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CLASS-XI
SUBJECT-PHYSICS

Chapter -3
Motion in Straight Line

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GIST

1. Motion:

An object is said to be in motion if it changes its position w.r.t. its surroundings with the passage of time .e.g. A train is moving on rails

2. Rest:

If an object does not change its position with respect to its surroundings with time, then it is called at rest.

[Rest and motion are relative states. It means an object which is at rest in one frame of reference can be in motion in another frame of reference at the same time.]

3. Point Mass Object

An object can be considered as a point mass object, if the distance travelled by it in motion is very large in comparison to its dimensions.

4. Types of Motion

1. One Dimensional Motion (Linear Motion or Rectilinear Motion)

If only one out of three coordinates specifying the position of the object changes with respect to time, then the motion is called one dimensional motion

Ex. motion of a block in a straight line, motion of a train along a straight track, a man walking on a level and narrow road and object falling under gravity etc.

2. Two-Dimensional Motion:(Motion in a Plane)

If only two out of three coordinates specifying the position of the object changes with respect to time, then the motion is called two- dimensional motion.

A circular motion is an instance of two-dimensional motion

3. Three-Dimensional Motion:(Motion in space)

If all the three coordinates specifying the position of the object changes with respect to time, then the motion is called three-dimensional motion.

A few instances of three dimension are flying bird, a flying kite, a flying aero plane, the random motion of gas molecule etc.

Types of Linear Motion

The two types of linear motion can be stated as follows:

1. Uniform linear motion
2. Non-Uniform linear motion

A body is known to be in uniform motion if it covers equal distance in equal motion time-span. Here, the motion is with zero acceleration and constant velocity.

Whereas, a body is known as non-uniform if it covers unequal distance in equal time-span. It comprises with non-zero acceleration and variable velocity

5. Distance:

The length of the actual path traversed by an object is called the distance

It is a scalar quantity and it can never be zero or negative during the motion of an object. Its SI unit is meter.

6. Displacement:

The shortest distance between the initial and final positions of any object during motion is called displacement. The displacement of an object in a given time can be positive, zero or negative. It is a vector quantity. Its unit is meter

Displacement = (Final position - Initial position)

$$\Delta X = (X_2 - X_1)$$

7. Speed:

The time rate of change of position of the object in any direction is called speed of the object.

Speed (v) = Distance travelled (s) / Time taken (t), $v = s/t$

Its unit is m/s. It is a scalar quantity. Its dimensional formula is $[M^0 L^1 T^{-1}]$.

Types of speed:

(a) Uniform Speed

If an object covers equal distances in equal intervals of time, then its speed is called uniform speed.

(b) Non-uniform or Variable Speed

If an object covers unequal distances in equal intervals of time, then its speed is called nonuniform or variable speed.

(c) Average Speed

The ratio of the total distance travelled by the object to the total time taken is called average speed of the object.

Average speed = Total distance travelled / Total time taken

If a particle travels distances s_1, s_2, s_3, \dots with speeds v_1, v_2, v_3, \dots , then

Average speed = $s_1 + s_2 + s_3 + \dots / (s_1 / v_1 + s_2 / v_2 + s_3 / v_3 + \dots)$

If particle travels equal distances ($s_1 = s_2 = s$) with velocities v_1 and v_2 , then

Average speed = $2 v_1 v_2 / (v_1 + v_2)$

If a particle travels with speeds v_1, v_2, v_3, \dots , during time intervals t_1, t_2, t_3, \dots , then

Average speed = $v_1 t_1 + v_2 t_2 + v_3 t_3 + \dots / t_1 + t_2 + t_3 + \dots$

If particle travels with speeds v_1 , and v_2 for equal time intervals, i.e., $t_1 = t_2 = t_3$, then

Average speed = $(v_1 + v_2) / 2$

When a body travels equal distance with speeds V_1 and V_2 , the average speed (v) is the harmonic mean of two speeds.

$$2/v = 1/v_1 + 1/v_2$$

(d) Instantaneous Speed

When an object is travelling with variable speed, then its speed at a given instant of time is called its instantaneous speed.

$$\text{Instantaneous speed} = \lim_{\Delta t \rightarrow 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

8. Velocity:

The rate of change of displacement of an object in a particular direction is called its velocity.

Velocity = Displacement / Time taken

Its unit is m/s.

Its dimensional formula is $[M^0 L T^{-1}]$.

It is a vector quantity, as it has both, the magnitude and direction.

The velocity of an object can be positive, zero and negative.

Types of velocity:

(a) Uniform Velocity

If an object undergoes equal displacements in equal intervals of time, then it is said to be moving with a uniform velocity.

(b) Non-uniform or Variable Velocity

If an object undergoes unequal displacements in equal intervals of time, then it is said to be moving with a non-uniform or variable velocity.

(c) Relative Velocity

Relative velocity of one object with respect to another object is the time rate of change of relative position of one object with respect to another object.

