, $s \propto t^2$).
  For example : the ratio of distance covered in 1 sec, 2 sec and 3 sec is $1^2 : 2^2 : 3^2$ or 1 : 4 : 9.
- If a body is starting from rest and is moving with uniform acceleration then distance covered by the body in nth sec is proportional to (2n – 1)(*i.e.*, $s_n \propto (2n - 1)$).
  For example : the ratio of distance covered in 1st, 2nd and 3rd second is 1 : 3 : 5.
- A body moving with a velocity u comes to stop on application of brakes after covering a distance s. If the same body moves with velocity nu and same braking force is applied on it then it will come to stop after covering a distance of n^2s.
- When a body is thrown vertically upwards, then its acceleration = $-g$. Similarly for a body moving downward, acceleration = g.
- When friction of the air is assumed negligible, then Time taken to go up (ascent) = Time taken to come down (descent)
- A ball is thrown downwards from a building of height h and it reaches after t seconds on earth. From the same building if two balls are thrown (one upwards and other downwards) with the same velocity u and they reach the earth surface after t_1 and t_2 seconds respectively then

  $$t = \sqrt{t_1t_2}$$
- A particle is thrown downwards from rest from a height. The ratio of time taken by it to fall through successive distance of 1m each will be given by

  $$\sqrt{1}, (\sqrt{2} - \sqrt{1}), (\sqrt{3} - \sqrt{2}).....(\sqrt{4} - \sqrt{3}),.......$$
- When friction of air be taken into account, then Time taken for upward journey < time taken for downward journey.
- The path length traversed by an object between two points is, in general, not the same as the magnitude of displacement. The displacement depends only on the end points; the path length (as the name implies) depends on the actual path. In one dimension, the two quantities are equal only if the object does not change its direction during the course of motion. In all other cases, the path length is greater than the magnitude of displacement.
- In view of point 1 above, the average speed of an object is greater than or equal to the magnitude of the average velocity over a given time interval. The two are equal only if the path length is equal to the magnitude of displacement.
- The origin and the positive direction of an axis are a matter of choice. You should first specify this choice before you assign signs to quantities like displacement, velocity and acceleration.
- If a particle is speeding up, acceleration is in the direction of velocity; if its speed is decreasing, acceleration is in the direction opposite to that of the velocity. This statement is independent of the choice of the origin and the axis.
- The sign of acceleration does not tell us whether the particle's speed is increasing or decreasing. The sign of acceleration (as mentioned in point 3) depends on the choice of the positive direction of the axis. For example, if the vertically upward direction is chosen to be the positive direction of the axis, the acceleration due to gravity is negative. If a particle is falling under gravity, this acceleration, though negative, results in increase in speed. For a particle thrown upward, the same negative acceleration (of gravity) results in decrease in speed.
- The zero velocity of a particle at any instant does not necessarily imply zero acceleration at that instant. A particle may be momentarily at rest and yet have non-zero acceleration. For example, a particle thrown up has zero velocity at its uppermost point but the acceleration at that instant continues to be the acceleration due to gravity.
- In the kinematic equations of motion, the various quantities are algebraic, i.e. they may be positive or negative. The equations are applicable in all situations (for one dimensional motion with constant acceleration) provided the values of different quantities are substituted in the equations with proper signs.
- The definitions of instantaneous velocity and acceleration are exact and are always correct while the kinematic equations of motion are true only for motion in which the magnitude and the direction of acceleration are constant during the course of motion.

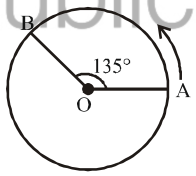
Exercise 1 : NCERT Based Topic-wise MCQs

3.1 Introduction

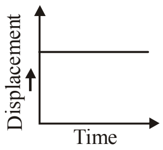
1. Which of the following is a one dimensional motion ? NCERT Page-40
   (a) Motion of snake
   (b) Motion of air particle
   (c) Motion of satellite
   (d) Motion of train running on a straight track

3.2 Position, Path Length and Displacement

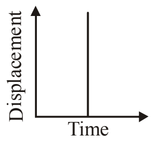
2. The location of a particle has changed. What can we say about the displacement and the distance covered by the particle? NCERT Page-41
   (a) Neither can be zero (b) One may be zero
   (c) Both may be zero (d) One is +ve, other is –ve
3. The displacement of a body is zero. The distance covered NCERT Page-41
   (a) is zero
   (b) is not zero
   (c) may or may not be zero
   (d) depends upon the acceleration
4. The numerical ratio of displacement to distance for a moving object is NCERT Page-41
   (a) always less than 1 (b) always equal to 1
   (c) always more than 1 (d) equal to or less than 1
5. Which of the following can be zero, when a particle is in motion for some time? NCERT Page-41
   (a) Distance (b) Displacement
   (c) Speed (d) None of these
6. A person moved from A to B on a circular path as shown in figure. If the distance travelled by him is 60 m, then the magnitude of displacement would be : NCERT Page-41
   (Given $\cos 135° = -0.7$)
   (a) 42 m
   (b) 47 m
   (c) 19 m
   (d) 40 m



7. An athlete completes one round of a circular track of radius R in 40 sec. What will be his displacement at the end of 3 min. 20 sec? NCERT Page-41
   (a) Zero (b) 2 R
   (c) $2\pi R$ (d) $7\pi R$
8. A particle moves 2m east then 4m north then 5 m west. The distance is NCERT Page-40
   (a) 11 m (b) 10 m (c) –11 m (d) 5 m
9. A particle moves from (2,3) m to (4,1) m. The magnitude of displacement is NCERT Page-41
   (a) 2 m (b) $2\sqrt{3}$ m (c) $2\sqrt{2}$ m (d) $3\sqrt{2}$ m
10. Which of the following is not possible for a body in uniform motion? NCERT Page-41
    (a)



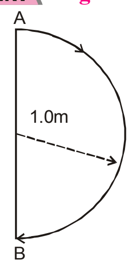
    (b)



    (c) Both (a) & (b) (d) None of these

3.3 Average Velocity and Average Speed

11. In 1.0 s, a particle goes from point *A* to point *B*, moving in a semicircle of radius 1.0 m (see Figure). The magnitude of the average velocity is NCERT Page-42
    (a) 3.14 m/s
    (b) 2.0 m/s
    (c) 1.0 m/s
    (d) Zero



12. A body moves in straight line with velocity v_1 for 1/3[rd] time and for remaining time with v_2. Find average velocity. NCERT Page-42
    (a) $\frac{v_1}{3}+\frac{2v_2}{3}$ (b) $\frac{v_1}{3}+\frac{v_2}{3}$
    (c) $\frac{2v_1}{3}+\frac{v_2}{3}$ (d) $v_1+\frac{2v_2}{3}$
13. A particle moves in straight line with velocity 6 m/s and 3 m/s for time intervals which are in ratio 1:2. Find average velocity. NCERT Page-42
    (a) 2 m/s (b) 3 m/s
    (c) 4 m/s (d) 5 m/s
14. A man leaves his house for a cycle ride. He comes back to his house after half-an-hour after covering a distance of one km. What is his average velocity for the ride? NCERT Page-42
    (a) zero (b) 2 km h^{-1}
    (c) 10 km s^{-1} (d) $\frac{1}{2}$ km s^{-1}
15. A point traversed half of the distance with a velocity v_0. The half of remaining part of the distance was covered with velocity v_1 & second half of remaining part by v_2 velocity. The mean velocity of the point, averaged over the whole time of motion is NCERT Page-42
    (a) $\frac{v_0+v_1+v_2}{3}$ (b) $\frac{2v_0+v_1+v_2}{3}$
    (c) $\frac{v_0+.2v_1+2v_2}{3}$ (d) $\frac{2v_0(v_1+v_2)}{(2v_0+v_1+v_2)}$

3.4 Instantaneous Velocity and Speed

16. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is: NCERT Page-43

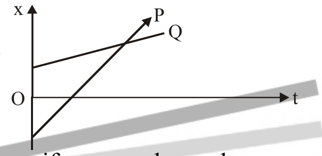
(a) $3\alpha + 7\beta$ (b) $\frac{3}{2}\alpha + \frac{7}{3}\beta$

(c) $\frac{\alpha}{2} + \frac{\beta}{3}$ (d) $\frac{3}{2}\alpha + \frac{7}{2}\beta$

17. Two buses P and Q start from a point at the same time and move in a straight line and their positions are represented by $X_P(t) = \alpha t + \beta t^2$ and $X_Q(t) = ft - t^2$. At what time, both the buses have same velocity? NCERT Page-43

(a) $\frac{\alpha - f}{1+\beta}$ (b) $\frac{\alpha + f}{2(\beta - 1)}$ (c) $\frac{\alpha + f}{2(1+\beta)}$ (d) $\frac{f - \alpha}{2(1+\beta)}$

18. The fig given shows the time-displacement curve of two particles P and Q. Which of the following statement is correct? NCERT Page-52



(a) Both P and Q move with uniform equal speed
(b) P is accelerated Q is retarded
(c) Both P and Q move with uniform speeds but the speed of P is more than the speed of Q
(d) Both P and Q move with uniform speeds but the speed of Q is more than the speed of P.

19. The distance travelled by a body is directly proportional to the time taken. Its speed NCERT Page-42

(a) increases (b) decreases
(c) becomes zero (d) remains constant

20. The slope of velocity-time graph for motion with uniform velocity is equal to NCERT Page-46, 47

(a) final velocity (b) initial velocity
(c) zero (d) none of these

21. The ratio of the numerical values of the average velocity and average speed of a body is NCERT Page-42

(a) unity (b) unity or less
(c) unity or more (d) less than unity

22. The slope of the tangent drawn on position-time graph at any instant is equal to the instantaneous NCERT Page-43

(a) acceleration (b) force
(c) velocity (d) momentum

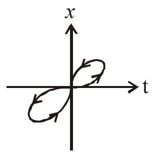
23. The displacement-time graphs of two particles A and B are straight lines making angles of 30° and 60° respectively with the time axis. If the velocity of A is v_A and that of B is v_B, the value of v_A/v_B is NCERT Page-41

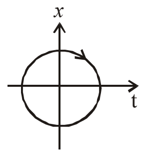
(a) 1/2 (b) $1/\sqrt{3}$ (c) $\sqrt{3}$ (d) 1/3

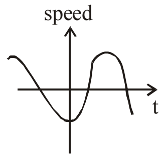
24. Choose the wrong statement from the following. NCERT Page-47

(a) The motion of an object along a straight line is a rectilinear motion.
(b) The speed in general is less than the magnitude of the velocity.
(c) The slope of the displacement-time graph gives the velocity of the body.
(d) The area under the velocity-time graph gives the displacement of the body.

25. Which of the following graph cannot possibly represent one dimensional motion of a particle? NCERT Page-40

(a) 

(b) 

(c) 

(d) All of these

26. The total distance travelled by the body in the given time is equal to NCERT Page-47

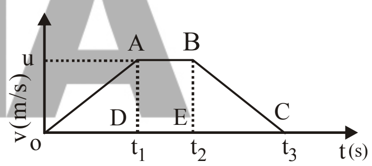
(a) the area which v – t graph encloses with displacement axis
(b) the area which x – t graph encloses with time axis
(c) the area which v – t graph encloses with time axis
(d) the area which a – t graph encloses with axis

27. Choose the correct equation to determine distance in a straight line for a body with uniform motion. NCERT Page-47

(a) $s = \frac{v}{t}$ (b) $s = v^2 t$

(c) $s = ut + \frac{1}{2}at^2$ (d) $s = v \times t^2$

28. The velocity time graph of the motion of the body is as shown below NCERT Page-47



The total distance travelled by the body during the motion is equal to ____.

(a) $\frac{1}{2}$ (AD + BE) × OC (b) $\frac{1}{2}$ (OA + BC) × OC

(c) $\frac{1}{2}$ (OC + AB) × AD (d) $\frac{1}{2}$ (OA + AB) × BC

3.5 Acceleration

29. What is the rate of change of velocity of an object in uniform motion ? NCERT Page-47

(a) Always equal to zero
(b) Always less than one
(c) Always greater than one
(d) Either less than or equal to one.

30. What determines the nature of the path followed by the particle? NCERT Page-45

(a) Speed (b) Velocity
(c) Acceleration (d) Both (b) and (c)

31. The acceleration of a moving body can be found from
(a) area under velocity - time graph **NCERT** Page-45
(b) area under distance -time graph
(c) slope of the velocity- time graph
(d) slope of distance-time graph

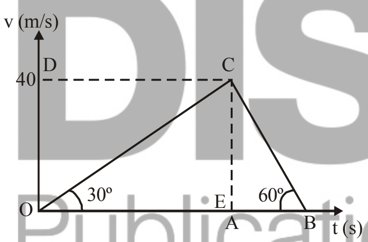
32. Acceleration of a particle changes when
(a) direction of velocity changes **NCERT** Page-45
(b) magnitude of velocity changes
(c) speed changes
(d) Both (a) and (b)

33. The area under acceleration time graph gives **NCERT** Page-45
(a) distance travelled (b) change in acceleration
(c) force acting (d) change in velocity

34. Which of the following is the correct expression of instantaneous acceleration? **NCERT** Page-45
(a) $a=\frac{\Delta v}{(\Delta t)^2}$ (b) $a = \frac{dv}{dt}$
(c) $a = \frac{d^2v}{dt^2}$ (d) $a = \left(\frac{\Delta v}{\Delta t}\right)^2$

35. The displacement of a particle is represented by the following equation: $S = 3t^3 + 7t^2 + 5t + 8$ where 5 is in meter and t in second. The acceleration of the particle at $t = 15$ is **NCERT** Page-45
(a) $14\ m/s^2$ (b) $18\ m/s^2$ (c) $32\ m/s^2$ (d) zero

36. The velocity-time graph of a body is shown in fig. The ratio of average acceleration during the intervals OA and AB is **NCERT** Page-45
(a) 1
(b) $\frac{1}{2}$
(c) $\frac{1}{3}$
(d) 3



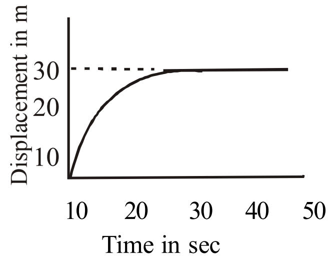
37. The distance time graph of a particle at time t makes angles 45° with the time axis. After one second, it makes angle 60° with the time axis. What is the acceleration of the particle? **NCERT** Page-46
(a) $\sqrt{3}-1$ (b) $\sqrt{3}+1$ (c) $\sqrt{3}$ (d) 1

38. The displacement x of a particle along a straight line at time t is given by : $x = a_0 + \frac{a_1 t}{2} + \frac{a_2}{3}t^2$. The acceleration of the particle is **NCERT** Page-45
(a) $\frac{a_2}{3}$ (b) $\frac{2a_2}{3}$ (c) $\frac{a_1}{2}$ (d) $a_0 + \frac{a_2}{3}$

39. The dependence of velocity of a body with time is given by the equation $v = 20 + 0.1t^2$. The body is in
(a) uniform retardation **NCERT** Page-45
(b) uniform acceleration
(c) non-uniform acceleration
(d) zero acceleration.

