PHYSICS

MOTION

Concepts Covered

- Scalar and vector quantities
- Distance and displacement
- Speed and velocity (average and instantaneous)
- Acceleration
- Various graphs
- Equations of motion

Introduction of Motion

When a body does not change its position with time, we can say that the body is at **rest;** while if a body changes its position with time, it is said to be in **motion**.

- An object is said to be a point object if the size of the object is very small as compared to its covered distance.
  Example: Earth can be treated as a point object for studying its motion around the Sun.
- A point or some stationary object with respect to which a body changes its position in the state of motion is known as the origin or reference point.

Terms Used to Define Motion

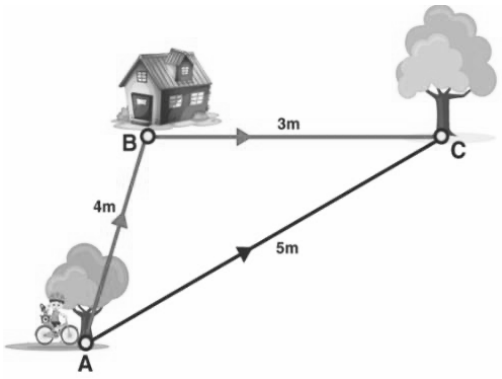
Distance

It is the actual length of the path travelled by a moving body, irrespective of the direction in which the body moves.

- Distance = Length of the path (ABC)
- Distance is a scalar quantity.

Unit

- In SI system: meter (m)
- In CGS system: centimeter (cm)



Displacement

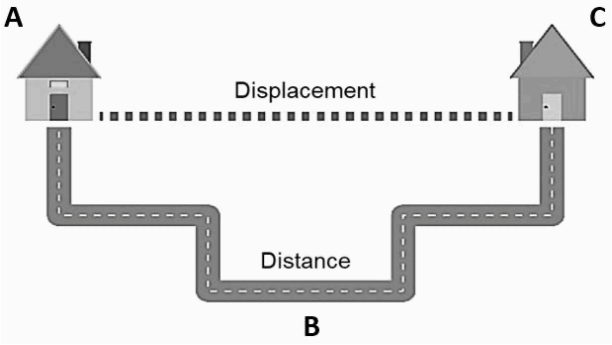
The shortest distance of a body from the starting point to the final point in a given direction is called displacement.

Displacement has magnitude as well as direction.

- Displacement = Length of path (AC)
- Displacement is a vector quantity.

Unit

- In SI system: meter (m)
- In CGS system: centimeter (cm)



Difference between Distance and Displacement

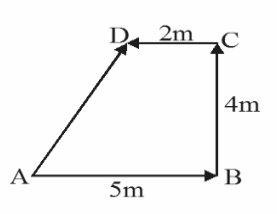
	Distance	Displacement
1	It is the actual length of the path travelled by a moving body.	It is the shortest distance between the initial position and the final position of the body.
2	The direction need not be specified.	The direction has to be specified.
3	The distances covered in a different directions can be added by simple arithmetic.	The displacement in a different direction cannot be added by simple arithmetic.
4	The distance covered by a moving body cannot be zero or negative.	The displacement of a moving body can be zero or negative.
5	Distance is a scalar quantity.	Displacement is a vector quantity.

Example:

A person travels a distance of 5 m towards the east, then 4 m towards the north, and then 2 m towards the west.

(i) Calculate the total distance travelled.

(ii) Calculate the resultant displacement.



Solution:

(i) Total distance travelled by the person = 5 m + 4 m + 2 m = 11 m

(ii) Displacement $\mathrm{AD} = \sqrt{[(5-2)^2 + 4^2]} = 5\ \mathrm{m}$

Speed

The 'distance' travelled by a body in unit time interval is called its speed.

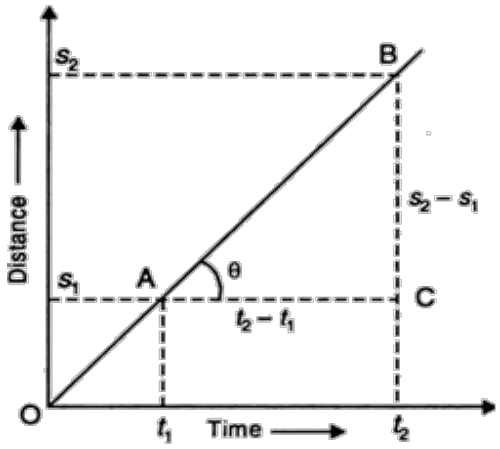
$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

- Speed is a scalar quantity.