Relative velocity of object A with respect to object B

$$V_{AB} = V_A - V_B$$

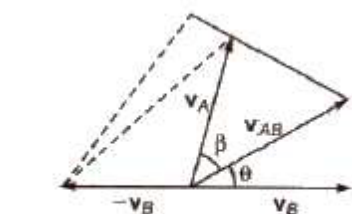
(i) When two objects are moving in the same direction, then

$$\begin{aligned} V_{AB} &= V_A - V_B \\ \text{or } V_{AB} &= V_A - V_B \end{aligned}$$


(ii) When two objects are moving in opposite direction, then

$$\begin{aligned} V_{AB} &= V_A + V_B \\ \text{or } V_{AB} &= V_A + V_B \end{aligned}$$


(iii) When two objects are moving at an angle, then



$$V_{AB} = \sqrt{V_A^2 + V_B^2 - 2V_A V_B \cos \theta}$$

$$\text{and } \tan \beta = V_B \sin \theta / (V_A - V_B \cos \theta)$$

(d) Average Velocity

The ratio of the total displacement to the total time taken is called average velocity.

Average velocity = Total displacement / Total time taken

9. Acceleration:

The time rate of change of velocity is called acceleration.

Acceleration (a) = Change in velocity (Δv) / Time interval (Δt)

Its unit is m/s^2

Its dimensional formula is $[M^0 L T^{-2}]$.

It is a vector quantity.

Acceleration can be positive, zero or negative. Positive acceleration means velocity increasing with time, zero acceleration means velocity is uniform while negative acceleration (retardation) means velocity is decreasing with time.

If a particle is accelerated for a time t_1 with acceleration a_1 and for a time t_2 with acceleration a_2 , then average acceleration

$$a_{av} = (a_1 t_1 + a_2 t_2) / (t_1 + t_2)$$

10. Equations of Uniformly Accelerated Motion :

If a body starts with initial velocity (u) and after time t its velocity changes to v, if the uniform acceleration is 'a' and the distance travelled in time t is 's' then the following relations are obtained, which are called equations of uniformly accelerated motion

(i) $v = u + at$

(ii) $s = ut + (1/2) at^2$

(iii) $v^2 = u^2 + 2as$

(iv) Distance travelled in nth second.

$$S_n = u + (a / 2) (2n - 1)$$

If a body moves with uniform acceleration and velocity changes from u to v in a time interval, then the velocity at the midpoint of its path

$$(V_m)^2 = (u^2 + v^2) / 2$$

11. Equations of Motion Under Gravity:

If an object is falling freely ($u = 0$) under gravity, then equations of motion

(i) $v = u + gt$

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

(iii) $v^2 = u^2 + 2gh$

(iv) Distance travelled in nth second.

$$S_n = u + (g / 2) (2n - 1)$$

Note If an object is thrown upward then g is replaced by $-g$ in above three equations.

It thus follows that

(i) Time taken to reach maximum height

$$t_A = u / g = \sqrt{2h / g}$$

(ii) Maximum height reached by the body

$$h_{max} = u^2 / 2g$$

(iii) A ball is dropped 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

$$t = \sqrt{t_1 t_2}$$

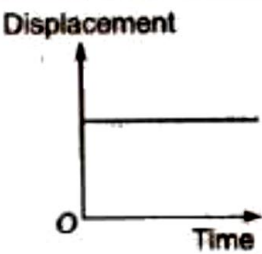
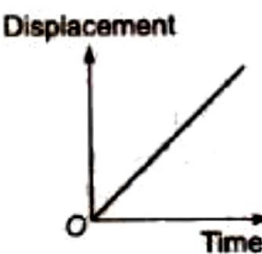
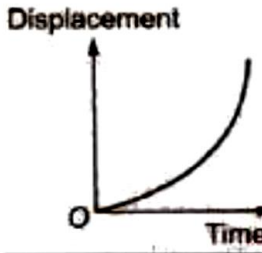
(iv) When a body is dropped freely from the top of the tower and another body is projected horizontally from the same point, both will reach the ground at the same time


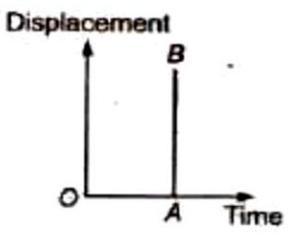
(v) When a body is thrown from the top of a tower of height H with velocity u in upward direction and body reaches to the ground in time t

$$\text{Then } H = -u t + \frac{1}{2} g t^2$$

12. Different Graphs of Motion :

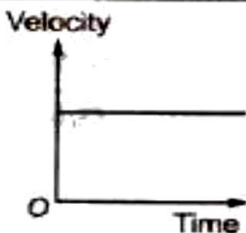
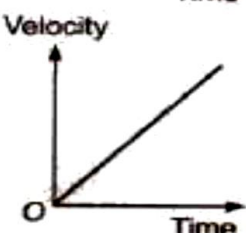
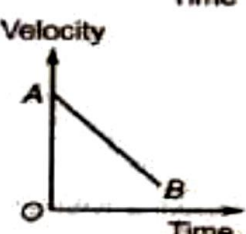
(i) Displacement – Time Graph

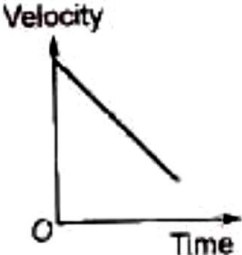
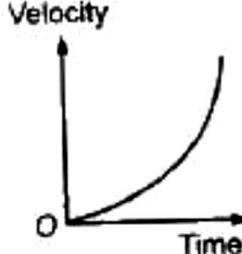
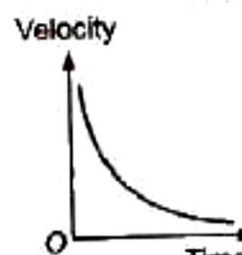
S. No.	Condition	Graph
(a)	For a stationary body	
(b)	Body moving with a constant velocity	
(c)	Body moving with a constant acceleration	