40. The deceleration experienced by a moving motorboat after its engine is cut off, is given by $\frac{dv}{dt} = -KV^3$ where K is constant. If V_0 is the magnitude of the velocity at cut-off, the magnitude of the velocity at a time t after the cut-off is **NCERT** Page-45
(a) $\frac{V_0}{\sqrt{(2V_0^2Kt+1)}}$ (b) V_0e^{-Kt}
(c) $V_0/2$ (d) V_0

41. The displacement of a particle as a function of time is shown in figure. It indicates that **NCERT** Page-46



(a) the velocity of the particle is constant throughout
(b) the acceleration of the particle is constant throughout
(c) the particle starts with a constant velocity and is accelerated
(d) the motion is retarded and finally the particle stops

42. A particle moves along a straight line OX. At a time t (in second) the distance x (in metre) of the particle from O is given by $x = 40 + 12t - t^3$. How long would the particle travel before coming to rest? **NCERT** Page-43
(a) 24 m (b) 40 m (c) 56 m (d) 16 m

43. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to **NCERT** Page-45
(a) $(\text{velocity})^{3/2}$ (b) $(\text{distance})^2$
(c) $(\text{distance})^{-2}$ (d) $(\text{velocity})^{2/3}$

44. A particle is moving eastwards with a velocity of $5\ ms^{-1}$. In 10 seconds the velocity changes to $5\ ms^{-1}$ northwards. The average acceleration in this time is **NCERT** Page-45
(a) $\frac{1}{2}ms^{-2}$ towards north
(b) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - east
(c) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - west
(d) zero

45. It is given that $t = px^2 + qx$, where x is displacement and t is time. The acceleration of particle at origin is **NCERT** Page-45
(a) $-\frac{2p}{q^3}$ (b) $-\frac{2q}{p^3}$
(c) $\frac{2p}{q^3}$ (d) $\frac{2q}{p^3}$

46. An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by: $\frac{dv}{dt} = -2.5\sqrt{v}$ where v is the instantaneous speed. The time taken by the object, to come to rest, would be **NCERT** Page-45

(a) 2 s (b) 4 s (c) 8 s (d) 1 s

47. The position of a particle along the x-axis at certain times is given below **NCERT** Page-45

t(s)	0	1	2	3
x(m)	–2	0	6	16

Which of the following describes the motion correctly?

(a) uniform acceleration
(b) uniform retardation
(c) non-uniform acceleration
(d) there is not enough data for generalization

3.6 Kinematic Equations for Uniformly Accelerated Motion

48. The graph between displacement and time for a particle moving with uniform acceleration is a/an **NCERT** Page-48

(a) straight line with a positive slope
(b) parabola
(c) ellipse
(d) straight line parallel to time axis

49. In a car race on straight road, car A takes a time t less than car B at the finish and passes finishing point with a speed 'v' more than of car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then 'v' is equal to: **NCERT** Page-48

(a) $\frac{2a_1 a_2}{a_1 + a_2} t$ (b) $\sqrt{2a_1 a_2}\ t$

(c) $\sqrt{a_1 a_2}\ t$ (d) $\frac{a_1 + a_2}{2} t$

50. Velocity time curve for a body projected vertically upwards is **NCERT** Page-50

(a) parabola (b) ellipse
(c) hyperbola (d) straight line

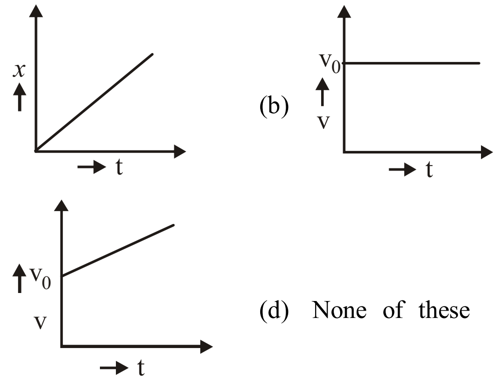
51. A bus starts moving with acceleration 2 m/s^2. A cyclist 96 m behind the bus starts simultaneously towards the bus at 20 m/s. After what time will he be able to overtake the bus? **NCERT** Page-48

(a) 4 sec (b) 8 sec
(c) 18 sec (d) 16 sec

52. Stopping distance of a moving vehicle is directly proportional to **NCERT** Page-50

(a) square of the initial velocity
(b) square of the initial acceleration
(c) the initial velocity
(d) the initial acceleration

53. Which of the following graphs gives the equation $x = v_o t + \frac{1}{2} at^2$ **NCERT** Page-48



(a) (b) (c) (d) None of these

54. If a train travelling at 20 m/s is to be brought to rest in a distance of 200 m, then its retardation should be **NCERT** Page-48

(a) 1 m/s^2 (b) 2 m/s^2
(c) 10 m/s^2 (d) 20 m/s^2

55. A body starts from rest and travels 's' m in 2nd second, then acceleration is **NCERT** Page-47

(a) 2s m/s^2 (b) 3s m/s^2

(c) $\frac{2}{3}$s m/s^2 (d) $\frac{3}{2}$s m/s^2

56. A bullet fired into a wooden block loses half of its velocity after penetrating 40 cm. It comes to rest after penetrating a further distance of **NCERT** Page-48

(a) $\frac{22}{3}$cm (b) $\frac{40}{3}$cm (c) $\frac{20}{3}$cm (d) $\frac{22}{5}$cm

57. A body covers 26, 28, 30, 32 meters in 10th, 11th, 12th and 13th seconds respectively. The body starts **NCERT** Page-48

(a) from rest and moves with uniform velocity
(b) from rest and moves with uniform acceleration
(c) with an initial velocity and moves with uniform acceleration
(d) with an initial velocity and moves with uniform velocity

58. The displacement x of a particle at the instant when its velocity is v is given by $v = \sqrt{3x+16}$. Its acceleration and initial velocity are **NCERT** Page-48

(a) 1.5 units, 4 units (b) 3 units, 4 units
(c) 16 units, 1.6 units (d) 16 units, 3 units

59. A particle experiences constant acceleration for 20 seconds after starting from rest. If it travels a distance s_1 in the first 10 seconds and distance s_2 in the next 10 seconds, then **NCERT** Page-48

(a) $s_2 = s_1$ (b) $s_2 = 2\ s_1$
(c) $s_2 = 3\ s_1$ (d) $s_2 = 4\ s_1$

60. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3}ms^{-2}$, in the third second is: **NCERT** Page-48

(a) 6m (b) 4m (c) $\frac{10}{3}$m (d) $\frac{19}{3}$m

61. If a car at rest accelerates uniformly to a speed of 144 km/h in 20 s, it covers a distance of **NCERT** Page-48

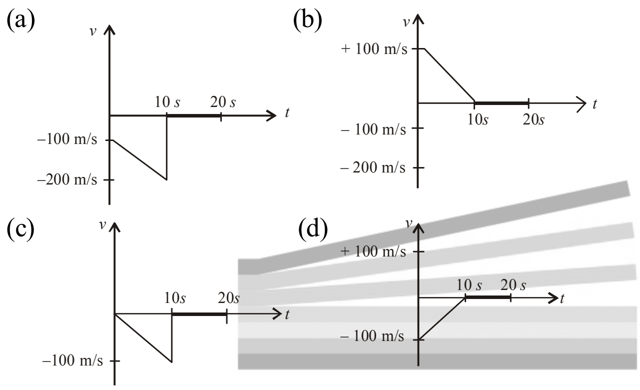
(a) 2880 m (b) 1440 m (c) 400 m (d) 20 m

62. A car accelerates from rest at a constant rate α for some time, after which it decelerates at a constant rate β and comes to rest. If the total time elapsed is t, then the maximum velocity acquired by the car is NCERT Page-47

(a) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ (b) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)$

(c) $\frac{(\alpha+\beta)t}{\alpha\beta}$ (d) $\frac{\alpha\beta t}{\alpha+\beta}$

63. A bullet is shot vertically downwards with an initial velocity of 100 m/s from a certain height. Within 10 s, the bullet reaches the ground and instantaneously comes to rest due to the perfectly inelastic collision. The velocity-time curve for total time $t = 20\,s$ will be : (Take $g = 10$ m/s^2) NCERT Page-49



64. A bike accelerates from rest at a constant rate 5 m/s^2 for some time after which it decelerates at a constant rate 3 m/s^2 to come to rest. If the total time elapsed is 8 second, the maximum velocity acquired by the bike is given by NCERT Page-47

(a) 5 m/s (b) 10 m/s (c) 12 m/s (d) 15 m/s

65. A metro train starts from rest and in 5 s achieves 108 km/h. After that it moves with constant velocity and comes to rest after travelling 45 m with uniform retardation. If total distance travelled is 395 m, find total time of travelling. NCERT Page-48

(a) 12.2 s (b) 15.3 s (c) 9 s (d) 17.2 s

66. A car, starting from rest, accelerates at the rate f through a distance S, then continues at constant speed for time t and then decelerates at the rate $\frac{f}{2}$ to come to rest. If the total distance traversed is 15 S , then NCERT Page-48

(a) $S = \frac{1}{6} f t^2$ (b) $S = f t$

(c) $S = \frac{1}{4} f t^2$ (d) $S = \frac{1}{72} f t^2$

67. A particle starting with certain initial velocity and uniform acceleration covers a distance of 12 m in first 3 seconds and a distance of 30 m in next 3 seconds. The initial velocity of the particle is NCERT Page-48

(a) 3 ms^{-1} (b) 2.5 ms^{-1}

(c) 2 ms^{-1} (d) 1 ms^{-1}

68. A body is thrown vertically upwards. If air resistance is to be taken into account, then the time during which the body rises is NCERT Page-49

(a) equal to the time of fall
(b) less than the time of fall
(c) greater than the time of fall
(d) twice the time of fall

69. A body is thrown upwards and reaches half of its maximum height. At that position NCERT Page-49

(a) its acceleration is minimum
(b) its velocity is maximum
(c) its velocity is zero
(d) its acceleration is constant

70. Velocity-time curve for a body projected vertically upwards is NCERT Page-50

(a) parabola (b) ellipse
(c) hyperbola (d) straight line

71. An object accelerated downward under the influence of force of gravity. The motion of object is said to be NCERT Page-49

(a) uniform motion
(b) free fall
(c) non uniformly accelerated motion
(d) None of these

72. Free fall of an object (in vacuum) is a case of motion with NCERT Page-49

(a) uniform velocity (b) uniform acceleration
(c) variable acceleration (d) constant momentum

73. A ball thrown vertically upwards after reaching a maximum height h, returns to the starting point after a time of l0 s. Its displacement is NCERT Page-49

(a) h (b) $2h$ (c) $10h$ (d) zero

74. A ball is released from a height h. If t_1 and t_2 be the time required to complete first half and second half of the distance respectively. Then, choose the correct relation between t_1 and t_2. NCERT Page-49

(a) $t_1 = (\sqrt{2})t_2$ (b) $t_1 = (\sqrt{2}-1)t_2$

(c) $t_2 = (\sqrt{2}+1)t_1$ (d) $t_2 = (\sqrt{2}-1)t_1$

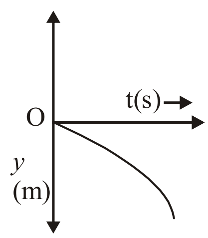
75. The equation represented by the graph below is : NCERT Page-50

(a) $y = \frac{1}{2} gt$

(b) $y = \frac{-1}{2} gt$

(c) $y = \frac{1}{2} gt^2$

(d) $y = \frac{-1}{2} gt^2$



76. A body is projected vertically upwards. If t_1 and t_2 be the times at which it is at height h above the projection while ascending and descending respectively, then h is NCERT Page-49

(a) $\frac{1}{2} g t_1 t_2$ (b) $g t_1 t_2$

(c) $2 g t_1 t_2$ (d) $2hg$

77. From a tower of height 400 m, a particle is thrown vertically upwards with a speed of 10 m/s. If the time taken by if to reach the highest point is T then the time taken by the particle to hit the ground is NCERT Page-49

(a) 20T (b) 15T
(c) 10T (d) 5T

78. A rocket is fired upward from the earth's surface such that it creates an acceleration of 19.6 ms^{-2}. If after 5 s, its engine is switched off, the maximum height of the rocket from earth's surface would be NCERT Page-49

(a) 980 m (b) 735 m (c) 490 m (d) 245 m

79. A man throws balls with same speed vertically upwards one after the other at an interval of 2 sec. What should be the speed of throw so that more than two balls are in air at any time? NCERT Page-49

(a) Only with speed 19.6 m/s
(b) More than 19.6 m/s
(c) At least 9.8 m/s
(d) Any speed less then 19.6 m/s.

80. A ball is dropped from a high rise platform at t = 0 starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 18s. What is the value of v?(take g = 10 m/s^2) NCERT Page-49

(a) 75 m/s (b) 55 m/s
(c) 40 m/s (d) 60 m/s

81. A stone falls freely under gravity. It covers distances h_1, h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1, h_2 and h_3 is NCERT Page-49

(a) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$ (b) $h_2 = 3h_1$ and $h_3 = 3h_2$
(c) $h_1 = h_2 = h_3$ (d) $h_1 = 2h_2 = 3h_3$

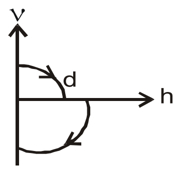
82. From a building two balls *A* and *B* are thrown such that *A* is thrown upwards and *B* downwards (both vertically). If T_A and T_B are their respective time of flights then NCERT Page-49

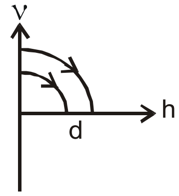
(a) $T_A > T_B$
(b) $T_A = T_B$
(c) $T_A < T_B$
(d) their time of flights depend on their masses.