  Unit:

  - In SI system $= \mathrm{ms}^{-1}$
  - In C.G.S. system $= \mathrm{cms}^{-1}$
- If distance-time graph is given, the speed can be given by the slope of the line, at a given time.

$$v = \frac{\Delta s}{\Delta t} = \frac{s_2 - s_1}{t_2 - t_1}$$



Types of Speed

(A) Average and Instantaneous Speed

Average Speed

Average speed of a body in a given time interval is defined as the ratio of total distance travelled to the total time taken.

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

- The average speed is a scalar quantity.
- For a moving body, average speed can never be negative or zero (unless $t \to \infty$).
- If a particle travels distances L_1, L_2, L_3 at speeds v_1, v_2, v_3 etc. respectively, then

$$v_{avg} = \frac{\Delta s}{\Delta t} = \frac{L_1 + L_2 + \cdots ... + L_n}{\frac{L_1}{v_1} + \frac{L_2}{v_2} + \cdots + \frac{L_n}{v_n}}$$

The fastest fish in the sea is the swordfish which can reach up to the speed of 108 km/hr.

If a particle travels at speeds v_1, v_2 etc, for intervals t_1, t_2 etc, respectively, then

$$v_{avg} = \frac{v_1 t_1 + v_2 t_2 + \cdots}{t_1 + t_2 + \cdots} = \frac{\sum vt}{\sum t}$$

Instantaneous Speed

The speed of a body at any particular instant of time or a particular point of its path is called the instantaneous speed of the body.

$$\text{Instantaneous Speed} = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

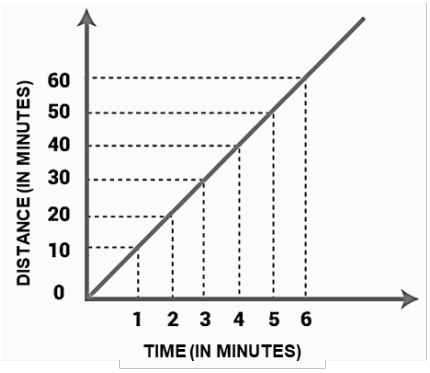
(B) Uniform and Non-uniform Speed

Uniform Speed

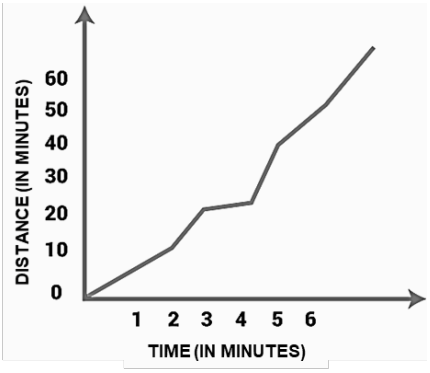
If an object covers an equal distance in an equal interval of time, the body is moving with a uniform speed.

Non-Uniform Speed

If an object covers an unequal distance in an equal interval of time or an equal distance in an unequal interval of time, the body is moving with a non-uniform speed.



Uniform Speed



Non-Uniform Speed

Velocity

The displacement of a body per unit time is called velocity.

- Velocity is a vector quantity.
- **Unit:**
  - In SI system $= ms^{-1}$
  - In C.G.S. system $= cms^{-1}$
- The area of velocity-time graph gives displacement travelled.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

There are over 97,000 km (60,000 miles) of blood vessels in an average person.

Types of Velocity

(A) Average and Instantaneous Velocity

Average Velocity

Average velocity is defined as the ratio of total displacement to the total time taken.

$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time}} \quad \text{OR} \quad v = \frac{s}{t}$$

Instantaneous Velocity

Instantaneous velocity is defined as the rate of change of position for a very small-time interval (almost zero).

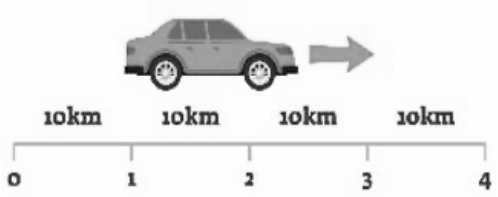
- SI unit is m/s.
- $v_i = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$

Here, $\lim_{\Delta t \to 0}$ means that time duration is very close to zero but not exactly equal to zero.

(B) Uniform and Non-Uniform Velocity

Uniform Velocity

When a body covers equal displacement in an equal interval of time, the body is said to be moving with a uniform velocity.