S. No.	Condition	Graph
(d)	Body moving with a constant retardation	 <p>A graph with Displacement on the vertical axis and Time on the horizontal axis. The curve starts at the origin O and increases with a decreasing slope, representing constant retardation.</p>
(e)	Body moving with infinite velocity. But such motion of a body is never possible.	 <p>A graph with Displacement on the vertical axis and Time on the horizontal axis. The curve is a vertical line segment starting from point A on the Time axis and going up to point B, representing infinite velocity.</p>

Note: Slope of displacement-time graph gives average velocity

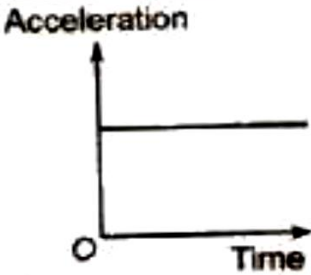
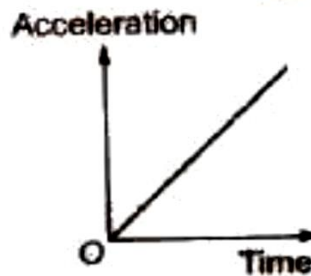
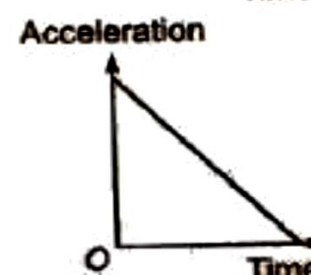
(ii) Velocity – Time Graph :

S. No.	Condition	Graph
(a)	Moving with a constant velocity	 <p>A graph with Velocity on the vertical axis and Time on the horizontal axis. The curve is a horizontal line starting from a point on the Velocity axis, representing constant velocity.</p>
(b)	Moving with a constant acceleration	 <p>A graph with Velocity on the vertical axis and Time on the horizontal axis. The curve is a straight line starting from the origin O and increasing linearly, representing constant acceleration.</p>
(c)	Body moving with a constant retardation and its initial velocity is not zero.	 <p>A graph with Velocity on the vertical axis and Time on the horizontal axis. The curve is a straight line starting from point A on the Velocity axis and decreasing linearly to point B on the Time axis, representing constant retardation.</p>

S. No.	Condition	Graph
(d)	Moving with a constant retardation	 <p>A velocity-time graph showing a straight line with a negative slope. The vertical axis is labeled 'Velocity' and the horizontal axis is labeled 'Time'. The origin is marked 'O'. The line starts at a positive velocity value on the vertical axis and decreases linearly towards the horizontal axis.</p>
(e)	Moving with increasing acceleration	 <p>A velocity-time graph showing a curve that starts at the origin (0,0) and increases with an increasing slope. The vertical axis is labeled 'Velocity' and the horizontal axis is labeled 'Time'. The origin is marked 'O'. The curve is concave up, indicating that the acceleration is increasing over time.</p>
(f)	Moving with decreasing acceleration	 <p>A velocity-time graph showing a curve that starts at a positive velocity value on the vertical axis and decreases towards the horizontal axis with a decreasing slope. The vertical axis is labeled 'Velocity' and the horizontal axis is labeled 'Time'. The origin is marked 'O'. The curve is concave up, indicating that the acceleration is decreasing over time.</p>

Note Slope of velocity-time graph gives average acceleration.

(iii) Acceleration – Time:

S. No.	Condition	Graph
(a)	When object is moving with constant acceleration	
(b)	When object is moving with constant increasing acceleration	
(c)	When object is moving with constant decreasing acceleration	

Important Formulas

1. Displacement (ΔX) = (Final position - Initial position)
 $\Delta X = (X_2 - X_1)$
2. Speed (v) = Distance travelled (s) / Time taken (t), $v = s/t$
3. Average speed = Total distance travelled / Total time taken
4. Average speed = $(s_1 + s_2 + s_3 + \dots + s_n) / (s_1 / v_1 + s_2 / v_2 + s_3 / v_3 + \dots + s_n / v_n)$
5. If particle travels equal distances ($s_1 = s_2 = s$) with velocities v_1 and v_2 , then
 Average speed = $2 v_1 v_2 / (v_1 + v_2)$
6. If a particle travels with speeds v_1, v_2, v_3, \dots , during time intervals t_1, t_2, t_3, \dots , then
 Average speed = $(v_1 t_1 + v_2 t_2 + v_3 t_3 + \dots) / (t_1 + t_2 + t_3 + \dots)$
7. If particle travels with speeds v_1 , and v_2 for equal time intervals, i.e., $t_1 = t_2 = t$, then
 Average speed = $(v_1 + v_2) / 2$

8. Instantaneous speed = $\lim_{\Delta t \rightarrow 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

9. Velocity = Displacement / Time taken = $\Delta x / \Delta t$
10. Relative Velocity = $V_{AB} = V_A - V_B$
11. Average Velocity = Total displacement / Total time taken
12. Acceleration (a) = Change in velocity (Δv) / Time interval (Δt)
13. Equations of Uniformly Accelerated Motion:

- (i) $v = u + at$
- (ii) $s = ut + at^2/2$
- (iii) $v^2 = u^2 + 2as$
- (iv) Distance travelled in n th second (S_n) = $u + (a/2)(2n - 1)$