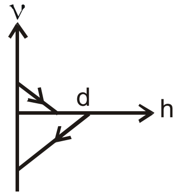
83. A ball is released from the top of tower of height h metre. It takes T second to reach the ground. What is the position in (m) from the ground of the ball in T/3 second ? NCERT Page-49

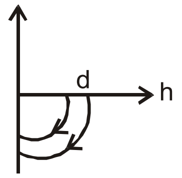
(a) $\frac{h}{9}$ (b) $\frac{7h}{9}$ (c) $\frac{8h}{9}$ (d) $\frac{17h}{18}$

84. A ball is dropped vertically from a height *d* above the ground. It hits the ground and bounces up vertically to a height *d*/2. Neglecting subsequent motion and air resistance, its velocity *v* varies with the height h above the ground as NCERT Page-49

(a)


(b)


(c)


(d)


85. A stone is dropped into a well in which the level of water is *h* below the top of the well. If *v* is velocity of sound, the time *T* after which the splash is heard is given by NCERT Page-49

(a) T = 2h/v (b) $T = \sqrt{\left(\frac{2h}{g}\right)} + \frac{h}{v}$
(c) $T = \sqrt{\left(\frac{2h}{v}\right)} + \frac{h}{g}$ (d) $T = \sqrt{\left(\frac{h}{2g}\right)} + \frac{2h}{v}$

86. A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is NCERT Page-49

(a) 35 m (b) 45 m (c) 25 m (d) 50 m

87. The balls are released from the top of a tower of height H at regular interval of time. When first ball reaches at the ground, the n^{th} ball is to be just released and $\left(\frac{n+1}{2}\right)^{th}$ ball is at same distance 'h' from top of the tower. The value of h is NCERT Page-49

(a) $\frac{2}{3}H$ (b) $\frac{3}{4}H$
(c) $\frac{4}{5}H$ (d) $\frac{5H}{6}$

88. A stone is dropped from a rising balloon at a height of 76 m above the ground and reaches the ground in 6s. What was the velocity of the balloon when the stone was dropped? Take g = 10 m/s^2. NCERT Page-49

(a) $\left(\frac{52}{3}\right)$ m/s upward (b) $\left(\frac{52}{3}\right)$ m/s downward
(c) 3 m/s (d) 9.8 m/s

89. Let A, B, C, D be points on a vertical line such that AB = BC = CD. If a body is released from position A, the times of descent through AB, BC and CD are in the ratio. NCERT Page-49

(a) $1 : \sqrt{3} - \sqrt{2} : \sqrt{3} + \sqrt{2}$ (b) $1 : \sqrt{2} - 1 : \sqrt{3} - \sqrt{2}$
(c) $1 : \sqrt{2} - 1 : \sqrt{3}$ (d) $1 : \sqrt{2} : \sqrt{3} - 1$

90. Water drops fall at regular intervals from a tab which is hm above the ground. After how many seconds does the first drop reach the ground? NCERT Page-49

(a) $\sqrt{\frac{2h}{g}}$ (b) $\sqrt{\frac{h}{2g}}$ (c) $\frac{h}{2g}$ (d) $\frac{2h}{g}$

91. If two balls of masses m_1 and $m_2(m_1 = 2m_2)$ are dropped from the same height, then the ratio of the time taken by them to reach the ground will be NCERT Page-49

(a) $m_1 : m_2$ (b) $2m_2 : m_1$
(c) 1 : 1 (d) 1 : 2

92. A boy standing at the top of a tower of 20m height drops a stone. Assuming g = 10 ms^{-2}, the velocity with which it hits the ground is NCERT Page-49

(a) 10.0 m/s (b) 20.0 m/s (c) 40.0 m/s (d) 5.0 m/s

93. What will be the ratio of the distances moved by a freely falling body from rest on 4th and 5th seconds of journey? NCERT Page-49

(a) 4 : 5 (b) 7 : 9 (c) 16 : 25 (d) 1 : 1

94. A ball released from a height falls 5 m in one second. In 4 seconds it falls through NCERT Page-49

(a) 20 m (b) 1.25 m (c) 40 m (d) 80 m

95. From a balloon moving upwards with a velocity of 12 ms^{-1}, a packet is released when it is at a height of 65 m from the ground. The time taken by it to reach the ground is (g = 10 ms^{-2}) NCERT Page-49

(a) 5 s (b) 8 s (c) 4 s (d) 7 s

96. A ball dropped from a point A falls down vertically to C, through the midpoint B. The descending time from A to B and that from A to C are in the ratio NCERT Page-49

(a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) $1 : \sqrt{2}$

97. A ball is dropped from the top of a tower of height 100 m and at the same time another ball is projected vertically upwards from ground with a velocity 25 ms^{-1}. Then the distance from the top of the tower, at which the two balls meet is NCERT Page-49

(a) 68.4 m (b) 48.4 m (c) 18.4 m (d) 78.4 m

98. A body released from the top of a tower falls through half the height of the tower in 2 s. In what time shall the body fall through the height of the tower ? NCERT Page-49

(a) 4 s (b) 3.26 s (c) 3.48 s (d) 2.828 s

99. Two bodies of masses m_1 and m_2 fall from heights h_1 and h_2 respectively. The ratio of their velocities, when they hit the ground is NCERT Page-49

(a) $\frac{h_1}{h_2}$ (b) $\sqrt{\frac{h_1}{h_2}}$

(c) $\frac{m_1 h_1}{m_1 h_2}$ (d) $\frac{h_1^2}{h_2^2}$

100. A stone falls from a balloon that is descending at a uniform rate of 12 m/s. The displacement of the stone from the point of release after 10 sec is NCERT Page-49

(a) 490 m (b) 510 m
(c) 610 m (d) 725 m

101. A body thrown vertically so as to reach its maximum height in t second. The total time from the time of projection to reach a point at half of its maximum height while returning (in sec) is NCERT Page-49

(a) $\sqrt{2}t$ (b) $\left(1+\frac{1}{\sqrt{2}}\right)t$

(c) $\frac{3t}{2}$ (d) $\frac{t}{\sqrt{2}}$

102. The ratio of distances traversed in successive intervals of time when a body falls freely under gravity from certain height is NCERT Page-49

(a) 1 : 2 : 3 (b) 1 : 5 : 9
(c) 1 : 3 : 5 (d) $\sqrt{1} : \sqrt{2} : \sqrt{3}$

103. A body dropped from top of a tower fall through 40 m during the last two seconds of its fall. The height of tower is (g = 10 m/s^2) NCERT Page-49

(a) 60 m (b) 45 m (c) 80 m (d) 50 m

104. A stone thrown upward with a speed u from the top of the tower reaches the ground with a velocity 3u. The height of the tower is NCERT Page-49

(a) $3u^2/g$ (b) $4u^2/g$ (c) $6u^2/g$ (d) $9u^2/g$

105. A stone thrown vertically upwards with a speed of 5 m/sec attains a height H_1. Another stone thrown upwards from the same point with a speed of 10 m/sec attains a height H_2. The correct relation between H_1 and H_2 is NCERT Page-49

(a) $H_2 = 4H_1$ (b) $H_2 = 3H_1$
(c) $H_1 = 2H_2$ (d) $H_1 = H_2$

106. From a pole of height 10 m, a stone is thrown vertically upwards with a speed 5 m/s. The time taken by the stone, to hit the ground, is n times that taken by it to reach the highest point of its path. The value of n is [take g = 10 m/s^2] NCERT Page-49

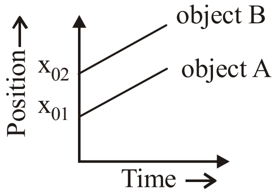
(a) 2 (b) 3 (c) 4 (d) 5

3.7 Relative Velocity

107. Two trains, each 40 m long are travelling in opposite direction with equal velocity 20 m/s. The time of crossing is NCERT Page-51

(a) 1 s (b) 2 s (c) 3 s (d) Zero

108. The graph shown below represent



NCERT Page-52

(a) A and B are moving with same velocity in opposite directions
(b) velocity of B is more than A in same direction
(c) velocity of A is more than B in same direction
(d) velocity of A and B is equal in same direction

109. The speed of a swimmer in still water is 16 m/s. The speed of river water is 8 m/s and is flowing due east. If he is standing on the south bank and wiches to cross the river along the shortest path. The angle at which he should make his strokes w.r.t. north is given by NCERT Page-52

(a) 60° west (b) 45° west
(c) 30° west (d) 0°

110. A train of 150 m length is going towards north direction at a speed of 10 ms^{-1}. A parrot flies at a speed of 5 ms^{-1} towards south direction parallel to the railway track. The time taken by the parrot to cross the train is equal to **NCERT** Page-51

(a) 12 s (b) 8 s (c) 15 s (d) 10 s

111. A boat takes 2 hours to travel 8 km and back in still water lake. With water velocity of 4 km h^{-1}, the time taken for going upstream of 8 km and coming back is **NCERT** Page-51

(a) 160 minutes (b) 80 minutes
(c) 100 minutes (d) 120 minutes

112. A car is moving on a road and rain is falling vertically. Select the correct answer. **NCERT** Page-51

(a) The rain will strike the back screen only
(b) The rain will strike the front screen only
(c) The rain will strike both the screens
(d) The rain will not strike any of the screens

113. If a boat can travel with a speed of v in still water, which of the following trips will take the least amount of time? **NCERT** Page-51

(a) travelling a distance of $2d$ in still water
(b) travelling a distance of $2d$ across (perpendicular to) the current in a stream
(c) travelling a distance d downstream and returning a distance d upstream
(d) travelling a distance d upstream and returning a distance d downstream

114. An object has velocity $\vec{v}_1$ relative to the ground. An observer moving with a constant velocity $\vec{v}_0$ relative to the ground measures the velocity of the object to be $\vec{v}_2$ (relative to the observer). The magnitudes of these velocities are related by **NCERT** Page-51

(a) $v_0 \le v_1 + v_2$ (b) $v_1 \le v_2 + v_0$
(c) $v_2 \le v_0 + v_1$ (d) All of these

115. Two trains are each 50 m long moving parallel towards each other at speeds 10 m/s and 15 m/s respectively. After what time will they pass each other? **NCERT** Page-52,53

(a) $5\sqrt{\frac{2}{3}}$ sec (b) 4 sec
(c) 2 sec (d) 6 sec

116. A ship A is moving Westwards with a speed of 10 km h^{-1} and a ship B 100 km South of A, is moving Northwards with a speed of 10 km h^{-1}. The time after which the distance between them becomes shortest, is **NCERT** Page-51

(a) 5 h (b) $5\sqrt{2}$ h
(c) $10\sqrt{2}$ h (d) 0 h

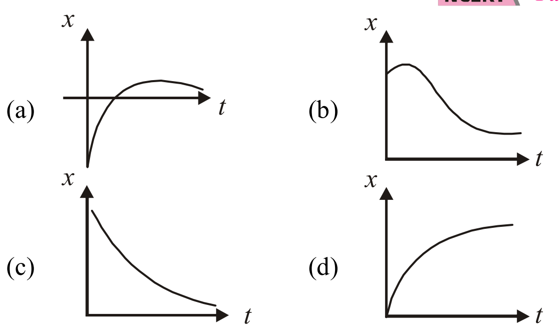
117. A bus is moving with a velocity of 10 ms^{-1} on a straight road. A scootorist wishes to overtake the bus in one minute. If the bus is at a distance of 1.2 km ahead, then the velocity with which he has to chase the bus is **NCERT** Page-51

(a) 20 ms^{-1} (b) 25 ms^{-1}
(c) 60 ms^{-1} (d) 30 ms^{-1}

Exercise 2 : NCERT Exemplar & Past Years NEET & JEE Main

NCERT Exemplar Questions

1. Among the four graph shown in the figure there is only one graph for which average velocity over the time interval (O, T) can vanish for a suitably chosen T. Which one is it? **NCERT** Page-46



2. A lift is coming from 8th floor and is just about to reach 4th floor. Taking ground floor as origin and positive direction upwards for all quantities, which one of the following is correct? **NCERT** Page-45

(a) $x < 0, v < 0, a > 0$ (b) $x > 0, v < 0, a < 0$
(c) $x > 0, v < 0, a > 0$ (d) $x > 0, v > 0, a < 0$

3. In one dimensional motion, instantaneous speed v satisfies $0 \le v < v_0$. **NCERT** Page-43

(a) The displacement in time T must always take non-negative values
(b) The displacement x in time T satisfies $-v_0T < x < v_0T$
(c) The acceleration is always a non-negative number
(d) The motion has no turning points

4. A vehicle travels half the distance l with speed v_1 and the other half with speed v_2, then its average speed is **NCERT** Page-42

(a) $\frac{v_1 + v_2}{2}$ (b) $\frac{2v_1 + v_2}{v_1 + v_2}$
(c) $\frac{2v_1v_2}{v_1 + v_2}$ (d) $\frac{L(v_1 + v_2)}{v_1v_2}$

5. The displacement of a particle is given by $x = (t - 2)^2$ where x is in metre and t in second. The distance covered by the particle in first 4 seconds is **NCERT** Page-43, 47

(a) 4 m (b) 8 m
(c) 12 m (d) 16 m

Past Years NEET & JEE Main

6. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = bx^{-2n}$ where b and n are constants and x is the position of the particle. The acceleration of the particle as d function of x, is given by: NCERT Page-45 | AIPMT 2015, S

(a) $-2nb^2x^{-4n-1}$ (b) $-2b^2x^{-2n+1}$

(c) $-2nb^2e^{-4n+1}$ (d) $-2nb^2x^{-2n-1}$

7. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1s and 2s is : NCERT Page-43 | NEET 2016, C

(a) $\frac{3}{2}A + 4B$ (b) $3A + 7B$

(c) $\frac{3}{2}A + \frac{7}{3}B$ (d) $\frac{A}{2} + \frac{B}{3}$

8. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1. On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2. The time taken by her to walk up on the moving escalator will be: NCERT Page-51 | NEET 2017, S

(a) $\frac{t_1t_2}{t_2 - t_1}$ (b) $\frac{t_1t_2}{t_2 + t_1}$ (c) $t_1 - t_2$ (d) $\frac{t_1 + t_2}{2}$

9. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field $\vec{E}$. Due to the force q $\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively NCERT Page-42 | NEET 2018, A

(a) 2 m/s, 4 m/s (b) 1 m/s, 3 m/s

(c) 1.5 m/s, 3 m/s (d) 1 m/s, 3.5 m/s

10. The speed of a swimmer in still water is 20 m/s. The speed of river water is 10 m/s and is flowing due east. If he is standing on the south bank and wishes to cross the river along the shortest path, the angle at which he should make his strokes w.r.t. north is given by : NCERT Page-52 | NEET 2019, S

(a) 30° west (b) 0°

(c) 60° west (d) 45° west

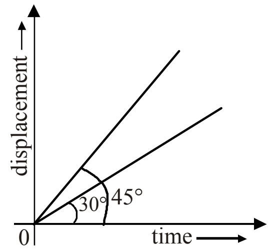
11. A ball is thrown vertically downward with a velocity of 20 m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is : ($g = 10$ m/s^2) NCERT Page-49 | NEET 2020, A

(a) 340 m (b) 320 m (c) 300 m (d) 360 m

12. A small block slides down on a smooth inclined plane, starting from rest at time $t = 0$. Let S_n be the distance travelled by the block in the interval $t = n - 1$ to $t = n$. Then, the ratio $\frac{S_n}{S_{n+1}}$ is NCERT Page-48 | NEET 2021, A

(a) $\frac{2n}{2n-1}$ (b) $\frac{2n-1}{2n}$ (c) $\frac{2n-1}{2n+1}$ (d) $\frac{2n+1}{2n-1}$

13. The displacement-time graphs of two moving particles make angles of 30° and 45° with the x-axis as shown in the figure. The ratio of their respective velocity is: NCERT Page-44 | NEET 2022



(a) 1 : 1 (b) 1 : 2

(c) $1 : \sqrt{3}$ (d) $\sqrt{3} : 1$

14. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second: NCERT Page-50 | NEET 2022

(a) 1 : 4 : 9 : 16 (b) 1 : 3 : 5 : 7

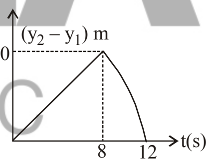
(c) 1 : 1 : 1 : 1 (d) 1 : 2 : 3 : 4

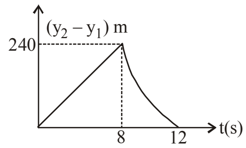
15. Two stones are thrown up simultaneously from the edge of a cliff 240 m high with initial speed of 10 m/s and 40 m/s respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first?

