Motion in One Dimension

1. *What do you understand by the terms (i) rest (ii) motion ? Support your answer by giving two examples each.*

Ans. (i) When a body does not change its position with respect to the surrounding, the body is said to be at rest.

Examples : A lamp post, a table in a room.

(ii) When a body changes its position with respect to the surroundings, the body is said to be in motion.

Examples : Running horse, speeding car.

2. *By giving an example prove rest and motion are relative terms.*

Ans. A person sitting at the back seat of a moving car is at rest with respect to the internal surroundings of car. However, same person is in motion as his position with respect to external surrounding of the car changes. Thus, rest and motion are relative terms with respect to surroundings.

3. *By giving three examples define the following : (a) Scalar quantity (b) Vector quantity.*

Ans. (a) The quantities which are expressed only in terms of magnitude but not direction are called scalar quantities.

Examples of scalar quantities : Mass, length, time, speed, density, temperature, area, volume, energy, work, power, pressure etc.

(b) The quantities which are expressed in terms of magnitude as well as direction are called vector quantities.

Examples of vector quantities : Displacement, velocity, acceleration, retardation, momentum, force, etc.

4. *Pick out the scalar and vector quantities from the following list :*
(i) Mass (ii) Displacement (iii) Density
(iv) Distance (v) Momentum (vi) Acceleration
(vii) Temperature (viii) Time (ix) Force (x) Pressure

Ans. **Scalar quantities :** Mass, density, distance, temperature, time, pressure.
Vector quantities : Displacement, momentum, acceleration, force.

5. **(a)** *What do you understand by the terms distance and displacement?*
(b) *State their C.G.S. and S.I. units.*
(c) *Give two differences between distance and displacement.*

Ans. **(a)** The length of path moved by a moving body in a certain time is called distance and the shortest distance between the initial and final position of a body in a specified direction is called displacement.
(b) **Centimetre** is the unit in C.G.S. system and metre in S.I. system for both.
(c) Distance is actual length of path covered and is a scalar quantity.
Displacement is the shortest distance in a specified direction and is a vector quantity.

6. **(a)** *Define (i) speed (ii) velocity.*
(b) *State the units of above in C.G.S. and S.I. system.*
(c) *Give two differences between speed and velocity.*

Ans. **(a)** (i) **Speed :** Rate of change of distance is called speed.
(ii) **Velocity :** The rate of change of displacement of a body is called its velocity.
(b) cms^{-1} in C.G.S. system and ms^{-1} in S.I. system are the units of speed as well as velocity.
(c) **(i)** In speed, direction is not specified, but in velocity, direction is specified.
(ii) Speed is a scalar quantity, but velocity is a vector quantity.

7. *By giving one example each define (i) uniform velocity (ii) variable velocity (iii) average velocity.*

Ans. (i) **Uniform velocity** : When a body covers equal distances in equal intervals of time (however small may be the time intervals) in a specified direction, the body is said to have uniform velocity. Light energy travels at a uniform velocity of 3×10^8 ms^{-1}.

(ii) **Variable velocity** : When a body covers unequal distances in equal intervals of time in specified direction or equal distances in equal intervals of time, but, its direction changes the body is said to be moving with variable velocity. A train starting from a station has variable velocity.

(iii) **Average velocity :** The average distance travelled by a body per unit time in a specified direction, when body is actually moving with a variable velocity. If a train starts from rest, moves along a straight path with uniform velocity and finally stops then average velocity is equal to total distance covered by train, divided by total time taken.

8. **(a)** *Define the term acceleration.*

(b) *When is acceleration (i) positive? (ii) negative?*

(c) *State the unit of acceleration in C.G.S. and S.I. systems.*

Ans. **(a)** **Acceleration** : The rate of change of velocity (when velocity is increasing), is called acceleration

(b) **(i)** When the velocity is increasing with time, acceleration is positive.

(ii) When the velocity is decreasing with time, acceleration is negative.

(c) **cms^{-2}** in C.G.S. system and ms^{-2} in S.I. system are units of acceleration.

9. **(a)** *Define acceleration due to gravity?*
(b) *State its value in C.G.S. and S.I. system.*
(c) *When is acceleration due to gravity (i) positive? (ii) negative?*

Ans. **(a)** **Acceleration due to gravity (g)** : The acceleration of freely falling body under the action of gravity of the earth is called acceleration due to gravity. Its average value is 980 cms^{-2} or 9.80 ms^{-2}

(b) Its average value is 980 cms^{-2} in C.G.S. system and 9.80 ms^{-2} in S.I. system.

(c) **(i)** When a body falls towards the earth, the acceleration due to gravity is positive.
(ii) When a body moves away from the earth, the acceleration due to gravity is negative.

10. *Give an example of a body which covers a certain distance but its displacement is zero.*

Ans. When a body moves along a circular path, such that it reaches the starting point after a certain interval of time, it covers a distance equal to the circumference of circular path, but its displacement is zero, because the distance between initial and final position of body is zero.

11. *Give an example of an accelerated body, moving with uniform speed. Explain your answer.*

Ans. A dust particle which lies on the circumference of a revolving rim of a bicycle has a uniform speed. However, as the direction of motion of particle continuously changes, it has a variable velocity and hence has an acceleration.

12. *Does the value of acceleration due to gravity remains the same at all places of earth ? Explain your answer.*

Ans. No, value of acceleration due to gravity changes from place to place. It is maximum at poles and decreases, if the body is moved towards equator.

13. *Pick out the correct answers :*

(a) *A ball is projected vertically upward rises to a height x and then returns back to thrower in time t.*

(i) *The average velocity of ball is* $\frac{2x}{t}$.

(ii) *The acceleration of ball is zero.*

(iii) *The initial speed of ball is half than final speed.*

(iv) *Displacement of ball is zero.*

(b) *Unit for acceleration is* (i) ms^{-1} (ii) m (iii) ms^{-2} (iv) ms^{2}.

Ans. (a) Displacement of ball is zero. (b) Unit for acceleration is ms^{-2}.

14. *What is the relation between distance and time, when :*

(i) *body is moving with a uniform velocity?*

(ii) *body is moving with variable velocity?*

Ans. (i) The distance covered by a body is directly proportional to time.

(ii) The distance covered by a body is not directly proportional to time.

15. *The Shatabadi Express covers a distance of 450 km in 5 hr between Amritsar and Delhi. What is average speed of train in* (i) $km\ hr^{-1}$ *(ii)* ms^{-1}.

Ans. Distance between Amritsar and Delhi (s) = 450 km.

Time for journey (t) = 5 hr.

(i) ∴ Speed of train $= \frac{s}{t} = \frac{450\text{ km}}{5\text{ hr}} = \mathbf{90\ km\ hr^{-1}}$.

(ii) ∴ Speed of train in $ms^{-1} = 90 \times \frac{5}{18}\ ms^{-1} = \mathbf{25\ ms^{-1}}$.

16. *An athlete runs around a circular path of circumference 360 m in 1 minute and reaches the starting point. Calculate (i) distance covered by the athlete (ii) displacement (iii) average speed (iv) average velocity.*

Ans. *(i)* Distance covered = Length of path travelled along circumference = **360 m.**

(ii) Displacement = zero. It is because the athelete reaches back at the initial point.

(iii) Average speed = $\frac{s}{t} = \frac{360 \text{ m}}{60 \text{ s}} = \mathbf{6\ ms^{-1}}$**.**

(iv) Average velocity = $\frac{\text{Displacement}}{\text{Time}} = \frac{0}{60 \text{ s}} =$ **zero.**

17. *A train takes 80 minutes to travel from station P to Q and 40 minutes to return from Q to P. If the distance between P to Q is 60 km, calculate (i) average speed (ii) average velocity of train.*

Ans. **(i)** Total distance between P and Q on both ways journey

$= 2 \times 60 = 120$ km.

Total time for journey = $(40 + 80) = 120$ min = 2 hr.

$\therefore$ Average speed of train $= \frac{s}{t} = \frac{120 \text{ km}}{2 \text{ hr}} = \mathbf{60\ km\ hr^{-1}}$**.**

(ii) As the train reaches back to its initial position, therefore, displacement is zero.