14. Equations of Motion Under Gravity

- (i) $v = u + gt$
- (ii) $h = ut + (1/2)gt^2$

(iii) $v^2 = u^2 + 2gh$

15. (i) Time taken to reach maximum height
 $t_A = u / g = \sqrt{2h} / g$
- (ii) Maximum height reached by the body
 $h_{\max} = u^2 / 2g$

16. A ball is dropped 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

$$t = \sqrt{t_1 t_2}$$

17. When a body is thrown from the top of a tower of height H with initial velocity u in upward direction and body reaches to the ground in time t

Then $H = -u t + (1/2) g t^2$

MCQs

Q.1. The displacement in meters of a body varies with time t in second as $y = t^2 - t - 2$. The displacement is zero for a positive of t equal to

- | | |
|---------|---------|
| (a) 1 s | (b) 2 s |
| (c) 3 s | (d) 4 s |

Q.2. A boy starts from a point A, travels to a point B at a distance of 3 km from A and returns to A. If he takes two hours to do so, his speed is

- | | |
|------------|--------------|
| (a) 3 km/h | (b) zero |
| (c) 2 km/h | (d) 1.5 km/h |

Q.3. A 180 meter long train is moving due north at a speed of 25 m/s. A small bird is flying due south, a little above the train, with a speed of 5 m/s. The time taken by the bird to cross the train is

- | | |
|----------|----------|
| (a) 10 s | (b) 12 s |
| (c) 9 s | (d) 6 s |

Q.4. A boy starts from a point A, travels to a point B at a distance of 1.5 km and returns to A. If he takes one hour to do so, his average velocity is

- | | |
|--------------|------------|
| (a) 3 km/h | (b) zero |
| (c) 1.5 km/h | (d) 2 km/h |

Q.5. A body starts from rest and travels with uniform acceleration on a straight line. If its velocity after making a displacement of 32 m is 8 m/s, its acceleration is

- | | |
|------------------------|------------------------|
| (a) 1 m/s ² | (b) 2 m/s ² |
| (c) 3 m/s ² | (d) 4 m/s ² |

Q.6. Which one of the following is the unit of velocity?

- | | |
|--------------|------------|
| (a) kilogram | (b) meter |
| (c) m/s | (d) second |

Q.7. A body starts from rest and travels for t second with uniform acceleration of 2 m/s². If the displacement made by it is 16 m, the time of travel t is

- | | |
|---------|---------|
| (a) 4 s | (b) 3 s |
| (c) 6 s | (d) 8 s |

Q.8. The dimensional formula for speed is

- | | |
|-------------------------------------|-----------------------|
| (a) T ⁻¹ | (b) LT ⁻¹ |
| (c) L ⁻¹ T ⁻¹ | (d) L ⁻¹ T |

Q.9. The dimensional formula for velocity is

- | | |
|------------------------|-------------------------|
| (a) [LT] | (b) [LT ⁻¹] |
| (c) [L ² T] | (d) [L ⁻¹ T] |

Q.10. A body starts from rest and travels with an acceleration of 2 m/s^2 . After t seconds its velocity is 10 m/s . Then t is

- (a) 10 s (b) 5 s
(c) 20 s (d) 6 s

Q.11. A boy starts from a point A, travels to a point B at a distance of 1.5 km and returns to A. If he takes one hour to do so, his average velocity is

- (a) 3 km/h (b) zero
(c) 1.5 km/h (d) 2 km/h

Q.12. A body starts from rest. If it travels with an acceleration of 2 m/s^2 , its displacement at the end of 3 seconds is

- (a) 9 m (b) 12 m
(c) 16 m (d) 10 m

Q.13. A body starts from rest and travels with uniform acceleration of 2 m/s^2 . If its velocity is v after making a displacement of 9 m, then v is

- (a) 8 m/s (b) 6 m/s
(c) 10 m/s (d) 4 m/s

Q.14. A body starts from rest and travels with an acceleration of 2 m/s^2 . After t seconds its velocity is 10 m/s . Then t is

- (a) 10 s (b) 5 s
(c) 20 s (d) 6 s

Q.15. A body starts from rest and travels for five seconds to make a displacement of 25 m if it has travelled the distance with uniform acceleration a then a is

- (a) 3 m/s^2 (b) 4 m/s^2
(c) 2 m/s^2 (d) 1 m/s^2

Q.16: A boy moves on a circular distance of radius R . Starting from a point A he moves to a point B which is on the other end of the diameter AB. The ratio of the distance travelled to the displacement made by him is

- (a) $\pi/2$ (b) π
(c) 2π (d) 4π

Q.17. The dimensional formula for acceleration is

- (a) $[LT^2]$ (b) $[LT^{-2}]$
(c) $[L^2T]$ (d) $[L^2T^2]$

Q.18. A body starts from rest and travels with uniform acceleration a to make a displacement of 6 m. If its velocity after making the displacement is 6 m/s , then its uniform acceleration a is

- (a) 6 m/s^2 (b) 2 m/s^2
(c) 3 m/s^2 (d) 4 m/s^2

Q.19. Which one of the following is the unit of velocity?

- (a) kilogram (b) meter
(c) m/s (d) second

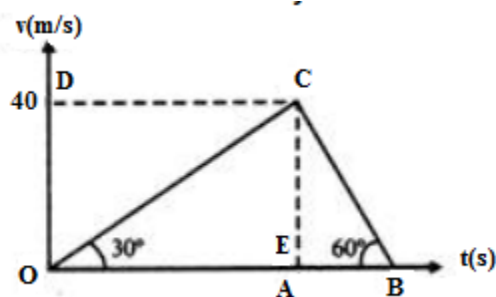
Q.20. The displacement in meters of a body varies with time t in second as $y = t^2 - t - 2$. The displacement is zero for a positive of t equal to

- (a) 1 s (b) 2 s
(c) 3 s (d) 4 s

Q.21. What is the acceleration if the body starts from rest and travels a distance of 'S' m in 2 seconds?