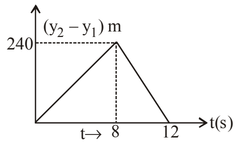
(Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10$ m/s^2)

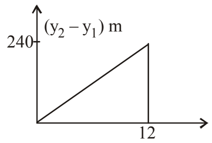
(*The figures are schematic and not drawn to scale*)

NCERT Page-49, 50 | JEE M 2015, C

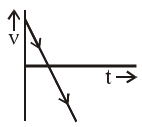
(a) 

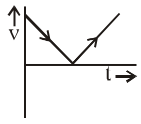
(b) 

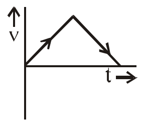
(c) 

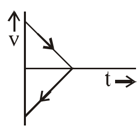
(d) 

16. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time? NCERT Page-50 | JEE M 2017, C

(a) 

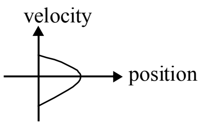
(b) 

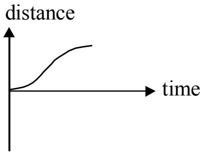
(c) 

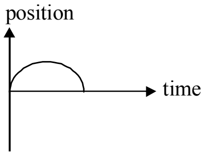
(d) 

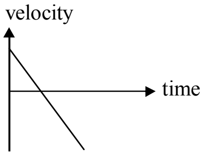
17. All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up.

NCERT Page-46 | JEE M 2018, C

(a) 

(b) 

(c) 

(d) 

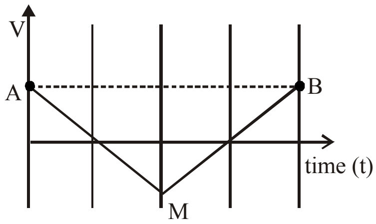
18. The stream of a river is flowing with a speed of 2 km/h. A swimmer can swim at a speed of 4 km/h. What should be the direction of the swimmer with respect to the flow of the river to cross the river straight?

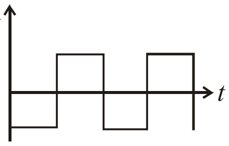
NCERT Page-52 | JEE M 2019, S

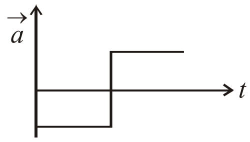
(a) 90° (b) 150°
(c) 120° (d) 60°

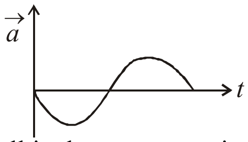
19. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?

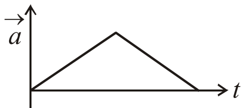
NCERT Page-45, 46 | JEE M 2020, C



(a) 

(b) 

(c) 

(d) 

20. A ball is thrown up vertically with a certain velocity so that, it reaches a maximum height h. Find the ratio of the times in which it is at height $\frac{h}{3}$ while going up and coming down respectively.

NCERT Page-49 | JEE M 2022

(a) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (b) $\frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$

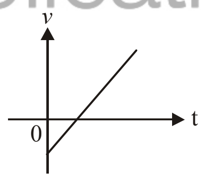
(c) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ (d) $\frac{1}{3}$

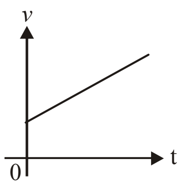
Exercise 3 : Matching, Statement & Assertion-Reason Type

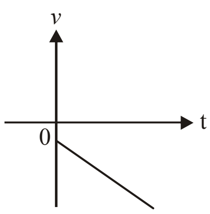
Match the Following

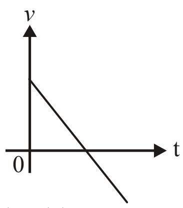
1. A particle is going along a straight line with constant acceleration a, having initial velocity u. Then match the columns :

Column I — **Column II**

(A) $u = +$ ve and $a = +$ ve — (1) 

(B) $u = -$ ve, and $a = +$ ve — (2) 

(C) $u = +$ ve, and $a = -$ ve — (3) 

(D) $u = -$ ve, and $a = -$ ve — (4) 

(a) (A)→(3); (B)→(2); C→(1); (D)→(1)
(b) (A)→(2); (B)→(1); C→(4); (D)→(3)
(c) (A)→(1); (B)→(2); C→(3); (D)→(4)
(d) (A)→(4); (B)→(3); C→(2); (D)→(1)

2. For a particle in one dimensional motion, match the following columns :

Column I	Column II
(A) Zero speed but non-zero acceleration.	(1) Body which is about to fall
(B) Zero speed non-zero velocity.	(2) Extreme position of oscillating body
(C) Constant speed non-zero acceleration.	(3) Possible
(D) Positive acceleration must speeding up.	(4) Not possible

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4)
(c) (A)→(1, 2, 3); (B)→(4); C→(4); (D)→(1, 3)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

3.

Column I	Column II
(A) Cause increase in velocity	(1) Linear motion
(B) Negative acceleration	(2) Zero
(C) Motion exhibited by body moving in a straight line	(3) Distance
(D) Area under a speed time graph	(4) Acceleration
(E) Velocity of an upward throwing body at the peak point	(5) Retardation

(a) (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(2)
(b) (A)→(2); (B)→(1); C→(3); (D)→(4) ; (E)→(5)
(c) (A)→(5); (B)→(2); C→(3); (D)→(1) ; (E)→(4)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3) ; (E)→(5)

4.

Column I	Column II
(A) Distance travelled by a body	(1) zero acceleration
(B) Uniform velocity	(2) $ut + \frac{1}{2}at^2$
(C) Speedometer	(3) instantaneous speed
(D) Height of a vertically thrown body	(4) $\frac{u^2}{2g}$

(a) (A)→(2, 3); (B)→(2); C→(3, 4); (D)→(1, 5)
(b) (A)→(1, 2); (B)→(3); C→(5); (D)→(4)
(c) (A)→(1, 5); (B)→(1); C→(3); (D)→(4, 5)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

5. Match the Column I and Column II.

Column I	Column II
(A) Displacement	(1) Slope of $x - t$ graph
(B) Velocity	(2) Slope of tangent to x – t Curve
(C) Acceleration	(3) Area under $v - t$ curve
(D) Instantaneous velocity	(4) Slope of $v - t$ graph
	(5) Area under $x - t$ curve

(a) (A)→(4); (B)→(2); C→(1); (D)→(3)
(b) (A)→(2); (B)→(4); C→(3); (D)→(1)
(c) (A)→(3); (B)→(1); C→(4); (D)→(2)
(d) (A)→(2); (B)→(4); C→(1); (D)→(3)

Two-Statement Type Questions

Directions : *Read the statements carefully and answer the question on the basis of following options.*

(a) Both statement I and II are correct.
(b) Both statement I and II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement II is correct but statement I is incorrect.

6. **Statement I:** A body may be accelerated even when it is moving uniformly.
Statement II: When direction of motion of the body is changing, the body must have acceleration.

7. **Statement I:** The equation of motion can be applied only if acceleration is along the direction of velocity and is constant.
Statement II: If the acceleration of a body is zero then its motion is known as uniform motion.

8. **Statement I:** The relative velocity between any two bodies moving in opposite direction is equal to sum of the velocities of two bodies.
Statement II: Sometimes relative velocity between two bodies is equal to difference in velocities of the two.

9. **Statement I:** For one dimensional motion the angle between acceleration and velocity must be 0^o or 180^o.
Statement II: One dimensional motion is always on a circle.

10. **Statement I:** A body is momentarily at rest when it reverses its direction of motion.
Statement II: A body cannot have acceleration if its velocity is zero at a given instant of time.

Four/Five Statement Type Questions

11. Consider the following statements and select the incorrect statements.
I. The magnitude of instantaneous velocity of a particle is equal to its instantaneous speed.
II. The magnitude of the average velocity in an interval is equal to its average speed in that interval.
III. It is possible to have a situation in which the speed of the particle is never zero but the average speed in an interval is zero.
IV. It is possible to have a situation in which the speed of particle is zero but the average speed is not zero.
(a) II, III and IV (b) I and II
(c) II and III (d) IV only

12. Select the incorrect statements from the following.
I. Average velocity is path length divided by time interval.
II. In general, speed is greater than the magnitude of the velocity.
III. A particle moving in a given direction with a non-zero velocity can have zero speed.
IV. The magnitude of average velocity is equal to the average speed.
(a) II and III (b) I and IV
(c) I, III and IV (d) I, II, III and IV

13. The incorrect statement(s) from the following is/are
I. A body having zero velocity will not necessarily have zero acceleration.
II. A body having zero velocity will necessarily have zero acceleration.
III. A body having uniform speed can have only uniform acceleration.
IV. A body having non-uniform velocity will have zero acceleration.
(a) II, III and IV (b) I and II
(c) II and III (d) IV only

14. The relative velocity V_{AB} or V_{BA} of two bodies A and B may be
I. greater than velocity of body A
II. greater than velocity of body B
III. less than the velocity of body A
IV. less than the velocity of body B
(a) I and II only (b) III and IV only
(c) I, II and III only (d) I, II, III and IV

Assertion & Reason Questions

Directions : *These questions consist of two statements, each printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.*

(a) If both Assertion and Reason are correct and the Reason is a correct explanation of the Assertion.
(b) If both Assertion and Reason are correct but Reason is not a correct explanation of the Assertion.
(c) If the Assertion is correct but Reason is incorrect.
(d) If the Assertion is incorrect and Reason is correct.

15. **Statement I:** A particle starting from rest and moving with uniform acceleration travels' a length of x and 3x in first two and next two-seconds.
Statement II: Displacement is directly proportional to velocity.

16. **Statement I:** Magnitude of average velocity is equal to average speed.
Statement II: Magnitude of instantaneous velocity is not equal to instantaneous speed.

17. **Statement I:** A body falling freely may do so with constant velocity.
Statement II: The body falls freely, when acceleration of a body is not equal to acceleration due to gravity.

18. **Statement I:** A body, whatever its motion is always at rest in a frame of reference which is fixed to the body itself.
Statement II: The relative velocity of a body with respect to itself is zero.

19. **Statement I:** Magnitude of average velocity is equal to average speed.
Statement II: Magnitude of instantaneous velocity is not equal to instantaneous speed.

Exercise 4 : Skill Enhancer MCQs

1. A particle when thrown, moves such that it passes from same height at 2 and 10 seconds, then this height h is :
(a) 5g (b) g (c) 8g (d) 10g

2. A particle moving along x-axis has acceleration f, at time t, given by $f = f_0\left(1 - \frac{t}{T}\right)$, where f_0 and T are constants.
The particle at t = 0 has zero velocity. In the time interval between t = 0 and the instant when f = 0, the particle's velocity (v_x) is

(a) $\frac{1}{2}f_0T^2$ (b) f_0T^2

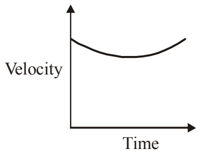
(c) $\frac{1}{2}f_0T$ (d) f_0T

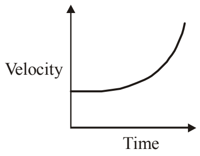
3. A hunter tries to hunt a monkey with a small, very poisonous arrow, blown from a pipe with initial speed v_0. The monkey is hanging on a branch of a tree at height H above the ground. The hunter is at a distance L from the bottom of the tree. The monkey sees the arrow leaving the blow pipe and immediately loses the grip on the tree, falling freely down with zero initial velocity. The minimum initial speed v_0 of the arrow for hunter to succeed while monkey is in air is

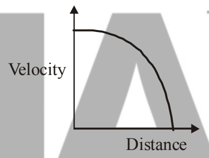
(a) $\sqrt{\frac{g(H^2+L^2)}{2H}}$ (b) $\sqrt{\frac{gH^2}{\sqrt{H^2+L^2}}}$

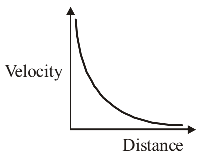
(c) $\sqrt{\frac{g\sqrt{H^2+L^2}}{H}}$ (d) $\sqrt{\frac{2gH^2}{\sqrt{H^2+L^2}}}$

4. Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

(a)


(b)


(c)


(d)


5. A particle starts sliding down a frictionless inclined plane. If S_n is the distance travelled by it from time $t = n - 1$ sec to $t = n$ sec, the ratio S_n/S_{n+1} is

(a) $\frac{2n-1}{2n+1}$ (b) $\frac{2n+1}{2n}$

(c) $\frac{2n}{2n+1}$ (d) $\frac{2n+1}{2n-1}$

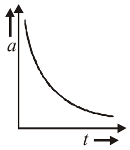
6. Starting from rest a particle moves in a straight line with acceleration $a = (25 - t^2)^{1/2}$ m/s^2 for $0 \le t \le 5$s, $a = \frac{3\pi}{8}$ m/s^2 for $t > 5$s. The velocity of particle at $t = 7$s is:
(a) 11 m/s (b) 22 m/s (c) 33 m/s (d) 44 m/s

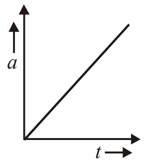
7. The acceleration of a particle, starting from rest, varies with time according to the relation $a = -s\omega^2 \sin \omega t$. The displacement of this particle at a time t will be
(a) $s \sin \omega t$ (b) $s\, \omega \cos \omega t$
(c) $s\, \omega \sin \omega t$ (d) $-\frac{1}{2}(s\omega^2 \sin \omega t)t^2$

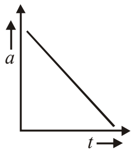
8. The displacement 'x' (in meter) of a particle of mass 'm' (in kg) moving in one dimension under the action of a force, is related to time '*t*' (in sec) by $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

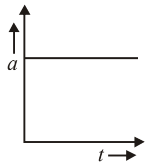
(a) 2 m (b) 4 m
(c) 0 m (d) 6 m

9. The distance travelled by a body moving along a line in time *t* is proportional to t^3. The acceleration-time (a, t) graph for the motion of the body will be

(a)


(b)


(c)


(d)


10. A ball is dropped from a height of 5 m onto a sandy floor and penetrates the sand upto 10 cm before coming to rest. Find the retardation of the ball in sand assuming it to be uniform.

(a) $490\ m/s^2$ (b) $610\ m/s^2$
(c) $720\ m/s^2$ (d) $810\ m/s^2$

11. A bird flies with a speed of 10 km/h and a car moves with uniform speed of 8 km/h. Both start from *B* towards *A* (*BA* = 40km) at the same instant. The bird having reached *A*, flies back immediately to meet the approaching car. As soon as it reaches the car, it flies back to *A*. The bird repeats this till both the car and the bird reach *A* simultaneously. The total distance flown by the bird is

(a) 80 km (b) 40 km
(c) 50 km (d) 30 km

12. The displacement of a particle is given by

$y = a + b\,t + c\,t^2 - d\,t^4$

The initial velocity and acceleration are respectively

(a) $b, -4\,d$ (b) $-b, 2\,c$
(c) $b, 2\,c$ (d) $2\,c, -4\,d$

13. The displacement x of a particle varies with time t as $x = ae^{-\alpha t} + be^{\beta t}$, where a, b, α and β are positive constants. The velocity of the particle will

(a) be independent of α and β
(b) drop to zero when $\alpha = \beta$
(c) go on decreasing with time
(d) go on increasing with time

14. A point moves with uniform acceleration and V_1, V_2, V_3 denote the average velocities in three successive intervals of time t_1, t_2, t_3. Which of the following relations is correct?