Conditions for Uniform Velocity

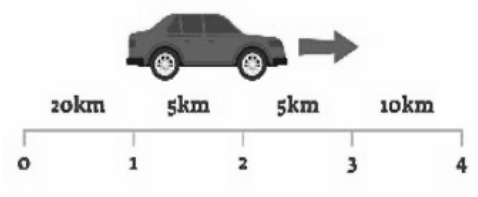
(i) The body must cover equal displacement in equal intervals of time.

(ii) The direction of motion of the body should not change.

Key Point: When a body moves with constant velocity, the average velocity is equal to the instantaneous velocity.

Non-Uniform Velocity

When a body covers unequal displacement in equal intervals of time, the body is said to be moving with non-uniform velocity.



Conditions for Non-Uniform Velocity

(i) It should cover unequal displacement in equal intervals of time, or equal displacement in unequal intervals of time.

(ii) It should cover equal distances in equal intervals of time, but its direction must change.

Differences between Speed and Velocity

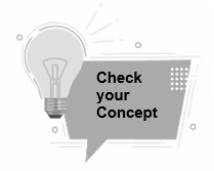
	Speed	Velocity
1	The distance covered per unit time is called speed.	The displacement covered per unit time is called velocity.
2	It can never be zero for a moving body.	It can be zero when displacement is zero.
3	It can never be negative.	It can be negative.
4	It is a scalar quantity.	It is a vector quantity.

Example:

Calculate velocity if the displacement of the body is 80m in 5 seconds.

Solution: Velocity = $\frac{\text{Displacement}}{\text{Time}}$

$= \frac{80}{5}$ = 16 m/s



Q. What is the meaning of the given statement: "The Average velocity of a body is equal to the instantaneous velocity"?

Answer Key

Answer: The average velocity is equal to instantaneous velocity which means the body is moving with constant or uniform velocity.

Acceleration

The rate of change of velocity is called acceleration, i.e. change in velocity per unit time is called acceleration.
Mathematically,

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

Acceleration is a change in velocity divided by the time taken.
Here v = final velocity, u = initial velocity and t = time taken

- It is a vector quantity.

  Unit:
  - In SI system $= ms^{-2}$
  - In C.G.S. system $= cms^{-2}$

A woodpecker can peck 20 times a second.

Types of Acceleration

(A) Uniform & Non-Uniform Acceleration

Uniform Acceleration

If a body travels in a straight line and its velocity increases by equal amounts in equal intervals of time, it is said to be in a state of uniform acceleration.

Example: Motion of a freely falling body

Non-Uniform Acceleration

A body has a non-uniform acceleration if its velocity increases by unequal amounts in equal intervals of time.

Example: Car moving on the crowded street

Average Acceleration

It is the ratio of change in velocity to the total time taken.

$$\text{Average acceleration} = \frac{\text{Change in velocity}}{\text{Total time taken}}$$

- If the velocity of a body decreases, it will experience a negative acceleration which is called deceleration or retardation.
- Acceleration is determined by the slope of the velocity-time graph.

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

(i) If the velocity-time graph is a straight line, acceleration remains constant.

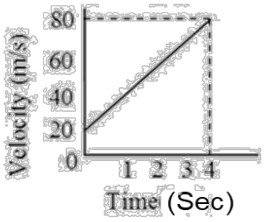
(ii) If the slope of the velocity-time graph is positive, the body is accelerating.

(iii) If the slope of the velocity-time graph is negative, the body is deaccelerating.

(iv) If the slope of the velocity-time graph is zero i.e. line is horizontal, acceleration is zero and velocity is constant or uniform.

Example:

Velocity-time graph of a body is shown in the figure. Find its acceleration in m/s^2.



Solution:

As it is clear from the figure,

At t = 0 s, v = 20 m/s

At t = 4 s, v = 80 m/s

$$\therefore \text{ Acceleration, } a = \frac{\text{Change in velocity}}{\text{Time interval}}$$

$$= \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{80 - 20}{(4 - 0)}$$

$$= \mathbf{15\ m/s^2}$$

The spacecraft would have to attain a speed of at least 11.186 km per second to escape the Earth's gravitational pull.

Q. Calculate acceleration if the body changes its velocity from 10 m/s to 30 m/s in 5s.

Answer Key

Solution: 4 m/s^2

Equations of Motion

Motion Under Uniform Acceleration

(A) 1st Equation of Motion

Consider a body having initial velocity 'u'. Suppose it is subjected to a uniform acceleration 'a' so that after time 't' its final velocity becomes 'v'.