$\therefore$ Average velocity = $\frac{\text{Displacement}}{\text{Time}} = \frac{0}{2 \text{ hr}} =$ **zero.**

18. *A car covers 90 km in 1.5 hours towards east. Calculate (i) displacement of car (ii) velocity of car in (a) km hr^{-1} (b) ms^{-1}.*

Ans. (i) Displacement of car = Distance covered towards east

= **90 km – east**.

(ii) (a) Velocity of car $= \dfrac{\text{Displacement}}{\text{Time}} = \dfrac{90 \text{ km}}{1.5 \text{ hr}}$

$= 60 \text{ km hr}^{-1}$ – east.

(b) Velocity of car in $ms^{-1} = 60 \times \dfrac{5}{18} = \dfrac{150}{9}$

$= 16.67 \text{ ms}^{-1}$ – east.

19. *A race horse runs straight towards north and covers 540 m in one minute. Calculate (i) displacement of horse (ii) velocity in (a) ms^{-1} (b) $kmhr^{-1}$.*

Ans. (i) Displacement of horse = Distance covered towards north

= 540m – north.

(ii) (a) Velocity of horse $= \dfrac{\text{Displacement}}{\text{Time}} = \dfrac{540}{60\text{s}} = 9 \text{ ms}^{-1}$ – north.

(b) Velocity of horse in km $hr^{-1} = 9 \times \dfrac{18}{5} = \dfrac{162}{5}$

$= 32.4 \text{ km hr}^{-1}$ – north.

20. *The change in velocity of 54 km hr^{-1} takes place in one minute for a motor bike. Calculate acceleration in (i) $kmhr^{-2}$ (ii) ms^{-2}.*

Ans. (i) Acceleration $= \dfrac{\text{Change in velocity}}{\text{Time}}$

$$= \frac{54 \text{ km hr}^{-1}}{1 \text{ min}} = \frac{54 \text{ km hr}^{-1}}{\frac{1}{60} \text{ hr}} = 54 \times 60 \text{ km hr}^{-2} = 3240 \text{ km hr}^{-2}.$$

(ii) $\therefore$ Acceleration in $ms^{-2} = \dfrac{3240 \times 100 \text{ m}}{3600\text{s} \times 3600\text{s}} = \mathbf{0.25\ ms^{-2}}$.

21. *A body starts from rest and picks up a velocity of 15 ms^{-1} in 3 s. Find the acceleration in (i) ms^{-2} (ii) km hr^{-2}.*

Ans. (i) Change in velocity = (15 – 0) = 15 ms^{-1}

Time = 3 s.

$$\therefore \quad \text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}} = \frac{15\ ms^{-1}}{3s} = \mathbf{5\ ms^{-2}}.$$

(ii) Acceleration in km hr^{-2} $= \frac{5}{1000} \times \frac{3600 \times 3600}{1 \times 1}$ km hr^{-2}

$= \mathbf{64800\ km\ hr^{-2}}$.

22. A speeding car slows down from 108 km hr^{-1} to 36 km hr^{-1} in 4 s. Calculate de-acceleration in (i) ms^{-2} (ii) km hr^{-2}.

Ans. (i) Change in velocity = (36 –108) = – 72 km hr^{-1}

$$= -72 \times \frac{5}{18} = -20\ ms^{-1}$$

Time = 4 s

$$\therefore \quad \text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}} = \frac{-20\ ms^{-1}}{4s} = \mathbf{-5\ ms^{-2}}.$$

$\therefore$ Deacceleration = – (a) = – (– 5ms^{-2}) = 5 ms^{-2}.

(ii) $\therefore$ Deacceleration in km hr^{-2} $= -\frac{5}{1000} \times \frac{3600 \times 3600}{1 \times 1}$ km hr^{-2}

$= \mathbf{-64800\ km\ hr^{-2}}$.

$\therefore$ Deacceleration = – (a) = – (– 64800 kmhr^{-2}) = **64800 km hr^{-2}.**

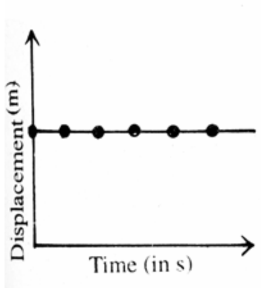
23. *Draw displacement-time graphs in the following situations :*

(i) *When the body is stationary.*

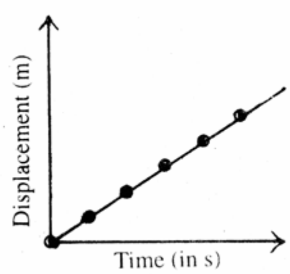
(ii) *When the body is moving with a uniform velocity.*

(iii) *When the body is moving with variable velocity.*

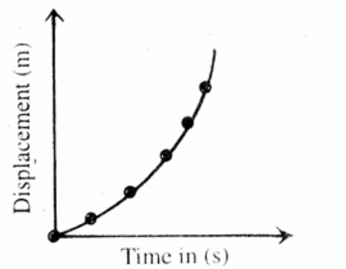
Ans.



(i) For stationary body



(ii) For a body moving With a uniform velocity



(iii) For a body moving with variable velocity

24. *Draw the velocity-time graph for following situations :*

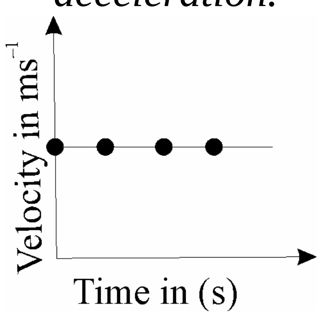
(i) *When a body is moving with a uniform velocity.*

(ii) *When a body is moving with variable velocity, but uniform acceleration.*

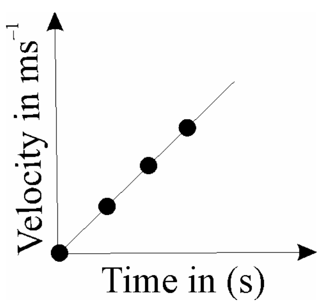
(iii) *When a body is moving with variable velocity and uniform retardation.*

(iv) *When a body is moving with variable velocity and variable acceleration.*

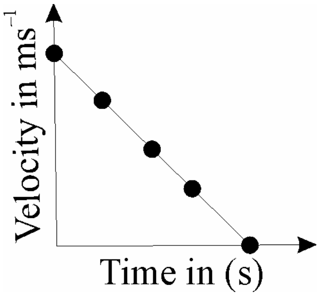
Ans.



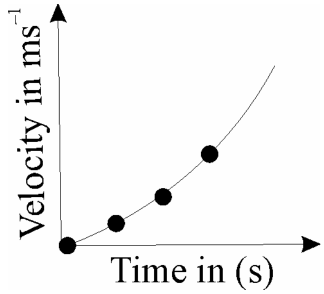
(i) For uniform velocity



(ii) For variable velocity, but uniform acceleration



(iii) For variable velocity and uniform retardation



(iv) For variable velocity and variable acceleration

25. *How can you calculate the following ?*

(i) Velocity from displacement-time graph.

(ii) Acceleration from velocity-time graph.

(iii) Displacement from velocity-time graph.

(iv) Velocity from acceleration-time graph.

Ans. (i) By finding the slope of graph, i.e.,

$$v = \frac{\Delta S}{\Delta t} \times \frac{\text{Change in displacement}}{\text{Time}}$$

(ii) By finding the slope of graph, i.e.,

$$a = \frac{\Delta v}{\Delta t} \times \frac{\text{Change in velocity}}{\text{Time}}$$