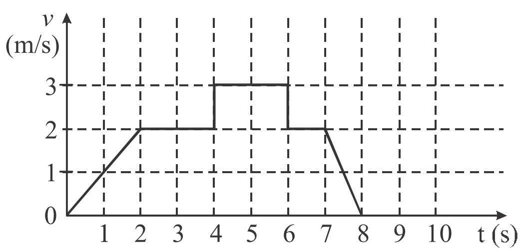
(a) $V_1 - V_2 : V_2 - V_3 = t_1 - t_2 : t_2 + t_3$
(b) $V_1 - V_2 : V_2 - V_3 = t_1 + t_2 : t_2 + t_3$
(c) $V_1 - V_2 : V_2 - V_3 = t_1 - t_2 : t_2 - t_3$
(d) $V_1 - V_2 : V_2 - V_3 = t_1 - t_2 : t_1 - t_3$

15. Two fixed points *A* and *B* are 20 metres apart. At time $t = 0$, the distance between a third point *C* and *A* is 20 meters and the distance between *C* and *B* is 10 metres. The component of velocity of point *C* along both *CA* and *CB* at any instant is 5m/s. Then the distance between *A* and *C* at the instant all the three points are collinear will be

(a) 5 m (b) 15 m
(c) 10 m (d) 25 m

Exercise 5 : Numeric Value Answer Questions

1. A particle starts from the origin at time t = 0 and moves along the positive *x*-axis. The graph of velocity with respect to time is shown in figure. What is the position (in metre) of the particle at time t = 5s?



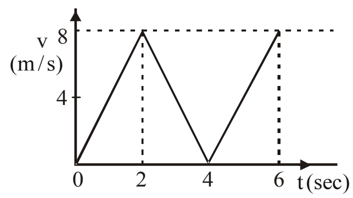
2. A car travels half the distance with constant velocity of 40 kmph and the remaining half with a constant velocity of 60 kmph. The average velocity of the car (in kmph is)

3. The position of an object moving along x-axis is given by $a+bt^2$, where a = 8.5 m and b = 2.5 m/s^2 and t is measured in seconds. The average velocity (in m/s) of the object between t = 2s and t = 4s is

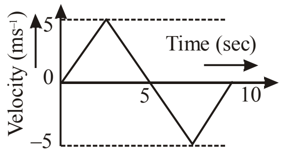
4. A car moves a distance of 200 m. It covers the first half of the distance at speed 40 km/h and the second half of distance at speed *v* (km/h). The average speed is 48 km/h. Find the value of *v*

5. A bus travelling the first one third distance at a speed of 10 km/h, the next one third at 20 km/h and the last one-third at 60 km/h. The average speed (in km/h) of the bus is

6. The $v-t$ graph for a particle is as shown below. The distance (in metre) travelled in the first four seconds is



7. The v – t plot of a moving object is shown in the figure. The average velocity of the object during the first 10 seconds is



8. A motor car moving with a uniform speed of 20 m/sec comes to stop on the application of brakes after travelling a distance of 10 m, its deceleration is

9. A body moves from rest with a constant acceleration of 5 m/s^2. Its instantaneous speed (in m/s) at the end of 10 sec is

10. A body starts from rest, if the ratio of the distance travelled by the body during the 4th and 3rd second is $\frac{x}{5}$. Find the value of x.

11. If a ball is thrown vertically upwards with a velocity of 40 m/s, then velocity (in m/s) of the ball after two seconds will be ($g = 10\ m/s^2$)

12. The water drops fall at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at an instant when the first drop touches the ground. How far (in metre) above the ground is the second drop at that instant ? (Take $g = 10\ m/s^2$)

Answer Keys

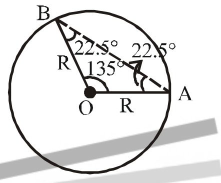
Exercise 1 : (NCERT Based Topic-wise MCQs)																			
1	(d)	**14**	(a)	**27**	(c)	**40**	(d)	**53**	(c)	**66**	(d)	**79**	(b)	**92**	(b)	**105**	(a)		
2	(a)	**15**	(d)	**28**	(c)	**41**	(d)	**54**	(a)	**67**	(d)	**80**	(a)	**93**	(b)	**106**	(c)		
3	(c)	**16**	(b)	**29**	(a)	**42**	(c)	**55**	(c)	**68**	(b)	**81**	(a)	**94**	(d)	**107**	(a)		
4	(d)	**17**	(d)	**30**	(d)	**43**	(a)	**56**	(b)	**69**	(d)	**82**	(a)	**95**	(a)	**108**	(d)		
5	(b)	**18**	(c)	**31**	(c)	**44**	(c)	**57**	(c)	**70**	(d)	**83**	(c)	**96**	(d)	**109**	(c)		
6	(b)	**19**	(d)	**32**	(c)	**45**	(a)	**58**	(a)	**71**	(b)	**84**	(a)	**97**	(d)	**110**	(d)		
7	(a)	**20**	(c)	**33**	(d)	**46**	(a)	**59**	(c)	**72**	(b)	**85**	(b)	**98**	(d)	**111**	(a)		
8	(a)	**21**	(b)	**34**	(b)	**47**	(a)	**60**	(c)	**73**	(d)	**86**	(b)	**99**	(b)	**112**	(b)		
9	(c)	**22**	(c)	**35**	(c)	**48**	(b)	**61**	(c)	**74**	(d)	**87**	(b)	**100**	(c)	**113**	(a)		
10	(c)	**23**	(d)	**36**	(c)	**49**	(c)	**62**	(d)	**75**	(d)	**88**	(a)	**101**	(b)	**114**	(d)		
11	(b)	**24**	(b)	**37**	(a)	**50**	(d)	**63**	(a)	**76**	(a)	**89**	(b)	**102**	(c)	**115**	(b)		
12	(a)	**25**	(d)	**38**	(b)	**51**	(b)	**64**	(d)	**77**	(c)	**90**	(a)	**103**	(b)	**116**	(a)		
13	(c)	**26**	(c)	**39**	(c)	**52**	(a)	**65**	(d)	**78**	(b)	**91**	(c)	**104**	(b)	**117**	(d)		
Exercise 2 : (NCERT Exemplar & Past Years NEET & JEE Main)																			
1	(b)	**3**	(b)	**5**	(b)	**7**	(c)	**9**	(b)	**11**	(c)	**13**	(c)	**15**	(b)	**17**	(b)	**19**	(b)
2	(a)	**4**	(c)	**6**	(a)	**8**	(b)	**10**	(a)	**12**	(c)	**14**	(b)	**16**	(a)	**18**	(c)	**20**	(b)
Exercise 3 : (Matching, Statement & Assertion-Reason Type)																			
1	(b)	**3**	(a)	**5**	(c)	**7**	(d)	**9**	(c)	**11**	(a)	**13**	(a)	**15**	(c)	**17**	(d)	**19**	(d)
2	(c)	**4**	(c)	**6**	(a)	**8**	(b)	**10**	(c)	**12**	(c)	**14**	(d)	**16**	(d)	**18**	(a)		
Exercise 4 : (Skill Enhancer MCQs)																			
1	(d)	**3**	(a)	**5**	(a)	**7**	(a)	**9**	(b)	**11**	(c)	**13**	(d)	**15**	(b)				
2	(c)	**4**	(c)	**6**	(b)	**8**	(c)	**10**	(a)	**12**	(c)	**14**	(b)						
Exercise 5 : (Numeric Value Answer Questions)																			
1	(9)	**3**	(15)	**5**	(18)	**7**	(0)	**9**	(50)	**11**	(20)								
2	(48)	**4**	(60)	**6**	(16)	**8**	(20)	**10**	(7)	**12**	(3.75)								

Chapter 3

Motion in a Straight Line

EXERCISE - 1

1. **(d)** Motion of a body along a straight line is one dimensional motion.
2. **(a)** When location of a particle has changed, it must have covered some distance and undergone some displacement.
3. **(c)**
4. **(d)** $\frac{\text{Displacement}}{\text{distance}} \le 1$
5. **(b)**
6. **(b)** From ΔAOB



$\frac{AB}{\sin 135} = \frac{OB}{\sin 22.5}$

$AB = \frac{\sin 135}{\sin 22.5} OB$

$= \frac{\sin(135)}{\sin(22.5)} \frac{\text{arc}(AB)}{\frac{3\pi}{4}} = \frac{\sin(45)}{\sin(22.5)} \times \frac{60\times 4}{3\pi} = 47\,\text{m}$

7. **(a)** Total time of motion is 3 min 20 sec = 20 sec.
As time period of circular motion is 40 sec so in 20 sec athlete will complete 5 revolution *i.e.*, he will be at starting point *i.e.*, displacemet = zero.
8. **(a)** 9. **(c)** 10. **(c)**
11. **(b)** $|\text{Average velocity}| = \frac{|\text{displacement}|}{\text{time}}$

$= \frac{2r}{t} = 2 \times \frac{1}{1} = 2\,\text{m/s}.$

12. **(a)** $v_{av} = \frac{v_1 t/3 + v_2(2t/3)}{t} = \frac{v_1}{3} + \frac{2v_2}{3}$
13. **(c)**
14. **(a)** Since displacement is zero.
15. **(d)** Let the total distance be d. Then for first half distance, time $= \frac{d}{2v_0}$, next distance. $= v_1 t$ and last half distance $= v_2 t$

$\therefore\ v_1 t + v_2 t = \frac{d}{2};\ t = \frac{d}{2(v_1+v_2)}$

Now average speed

$t = \frac{d}{\frac{d}{2v_0} + \frac{d}{2(v_1+v_2)} + \frac{d}{2(v_1+v_2)}}$

$= \frac{2v_0(v_1+v_2)}{(v_1+v_2)+2v_0}$

16. **(b)** We have given,
$v = \alpha t + \beta t^2$

$\Rightarrow \frac{ds}{dt} = \alpha t + \beta t^2 \Rightarrow \int_{s_1}^{s_2} ds = \int_1^2 \left(\alpha t + \beta t^2\right) dt$

$\Rightarrow s_2 - s_1 = \left[\frac{\alpha t^2}{2} + \frac{\beta t^3}{3}\right]_1^2$

As particle is moving in a straight line,
$\therefore$ Distance = Displacement

$\therefore$ Distance $= \left[\frac{\alpha[4-1]}{2} + \frac{\beta[8-1]}{3}\right] = \frac{3\alpha}{2} + \frac{7\beta}{3}$

17. **(d) For bus P**

$x_p(t) = \alpha t + \beta t^2$

$V_p(t) = \alpha + 2\beta t \quad [\because V_p = \frac{dx_p}{dt}]$

For bus Q

$x_q(t) = f t - t^2$

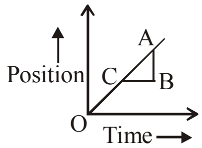
$V_q(t) = f - 2t \ [\because\ V_q = \frac{dx_q}{dt}]$

As, $V_p(t) = V_q(t) \ \Rightarrow \alpha + 2\beta t = f - 2t$

$\Rightarrow \alpha - f = -2\beta t - 2t \quad \Rightarrow f - \alpha = 2\beta t + 2t$

$\Rightarrow t = \frac{f-\alpha}{(2\beta+2)}$

18. **(c)** As x – t graph is a straight line in either case, velocity of both is uniform. As the slope of x – t graph for P is greater, therefore, velocity of P is greater than that of Q.
19. **(d)** When $s \propto t$, so $\frac{s}{t} = \text{constant}$.
20. **(c)** The velocity-time graph for a uniform motion is a straight. line parallel to time axis. Its slope is zero.
21. **(b)** $\frac{|\text{Average velocity}|}{|\text{Average speed}|} = \frac{|\text{displacement}|}{|\text{distance}|}$
because displacement will either be equal or less than distance. It can never be greater than distance travelled.
22. **(c)** The slope of the tangent drawn on position-time graph at any instant gives instantaneous velocity.



$AC = \frac{AB}{BC} = V_{inst}$

23. **(d)** $v_A = \tan 30^\circ$ and $v_B = \tan 60^\circ$

$\therefore\ \frac{v_A}{v_B} = \frac{\tan 30^\circ}{\tan 60^\circ} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

24. **(b)** The speed in general $\geq$ the magnitude of velocity.

25. **(d)** In (a), at the same time particle has two positions which is not possible. In (b), particle has two velocities at the same time. In (c), speed is negative which is not possible.

26. **(c)** 27. **(c)** 28. **(c)** 29. **(a)**

30. **(d)** The nature of the path is decided by the direction of velocity, and the direction of acceleration. The trajectory can be a straight line, circle or a parabola depending on these factors.

31. **(c)** Slope of velocity-time graph shows acceleration.

32. **(c)** Because acceleration is a vector quantity.

33. **(d)** 34. **(b)** 35. **(c)**

36. **(c)** During OA, acceleration = tan 30° = $\frac{1}{\sqrt{3}}$ m/s^2

During AB, acceleration = –tan60° = $-\sqrt{3}$ m/s^2

Required ratio = $\frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$

37. **(a)** Velocity at time t is tan 45° = 1. Velocity at time (t = 1) is $\tan 60° = \sqrt{3}$. Acceleration is change in velocity in one second = $\sqrt{3}-1$.

38. **(b)** Differentiated twice.

39. **(c)** On differentiating, acceleration = $0.2t$

$\Rightarrow \quad a = f(t)$

40. **(d)**

41. **(d)** From displacement-time graph, it is clear that in equal intervals of time displacements are not equal infact, decreases and after 40s displacement constant *i.e.*, the particle stops.

42. **(c)** When particle comes to rest,

$$V = 0 = \frac{dx}{dt} = \frac{d}{dt}(40 + 12t - t^3)$$

$$\Rightarrow \quad 12 - 3t^2 = 0$$

$$\Rightarrow \quad t^2 = \frac{12}{3} = 4 \ \therefore t = 2 \text{ sec}$$

Therefore distance travelled by particle before coming to rest,

$x = 40 + 12t - t^3 = 40 + 12 \times 2 - (2)^3 = 56\text{m}$

43. **(a)** $x = \frac{1}{t+5} \quad \therefore \quad v = \frac{dx}{dt} = \frac{-1}{(t+5)^2}$

$$\therefore \quad a = \frac{d^2x}{dt^2} = \frac{2}{(t+5)^3} = 2x^3$$

Now $\frac{1}{(t+5)} \propto v^{\frac{1}{2}} \quad \therefore \quad \frac{1}{(t+5)^3} \propto v^{\frac{3}{2}} \propto a$

44. **(c)** Average acceleration = $\frac{\text{change in velocity}}{\text{time interval}} = \frac{\Delta\vec{v}}{t}$

$\vec{v}_1 = 5\hat{i}, \vec{v}_2 = 5\hat{j}$

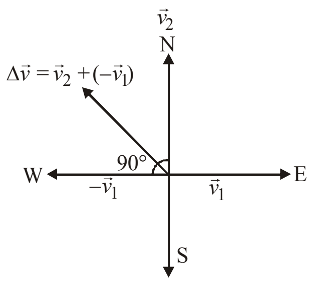
$\Delta\vec{v} = (\vec{v}_2 - \vec{v}_1)$

$= \sqrt{v_1^2 + v_2^2 + 2v_1v_2\cos 90}$

$= \sqrt{5^2 + 5^2 + 0}$

[As $|v_1| = |v_2| = 5$ m/s]

$= 5\sqrt{2}$ m/s



Avg. acc. = $\frac{\Delta\vec{v}}{t} = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}}$ m/s^2 $\Rightarrow \tan\theta = \frac{5}{-5} = -1$

which means θ is in the second quadrant. (towards north-west)

45. **(a)** Differentiate two times and put $x = 0$.