- (a) $(2/3)S \text{ m/s}^2$ (b) $(3/2) S \text{ m/s}^2$
(c) $(1/3)S \text{ m/s}^2$ (d) $(S/2) \text{ m/s}^2$

Q.22. What is the ratio of the average acceleration during the intervals OA and AB in the velocity-time graph as shown below?



- (a) $\frac{1}{2}$ (b) $\frac{1}{3}$
(c) 1 (d) 3

Q.23. A body covers 16, 18, 20, 22 meters in 5th, 6th, 7th and 8th seconds respectively. Which of the following statements is true about the body?

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

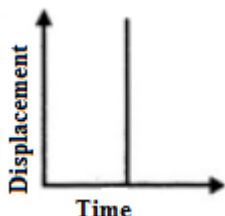
Q.24. What can be said about the displacement of the body if it covers a distance of zero?

- (a) It is zero (b) It cannot be zero
(c) It may or may not be zero (d) It is negative

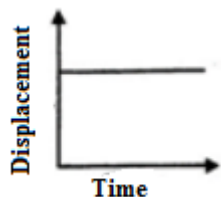
.Q.25. An athlete finishes a round of circular track of radius R in 40 sec. What is his displacement at the end of 2 min 20 sec?

- (a) $2R$ (b) $2\pi R$
(c) 7π (d) Zero

Q.26. Which of the following is not possible for a body in uniform motion?



(a)



(b)

- (c) Both (a) & (b)
(d) None of the above

Q.27. If a car travels $(2/5)$ th of the total distance with a speed 10m/s and $(3/5)$ th of the distance with a speed 20m/s . The average speed is given by

- (a) 15 m/s (b) 200 m/s
(c) $133/7\text{ m/s}$ (d) 5 m/s

Q.28. A man leaves home for a cycle ride and comes back home after an half-an-hour ride covering a distance of one km. What is the average velocity of the ride?

- (a) 10 kms^{-1} (b) $\frac{1}{2}\text{ kms}^{-1}$
(c) 2 kms^{-1} (d) Zero

Q.29. A bird flies with a speed of 10 km/hr and a car moves with uniform speed 8 km/hr . Both start from B to A at the same instant ($BA = 40\text{ km}$). The bird after reaching A flies back immediately to meet the approaching car. Once it reaches the car, it flies back to A. The bird repeats this until both the car and the bird reach A simultaneously. What is the total distance flown by the bird?

- (a) 80 km (b) 50 km

- (c) 40 km (d) 30 km

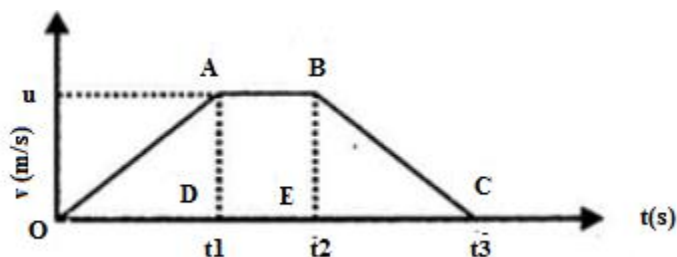
Q.30. Elephants A, B and C move with a constant speed in the same direction along a straight line as shown in the figure. The speed of the elephant A is 5 m/s and the speed of the elephant C is 10 m/s. Initially, the separation between A and B is d and between B and C is also d . When B catches C, the separation between A and C becomes $3d$. What will the speed of B be?

- (a) 5 m/s (b) 7.5 m/s
(c) 15 m/s (d) 20 m/s

Q.31. Which of the following remains constant if a body travels with constant acceleration?

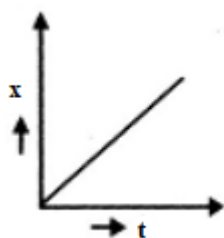
- (a) Time (b) Velocity
(c) Displacement (d) None of the above

Q.32. Given here is a velocity-time graph of the motion of a body. What is the distance travelled by the body during the motion?

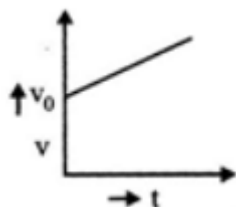


- (a) $(1/2)(OA+AB) \times BC$ (b) $(1/2)(OA+BC) \times OC$
(c) $(1/2)(OC+AB) \times AD$ (d) $(1/2)(AD+BE) \times OC$

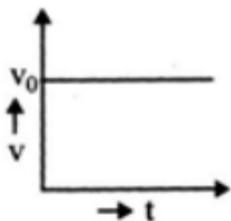
Q.33. Which of the following graphs gives the equation $x = v_0 t + \frac{1}{2} a t^2$



(a)



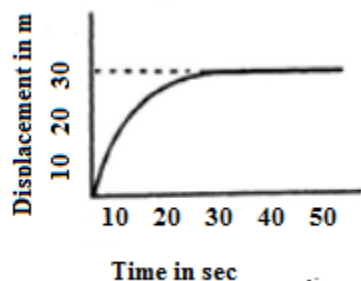
(b)



(c)

(d) None of the above

Q.34. What does the displacement of the particle shown in the graph indicate?