Now we know,

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time interval}}$$

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

$$\mathbf{v = u + at} \ \ldots\ldots (\mathbf{i})$$

(B) 2nd Equation of Motion

Suppose a body has an initial velocity 'u' and uniform acceleration 'a' for time 't' so that its final velocity becomes 'v'.

The distance travelled by moving body in time 't' is 's'.

Then, the average velocity $= \frac{v+u}{2}$.

Distance travelled = Average velocity × time

$$s = \left(\frac{u + v}{2}\right) t$$

$$\Rightarrow s = \left(\frac{u+u+at}{2}\right) t \ \ (\text{as } v = u + at)$$

$$s = \left(\frac{2u + at}{2}\right) t \Rightarrow s = \frac{2ut + at^2}{2}$$

$$\mathbf{s = ut + \frac{1}{2}at^2} \ \ldots\ldots (\mathbf{ii})$$

(C) 3rd Equation of Motion

Distance travelled = Average velocity × time

$$s = \left(\frac{u+v}{2}\right) t \ldots\ldots\ldots\ldots (iii)$$

from equation (i) $t = \frac{v-u}{a}$

Substituting the value of t in equation (iii),

we get $s = \left(\frac{v-u}{a}\right)\left(\frac{v+u}{2}\right)$

$$s = \left(\frac{v^2-u^2}{2a}\right)$$

$$\Rightarrow 2as = v^2 - u^2$$

$$\mathbf{v^2 = u^2 + 2as} \ldots . \textbf{(iv)}$$

Roller coasters use the force of gravity to make a rip-roaring ride. When the roller coaster cars get to the top, gravity pulls them down the track toward the ground, getting faster and faster.

- When the body is falling freely under the influence of gravity, the equations of motion can be obtained by replacing acceleration with acceleration due to gravity (g) and can be written as follows:

  (A) $v = u + gt$

  (B) $h = ut + \frac{1}{2}gt^2$

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

- When a body is thrown upwards with some initial velocity, retardation is produced due to the attraction of the earth. In equations of motion, a is replaced by $(-g)$ and thus equations become:

  (A) $v = u - gt$

  (B) $h = ut - \frac{1}{2}gt^2$

  (C) $v^2 = u^2 - 2gh$

Free Fall

Assuming u = 0 for a freely falling body

t is given	h is given	v is given
$v = gt$	$t = \sqrt{\frac{2h}{g}}$	$t = \frac{v}{g}$
$h = \frac{1}{2}gt^2$	$v = \sqrt{2gh}$	$h = \frac{v^2}{2g}$

If the body is projected vertically up

Taking an initial position as origin and direction of motion (i.e., vertically up) as positive.

(A) At the highest point, v = 0

(B) a = – g

t is given	h is given	u is given
$u = gt$	$t = \sqrt{\frac{2h}{g}}$	$t = \frac{u}{g}$
$h = \frac{1}{2}gt^2$	$u = \sqrt{2gh}$	$h = \frac{u^2}{2g}$

- It is clear that in the case of a motion under gravity
  (A) time taken to go up is equal to the time taken to fall through the same distance.
  (B) the speed with which a body is projected up is equal to the speed with which it comes back to the point of projection.
  (C) the body returns to the starting point at the same speed with which it was thrown.

Example:

A body is moving with a speed of $20\ m/s$. When a certain force is applied, an acceleration of $4\ m/s^2$ is produced. After how much time its velocity will be $80\ m/s$?

Solution: Given: $u = 20\ m/s, a = 4\ m/s^2$, $v = 80\ m/s, t = ?$

Using the equation, $v = u + at$, we get

$80 = 20 + 4 \times t$

or $4t = 80 - 20 = 60$ or $t = 15\ s$

Therefore, after 15 seconds, the velocity of the body will be $80\ m/s$.

(1) A cycle covered 40 m in 8 seconds and the initial velocity of the cycle was 1 m/sec. Find the acceleration that the cycle had in its motion.