46. **(a)** $\frac{dv}{dt} = -2.5\sqrt{v} \Rightarrow \frac{dv}{\sqrt{v}} = -2.5\,dt$

Integrating,

$$\int_{6.25}^{0} v^{-\frac{1}{2}} dv = -2.5\int_0^t dt \Rightarrow \left[\frac{v^{+\frac{1}{2}}}{(\frac{1}{2})}\right]_{6.25}^{0} = -2.5[t]_0^t$$

$\Rightarrow \quad -2(6.25)^{\frac{1}{2}} = -2.5t \Rightarrow t = 2$ sec

47. **(a)** $x = x_0 + (ut + \frac{1}{2}at^2)$ At $t = 0, x = -2, \therefore -2 = x_0 + 0$

or $x_0 = -2$

Thus, $0 = -2 + (u \times 1 + \frac{1}{2} \times a \times 1^2)$ ...(i)

and $6 = -2 + (u \times 2 + \frac{1}{2} \times a \times 2^2)$ ...(ii)

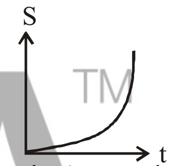
After solving equations, we get $u = 0$, $a = 4$ m/s^2.

Now for $t = 3$,

$x = -2 + (u \times 3 + \frac{1}{2} \times 4 \times 3^2) = 16$m.

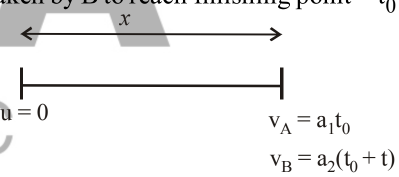
Clearly it represents motion with constant acceleration.

48. **(b)** For a particle moving with uniform acceleration the displacement-time graph is a parabola.



49. **(c)** Let time taken by A to reach finishing point is t_0

$\therefore$ Time taken by B to reach finishing point = $t_0 + t$



$v_A - v_B = v$

$\Rightarrow v = a_1 t_0 - a_2(t_0 + t) = (a_1 - a_2)t_0 - a_2t$ ...(i)

$x_B = x_A = \frac{1}{2}a_1 t_0^2 = \frac{1}{2}a_2(t_0 + t)^2$

$\Rightarrow \sqrt{a_1}t_0 = \sqrt{a_2}(t_0 + t) \Rightarrow (\sqrt{a_1} - \sqrt{a_2})t_0 = \sqrt{a_2}t$

$\Rightarrow t_0 = \frac{\sqrt{a_2}t}{\sqrt{a_1} - \sqrt{a_2}}$

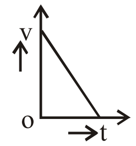
Putting this value of t_0 in equation (i)

$v = (a_1 - a_2)\frac{\sqrt{a_2}t}{\sqrt{a_1} - \sqrt{a_2}} - a_2t$

$= (\sqrt{a_1} + \sqrt{a_2})\sqrt{a_2}t - a_2t = \sqrt{a_1a_2}t + a_2t - a_2t$

or, $v = \sqrt{a_1a_2}t$

50. **(d)** Velocity time curve will be a straight line as shown:



51. **(b)** At the highest point v = 0.

52. **(a)** Let s be the distance travelled by the vehicle before it stops.
Final velocity υ = 0, initial velocity = u
Using equation of motion $v^2 - u^2 = 2aS$
$0^2 - u^2 = 2aS$
Stopping distance, $S = -\frac{u^2}{2a}$

53. **(c)**

54. **(a)** $v^2 - u^2 = 2as \Rightarrow a = \frac{u^2}{2as} = \frac{(20)^2}{2 \times 200} = 1 \text{ m/s}^2$

55. **(c)** $S_n = u + \frac{a}{2}(2n - 1)$

or, $S = \frac{a}{2}(2 \times 2 - 1) \Rightarrow a = \frac{2}{3} \text{m/s}^2$

56. **(b)** For first part of penetration, by equation of motion

$\left(\frac{u}{2}\right)^2 - (u)^2 = 2aS$ or $a = -\frac{3u^2}{8S}$ ...(i)

For latter part of penetration

$(0)^2 - \left(\frac{u}{2}\right)^2 = 2aS'$, $S' = -\frac{u^2}{8a}$

$S' = -\frac{u^2}{8}\left(\frac{8S}{-3u^2}\right)$ (Using (i))

$S' = \frac{S}{3}$ or $S' = \frac{40}{3}$ cm

57. **(c)** The distance covered in n^{th} second is

$S_n = u + \frac{1}{2}(2n - 1)a$

where u is initial velocity & a is acceleration

then $26 = u + \frac{19a}{2}$ ....(i)

$28 = u + \frac{21a}{2}$ ....(ii)

$30 = u + \frac{23a}{2}$ ....(iii)

$32 = u + \frac{25a}{2}$ ....(iv)

From eqs. (i) and (ii) we get u = 7m/sec, a=2m/sec^2
∴ The body starts with initial velocity u =7m/sec
and moves with uniform acceleration a = 2m/sec^2

58. **(a)** $v = \sqrt{3x + 16} \Rightarrow v^2 = 3x + 16 \Rightarrow v^2 - 16 = 3x$
Comparing with $v^2 - u^2 = 2aS$, we get, u = 4 units,
2a = 3 or a = 1.5 units

59. **(c)** Let a be the constant acceleration of the particle. Then

$s = ut + \frac{1}{2}at^2$ or $s_1 = 0 + \frac{1}{2} \times a \times (10)^2 = 50$ a

and $s_2 = \left[0 + \frac{1}{2}a(20)^2\right] - 50a = 150a$

$\therefore s_2 = 3s_1$

60. **(c)** Distance travelled in the nth second is given by

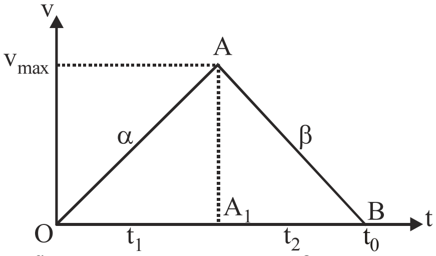
$t_n = u + \frac{a}{2}(2n - 1)$

put u = 0, $a = \frac{4}{3}\text{ms}^{-2}$, n = 3

$\therefore$ $d = 0 + \frac{4}{3 \times 2}(2 \times 3 - 1) = \frac{4}{6} \times 5 = \frac{10}{3}$ m

61. **(c)** Initial velocity of car (u) = 0
Final velocity of car (v) = 144 km/hr = 40 m/s
Time taken = 20 s
We know that, $v = u + at$
$40 = a \times 20 \Rightarrow a = 2 \text{ m/s}^2$
Also, $v^2 - u^2 = 2as \Rightarrow s = \frac{v^2 - u^2}{2a}$
$\Rightarrow s = \frac{(40)^2 - (0)^2}{2 \times 2} = \frac{1600}{4} = 400$ m.

62. **(d)**



In fig., $AA_1 = v_{max.} = \alpha t_1 = \beta t_2$

But $t = t_1 + t_2 = \frac{v_{max}}{\alpha} + \frac{v_{max}}{\beta}$

$= v_{max}\left(\frac{1}{\alpha} + \frac{1}{\beta}\right) = v_{max}\left(\frac{\alpha + \beta}{\alpha\beta}\right)$

or, $v_{max} = t\left(\frac{\alpha\beta}{\alpha + \beta}\right)$

63. **(a)** at $t = 0$, $u = 100$ m/s downwards
for 0 to 10 sec
$v = u - gt = -100 - 10 \times 10 = -200$ m/s
As $v = -100 - gt$ is straight line equation between v and t. So the curve will be straight line with –100 as intercept
for 10 to 20 sec, v = 0, so option (a) is correct.

64. **(d)**

65. **(d)** Given : u = 0, t = 5 sec, v = 108 km/hr = 30m/s
By eq^n of motion v = u + at

or $a = \frac{v}{t} = \frac{30}{5} = 6 \text{ m/s}^2$ [∵ u = 0]

$S_1 = \frac{1}{2}at^2 = \frac{1}{2} \times 6 \times 5^2 = 75$ m

Distance travelled in first 5 sec is 75m.
Distance travelled with uniform speed of 30 m/s is S_2
$395 = S_1 + S_2 + S_3 \Rightarrow 395 = 75 + S_2 + 45 \Rightarrow S_2 = 275$ m

Time taken to travel 275 m = $\frac{275}{30} = 9.2$ sec

For retarding motion, we have
$0^2 - 30^2 = 2(-a) \times 45$, we get a = 10 m/s^2

$S = ut + \frac{1}{2}at^2 \Rightarrow 45 = 30t + \frac{1}{2}(-10)t^2 \Rightarrow 45 = 30t - 5t^2$

On solving we get, t = 3 sec

Total time taken = 5 + 9.2 + 3 = 17.2 sec.

66. **(d)**

67. **(d)** Let u be the initial velocity that have to find and a be the uniform acceleration of the particle.

For $t = 3$s, distance travelled $S = 12$ m and

for $t = 3 + 3 = 6$ s distance travelled $S' = 12 + 30 = 42$ m

From, $S = ut + 1/2\, at^2$

$12 = u \times 3 + \frac{1}{2} \times a \times 3^2$

or $24 = 6u + 9a$ ...(i)

Similarly, $42 = u \times 6 + \frac{1}{2} \times a \times 6^2$

or $42 = 6u + 18a$ ...(ii)

On solving, we get $u = 1$ m s^{-1}

68. **(b)** Let the initial velocity of ball be u $\therefore$ Time of rise

$t_1 = \frac{u}{g+a}$ and height reached $= \frac{u^2}{2(g+a)}$

Time of fall t_2 is given by

$\frac{1}{2}(g-a)t_2^2 = \frac{u^2}{2(g+a)}$

$t_2 = \frac{u}{\sqrt{(g+a)(g-a)}} = \frac{u}{(g+a)}\sqrt{\frac{g+a}{g-a}}$

$\therefore$ $t_2 > t_1$ because $\frac{1}{g+a} < \frac{1}{g-a}$

69. **(d)**

70. **(d)** Because acceleration due to gravity is constant so the slope of line will be constant i.e. velocity time curve for a body projected vertically upwards is straight line.

71. **(b)**

72. **(b)** Free fall of an object (in vacuum) is a case of motion with uniform acceleration.

73. **(d)** As ball returns to starting point so displacement is zero.

74. **(d)** From equation of motion, $s = ut + \frac{1}{2}gt^2$

For first $\frac{h}{2}$, $\frac{h}{2} = \frac{1}{2}gt_1^2$ ...(i)

For total height h,

$h = \frac{1}{2}g(t_1 + t_2)^2$ ...(ii)

Divide equation (ii) by (i) we have $\frac{1}{2} = \frac{t_1^2}{(t_1+t_2)^2}$

$\frac{1}{\sqrt{2}} = \frac{t_1}{t_1 + t_2}$; $1 + \frac{t_2}{t_1} = \sqrt{2}$

$\frac{t_1}{t_2} = \frac{1}{\sqrt{2}-1} \Rightarrow t_2 = (\sqrt{2}-1)t_1$

75. **(d)**

76. **(a)** $h = ut_1 - \frac{1}{2}gt_1^2$

Also $h = ut_2 - \frac{1}{2}gt_2^2$

After simplify above equations, we get

$h = \frac{1}{2}gt_1t_2$.

77. **(c)**

78. **(b)** Velocity when the engine is switched off

$v = 19.6 \times 5 = 98$ ms^{-1}

$h_{max} = h_1 + h_2$ where $h_1 = \frac{1}{2}at^2$ & $h_2 = \frac{v^2}{2a}$

$h_{max} = \frac{1}{2} \times 19.6 \times 5 \times 5 + \frac{98 \times 98}{2 \times 9.8} = 735$ m

79. **(b)** Height attained by balls in 2 sec is

$= \frac{1}{2} \times 9.8 \times 4 = 19.6$m

the same distance will be covered in 2 second (for descent) Time interval of throwing balls, remaining same. So, for two balls remaining in air, the time of ascent or descent must be greater than 2 seconds. Hence speed of balls must be greater than 19.6 m/sec.

80. **(a)** Clearly distance moved by 1st ball in 18s = distance moved by 2nd ball in 12s.

Now, distance moved in 18 s by 1st ball

$= \frac{1}{2} \times 10 \times 18^2 = 90 \times 18 = 1620$ m

Distance moved in 12 s by 2nd ball

$= ut + \frac{1}{2}gt^2$ $\therefore$ $1620 = 12\,v + 5 \times 144$

$\Rightarrow$ $v = 135 - 60 = 75$ ms^{-1}

81. **(a)** $\because$ $h = \frac{1}{2}gt^2$ $\therefore$ $h_1 = \frac{1}{2}g(5)^2 = 125$

$h_1 + h_2 = \frac{1}{2}g(10)^2 = 500 \Rightarrow h_2 = 375$

$\therefore$ $h_1 + h_2 + h_3 = \frac{1}{2}g(15)^2 = 1125$

$\Rightarrow$ $h_3 = 625$

$h_2 = 3h_1$, $h_3 = 5h_1$ or $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

82. **(a)**

83. **(c)** In $\frac{T}{3}$ sec, the distance travelled $= \frac{1}{2}g\left(\frac{T}{3}\right)^2 = \frac{h}{9}$

$\therefore$ Position of the ball from the ground $= h - \frac{h}{9} = \frac{8h}{9}$ m

84. **(a)** Before hitting the ground, the velocity v is given by

$v^2 = 2gd$

Further, $v'^2 = 2g \times \left(\frac{d}{2}\right) = gd$;

$\therefore \left(\frac{v}{v'}\right) = \sqrt{2}$ or $v = v'\sqrt{2}$

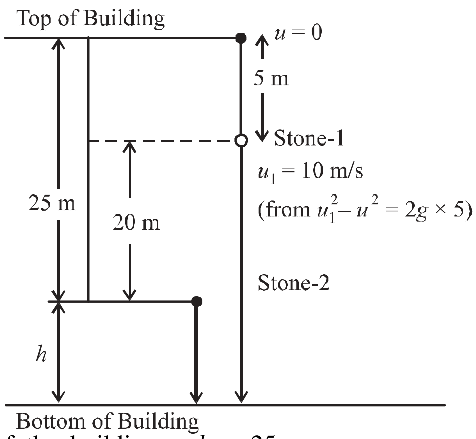
As the direction is reversed and speed is decreased and hence graph (a) represents these conditions correctly.