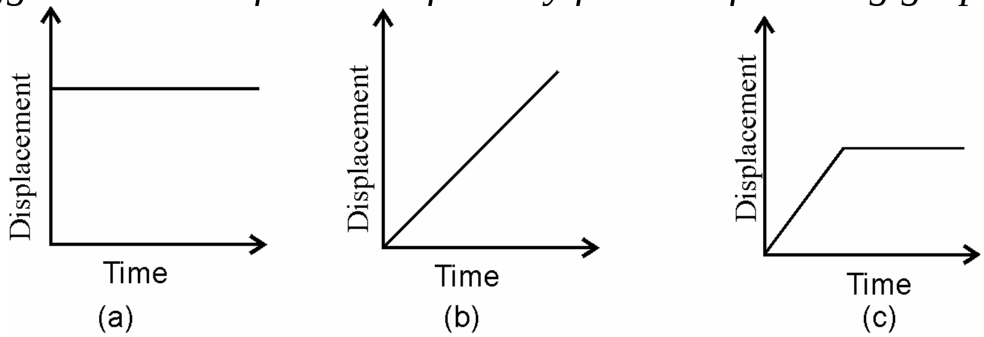
(iii) By finding area under the graph line i.e.,

$$S = \Delta v \times \Delta t = \text{Change in velocity} \times \text{Time.}$$

(iv) By finding the area under the graph line, i.e., $V = \Delta a \times \Delta t$

$$= \text{Change in acceleration} \times \text{Time.}$$

26. *Suggest the kind of motion of a body from the following graphs :*

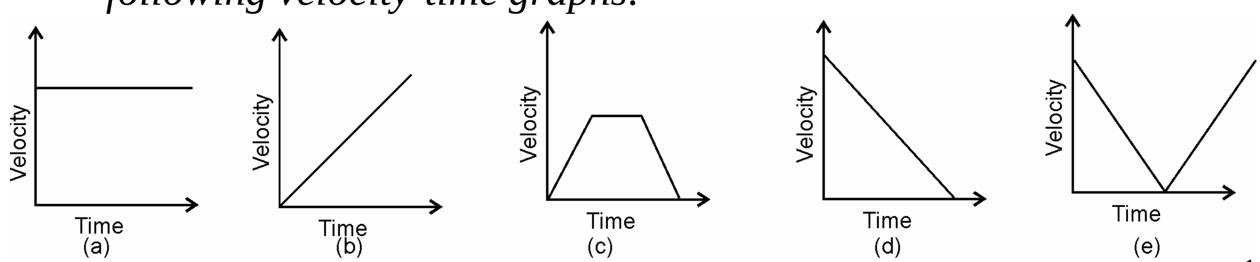


Ans. (a) Body is stationary.

(b) Body is moving with a uniform velocity.

(c) Initially the body moves with a uniform velocity and then suddenly stops.

27. *Suggest real life examples about the motion of body from the following velocity-time graphs:*



Ans. (a) A train heading straight towards east with a velocity of 20 ms^{-1} (say).

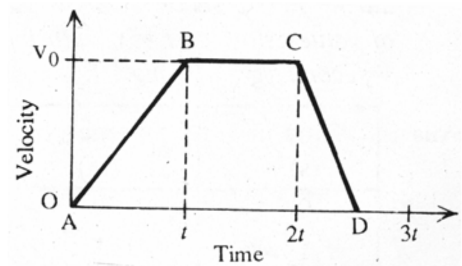
(b) A freely falling stone under the action of gravity.

(c) An electric train starts from a station, picks up velocity, then moves with a uniform velocity and finally is brought to rest by a uniform retarding force.

(d) A motor bike running at uniform velocity is brought to rest by uniform retarding force of brakes.

(e) A stone projected vertically upward returns back to the thrower.

28. *Diagram shows a velocity-time graph for a car starting from rest. The graph has three sections AB, BC and CD.*



(a) *From the study of graph, state how the distance travelled in any section is determined.*

(b) *In which section the car has zero acceleration?*

(c) *Is the magnitude of acceleration higher or lower than that of retardation? Give a reason.*

Ans. (a) The distance travelled under any section is calculated by finding the area of that section.

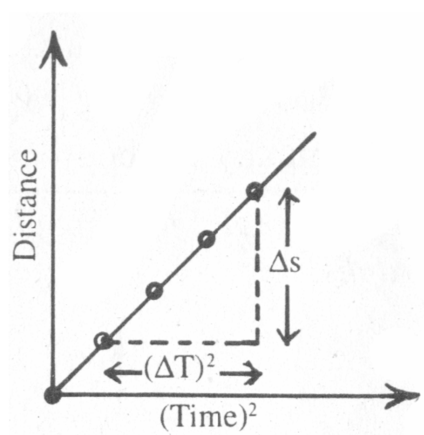
(b) In section BC, the car has zero acceleration.

(c) Magnitude of acceleration is lower than retardation.

The magnitude of acceleration = Slope of AB = $\frac{v_0}{t}$

The magnitude of retardation = Slope of CD = $\frac{v_0}{\frac{1}{2}}\ \frac{2v_0}{t}$.

29. *A body falls freely downward from a certain height. Show graphically the relation between the distance fallen and square of time. How will you determine 'g' from the graph.*



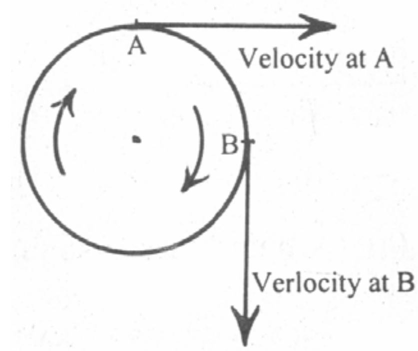
Ans. In order to find acceleration due to gravity, slope of graph is calculated.

Slope = $\frac{\Delta s}{(\Delta t)^2} = \frac{s}{t^2}$

The acceleration due to gravity is given by the expression

$g = 2 \times \text{Slope} = \frac{2s}{t^2}$

30. *Draw a diagram to show the motion of a body whose speed remains constant, but velocity changes continuously.*

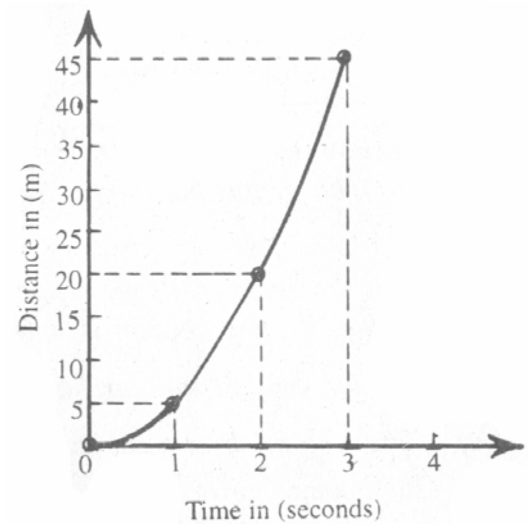


Ans. A body moving around a circular path has a uniform speed (such as revolving ceiling fan), but has a variable velocity because its direction continuously changes.

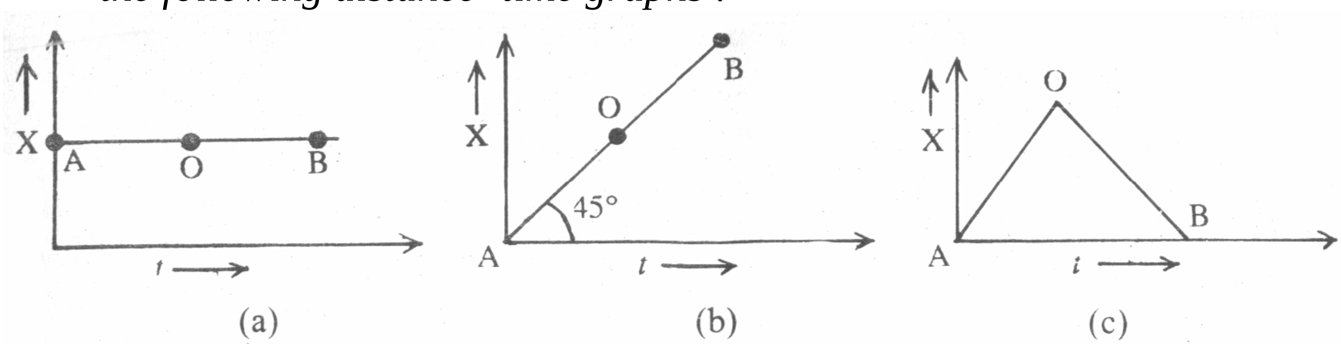
31. *A body at rest is thrown downward from the top of a tower. Draw a distance time-graph for its free fall under gravity during first 3 seconds. Show your table of values starting t = 0 with interval of 1 second [g = 10 ms^{-2}].*

Ans.

Time in (s)	Distance in (m)
0	0
1	5
2	20
3	45



32. *Write down the type of motion of a body during A – O –B in each of the following distance- time graphs :*



Ans. (a) The body is stationary from A to O and O to B.