(a) It indicates a constant velocity

(b) It indicates a constant acceleration

(c) It indicates that the particle starts with a constant velocity and is accelerated

(d) It indicates that the motion is retarded and the particle stops

Q.35. When a body is dropped from a tower, then there is an increase in its

(a) mass

(b) velocity

(c) acceleration

(d) potential energy

Q.36. The dimensional formula for acceleration is

(a) $[LT^2]$ (b) $[LT^{-2}]$ (c) $[L^2T]$ (d) $[L^2T^2]$

Q.37. Which one of the following is the unit of velocity?

(a) kilogram

(b) meter

(c) m/s

(d) second

Q.38. The ratio of the numerical values of the average velocity and average speed of a body is

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

Q39. A particle is moving with a constant speed along straight line path. A force is not required to

- (a) change its direction
- (b) increase its speed
- (c) decrease its momentum
- (d) keep it moving with uniform velocity

Q.40. The slope of velocity-time graph for motion with uniform velocity is equal to

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

Q41. Which one of the following is the unit of acceleration?

- (a) m/s
- (b) m/s^2
- (c) km/hr
- (d) cm/s

Q.42. A boy starts from a point A, travels to a point B at a distance of 3 km from A and returns to A. If he takes two hours to do so, his speed is

- (a) 3 km/h
- (b) zero
- (c) 2 km/h
- (d) 1.5 km/h

Q43. The distance travelled by an object is directly proportional to the time taken. Its acceleration

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

Q44. A body starts from rest and travels for t second with uniform acceleration of 2 m/s^2 . If the displacement made by it is 16 m, the time of travel t is

- (a) 4 s
- (b) 3 s
- (c) 6 s
- (d) 8 s

Q45. A body starts from rest and travels with an acceleration of 2 m/s^2 . After t seconds its velocity is 10 m/s. Then t is

- (a) 10 s
- (b) 5 s
- (c) 20 s
- (d) 6 s

Q46. Which of the following is a one dimensional motion ?

- (a) Motion of train running on a straight track
- (b) Motion of satellite
- (c) Motion of air particle
- (d) Motion of snake

Q47. If the displacement of an object is zero, then what can we say about its distance covered?

- (a) It is negative
- (b) It must be zero
- (c) It cannot be zero
- (d) It may or may not be zero

Q48. A boy moves on a circular distance of radius R . Starting from a point A he moves to a point B which is on the other end of the diameter AB. The ratio of the distance travelled to the displacement made by him is

- (a) $\pi/2$
- (b) π
- (c) 2π
- (d) 4π

Q49. A body starts from rest. If it travels with an acceleration of 2 m/s^2 , its displacement at the end of 3 seconds is

- (a) 9 m
- (b) 12 m
- (c) 16 m
- (d) 10 m

Q50. Which of the following can be zero, when a particle is in motion for some time?

- (a) Displacement
- (b) None of these
- (c) Distance
- (d) Speed

Q51. The acceleration of a moving object can be found from

- (a) area under displacement-time graph
- (b) slope of displacement-time graph
- (c) area under velocity-time graph
- (d) slope of velocity-time graph

Q52. The location of a particle has changed. What can we say about the displacement and the distance covered by the particle?

- (a) Neither can be zero
- (b) One may be zero
- (c) Both may be zero
- (d) One is +ve, other is -ve

Q53. If the displacement-time graph of an object is parallel to the time-axis, then it represents that the object is :

- (a) at rest
- (b) in uniform motion
- (c) in acceleration motion
- (d) none of the above

ASSERTION AND REASON TYPE QUESTIONS

Directions: The question numbers 1 to 20 consist of two statements one labeled Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) If both A and R are true and R is the correct explanation of A
 - (b) If both A and R are true but R is NOT the correct explanation of A
 - (c) If A is true but R is false
 - (d) If A is false and R is also false
- 1). A : It is not possible to have constant velocity and variable acceleration.
R : Accelerated body cannot have constant velocity.
 - 2). A : The direction of velocity of an object can be reversed with constant acceleration.
R : A ball projected upward reverse its direction under the effect of gravity.
 - 3). A : When the velocity of an object is zero at an instant, the acceleration need not to be zero at that instant.
R : In motion under gravity, the velocity of body is zero at the top-most point.
 - 4). A : A body moving with decreasing speed may have increased acceleration.
R : The speed of body decreases when acceleration of body is opposite to velocity.
 - 5). A : For a moving particle distance can never be negative or zero.
R : Distance is a scalar quantity and never decreases with time for moving object.
 - 6). A : If speed of a particle is never zero then it may have zero average speed.
R : The average speed of a moving object in a closed path is zero.
 - 7). A : The magnitude of average velocity in an interval can never be greater than average speed in that interval.
R : For a moving object distance travelled is greater than or equal to magnitude of displacement
 - 8). A : The area under acceleration-time graph is equal to velocity of object.
R : For an object moving with constant acceleration position-time graph is a straight line.
 - 9). A : The motion of body projected under the effect of gravity without a resistance is uniformly accelerated motion.
R : If a body is projected upwards or downwards, then the direction of acceleration is downward.

10). A : The relative acceleration of two objects moving under the effect of gravity, only is always zero, irrespective of direction of motion .

R : The acceleration of object moving under the effect of gravity have acceleration always in the downward direction and is independent from size and mass object.