85. **(b)** Time taken by the stone to reach the water level $t_1 = \sqrt{\frac{2h}{g}}$

Time taken by sound to come to the mouth of the well,

$t_2 = \frac{h}{v}$ $\therefore$ Total time $t_1 + t_2 = \sqrt{\frac{2h}{g}} + \frac{h}{v}$

86. **(b)**



Height of the building = h + 25

For stone-1, $20 + h = 10t + \frac{1}{2}gt^2$ ...(i)

And for stone-2, $h = \frac{1}{2}gt^2$ ...(ii)

Putting value of h from eq. (ii) in eq. (i)

$20 + \frac{1}{2}gt^2 = 10t + \frac{1}{2}gt^2 \quad \therefore t = 2s$

Therefore, $h = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times 2^2 = 20$ m

$\therefore$ Height of the building = h + 25 = 20 + 25 = 45 m.

87. **(b)**

88. **(a)** $S = ut + \frac{1}{2}at^2$

$-76 = 4 \times 6 - \frac{1}{2} \times 10 \times (6)^2 \Rightarrow u = \frac{52}{3}$ m/s

89. **(b)** $S = AB = \frac{1}{2}g t_1^2 \Rightarrow 2S = AC = \frac{1}{2}g\,(t_1 + t_2)^2$

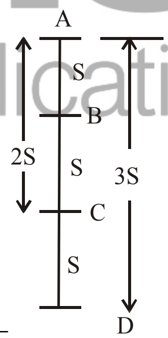
and $3S = AD = \frac{1}{2}g\,(t_1 + t_2 + t_3)^2$

$t_1 = \sqrt{\frac{2S}{g}}$

$t_1 + t_2 = \sqrt{\frac{4S}{g}},\ t_2 = \sqrt{\frac{4S}{g}} - \sqrt{\frac{2S}{g}}$

$t_1 + t_2 + t_3 = \sqrt{\frac{6S}{g}}$

$t_3 = \sqrt{\frac{6S}{g}} - \sqrt{\frac{4S}{g}}$



$t_1 : t_2 : t_3 :: 1 : (\sqrt{2} - \sqrt{1}) : (\sqrt{3} - \sqrt{2})$

90. **(a)** $h = ut + \frac{1}{2}gt^2 \Rightarrow h = \frac{1}{2}gt^2\ [\because u = 0] \therefore t = \sqrt{2h/g}$

91. **(c)** **92.** **(b)** **93.** **(b)**

94. **(d)** Since $S = ut + ½\,gt^2$
where u is initial velocity & a is acceleration.
In this case u = 0 & a = g
so distance travelled in 4 sec is,
S = ½ × 10 × 16 = 80m

95. **(a)** $s = ut + \frac{1}{2}at^2$

$-65 = 12t - 5t^2$ on solving we get, t = 5s

96. **(d)** For A to B

$S = \frac{1}{2}gt^2$ ...(i)

For A to C

$2S = \frac{1}{2}gt'^2$ ...(ii)

Dividing (i) by (ii) we get $\frac{t}{t'} = \frac{1}{\sqrt{2}}$

97. **(d)**

98. **(d)** For constant acceleration and zero initial velocity

$h \propto t^2$

$\frac{h_1}{h_2} = \frac{t_1^2}{t_2^2} \Rightarrow t_2 = \sqrt{\frac{h_2}{h_1}}t_1 = \sqrt{2} \times t_1 = \sqrt{2} \times 2s$

99. **(b)** When a body fallsthrough a height h, it acquires a velocity $\sqrt{2gh}$.

100. **(c)** u = 12m/s, g = 9.8 m/sec^2, t = 10 sec

Displacement $= ut + \frac{1}{2}gt^2$

$= 12 \times 10 + \frac{1}{2} \times 9.8 \times 100 = 610$m

101. **(b)**

102. **(c)** As we know, distance traversed in n^{th} second

$S_n = u + \frac{1}{2}a(2n - 1)$

Here, $u = 0$, $a = g$

$\therefore \quad S_n = \frac{1}{2}g(2n - 1)$

Distance traversed in 1st second i.e., $n = 1$

$S_1 = \frac{1}{2}g(2 \times 1 - 1) = \frac{1}{2}g$

Distance traversed in 2nd second i.e., $n = 2$

$S_2 = \frac{1}{2}g(2 \times 2 - 1) = \frac{3}{2}g$

Distance traversed in 3rd second i.e., $n = 3$

$S_3 = \frac{1}{2}g(2 \times 3 - 1) = \frac{5}{2}g$

$\therefore S_1 : S_2 : S_3 = \frac{1}{2}g : \frac{3}{2}g : \frac{5}{2}g = 1 : 3 : 5$

103. **(b)** Let the body fall through the height of tower in t seconds. From, $D_n = u + \frac{a}{2}(2n - 1)$ we have, total distance travelled in last 2 second of fall is

$D = D_t + D_{(t-1)}$

$= \left[0 + \frac{g}{2}(2t - 1)\right] + \left[0 + \frac{g}{2}\{2(t - 1) - 1\}\right]$

$= \frac{g}{2}(2t - 1) + \frac{g}{2}(2t - 3) = \frac{g}{2}(4t - 4)$

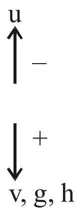
$= \frac{10}{2} \times 4(t - 1)$

or, $40 = 20\,(t - 1)$ or $t = 2 + 1 = 3$s

Distance travelled in t second is

$s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2} \times 10 \times 3^2 = 45$m

104. **(b)** The stone rises up till its vertical velocity is zero and again reached the top of the tower with a speed u (downward). The speed of the stone at the base is 3u.



Hence $(3u)^2 = (-u)^2 + 2gh$ or $h = \frac{4u^2}{g}$

105. **(a)** From third equation of motion

$v^2 = u^2 + 2ah$

In first case initial velocity $u_1 = 5$ m/sec

final velocity $v_1 = 0$, $a = -g$

and max. height obtained is H_1, then, $H_1 = \frac{25}{2g}$

In second case $u_2 = 10$ m/sec, $v_2 = 0$, $a = -g$

and max. height is H_2 then, $H_2 = \frac{100}{2g}$.

It implies that $H_2 = 4H_1$

106. **(c)** Given, H = 10 m, u = 5 m/s, g = 10 m/s^2

Speed on reaching ground $v = \sqrt{u^2 + 2gh}$

Now, $v = u + at$

$\Rightarrow \sqrt{u^2 + 2gh} = -u + gt$

Time taken to reach highest point is $t = \frac{u}{g}$,

$\Rightarrow t = \frac{u + \sqrt{u^2 + 2gH}}{g} = \frac{nu}{g}$ (from question)

$\Rightarrow 2gH = n(n-2)u^2$

$\Rightarrow n(n-2) = \frac{2gH}{u^2} = \frac{2 \times 10 + 10}{5 \times 5} = 8 \Rightarrow n = 4$

107. **(a)** Time $= \frac{\text{total length}}{\text{relative velocity}} = \frac{X + X}{20 + 20} = \frac{X}{40}$s = 1s

108. **(d)**

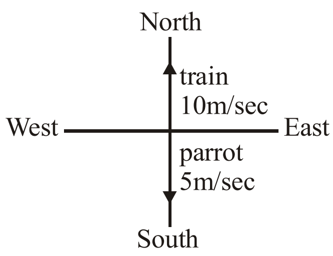
109. **(c)** $\sin\theta = \frac{\vec{v}_{RG}}{\vec{v}_{SR}} = \frac{8}{16} = \frac{1}{2}$

$\therefore \theta = 30°$ west

110. **(d)** So by figure the velocity of parrot w.r.t. train is = 5–(–10) = 15m/sec

so time taken to cross the train is

$= \frac{\text{length of train}}{\text{relative velocity}} = \frac{150}{15} = 10$ sec



111. **(a)** Velocity of boat $= \frac{8+8}{2} = 8\,\text{km h}^{-1}$

Velocity of water $= 4\,\text{km h}^{-1}$

$t = \frac{8}{8-4} + \frac{8}{8+4} = \frac{8}{3}\text{h} = 160$ minute

112. **(b)** The relative vel. of rain w.r.t. car is inclined to the vertical in the backward direction. Therefore, it will strike the front screen.

113. **(a)** In *a*, *b*, *c* and *d* time taken are respectively

$\frac{2d}{v}, \frac{2d}{\sqrt{v^2 - u^2}}, \frac{d}{u+v} - \frac{d}{u-v} = \frac{2du}{u^2 - v^2}$,

[u = stream speed]

114. **(d)** By definition of relative velocity

$\vec{v}_1 = \vec{v}_0 + \vec{v}_2 \Rightarrow \vec{v}_0 + \vec{v}_2 + (-\vec{v}_1) = 0$

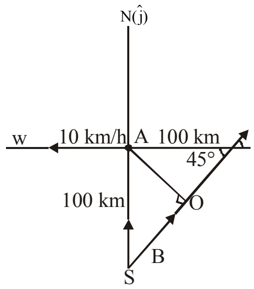
$\Rightarrow v_0, v_1$ and v_2 will be sides of a triangle and we know that the sum of any two sides is greater than third side of the triangle.

115. **(b)** Relative speed of each train with respect to each other be, v = 10 + 15 = 25 m/s

Here distance covered by each train = sum of their lengths = 50 + 50 = 100 m

$\therefore$ Required time $= \frac{100}{25} = 4$ sec.

116. **(a)** $\vec{V}_A = 10(-\hat{i})$



$\vec{V}_B = 10(\hat{j})$

$\vec{V}_{BA} = 10\hat{j} + 10\hat{i}$

$= 10\sqrt{2}$ km / h

Distance OB = 100 cos 45°

$= 50\sqrt{2}$ km

Time taken to each the shortest distance between

A and B $= \frac{OB}{V_{BA}} = \frac{50\sqrt{2}}{10\sqrt{2}} = 5$h

117. **(d)** Speed to cover 1200 m by scootarist

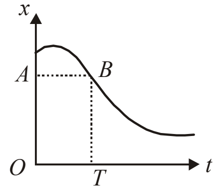
$v_r \times 60 = 1200 \Rightarrow v_r = 20$

speed to overtake bus

$v = v_r + 10 = 30$ m/s

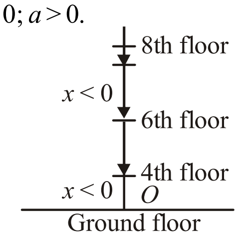
EXERCISE - 2

1. **(b)** If we draw a line parallel to time axis from the point (*A*) on graph at $t = 0$ sec. This line can intersect graph at *B*. In graph (b) for one value of displacement there are two different points of time. so, for one time, the average velocity is positive and for other time is equivalent negative. As there are opposite velocities in the inteval 0 to *T* hence average velocity can vanish in (b). Thiscan be seen in the figure given below.



Here, $OA = BT$ (same displacement) for two different points of time.

2. **(a)** As the lift is moving downward directions so displacement is negative (zero). We have to see whether the motion is accelerating or retarding.
Due to downward motion displacement is negative the lift reaches 4th floor is about to stop hence, motion is retarding (–a) downward in nature hence, $x < 0$; $a > 0$.
As displacement is in negative direction, $x < 0$ velocity will also be negative i.e., $v < 0$ but net acceleration is +ve $a > 0$, that can be shown in the graph.



3. **(b)** In one dimensional motion, for the maximum and minimum displacement we must have the magnitude and direction of maximum velocity.
As maximum velocity in positive direction is v_0, hence maximum velocity in opposite direction is also $-v_0$.
Maximum displacement in one direction = v_0T
Maximum displacement in opposite directions = $-v_0T$.
Hence, $-v_0T < x < v_0T$

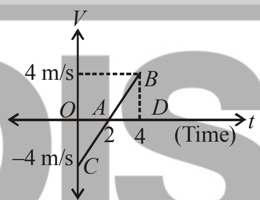
4. **(c)**

5. **(b)** As given that, $x = (t-2)^2$

velocity $v = \frac{dx}{dt} = \frac{d}{dt}(t-2)^2 = 2\,(t-2)$ m/s

$a = \frac{dv}{dt} = \frac{d}{dt}[2(t-2)] = 2\,[1-0] = 2\text{ m/s}^2 = 2\text{ ms}^{-2}$

at $t = 0$; $v_0 = 2\,(0-2) = -4$ m/s
$t = 2$ s; $v_2 = 2\,(2-2) = 0$ m/s
$t = 4$ s; $v_4 = 2\,(4-2) = 4$ m/s
v-t graph is shown in diagram.



Distance travelled
= area between time axis of the graph
= area OAC + are ABD

$= \frac{1}{2} OA \times OC + \frac{1}{2} AD \times BD = 8$ m

If displacement occurs

$= -\frac{1}{2} \times OA \times OC + \frac{1}{2} \times AD \times BD = 0$

6. **(a)** According to question,

$V(x) = bx^{-2n}$

So, $\frac{dv}{dx} = -2\,nb\,x^{-2n-1}$

Acceleration of the particle as function of x,

$a = v\frac{dv}{dx} = bx^{-2n}\left\{b\,(-2n)\,x^{-2n-1}\right\} = -2nb^2x^{-4n-1}$

7. **(c)** **Given :** Velocity

$V = At + Bt^2 \;\Rightarrow\; \frac{dx}{dt} = At + Bt^2$

By integrating we get distance travelled

$\Rightarrow \int_0^x dx = \int_1^2 \left(At + Bt^2\right)dt$

Distance travelled by the particle between 1s and 2s

$x = \frac{A}{2}\left(2^2 - 1^2\right) + \frac{B}{3}\left(2^3 - 1^3\right) = \frac{3A}{2} + \frac{7B}{3}$

8. **(b)** Velocity of preeti w.r.t. elevator $v_1 = \frac{d}{t_1}$

Velocity of elevator w.r.t. ground $v_2 = \frac{d}{t_2}$ then velocity of preeti w.r.t. ground

$v = v_1 + v_2$

$\frac{d}{t} = \frac{d}{t_1} + \frac{d}{t_2} \Rightarrow \frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}$

$\therefore\; t = \frac{t_1t_2}{(t_1 + t_2)}$ (time taken by preeti to walk up on the moving escalator)

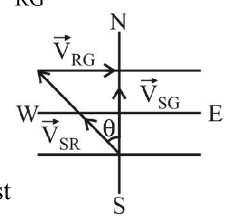
9. **(b)**

10. **(a)** Velocity of swimmer w.r.t. river $V_{SR} = 20$ m/s
Velocity of river w.r.t. ground $V_{RG} = 10$ m/s

$\vec{V}_{SG} = \vec{V}_{SR} + \vec{V}_{RG}$

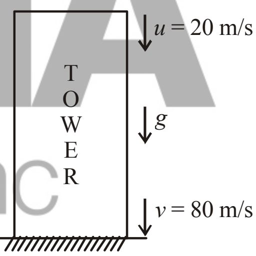
$\sin\theta = \left|\frac{\vec{V}_{RG}}{\vec{V}_{SR}}\right| \Rightarrow \sin\theta = \frac{10}{20}$

$\Rightarrow \sin\theta = \frac{1}{2} \qquad \therefore\; \theta = 30°$ west



i.e., to cross the river along the shortest path, swimmer should make his strokes 30° west.