(b) The body is moving with a uniform velocity from A to O and then from O to B :

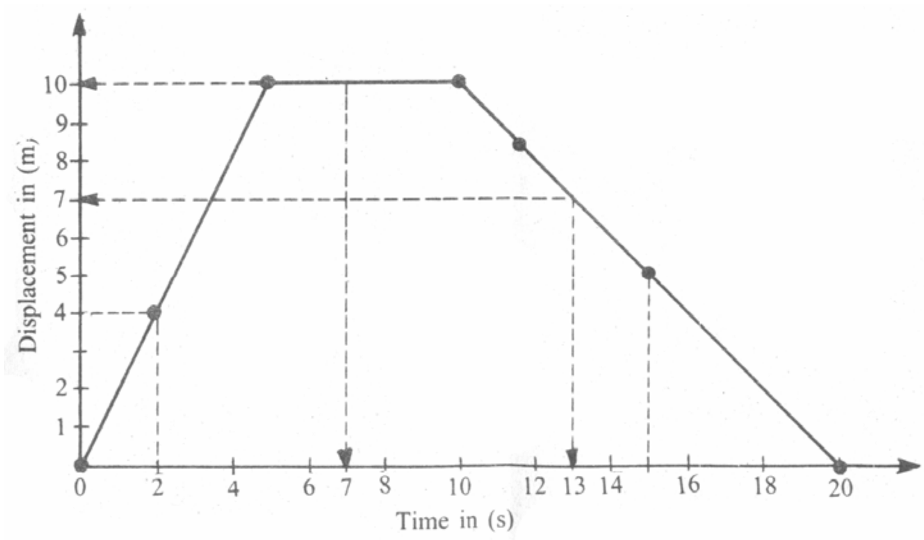
(c) The body is moving with a uniform velocity from A to O, away from origin. It then moves towards origin from O to B, with a uniform velocity.

33. *An object covers a distance S in time t as follows.*

S (metres)	0	4	10	10	8	5	0
t (seconds)	0	2	5	10	12	15	20

Plot a graph, taking t on x- axis. and S on y-axis. Determine displacement of object at time (i) 7 s. (ii) 13 s.

Ans.



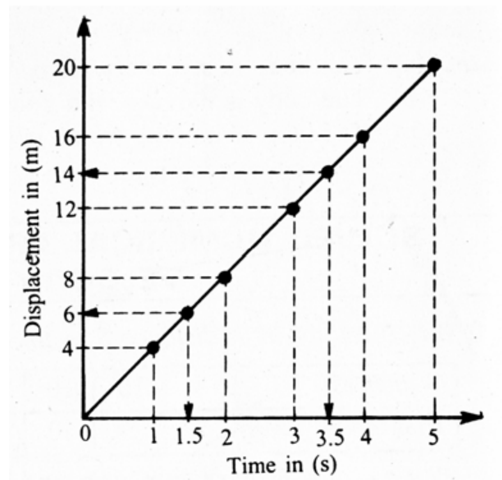
(i) Displacement after 7 seconds is 10m.

(ii) Displacement after 13 seconds is 7m.

34.

Displacement (m)	0	4	8	12	16	20
Time (s)	0	1	2	3	4	5

From the displacement-time table given above draw a graph choosing a suitable scale. From the graph calculate (i) average velocity (ii) displacement between 1.5 s and 3.5 s.



Ans. (i) Average velocity = $\frac{\text{Total displacement}}{\text{Total time}}$

$= \frac{20\text{ m}}{5\text{ s}} = \mathbf{4\ ms^{-1}}$.

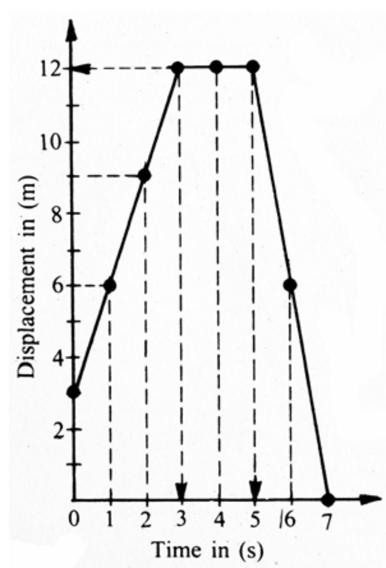
(ii) Displacement between 1.5 s and 3.5 s

= (14 m – 6 m) = **8 m**.

35.

Displacement (m)	3	6	9	12	12	12	6	0
Time (s)	0	1	2	3	4	5	6	7

From the table given above plot a displacement-time graph.
From the graph calculate :
(i) Average velocity between 0 – 3 s.
(ii) Average velocity between 3 s – 5 s.
(iii) Average velocity between 5 s – 7 s.



Ans. (i) Average velocity between 0 – 3 *s*.

$= \frac{9\text{ m}}{3\text{ s}} = \mathbf{3\ ms^{-1}}$.

(ii) Average velocity between 3 s –5 s

$= \frac{0\text{ m}}{2\text{ s}} = 0\text{ ms}^{-1}$.

(iii) Average velocity between 5 s – 7 s.

$$= \frac{0 - 12\text{ m}}{2\text{ s}} = \mathbf{-6\ ms^{-1}}.$$

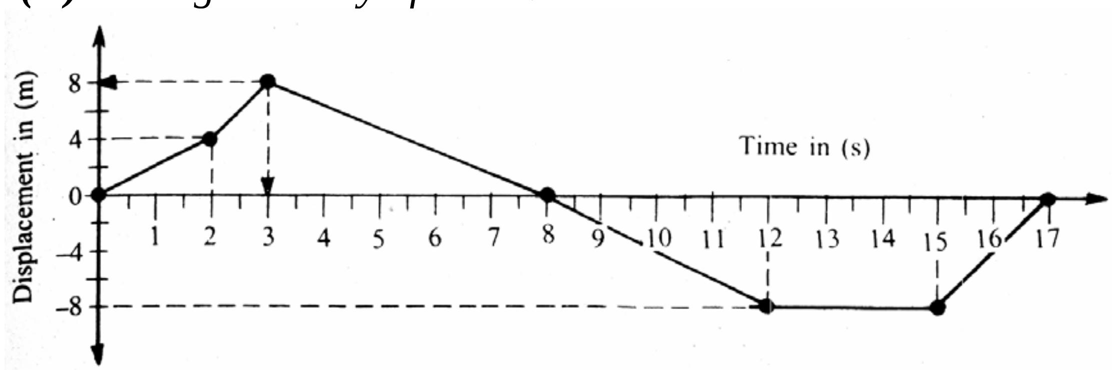
36. *From the displacement–time graph shown below calculate :*

(i) Average velocity in first three seconds.

(ii) Displacement from initial position at the end of 13 s.

(iii) Time after which body is at initial position.

(iv) Average velocity after 8 s.



Ans. (i) Average velocity in first 3s

$$= \frac{(8 - 0)\text{ m}}{3\text{ s}} = \frac{8}{3}\text{ ms}^{-1} = 2.67\text{ ms}^{-1}.$$

(ii) Displacement from initial to final position in 13 s = – 8 m.

(iii) Time after which body is at its initial position = 8 s and 17 s.

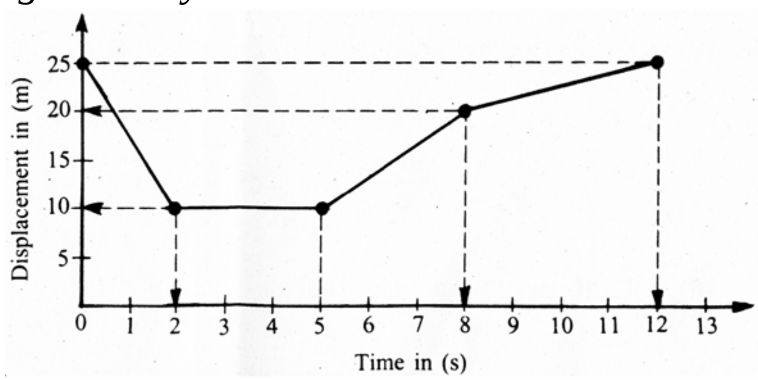
(iv) Average velocity after 8 s = $\frac{0\text{ m}}{8\text{ s}}$ = Zero.

37. *From the displacement–time graph shown below calculate :*

(i) Velocity between 0 – 2 s.