(2) A stone, thrown up is caught by the thrower after 6s. How high did it go and where was it 4 s after start? g = 10 m/s^2

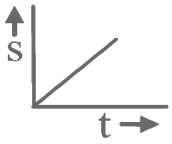
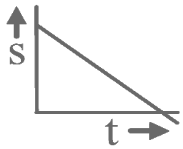
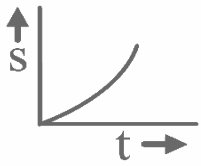
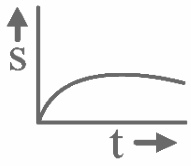
Answer Key

(1) 1 m/s^2

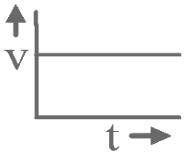
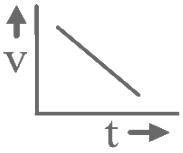
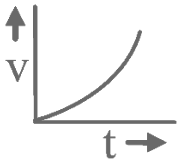
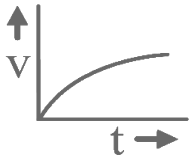
(2) 45 m, 40 m (from ground)

Various Graphs Related to Motion

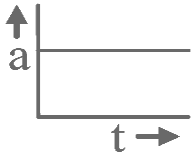
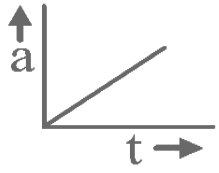
Displacement-Time Graph

1.	The straight-line inclined to the time axis in the s-t graph represents constant velocity. 	2.	In the s-t graph, the straight line inclined to the time axis at an angle greater than 90º shows negative velocity. 
3.	Body with accelerated motion. 	4.	Body with decelerated motion. 

Velocity-Time Graph

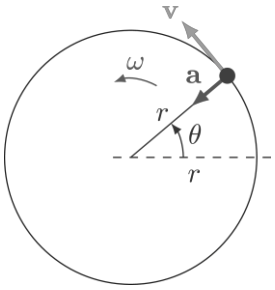
1.	For the body having constant velocity or zero acceleration 	2.	The body is moving with constant retardation and its initial velocity is not zero 
3.	The body is accelerated and the initial velocity is zero 	4.	The body is decelerated and the initial velocity is zero 

Acceleration-Time Graph

1.	Acceleration is constant. 	2.	Acceleration is increasing and is positive. 

Circular Motion

When a body moves in such a way that its distance from a fixed point always remains constant, its motion is said to be circular motion.



Uniform Circular Motion

If the radius vector sweeps out equal angles at equal times, then its motion is said to be a uniform circular motion.

- In a uniform circular motion, speed remains constant.
- Linear velocity being a vector quantity, its direction changes continuously.
- The direction of velocity is along the tangent at every point.

Angular Velocity

Angular velocity is the rate of change of angular displacement per unit time.

$$\omega = \frac{\Delta\theta}{\Delta t}$$

- It is a vector quantity.
- Direction is perpendicular to the plane of rotation.
- Unit is Radian/sec.
- In a uniform circular motion, the direction of angular velocity is along the axis of rotation which is constant throughout.
- Angular velocity remains constant in magnitude as well as in direction.
- Relation between angular and linear velocity is $v = r\omega$

  Where r = radius of the circle.

The smaller the radius of the circle, the more force required to achieve circular motion.

Centripetal Force

It is a net force that acts on an object to keep it moving along a circular path.

- It always acts towards the center.
- Centripetal force is required to move a particle in a circle. F_c is always perpendicular to velocity or displacement, hence the work done by this force will always be zero.

Note:

- Circular motion in the horizontal plane is usually a uniform circular motion.
- Remember that equations of motion are not applicable for circular motion.

Centripetal Acceleration

It is defined as the acceleration of a body traversing a circular path. Any object that is moving in a circle has an acceleration vector pointed towards the center of that circle known as centripetal acceleration.

$$a_c = \frac{v^2}{r}$$

The direction of centripetal acceleration is along the radius and towards the center.

Time Period

It is the time taken to complete one complete revolution.

- In one revolution, the angle subtended is 2π and if T is the time period, the angular velocity is given by

$$\omega = \frac{2\pi}{T} \quad \text{or} \quad T = \frac{2\pi}{\omega}$$

Frequency

Frequency is defined as the number of revolutions per second.

$$n = \frac{1}{T} = \frac{\omega}{2\pi}$$

Example:

Earth revolves around the Sun in 365 days. Calculate its angular velocity.

Solution.

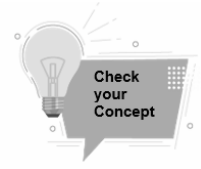
Time period, $T = 365$ days

$= 365 \times 24 \times 60 \times 60$ seconds

$\therefore$ Angular velocity, $\omega = \frac{2\pi}{T}$

$= \frac{2\pi}{365 \times 24 \times 60 \times 60} \frac{\text{rad}}{\text{s}}$

$= \mathbf{1.99 \times 10^{-7} rad/s.}$



Q. An artificial satellite is moving in a circular orbit of circumference 64,000 km. Calculate its speed if it takes 10 hours to revolve around the Earth.