11. **(c)**



Using $\boxed{v^2 = u^2 + 2gh}$

Height, $h = \frac{v^2 - u^2}{2g} = \frac{(80)^2 - (20)^2}{2 \times 10}$

$= \frac{6400 - 400}{20} = 300$ m

12. **(c)** Acceleration along inclined plane,
$a = g\sin\theta$
S_n = distance travelled by object during n^{th} second.
Initial speed $u = 0$

$S_n = u + \frac{a}{2}(2n-1)$

$\Rightarrow S_n = 0 + \frac{g\sin\theta}{2}(2n-1) = \frac{g\sin\theta}{2}(2n-1)$ ...(i)

Distance travelled during $(n + 1)^{th}$ second.

$$S_{n+1} = 0 + \frac{g\sin\theta}{2}\left[2(n+1)-1\right]$$

$$= \frac{g\sin\theta}{2}(2n+1) \qquad ...(ii)$$

Dividing equations (i) and (ii)

$$\frac{S_n}{S_{n+1}} = \frac{\frac{g\sin\theta}{2}(2n-1)}{\frac{g\sin\theta}{2}(2n+1)} = \frac{(2n-1)}{(2n+1)}$$

The distance covered by a body in n^{th} second i.e., $S_n \propto (2n-1)$ if body starts from rest and moves with uniform acceleration.

13. **(c)** $V = \frac{ds}{dt}$ = slope of s – t curve = tan θ

$$\frac{V_{80°}}{V_{45°}} = \frac{\tan 30°}{\tan 45°} = \frac{1}{\sqrt{3}}$$

14. **(b)** $Sn = u + \frac{a}{2}(2n-1)$

S1 : S2 : S3 : S4 = (2× 1 – 1) : (2× 2 – 1) : (2× 3 – 1) : (2 × 4 – 1)

= 1 : 3 : 5 : 7

15. **(b)** $y_1 = 10t - 5t^2$; $y_2 = 40t - 5t^2$

for $y_1 = -240$m, t = 8s

∴ $y_2 - y_1 = 30t$ for $t \le 8$s.

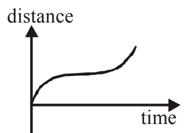
for $t > 8s$, $y_2 - y_1 = 240 - 40t - \frac{1}{2}gt^2$

16. **(a)** For a body thrown vertically upwards acceleration remains constant ($a = -g$) and velocity at anytime t is given by $V = u - gt$

During rise velocity decreases linearly and during fall velocity increases linearly and direction is opposite to each other.

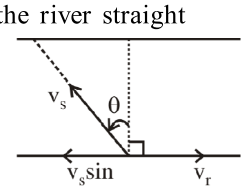
Hence graph (a) correctly depicts velocity versus time.

17. **(b)** Graphs in option (c) position-time and option (a) velocity-position are corresponding to velocity-time graph option (d) and its distance-time graph is as given below.



Hence distance-time graph option (b) is incorrect.

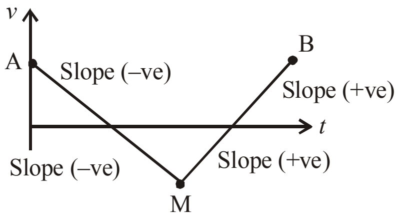
18. **(c)** To cross the river straight



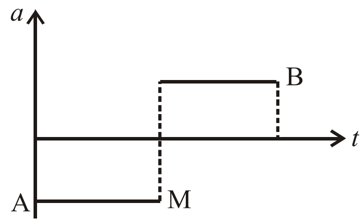
$V_s\sin\theta = V_r \therefore \sin\theta = \frac{v_r}{v_s} = \frac{2}{4} = \frac{1}{2} \qquad \therefore \theta = 30°$

Direction of swimmer with respect to flow = 90° + 30° = 120°

19. **(b)** Slope of v-t graph gives acceleration



As slope is negative from A to M. So, acceleration is negative and constant from A to M. From M to B, slope is positive and hence acceleration. So, correct graph will be as follow



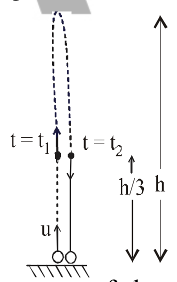
20. **(b)** Maximum height = $h = \frac{u^2}{2g}$ [∵ At maximum height $v = 0$. so, $0^2 = u^2 - 2gh$

$$\Rightarrow u = \sqrt{2gh}$$

As, $s = ut + \frac{1}{2}at^2$

$$\Rightarrow \frac{h}{3} = t\sqrt{2gh} + \frac{1}{2}(-g)t^2$$

$$\Rightarrow \frac{gt^2}{2} - t\sqrt{2gh} + \frac{h}{3} = 0$$



Let t_1 and t_2 be two roots of above equation.

Then, $$\frac{t_2}{t_1} = \frac{\sqrt{2gh} + \sqrt{2gh - 4\times\frac{g}{2}\times\frac{h}{3}}}{\sqrt{2gh} - \sqrt{2gh - 4\times\frac{g}{2}\times\frac{h}{3}}}$$

$$= \frac{\sqrt{2gh} + \sqrt{\frac{4gh}{3}}}{\sqrt{2gh} - \sqrt{\frac{4gh}{3}}} = \frac{\sqrt{3}+\sqrt{2}}{\sqrt{3}-\sqrt{2}}$$

EXERCISE - 3

1. **(b)** (A)→(2); (B)→(1); C→(4); (D)→(3)
2. **(c)** (A)→(1, 2, 3); (B)→(4); C→(4); (D)→(1, 3)
3. **(a)** (A)→(4); (B)→(5); C→(1); (D)→(3) ; (E)→(2)
4. **(c)** (A)→(2); (B)→(1); C→(3); (D)→(4)
5. **(c)** (A)→(3); (B)→(1); C→(4); (D)→(2)
6. **(a)** In uniform circular motion, there is acceleration of constant magnitude.
7. **(d)** Equation of motion can be applied if the acceleration is in opposite direction to that of velocity and uniform motion mean the acceleration is zero.
8. **(b)**
9. **(c)** One dimensional motion is always along straight line. But acceleration may be opposite of velocity and so angle between them will be 180°.
10. **(c)** Assertion is True, Reason is False.
11. **(a)** Instantaneous speed is the distance being covered by the particle per unit time at the given instant. It is equal to the magnitude of the instantaneous velocity at the given instant.
12. **(c)** Average velocity $= \dfrac{\text{displacement}}{\text{time interval}}$

    A particle moving in a given direction with non-zero velocity cannot have zero speed.
    In general, average speed is not equal to magnitude of average velocity. However, it can be so if the motion is along a straight line without change in direction.
13. **(a)** When the body is projected vertically upward then at the highest point its velocity is zero but acceleration is not equal to zero ($g = 9.8 m/s^2$).
14. **(d)** All options are correct :

    (i) When two bodies A & B move in opposite directions then relative velocity between A & B either V_{AB} or V_{BA} both are greater than V_A & V_B.

    (ii) When two bodies A & B move in same direction then

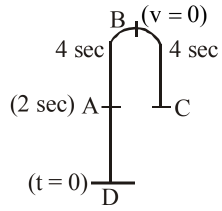
    $$V_{AB} = V_A - V_B \Rightarrow V_{AB} < V_A$$
    $$V_{BA} = V_B - V_A \Rightarrow V_{BA} < V_B$$
15. **(c)**
16. **(d)** Average velocity $= \dfrac{\text{Displacement}}{\text{Time}}$

    $\Rightarrow |\text{displacement}| \le \text{distance}$
17. **(d)** When a body falling freely, only gravitational force acts on it in vertically downward direction. Due to this downward acceleration the velocity of a body increases and will be maximum when the body touches the ground.
18. **(a)** A body has no relative motion with respect to itself. Hence, if a frame of reference of body is fixed, then the body will be always at relative rest in this frame of reference.
19. **(d)** Average velocity $= \dfrac{\text{Displacement}}{\text{Time}}$

    $\Rightarrow |\text{displacement}| \le \text{distance}$

EXERCISE - 4

1. **(d)**



As the time taken from D to A = 2 sec.
and D → A → B → C = 10 sec (given).
As ball goes from B → C (u = 0, t = 4 sec)

$v_c = 0 + 4g.$

As it moves from C to D, $s = ut + \frac{1}{2}gt^2$

$s = 4g \times 2 + \frac{1}{2} g \times 4 = 10\text{ g}.$

2. **(c)** 3. **(a)**
4. **(c)** According to question, object is moving with constant negative acceleration *i.e.*, a = – constant (C)

$$\frac{vdv}{dx} = -C \Rightarrow vdv = -Cdx$$

$$\frac{v^2}{2} = -Cx + k \Rightarrow x = -\frac{v^2}{2C} + \frac{k}{C}.$$

Hence, graph (c) represents correctly.

5. **(a)** $S_n = \dfrac{a}{2}(2n-1);$

$$S_{n+1} = \frac{a}{2}[2(n+1)-1] = \frac{a}{2}(2n+1) \therefore \frac{S_n}{S_{n+1}} = \frac{2n-1}{2n+1}$$

6. **(b)** $V_7 = V_5 + \dfrac{3\pi}{8} \times 2$

To calculate V_5 *i.e.*, velocity at end of 5 sec.

$$a = (25 - t^2)^{1/2} \Rightarrow \frac{dv}{dt} = (25 - t^2)^{1/2}$$

$$\int dv = \int 5\,(25 - 25\sin^2\theta)^{1/2} \cos\theta d\theta \quad \begin{cases} t = 5\sin\theta \\ \dfrac{dt}{d\theta} = 5\cos\theta \\ t = 0, \theta = 0 \\ t = 5, \theta = \dfrac{\pi}{2} \end{cases}$$

$$= \int_0^{\pi/2} 5 \times 5\cos^2\theta d\theta = \frac{25\pi}{4}$$

$$V_7 = \frac{25\pi}{4} + \frac{3\pi}{4} = \frac{28\pi}{4} = 7\pi = 22 m/s$$

7. **(a)** $a = \dfrac{d^2x}{dt^2} = -s\,\omega^2 \sin\omega t.$

On integrating, $\dfrac{dx}{dt} = s\,\omega^2 \dfrac{\cos\omega t}{\omega} = s\,\omega \cos\omega t$

Again on integrating, we get

$$x = s\,\omega \frac{\sin\omega t}{\omega} = s\ \sin\omega t$$

8. **(c)** $\because t = \sqrt{x} + 3 \Rightarrow \sqrt{x} = t - 3 \Rightarrow x = (t-3)^2$

$v = \frac{dx}{dt} = 2(t-3) = 0 \Rightarrow t = 3 \therefore x = (3-3)^2 \Rightarrow x = 0.$

9. **(b)** Distance along a line *i.e.*, displacement $(s) = t^3$ ($\because s \propto t^3$ given).

By double differentiation of displacement, we get acceleration.

$V = \frac{ds}{dt} = \frac{dt^3}{dt} = 3t^2$ and $a = \frac{dv}{dt} = \frac{d3t^2}{dt} = 6t$

$a = 6t$ or $a \propto t$

Hence graph (b) is correct.

10. **(a)**

11. **(c)**

$v_L = 8$ km/h, $s = v_0 \times t \Rightarrow t = \frac{40}{8} = 5\text{h}$.

Total distance flown by the bird = 10 × 5 = 50 km.

12. **(c)** $v = \frac{dy}{dt} = b + 2ct - 4dt^3$

$v_0 = b + 2c(0) - 4d(0)^3 = b$. ($\because$ for initial velocity, $t = 0$)

Now $a = \frac{dv}{dt} = 2c - 12dt^2$

$\therefore \quad a_0 = 2c - 12d(0)^2 = 2c$, (at $t = 0$)

13. **(d)** Given $x = ae^{-\alpha t} + be^{\beta t}$

Velocity, $v = \frac{dx}{dt} = -a\alpha e^{-\alpha t} + b\beta e^{\beta t}$

i.e., go on increasing with time.

14. **(b)** $V_1 = \frac{u_0 + u_1}{2}$, $V_2 = \frac{u_1 + u_2}{2}$, $V_3 = \frac{u_2 + u_3}{2}$

$u_2 = u_0 + a(t_1 + t_2)$, $u_3 = u_1 + a(t_2 + t_3)$

$\frac{V_1 - V_2}{V_2 - V_3} = \frac{u_0 - u_2}{u_1 - u_3} = \frac{-a(t_1 + t_2)}{-a(t_2 + t_3)}$

15. **(b)** The length of side *CA* at any time t is = 20 – 5*t*.

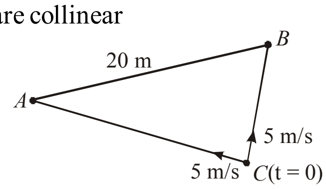
The length of side *CB* at any time *t* is = 10 – 5*t*.

At the instant *A*, *B* and *C* are collinear

$(20 - 5t) + (10 - 5t) = 20.$

Solving we get $t = 1$.

Therefore, length of *CA* at $t = 1$ is $20 - 5 = 15$ m.



EXERCISE - 5

1. **(9)** Position of the particle,

S = area under graph (time t = 0 to 5s)

$= \frac{1}{2} \times 2 \times 2 + 2 \times 2 + 3 \times 1 = 9\,\text{m}$

2. **(48)** $v_{av} = \frac{2v_1 v_2}{v_1 + v_2} = \frac{2 \times 40 \times 60}{100} = 48$ kmph.

3. **(15)**

4. **(60)** $48 = \frac{200 \times 10^{-3}}{\left(\frac{100 \times 10^{-3}}{40}\right) + \left(\frac{100 \times 10^{-3}}{v}\right)}$

or $v = 60$ km/h

5. **(18)** Average speed $= \frac{s}{\frac{s/3}{10} + \frac{s/3}{20} + \frac{s/3}{60}}$

$= \frac{s}{s/18} = 18\,\text{km/h}$

6. **(16)** The distance travelled in the first four seconds

= Area of triangle $= \frac{1}{2} \times 4 \times 8 = 16\,\text{m}$

7. **(0)** Since total displacement is zero, hence average velocity is also zero.

8. **(20)** From $v^2 = u^2 + 2as \Rightarrow 0 = u^2 + 2as$

$\Rightarrow a = \frac{-u^2}{2s} = \frac{-(20)^2}{2 \times 10} = -20\,\text{m/sec}^2$

9. **(50)** $v = u + at \Rightarrow v = 0 + 5 \times 10 = 50$ m/s

10. **(7)** $\frac{D_4}{D_3} = \frac{0 + \frac{a}{2}(2 \times 4 - 1)}{0 + \frac{a}{2}(2 \times 3 - 1)} = \frac{7}{5}$

11. **(20)** Initial velocity (u) = 40 m/s

Acceleration $(a) = -g\,\text{m/s}^2 = -10\,\text{m/s}^2$

Time (*t*) = 2 seconds

By Ist equation of motion,

$v = u + at$

$v = 40 - 10(2) = 20$ m/s

12. **(3.75)** Height of tap = 5m and (g) = 10 m/sec^2.

For the first drop,

$5 = ut + \frac{1}{2}gt^2 = (0 \times t) + \frac{1}{2} \times 10t^2 = 5t^2$ or $t^2 = 1$ or $t = 1$.

It means that the third drop leaves after one second of the first drop. Or, each drop leaves after every 0.5 sec.

Distance covered by the second drop in 0.5 sec

$= ut + \frac{1}{2}gt^2 = (0 \times 0.5) + \frac{1}{2} \times 10 \times (0.5)^2 = 1.25\,\text{m}$.

Therefore, distance of the second drop above the ground = 5 – 1.25 = 3.75 m.