(ii) Velocity between 8 s – 12 s

(iii) Average velocity between 5 s — 12 s.



Ans. (i) Velocity between 0–2*s*

$$= \frac{(10 - 25)\text{ m}}{2\text{ s}} = -\frac{15}{2} = \mathbf{-7.5\ ms^{-1}}.$$

(ii) Velocity between 8 s –12 *s*

$$= \frac{(25 - 20)\text{ m}}{4\text{ s}} = \frac{5}{4}\text{ ms}^{-1} = \mathbf{1.25\ ms^{-1}}.$$

(iii) Average velocity between 5 s – 12*s*

$$= \frac{(25 - 10)\text{ m}}{7\text{ s}} = \frac{15}{7} = \mathbf{2.14\ ms^{-1}}.$$

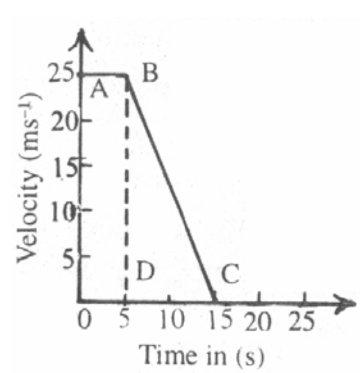
38. *A car travels at a uniform velocity of 25 ms^{-1} for 5 s. The brakes are then applied and car comes to rest with a uniform retardation in further 10 s. Draw a graph of velocity vs. time. From the graph find out distance which the car travels, after brakes are applied. Calculate the value of retardation.*

Ans. Distance travelled after the application of brakes

= Area of DBDC

$$= \frac{1}{2} \times BD \times DC = \frac{1}{2} \times 25\text{ ms}^{-1} \times 10\text{ s}$$

= **125 m.**



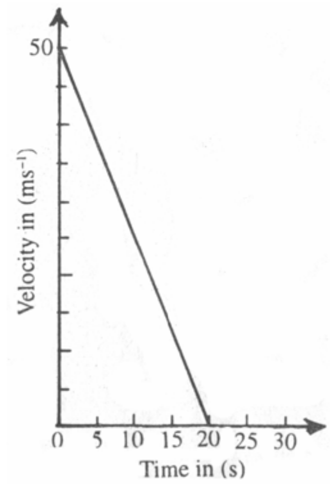
Retardation = Slope of BC

$$= \frac{BD}{DC} = \frac{25ms^{-1}}{10s}$$

$= \mathbf{2.5\ ms^{-2}}$.

39. *A racing car is moving with a velocity of 50 ms^{-1}. On applying brakes, it uniformly retards and comes to rest in 20 s. Draw a velocity-time graph and calculate :*

(i) Acceleration (ii) Distance covered by car.



Ans. (i) Acceleration $= \frac{v_f - v_i}{t}$

$= \frac{(0 - 50)\ ms^{-1}}{20\ s} = \mathbf{-2.5\ ms^{-2}}$.

(ii) Distance = Area under triangle

$= \frac{1}{2} \times 50\ ms^{-1} \times 20\ s.$

$= \mathbf{500\ m.}$

40.

Velocity in (ms^{-1})	20	20	10	20	0
Time in (seconds)	0	5	7	10	15

The table above shows the velocity of a motor bike at various intervals of time.

(i) *Plot the velocity-time graph.*

(ii) *Calculate de-acceleration between* 5 s – 7 s.

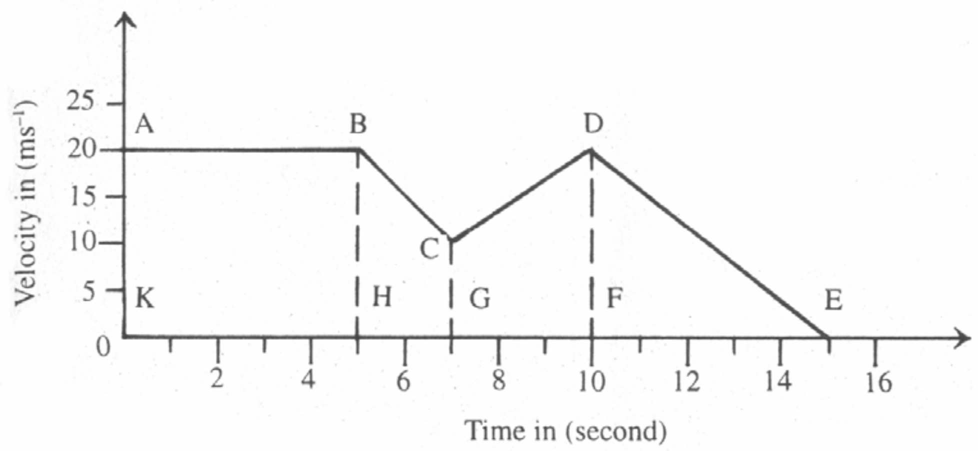
(iii) *Calculate acceleration between* 7 s *and* 10 s.

(iv) *Calculate de-acceleration between* 10 s *and* 15 s.

(v) *Total distance travelled by motor-bike.*

(vi) *Average velocity of motor bike.*

Ans. (i) The graph is shown below.



(ii) De-acceleration between 5 s – 7 s $= \dfrac{(10-20)\ \text{ms}^{-1}}{2\text{s}}$

$= \mathbf{-5\ ms^{-2}}$.

(iii) Acceleration between 7 s – 10 s $= \dfrac{(10-20)\ \text{ms}^{-1}}{3\text{s}}$

$= \mathbf{3.33\ ms^{-2}}$**.**

(iv) De-acceleration between 10 s – 15s $= \dfrac{(0-20)\ \text{ms}^{-1}}{5\text{s}}$

$= \mathbf{-4\ ms^{-2}}$**.**

(v) Total distance travelled

= Area of ABHK + Area of trapezium BCGH + Area of trapezium CGFD + Area of ΔDFE.

$= 20\ \text{ms}^{-1} \times \dfrac{1}{2}\ 5\ \text{s} + (20+10)\ \text{ms}^{-1} \times 2\ \text{s} + \dfrac{1}{2} + (10+20)$

$\text{ms}^{-1} \times 3\ \text{s} + \dfrac{1}{2} \times 20\ \text{ms}^{-1} \times 5\ \text{s}$

= 100 m + 30 m + 45 m + 50 m = **225 m**.

(vi) Average velocity of motor bike $= \dfrac{\text{Total distance}}{\text{Total time}}$

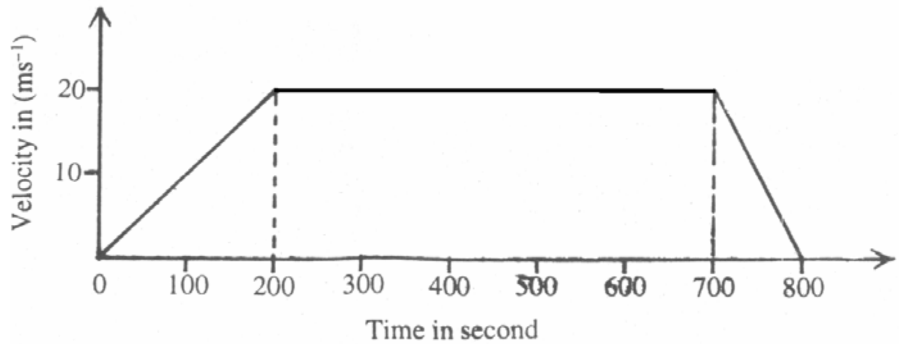
$= \dfrac{225\ \text{m}}{15\ \text{s}} = \mathbf{15\ ms^{-1}}$.

41. *A train starting from rest, picks up a speed of 20 ms–1 in 200 s. It continues to move at the same rate for the next 500 s and then brought to rest in another 100 s.*

(i) *Plot a speed-time graph.*

(ii) *From the graph calculate : (a) uniform rate of acceleration (b) uniform rate of retardation (c) total distance covered before stopping (d) average speed.*

Ans. (i) The graph is shown below :



(ii) (a) Acceleration $= \dfrac{v_f - v_i}{t} = \dfrac{(20 - 0)\ ms^{-1}}{200s} = \mathbf{0.1\ ms^{-2}}$.

(b) De-aceleration $= \dfrac{v_f - v_i}{t} = \dfrac{(20 - 0)\ ms^{-1}}{100s} = \mathbf{-\ 0.2\ ms^{-2}}$.