Answer Key

Answer: 6400 km/h

Solved Examples

(1) A helicopter is moving in a straight path. What type of motion will the propeller of the helicopter execute?

Solution: The propeller of the helicopter will execute both rotatory and translatory motions, since the propeller of the helicopter rotates and moves along with the helicopter and covers the distance.

(2) What do you mean by average speed? What is its SI unit?

Solution: Average speed is defined as the ratio of total distance travelled to the total time taken.

The unit of average speed is the same as that of the speed, i.e. ms^{-1}.

(3) If a simple pendulum takes 38 s to perform 10 oscillations, What is the time taken by it to move from one extreme position to the mean position?

Solution: Given $10\mathrm{T} = 38\ \mathrm{s}$

$1\mathrm{T} = 3.8\ \mathrm{s}$

Then, the time taken by the bob to move from one extreme position to the mean position

$= \frac{\mathrm{T}}{4} = \frac{3.8}{4}\ \mathrm{s} = 0.95\ \mathrm{s}.$

(4) A car starts from Hyderabad at 6 a.m. and reaches Warangal at 9 a.m. If the odometer reading shows $10,150\ \mathrm{km}$ at Hyderabad and $10,300\ \mathrm{km}$ at Warangal, What is the average speed of the car?

Solution: Time, $\mathrm{t} = 9$ a.m. $- 6$ a.m. $= 3\ \mathrm{h}$

Distance $\mathrm{S} = 150\ \mathrm{km}$

$$\text{Average speed} = \frac{\text{Total distance (s)}}{\text{Total time taken (t)}}$$

$$= \frac{150\ \mathrm{km}}{3\ \mathrm{h}} = 50\ \mathrm{km\ h^{-1}}.$$

(5) A stone is dropped from the top of a tower. If it reaches the ground in $10\ \mathrm{s}$ with a velocity of $100\ \mathrm{ms^{-1}}$, what is the acceleration of the stone?

Solution: Given: $\mathrm{t} = 10\ \mathrm{s}$

We know that $\mathrm{a} = \frac{\mathrm{v} - \mathrm{u}}{\mathrm{t}}$

$$\mathrm{a} = \frac{100 - 0}{10} = 10\ \mathrm{m\ s^{-2}}.$$

(6) The bike rider applies brakes and brings the velocity of the bike from $90\ \mathrm{m\ s^{-1}}$ to stop in $30\ \mathrm{s}$. Find the acceleration of the bike.

Solution: Given that: $\mathrm{u} = 90\ \mathrm{m\ s^{-1}}$

$\mathrm{v} = 0$

$\mathrm{t} = 30\ \mathrm{s}$

$$\mathrm{a} = \frac{\mathrm{v} - \mathrm{u}}{\mathrm{t}} = \frac{0 - 90}{30} = -3\ \mathrm{m\ s^{-2}}$$

(7) What is the difference between uniform velocity and non-uniform velocity?

Solution: Uniform velocity: An object with uniform velocity covers equal distances in equal intervals of time in a specified direction, e.g., an object moving with a speed of 40 kmh^{-1} towards the west has uniform velocity.

Non-uniform velocity: When an object covers unequal distances in equal intervals of time in a specified direction, or if the direction of motion changes, it is said to be moving with a non-uniform or variable velocity, e.g., a revolving fan at a constant speed has variable velocity.

(8) A train travels with a speed of $100\ \mathrm{km\ h^{-1}}$ towards north for $1\frac{1}{2}\ \mathrm{h}$, the distance covered by the train?

Solution: We know that:

$$\text{Speed, } \mathrm{v} = \frac{\text{distance (s)}}{\text{time (t)}}, 1\frac{1}{2}\ \mathrm{h} = \frac{3}{2}$$

$S = v \times t = 100 \text{ km h}^{-1} \times \frac{3}{2} \text{ h}$

$= 150 \text{ km}.$

(9) Can a body have constant speed but variable velocity?

Solution: Yes, e.g. a body in uniform circular motion has constant speed but due to the change in the direction of motion, its velocity changes at every point.

(10) An athlete completes one round of a circular track of radius R in 40 sec. What will be his displacement at the end of 2 minutes 20 seconds?