11). A : In the presence of air resistance, if the ball is thrown vertically upward then time of ascent is less than the time of descent.

R : Force due to air friction always acts opposite to the motion of body.

12). A : Average velocity can be zero, but average speed of a moving body cannot be zero in any finite time interval.

R : For a moving body displacement can be zero but distance can never be zero.

13). A : For a particle moving in a straight line its acceleration must be either parallel or antiparallel to velocity.

R : A body moving along a curved path may have constant acceleration.

14). A : A body can have acceleration even if its velocity is zero at that instant.

R : The body will momentarily at rest when it reverses its direction of motion.

15). A : When a body is dropped or thrown horizontally from the same height, it would reach the ground at the same time.

R : Horizontal velocity has no effect on the vertically direction.

16). A : Displacement of a body may be zero, when distance travelled by it is not zero.

R : The displacement is the larger distance between initial and final positions.

17). A: Retardation is directly opposite to the velocity.

R : Retardation is equal to the time rate of decrease of speed.

18). A : A body having a non-zero acceleration can have constant velocity.

R : Acceleration is the rate of change of velocity.

19). A : Two balls of different masses are thrown vertically upward with same speed. They will passthrough the point of projection in the downward direction with the same speed.

R : The maximum height and downward velocity attained at the point of projection are independent of the mass of the ball.

20). A : An object can have constant speed but variable velocity.

R ; Speed is a scalar but velocity is a vector quantity.

Case Study Based Questions

Following questions are case study-based questions. Each question has five sub parts of multiple-choice questions. Attempt any four sub parts from each question. Each sub part of question carries 1 mark.

Q.1. In the absence of air resistance, all bodies falls with same same acceleration near the surface of the earth. This motion of a body falling towards the earth from a small height is called free fall. The acceleration with which a body falls is called acceleration due to gravity and it is denoted by g .

(i) For a freely falling body, which of the following equation is incorrect.

- | | |
|---------------------------|-----------------------|
| (a) $h - ut = (1/2) gt^2$ | (b) $v^2 - u^2 = 2gh$ |
| (c) $h = (1/2) ut + gt^2$ | (d) $(v - u)/g = t$ |

(ii) The maximum height attained by a body thrown vertically upward with initial velocity u is

- | | |
|------------------|------------------|
| (a) $h = u^2/2g$ | (b) $h = u/2g$ |
| (c) $h = u^2/g$ | (d) $h = 2u^2/g$ |

(iii) The time of ascent of a body thrown vertically upward with initial velocity u is

- | | |
|-----------------|-----------------|
| (a) $t = u/2g$ | (b) $t = u/g$ |
| (c) $t = u^2/g$ | (d) $t = u/g^2$ |

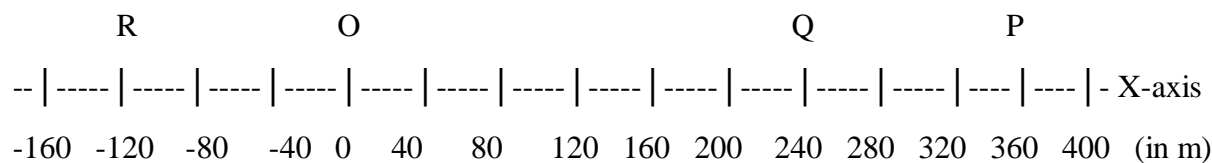
(iv) The total time of flight to come back to the point of projection of a body thrown vertically upward with initial velocity u is

- | | |
|-----------------|------------------|
| (a) $t = 2u/3g$ | (b) $t = u/2g$ |
| (c) $t = 2u/g$ | (d) $t = u^2/2g$ |

(v) Velocity of fall at the point of projection of a body thrown vertically upward with initial velocity u is

- | | |
|--------------|--------------|
| (a) $v = u$ | (b) $v = 2u$ |
| (c) $v = 3u$ | (d) $v = 4u$ |

Q.2. If the position of an object is continuously changing w.r.t. its surrounding, then it is said to be in the state of motion. Thus, motion can be defined as a change in position of an object with time. It is common to everything in the universe. In the given figure, let P, Q and R represent the position of a car at different instant of time



(i) With reference to the given figure, the position coordinates of point P and R are

- (a) $P=(+360, 0, 0)$; $R= (-120, 0, 0)$ (b) $P=(+360, 0, 0)$; $R= (+120, 0, 0)$
 (c) $P=(0, +360, 0)$; $R= (-120, 0, 0)$ (d) $P=(0, 0, +360)$; $R= (0, 0, -120)$

(ii) Displacement of an object can be

- (a) Positive (b) Negative
 (c) Zero (d) All of these

(iii) The displacement of car in moving from O to P and its displacement in moving from P to Q are

- (a) +360 m and -120 m (b) -120 m and +360 m
 (c) +360 m and +120 m (d) +360 m and -600 m.