(c) Total distance $= \dfrac{1}{2}$ (200 × 20 × 500 + $\dfrac{1}{2}$ (100 + 20)

= 2000 + 10000 + 1000 = **13,000 m.**

(d) Average speed $= \dfrac{13,000m}{800s} = \mathbf{16.25\ ms^{-1}}$.

42. *A ball is thrown vertically upwards, returns back to the thrower in 6s. Assuming there is no air friction, plot a velocity -time graph. From the graph calculate :*

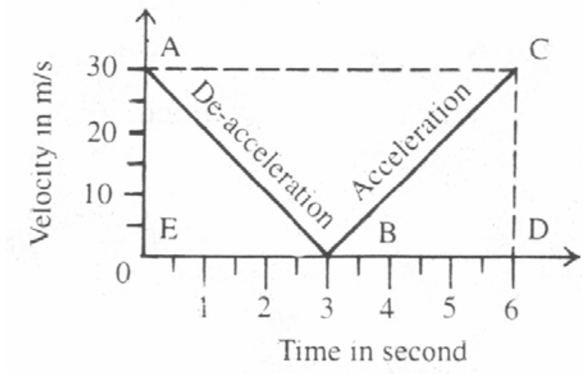
(i) *De-acceleration* ***(ii)*** *Acceleration*

(iii) *Total distance covered by ball* ***(iv)*** *Average velocity.*

Ans. (i) De-acceleration $= \dfrac{v_f - v_i}{t}$

$= \dfrac{(0 - 30)\ ms^{-1}}{3\ s}$

$= \mathbf{-10\ ms^{-2}}$.



(ii) Acceleration $= \dfrac{v_f - v_i}{t}$

$= \dfrac{(30 - 0)\ ms^{-1}}{3\ s}$

$= \mathbf{10\ ms^{-2}}$.

(iii) Total distance travelled = Area of ΔABE + Area of ΔBDC

$= \dfrac{1}{2} \times 30\ ms^{-1} \times 3\ s + \dfrac{1}{2} \times 30\ ms^{-1} \times 3\ s$

= 45 m + 45 m = **90 m.**

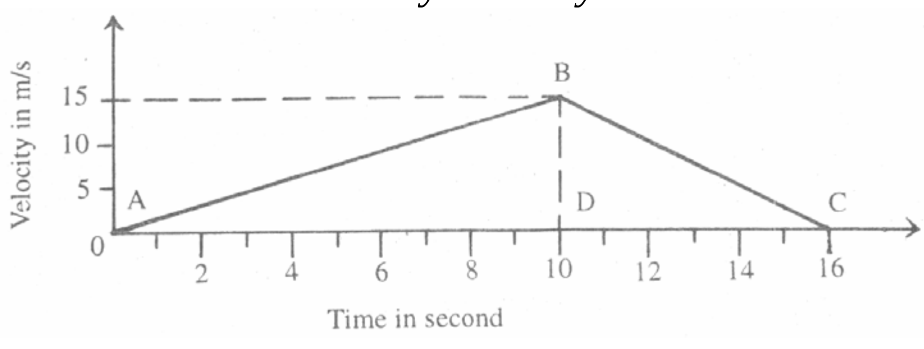
(iv) Average velocity $= \dfrac{\text{Total Distance}}{\text{Total time}} = \dfrac{90\ m}{6\ s} = \mathbf{15\ ms^{-1}}$.

43. *The diagram alongside is a velocity-time graph. From the graph calculate:*

(i) Acceleration of the body.

(ii) De-acceleration of the body.

(iii) Total distance covered by the body.



Ans. (i) Acceleration $= \dfrac{v_f - v_i}{t} = \dfrac{(15 - 0)\ ms^{-1}}{10\ s} = \dfrac{15}{10}\ ms^{-2}$

$= \mathbf{1.5\ ms^{-2}}$.

(ii) De-acceleration $= \dfrac{v_f - v_i}{t} = \dfrac{(0 - 15)\ ms^{-1}}{10\ s} = \dfrac{15}{6}\ ms^{-2}$

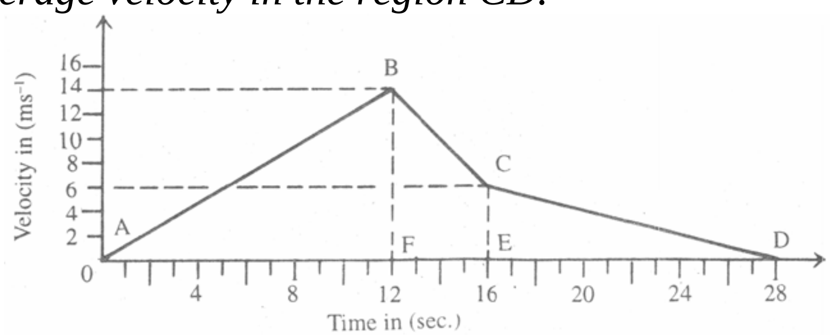
$= \mathbf{-2.5\ ms^{-2}}$.

(iii) Total distance covered = Area of ΔABD + Area of ΔBDC.

$= \dfrac{1}{2} \times 15\ ms^{-1} \times 10\ s + \dfrac{1}{2} \times 15\ ms^{-1} \times 6\ s$

$=$ 75 m + 45 m = **120 m**.

44. *The diagram alongside shows a velocity-time graph.*
From the graph calculate:
(i) Acceleration in the region AB.
(ii) De-acceleration in the region BC.
(iii) Distance covered in the region ABCE.
(iv) Average velocity in the region CD.



Ans. (i) Acceleration in region AB $= \dfrac{v_f - v_i}{t} = \dfrac{(14 - 0)\ ms^{-1}}{12\ s}$

$= \mathbf{1.16\ ms^{-2}}$.

(ii) De-aceleration in region BC $= \dfrac{v_f - v_i}{t} = \dfrac{(6 - 14)\ ms^{-1}}{4\ s} =$

$= \dfrac{-8\ ms^{-1}}{4\ s} = \mathbf{-2\ ms^{-2}}$.

(iii) Distance covered in region ABCE = Area of ΔAFB + Area of trapezium BFEC

$= \frac{1}{2} \times 14\ ms^{-1} \times\ 12\ s + \frac{1}{2} \times (14 + 6)\ ms^{-1} \times 4\ s$

$= 84\ m + 40\ m$

$=$ **124 m**.

(iv) Average velocity in region CD

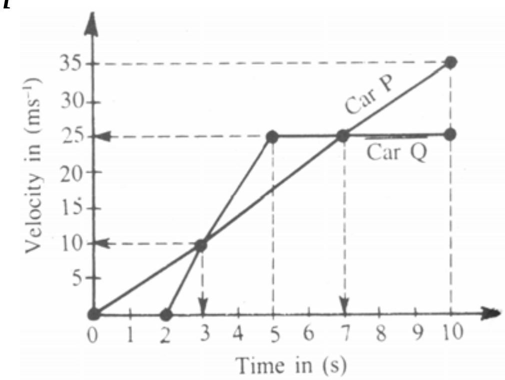
$= \frac{\text{Distance covered}}{\text{Time}} = \frac{\frac{1}{2} \times 6\ ms^{-1} \times 12\ s}{12\ s} = \mathbf{3\ ms^{-1}}.$

45. *Figure alongside shows a velocity-time graph for two cars P and Q, starting from the same point in same direction. Calculate :*

(i) Acceleration of car P.

(ii) Acceleration of car Q, between 2 s – 5 s.

(iii) At what time intervals, both cars have same velocity ?



(iv) Which car is ahead after 10 s and how much ?

Ans. (i) Acceleration of car P = $\frac{v_f - v_i}{t} = \frac{(35 - 0)\ ms^{-1}}{10\ s} = \mathbf{3.5\ ms^{-2}}.$

(ii) Acceleration of car Q = $\frac{v_f - v_i}{t} = \frac{(25 - 0)\ ms^{-1}}{3\ s} = \mathbf{8.33\ ms^{-2}}.$

(iii) (a) After 3 s when velocity is 10 ms^{-1}.

(b) After 7 s when velocity is 25 ms^{-1}.