(A) Zero

(B) $2R$

(C) $2\pi R$

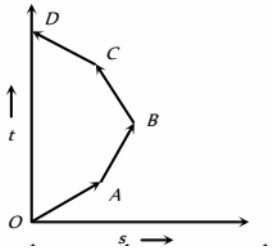
(D) $7\pi R$

Answer: (B)

Total time of motion is $2 \text{ min} 20 \text{sec} = 140 \text{sec}.$

As the time period of circular motion is 40sec so in $140 \text{sec}.$ an athlete will complete 3.5 revolutions i.e., he will be at diametrically opposite point i.e., Displacement $= 2R.$

(11) Which of the following options is correct for the object having a straight line motion represented by the following graph?



(A) The object moves with constantly increasing velocity from O to A and then it moves with constant velocity.

(B) Velocity of the object increases uniformly.

(C) Average velocity is zero.

(D) The graph shown is impossible.

Answer: (C)

From the given figure, it is clear that the net displacement is zero. So the average velocity will be zero.

(12) A robot runs forward with 5 m s^{-1} for 10 s and immediately backward with 5 m s^{-1} for 5s. Which of the following statements is wrong?

(A) The average speed of the robot is 5 m s^{-1}.

(B) The distance covered by the robot is more than its displacement.

(C) The average velocity of the robot is 5 m s^{-1}.

(D) The robot is moving at a uniform speed.

Answer: (C)

Given that:

Forward direction:

$V = 5 \text{ m s}^{-1}$

$t_1 = 10 \text{ s}$

$s_1 = u \times t_1 = 5 \times 10 = 50 \text{ m}$

Backward direction:

$v = 5 \text{ m s}^{-1}$

$T_2 = 5 \text{ s}$

$\Rightarrow s_2 = v \times t_2 = 5 \times 5 = 25 \text{ m}$

Average speed, $v_{avg} = \frac{\text{Total distance}}{\text{Total time taken}}$

$= \frac{s_1 + s_2}{t_1 + t_2} = \frac{50 + 25}{10 + 5} = \frac{75 \text{ m}}{15 \text{ s}}$

$= 5 \text{ m s}^{-1}$

$$\text{Average velocity, } v_{avg} = \frac{\text{Total displacement}}{\text{Total time taken}}$$

$$= \frac{50-25}{10+5} = \frac{25}{15} = \frac{5}{3} = 1.66 \text{ m s}^{-1}.$$

(13) A 150 m long train is moving with a uniform velocity of 45 km/h. What is the time taken by the train to cross a bridge of length 850 meters?

Solution: Total distance to be covered for crossing the bridge

= length of train + length of bridge

$= 150\text{m} + 850\text{m} = 1000\text{m}$

$$\text{Time} = \frac{\text{Distance}}{\text{Velocity}} = \frac{1000}{45 \times \frac{5}{18}} = 80\text{sec}$$

(14) A particle moves along a semicircle of radius 10 m in 5 seconds. What is the average velocity of the particle?

Solution: Velocity of particle $= \frac{\text{Total displacement}}{\text{Total time}}$

$$= \frac{\text{Diameter of circle}}{5} = \frac{2 \times 10}{5} = 4 \text{ m/s}$$

(15) If a car covers $2/5$ of the total distance with v_1 speed and $3/5$ distance with v_2, what is the average speed ?

Solution:

Let x be the total distance covered by the car

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$

$$= \frac{x}{\frac{2x/5}{v_1} + \frac{3x/5}{v_2}} = \frac{5v_1v_2}{3v_1 + 2v_2}$$

Exercise

FILL IN THE BLANKS

(1) If the ratio of the final velocities of two bodies falling freely is $4:3$, the ratio of the heights from which they fall is_____.

(2) If a stone is thrown vertically up and it is caught after time 't' seconds, the maximum height reached by it is_____.

(3) A body with an initial velocity of $3\ \text{m s}^{-1}$ moves with an acceleration of $2\ \text{m s}^{-2}$. The distance travelled in the 4th second is_____ m.

(4) The slope of displacement-time graph gives the_____ of motion.

(5) The ratio of magnitude of average velocity to average speed is_____.

(6) Area under the velocity-time graph gives_____.

(7) A particle moves from P to Q with a uniform velocity v_1 and Q to P with a velocity v_2. Its average velocity is_____.

(8) _____ is produced in a body whenever there is a change in its velocity.

(9) The _____circular motion is described as the motion of an object in a circular path with a constant speed.

(10) Retardation is a_____ quantity.