(iv) If the car goes from O to P and returns back to O , the displacement of the journey is

- (a) 0 m (b) 720 m
 (c) 420 m (d) 340 m

(v) the path length of journey from O to P and back to O is

- (a) 0 m (b) 720 m
 (c) 360 m (d) 480 m

Q.3. The acceleration of an object is said to be uniform acceleration if its velocity changes by equal amount in equal interval of time, however small these time intervals may be. A particle is moving with uniform acceleration in x-direction, the displacement x of particle varies with time t as $x = 4t^2 - 15t + 25$. m

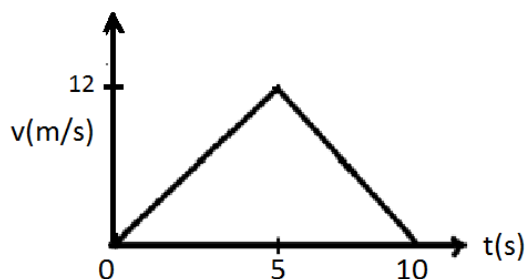
(i) The position of particle at $t = 0$,

- (a) 14 m. (b) 18 m
 (c) 20 m (d) 25 m

(ii) Velocity of particle at $t = 2$ s

- (a) -15 m/s (b) 1 m/s
 (c) 3 m/s (d) 31 m/s
- (iii) Acceleration of particle at $t = 2 \text{ s}$
 (a) 0 ms^{-2} (b) 8 ms^{-2}
 (c) 10 ms^{-2} (d) 20 ms^{-2}
- (iv) The velocity of particle will become zero at time t equal to
 (a) 2.975 s . (b) 1.875 s .
 (c) 2 s . (d) 1 s .
- (v) The particle has a uniform acceleration 'a' when
 (a) acceleration does not depend on time t (b) acceleration depends on time t
 (c) velocity changes by unequal amount in equal interval of time,
 (d) None of these

Q.4. The time rate of change of position of the object in any direction is called speed of the object. If an object covers equal distances in equal intervals of time, then its speed is called uniform speed and if it covers unequal distances in equal intervals of time, then its speed is called non-uniform or variable speed. The ratio of the total distance travelled by the object to the total time taken is called average speed of the object. The speed may be positive or zero but never negative. The speed-time graph of a particle moving along a fixed direction is shown in following Fig.



- (i) Distance travelled by the particle between 0 to 10 seconds
 (a) 60 m (b) 50 m
 (c) 120 m (d) zero
- (ii) Average speed between time interval 0 to 10 s
 (a) 12 m/s (b) 6 m/s

(c) 10 m/s

(d) 60 m/s

(iii) The time when the speed was minimum

(a) at $t = 0$ s and $t = 5$ s

(b) at $t = 5$ s and $t = 20$ s

(c) at $t = 5$ s and $t = 10$ s

(d) at $t = 0$ s and $t = 10$ s

(iv) The time when speed was maximum

(a) $t = 0$ s

(b) $t = 5$ s (c) $t = 10$ s

(d) $t = 12$ s

(v) Speed is positive at time interval

(a) $t = 0$ to $t = 5$ s

(b) $t = 5$ to $t = 10$ s

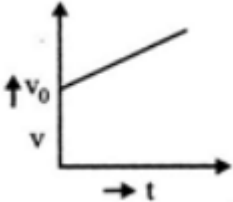
(c) $t = 0$ to $t = 10$ s

(d) All of these

Answer Keys

MCQ

Q. NO	Answer
1	(b) 2 s
2	(a) 3 km/h
3	(d) 6 s
4	(b) zero
5	(a) 1 m/s^2
6	(c) m/s
7	(a) 4 s
8	(b) LT^{-1}
9	(b) $[\text{LT}^{-1}]$
10	(b) 5 s
11	(b) zero
12	(a) 9 m
13	(b) 6 m/s
14	(b) 5 s
15	(c) 2 m/s^2
16	(a) $\pi/2$
17	(b) $[\text{LT}^{-2}]$
18	(c) 3 m/s^2
19	(c) m/s
20	(b) 2 s
21	(d) $(S/2)\text{m/s}^2$
22	(b) $1/3$
23	(c) The body moves with an initial velocity and moves with uniform acceleration
24	(a) It is zero
25	(a) $2R$
26	(c) Both (a) & (b)
27	(c) $100/7 \text{ m/s}$
28	(d) Zero
29	(b) 50 km
30	(c) 15 m/s

31	(d) None of the above
32	(c) $(1/2)(OC+AB) \times AD$
33	 <p>(b)</p>
34	(d) It indicates that the motion is retarded and the particle stops
35	(b) velocity
36	(b) $[LT^{-2}]$
37	(c) m/s
38	(a) unity or less
39	(d) keep it moving with uniform velocity
40	(a) zero
41	(b) m/s^2
42	(a) 3 km/h
43	(c) becomes zero
44	(a) 4 s
45	(b) 5 s
46	(a) Motion of train running on a straight track
47	(d) It may or may not be zero
48	(a) $\pi/2$
49	(a) 9 m

50	(a) Displacement
51	(d) slope of velocity-time graph
52	(a) Neither can be zero
53	(a) at rest

Answer Keys of Assertion and Reason Type Questions

Q.NO	Answer
1	(a)
2	(b)
3	(b)
4	(a)
5	(a)
6	(d)
7	(a)
8	(d)
9	(b)
10	(a)
11	(a)
12	(a)
13	(b)
14	(a)
15	(a)
16	(c)
17	(b)
18	(c)
19	(a)
20	(a)

ANSWER KEYS OF CASE STUDY BASED QUESTIONS

Q.N0	Answer
1	(i) c
	(ii) a
	(iii) b
	(iv) c
	(v) a
2	(i) a
	(ii) d
	(iii) a
	(iv) a
	(v) b
3	(i) d
	(ii) b
	(iii) b
	(iv) b
	(v) a
4	(i) a
	(ii) b
	(iii) d
	(iv) b
	(v) d