(iv) Distance travelled by car P = $\frac{1}{2} \times 35\ ms^{-1} \times 10\ s = 175\ m$

Distance travelled by car Q = $\frac{1}{2} \times\ 25 \times 3 + 25 \times 5$

$$= \frac{1}{2}(3 + 10)\ s \times 25\ ms^{-1} = 162.5\ m$$

$\therefore$ **Car P is ahead by (175 – 162.5) = 12.5 m**

46. *A motor bike, initially at rest, picks up a velocity of 72 km hr^{-1} over a distance of 40 m. Calculate (i) acceleration (ii) time in which it picks up the above velocity.*

Ans. u = 0; v = 72 km hr^{-1} = 20 ms^{-1}; S = 40 m; a = ? t = ?

(i) Applying, $v^2 - u^2 = 2aS$.

$$(20)^2 - (0)^2 = 2 \times a \times 40$$

$$\therefore \quad a = \frac{400}{80} = 5\ ms^{-2}.$$

(ii) Applying, $v = u + at$

$$20 = 0 + 5 \times t$$

$$\therefore \quad t = \frac{20}{5} = \mathbf{4\ s}.$$

47. *A cyclist driving at 5 ms–1, picks up a velocity of 10 ms^{-1}, over a distance of 50 m. Calculate (i) acceleration (ii) time in which the cyclist picks up the above velocity.*

Ans. u = 5 ms^{-1}; v = 10 ms^{-1}; S = 50 m; a = ? t = ?

(i) Applying, $v^2 - u^2 = 2aS$.

$$(10)^2 - (5)^2 = 2 \times a \times 50$$

$$\text{or } 75 = 100a$$

$$\therefore \quad a = \mathbf{0.75\ ms^{-2}}.$$

(ii) Applying, $v = u + at$

$$10 = 5 + 0.75 \times t$$

$$\therefore \quad t = \frac{5}{0.75} = \mathbf{6.67\ s.}$$

48. *An aeroplane lands at 216 km hr^{-1} and stops after covering a runway of 2 km. Calculate (i) acceleration (ii) time in which it comes to rest.*

Ans. u = 216 km hr^{-1} = 60 ms^{-1}; v = 0; S = 2 km = 2000 m; a = ? t = ?

(i) Applying, $v^2 - u^2 = 2aS$.

$$(0)^2 - (60)^2 = 2 \times a \times 2000$$

$$\therefore \quad a = \frac{-3600}{4000} = \mathbf{-0.90\ ms^{-2}}.$$

(ii) Applying, $v = u + at$

$$0 = 60 \times 0.90 \times t$$

$$\therefore \quad 0.90t = 60 \quad \text{or} \quad t = \frac{60}{0.90} = \mathbf{66.67\ s}.$$

49. *A truck running at 90 km hr^{-1} is brought to rest over a distance of 25 m. Calculate the retardation and time for which brakes are applied.*

Ans. u = 90 km hr^{-1} = 25 ms^{-1}; v = 0; S = 25 m a = ? t = ?

Applying, $v^2 - u^2 = 2aS$.

$$(0)^2 - (25)^2 = 2 \times a \times 25$$

$$\therefore \quad a = \frac{625}{50} = -12.5\ ms^{-2}$$

$\therefore$ Retardation = – (acceleration) = – (–12.5 ms^{-2}) = **12.5 ms^{-2}**

Applying, $v = u + at$

$$0 = 25 - 12.5 \times t$$

$$\therefore \quad 12.5\,t = 25 \text{ or } t = 2 \text{ s}.$$

50. *A racing car, initially at rest, picks up a velocity of 180 km hr^{-1} in 4.5 s. Calculate (i) acceleration (ii) distance covered by car.*

Ans. u = 0; v = 180 km hr^{-1} = 50 ms^{-1}; t = 4.5 s; a = ? S = ?

(i) Applying, $v = u + at$

$$50 = 0 + a \times 4.5$$

$$\therefore \quad a = \frac{50}{4.5} = \mathbf{11.11\ ms^{-2}}.$$

(ii) Applying, $v^2 - u^2 = 2aS$.

$$(50)^2 - (0)^2 = 2 \times \frac{50}{4.5} \times S$$

$$\therefore \quad S = \frac{50 \times 50 \times 4.5}{2 \times 50} = \mathbf{112.5\ m}.$$

51. *A motor bike running at 5 ms^{-1}, picks up a velocity of 30 ms^{-1} in 5 s. Calculate (i) acceleration (ii) distance covered during acceleration.*

Ans. u = 5 ms^{-1}; v = 30 ms^{-1}; t = 5 s; a = ? S = ?

(i) Applying, $v = u + at$

$$30 = 5 + a \times 5$$

$$\therefore \quad 5a = 25 \quad \text{or} \quad a = \mathbf{5\ ms^{-2}}.$$

(ii) Applying, $v^2 - u^2 = 2aS$.

$$(30)^2 - (5)^2 = 2 \times 5 \times S$$

$$\therefore \quad 875 = 10\ S \quad \text{or} \quad S = \mathbf{87.5\ m}.$$

52. *A motor bike running at 90 km hr^{-1} is slowed down to 18 kmhr^{-1} in 2.5 s. Calculate (i) acceleration (ii) distance covered during the action of slowing down.*

Ans. u = 90 km hr^{-1} = 25 ms^{-1}; v = 18 km hr^{-1} = 5 ms^{-1}; t = 2.5 s; a = ? S = ?

(i) Applying, $v = u + at$

$$5 = 25 + a \times 2.5$$

$$\text{or} \quad -20 = 2.5a$$

$$\text{or} \quad a = -\frac{20}{2.5} = \mathbf{-8\ ms^{-2}}.$$

(ii) Applying, $v^2 - u^2 = 2aS.$

$$(5)^2 - (25)^2 = 2 \times -8 \times S$$

or $-600 = -16S$

$$\therefore \quad S = \frac{600}{16} = \mathbf{37.5\ m.}$$

53. *A cyclist driving the 36 km hr^{-1}, stops his mount in 2 s, by the application of brakes. Calculate the (i) retardation (ii) distance covered during the action of application of brakes.*

Ans. u = 36 km hr^{-1} = 10 ms^{-1}; v = 0; a = ? S = ? t = 2s.

(i) Applying, $v = u + at$

$$0 = 10 + a \times 2$$

$$\therefore \quad a = -\frac{-10}{2} = -5\ ms^{-2}$$

$$\therefore \quad \text{Retardation} = -(\text{acceleration})$$

$$= -(-5\ ms^{-2})$$

$$= \mathbf{5\ ms^{-2}}.$$

(ii) Applying, $v^2 - u^2 = 2aS.$

$$(0)^2 - (10)^2 = 2 \times (-5) \times S$$

$$\therefore \quad S = \frac{-100}{-10} = \mathbf{10\ m.}$$

54. *A motor bike running at 90 km hr^{-1} is slowed down to 54 km hr^{-1} by the application of brakes, over a distance of 40 m. If the brakes are applied with same force, calculate the*
(i) total distance travelled by the bike. (ii) total time in which bike comes to rest.

Ans. Case 1. u = 90 km hr^{-1} = 25 ms^{-1}; v = 54 km hr^{-1} = 15 ms^{-1};
S = 40 m; a = ?