TRUE OR FALSE

(1) Acceleration-time graph can be used to find the displacement.

(2) The distance travelled by a freely falling body in every successive second is the same.

(3) A body is projected vertically up. On reaching maximum height, its velocity becomes zero.

(4) A body moves with retardation when it is projected vertically upwards.

(5) Equations of motion are applicable only when a body moves with uniform velocity.

(6) If a body is moving on a curved path with constant speed, its centripetal acceleration is perpendicular to the direction of motion.

(7) A body can have constant velocity and still have varying speeds.

(8) A motion that repeats itself after a fixed interval of time is called periodic motion.

(9) A ball thrown by a boy from a rooftop has oscillatory motion.

(10) Two trains going in the opposite direction with the same speed are at rest relative to each other.

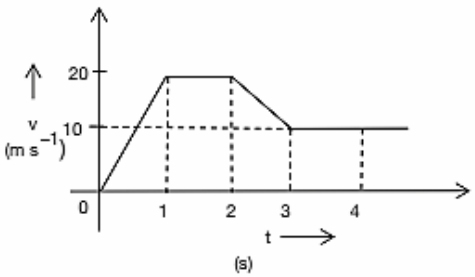
OBJECTIVE TYPE QUESTIONS

(1) The ratio of the heights from which two bodies are dropped is $3:5$, respectively. The ratio of their final velocities is

(A) $\sqrt{5}:\sqrt{3}$ (B) $\sqrt{3}:\sqrt{5}$

(C) $9:25$ (D) $5:3$

(2) The variation of the velocity of a particle moving along a straight line is illustrated in the graph given below. The distance covered by the particle in 4 seconds is ____m.



(A) 20

(B) 35

(C) 40

(D) 55

(3) If the body is projected up into the air with a certain angle, the path followed by it is_____.

(A) linear path
(B) elliptical path
(C) parabolic path
(D) spherical path

(4) A bus travels the first one-third distance at a speed of $10\ \text{km h}^{-1}$, the next one-third distance at a speed of $20\ \text{km h}^{-1}$ and the next one-third distance at a speed of $30\ \text{km h}^{-1}$. The average speed of the bus is

(A) $20\ \text{m s}^{-1}$
(B) $\frac{50}{11}\ \text{m s}^{-1}$
(C) $\frac{180}{11}\ \text{m s}^{-1}$
(D) $30\ \text{m s}^{-1}$

(5) A particle moves along a circular track of $6\ \text{m}$ radius such that the arc of the circular track covered subtends an angle of 30° at the centre. The distance covered by the body is

(A) πm
(B) $13\pi\text{m}$
(C) $4\pi\text{m}$
(D) $6\pi\text{m}$

(6) The relation among v, ω, and r is

(A) $\omega = \frac{v}{r}$
(B) $v = \frac{\omega}{r}$
(C) $\omega = \frac{r}{v}$
(D) None of these

(7) Rate of change of angular velocity with respect to time is referred to:

(A) Angular speed
(B) Angular displacement
(C) Angular acceleration
(D) None of these

(8) Uniform circular motion is an example of:

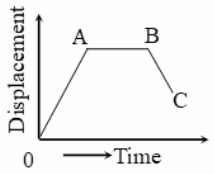
(A) Constant acceleration
(B) Variable acceleration
(C) A and B both
(D) None of these

(9) A body starts falling from height 'h' and travels a distance h/2 during the last second of motion. The time of travel (in sec.) is

(A) $\sqrt{2}-1$
(B) $2+\sqrt{2}$
(C) $\sqrt{2}+\sqrt{3}$
(D) $\sqrt{3}+2$

(10) In the given figure BC represents a body moving -

(A) backwards with uniform velocity.
(B) forward with uniform velocity.
(C) backward with non-uniform velocity.
(D) forward with non-uniform velocity.



Answer Key

(I) FILL IN THE BLANKS

(1) 16:9

(2) $g\frac{t^2}{8}$

(3) 10

(4) velocity

(5) less than or equal to 1

(6) displacement

(7) $\frac{2v_1v_2}{v_1+v_2}$

(8) acceleration

(9) uniform

(10) vector

(II) TRUE OR FALSE

(1) False

(2) False

(3) True

(4) True

(5) False

(6) True

(7) False

(8) True

(9) False

(10) False

(III) OBJECTIVE TYPE QUESTIONS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(B)	(D)	(C)	(C)	(A)	(A)	(C)	(B)	(B)	(A)