Applying, $v^2 - u^2 = 2aS$

$$(15)^2 - (25)^2 = 2 \times a \times 40$$

or $80a = -400$

$$\therefore \quad a = -5\ ms^{-2}$$

Case 2. $u = 90\ km\ hr^{-1} = 25\ ms^{-1}$; $v = 0$; $S = ?$; $a = -5\ ms^{-2}$; $t = ?$

(i) Applying, $v^2 - u^2 = 2aS$

$$(0)^2 - (25)^2 = 2 \times -5 \times S$$

$$\therefore \quad S = \frac{-625}{-10} = \mathbf{62.5\ m}.$$

(ii) Applying, $v = u + at$

$$0 = 25 - 5 \times t$$

$$\therefore \quad 5t = 25 \quad \text{or} \quad t = 5\ s.$$

55. *A motor car slows down from 72 kmhr^{-1} to 36 kmhr^{-1} over a distance of 25 m. If the brakes are applied with the same force, calculate (i) distance travelled by the car (ii) total time in which the car comes to rest.*

Ans. Case I. $u = 72\ km\ hr^{-1} = 20\ ms^{-1}$; $v = 36\ kmhr^{-1} = 10\ ms^{-1}$;

$S = 25\ m$; $a = ?$

Applying, $v^2 - u^2 = 2aS$

$$(10)^2 - (20)^2 = 2 \times a \times 25$$

$$\therefore \quad -300 = 50a \qquad \therefore \quad a = -6\ ms^{-2}$$

Case II. $u = 72\ kmhr^{-1} = 20\ ms^{-1}$; $v = 0$; $S = ?$; $t = ?$; $a = -6\ ms^{-2}$

(i) Applying, $v^2 - u^2 = 2aS$

$$(0)^2 - (20)^2 = 2 \times (-6) \times S$$

$$\therefore \quad S = \frac{-400}{-12} = 33.33\ m.$$

(ii) Applying, $v = u + at$

$$0 = 20 + (-6) \times t$$

$$\therefore \quad t = \frac{20}{6} = \mathbf{3.33\ s}.$$

56. *A packet is dropped from a stationary helicopter, hovering at a height 'h' from ground level, reaches the ground in 12 s. Calculate (i) value of 'h' (ii) final velocity of packet on reaching ground level [g = 9.8 ms^{-2}]*

Ans. u = 0; v = ?; t = 12 s; S = h; g = 9.8 ms^{-2};

(i) Applying, $S = ut + \frac{1}{2}gt^2$

$h = 0 \times 12 + \frac{1}{2} \times 9.8 \times 12 \times 12 =$ **705.6 m.**

(ii) Applying, $v = u + at$

$v = 0 + 9.8 \times 12 =$ **117.6 ms^{-1}.**

57. *A boy drops a stone from cliff. It reaches the ground in 8 s. Calculate (i) height of cliff (ii) final velocity of stone*

[Take g = 9.8 ms^{-2}].

Ans. u = 0; v = ?; S = ?; t = 8 s; g = 9.8 ms^{-2};

(i) Applying, $S = ut + \frac{1}{2}gt^2$

$S = 0 \times 8 + \frac{1}{2} \times 9.8 \times 8 \times 8 =$ **313.6 m**.

(ii) Applying, $v = u + gt$

$v = 0 + 9.8 \times 8 =$ **78.4 ms^{-1}**.

58. *A stone thrown vertically upward, takes 3 s to attain maximum height. Calculate (i) initial velocity of stone (ii) maximum height attained by the stone. [Take g = 9.8 ms^{-2}].*

Ans. u = ?; v = 0; t = 3 s; g = –9.8 ms^{-2}; S = ?

(i) Applying, $v = u + gt$

$0 = u - 9.8 \times 3$

$\therefore$ $u = 29.4\ ms^{-1}$.

(ii) Applying, $S = ut + gt^2$

$= 29.4 \times 3 + \frac{1}{2} \times (-9.8) \times 9 = 88.2 - 44.1$

= **44.1 m**.

59. *A stone is thrown vertically upwards, takes 4 s to return to the thrower. Calculate (i) initial velocity (ii) maximum height attained by stone. [Take, g = 9.8 ms^{-2}]*

Ans. Time for upward journey of stone = 4s ÷ 2 = 2s.

u = ?; v = 0; t = 2 s; g = –9.8 ms^{-2}; S = ?

(i) Applying, $v = u + gt$

$0 = u - 9.8 \times 2$

$\therefore u = \mathbf{19.6\ ms^{-1}}$.

(ii) Applying, $S = ut + \frac{1}{2}gt^2$

$= 19.6 \times 2 + \frac{1}{2} \times (-9.8) \times 4 = 39.2 - 19.6 = \mathbf{19.6\ m.}$

60. *A stone is dropped from a top of cliff reaches ground level in 4s and then buries itself into 0.80 m of mud. Calculate (i) height of cliff (ii) final velocity of stone on reaching ground level (iii) de-acceleration produced by mud. [Take g = 9.8 ms^{-2}].*

Ans. Case I : When the stone is having free fall.

u = 0; v = ?; t = 4 s; g = 9.8 ms^{-2} ; S = ?

(i) Applying, $S = ut + \frac{1}{2}gt^2$

$= 0 \times 4 + \frac{1}{2} \times 9.8 \times (4)^2 = \mathbf{78.4\ m}$.

(ii) Applying, $v = u + gt$

$= 0 + 9.8 \times 4 = \mathbf{39.2\ ms^{-1}}$.

Case II : When the stone buries itself in mud.

u = 39.2 ms^{-1}; v = 0; a = ?; S = 0.8 m

$v^2 - u^2 = 2aS$

(iii) Applying, $(0)^2 - (39.2)^2 = 2 \times a \times 0.8$

$\therefore a = -\frac{39.2 \times 39.2}{1.6} = -960.4\ ms^{-2}$

$\therefore$ De-acceleration = – (Acceleration) = –(–960.4 ms^{-2})

= 960.4 ms^{-2}.

61. *A packet dropped from a helicopter reaches the water level of a river in 7.5 s and then travels for 4m within the water, before coming to rest. Calculate (i) height of helicopter above the level of water (ii) final velocity of packet, before hitting water (iii) retardation offered by water. [Take g = 10 ms^{-2}].*

Ans. Case I : When the packet is having free fall.

$u = 0; \quad v = ?; \quad t = 7.5\ s; \quad g = 10\ ms^{-2}; \quad S = ?$

(i) Applying, $S = ut + \frac{1}{2}gt^2$

$S = 0 \times 7.5 + \frac{1}{2} \times 10 \times 7.5 \times 7.5$

or $S =$ **281.25 m.**

(ii) Applying, $v = u + gt$

$= 0 + 10 \times 7.5 =$ **75 ms^{-1}**

Case II : When the stone is being retarded by water.

$u = 75\ ms^{-1}; \quad v = 0; \quad S = 4\ m; \quad a = ?$

(iii) Applying, $v^2 - u^2 = 2aS.$

$(0)^2 - (75)^2 = 2 \times a \times 4$

or $a = \frac{-5625}{8}$

$\therefore \quad a = -703.125\ ms^{-2}$

$\therefore$ Retardation offered by water = – (Acceleration)

$= -(-703.125\ ms^{-2})$

= **703.125 ms^{-2}.**

62. *A spaceship is moving in space with a velocity of 50 kms^{-1}. Its engines fire for 10 s, such that its velocity increases to 60 kms^{-1}. Calculate the total distance travelled by the spaceship in ½ minute from the time of firing its engines.*

Ans. Case I : Time for which ship is accelerating = 10 s.

$u = 50\ kms^{-1}$; $v = 60\ kms^{-1}$; $t = 10\ s$; $a = ?$; $S = ?$

Applying, $v = u + at$

$60 = 50 + a \times 10$

$\therefore$ $10a = 10$ or $a = 1\ kms^{-2}$.

Applying, $v^2 - u^2 = 2aS$

$(60)^2 - (50)^2 = 2 \times 1 \times S$

or $1100 = 2S$ $\therefore$ $S =$ **550 km**.

Case II : Time for which ship is moving with uniform velocity of $60\ kms^{-1} = (30 - 10) = 20\ s$

$\therefore$ Distance covered by ship with uniform velocity

$= 60 \times 20 = 1200$ km.

$\therefore$ Total distance covered by ship $= 550 + 1200 =$ **1750 km**.

63. *A spaceship is moving in space with a velocity of 60 kms^{-1}. It fires its retro-engines for 20 s and the velocity is reduced to 55 kms^{-1}. Calculate the distance travelled by spaceship in 40 s, from the time of firing retro-engines.*

Ans. Case I : Time for which ship is de-accelerating = 20 s.

$u = 60\ kms^{-1}$; $v = 55\ kms^{-1}$; $t = 20\ s$; $a = ?$; $S = ?$

Applying, $v = u + at$

$55 = 60 + a \times 20$

$\therefore$ $20a = -5$ or $a = -0.25\ kms^{-2}$

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

$S = 60 \times 20 + \frac{1}{2} \times (-0.25) \times 20 \times 20$

$= 1200 - 50 = 1150$ km.

Case II : Time for which ship is moving with uniform velocity of 55 kms^{-1} = (40 –20) = 20 s

$\therefore$ Distance travelled by ship $= 55 \times 20 = 1100$ km.

$\therefore$ Total distance travelled by ship $= 1150 + 1100$

$=$ **2250 km**.