Q – 3. Define the terms distance and displacement.

Answer :

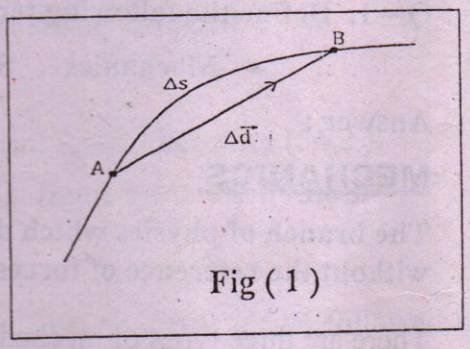


Fig (1)

DISTANCE (S or d)

The length of the actual path traversed by a body in motion is called distance (S or d). Distance is a scalar quantity.

System International unit (S I unit) of distance

The System International unit (S I unit) SI unit of distance is metre (m).

DISPLACEMENT ($\vec{S}$ or $\vec{d}$)

The shortest or straight directed distance covered by a moving body from the initial position to the final position is called displacement ($\vec{S}$ or $\vec{d}$).

Displacement is a vector quantity.

System International unit (S I unit) of displacement

The System International unit (S I unit) of displacement is metre (m).

The fig (2) shows the difference between the displacement and distance.

The body may move from (A) to (B) by any path whatsoever, straight or curved, the

Q – 5. Define the following terms as used in physics.

Speed , Average speed , Uniform speed , Non – uniform speed , Instantaneous speed.

Answer :

SPEED (v)

The distance covered (S) by a moving body between two points in a unit time (t) is called speed (v) of the body.

More precisely, speed is the time rate of the distance covered. Speed has magnitude only , it has no specified direction , therefore speed is a scalar quantity.

Mathematically

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

$$\boxed{v = \frac{s}{t}}$$

UNIFORM VELOCITY (Constant velocity)

The velocity of a body which cover equal displacement ($\vec{S}$) in equal intervals of time (t) is called uniform velocity or constant velocity of the body.

The velocity of a body is said to be uniform or constant when the speed as well as the direction of the body do not change with time.

Mathematically

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

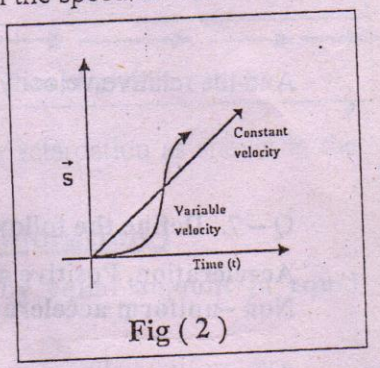


Fig (2)

A body having uniform velocity necessarily travels in a straight line with constant speed.

If we plot the graph between ($\vec{S}$) and time (t), the graph will be straight and its slope will be constant. See fig (3)

NON – UNIFORM VELOCITY

(Variable velocity)

The velocity of a body which does not cover equal displacement ($\vec{S}$) in equal intervals of time (t) is called non uniform velocity or variable velocity of the body.

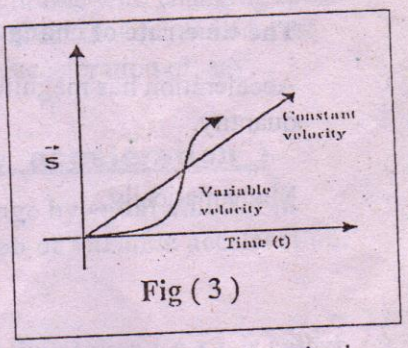


Fig (3)

Velocity is variable if it is changing in speed or in direction or in both. Motion of variable velocity is called accelerated motion. Velocity is variable, if either its magnitude or direction or both changes.

If we plot the graph between ($\vec{S}$) and (t), the graph is not straight line i.e. slope is not constant. See figure (3).

AVERAGE SPEED ($< v >$)

The total distance (S) covered by a moving body divided by the total time taken (t) to cover this distance is called average speed $< v >$ of the body.

Mathematically

$$\text{Average Speed} = \frac{\text{Total distance covered}}{\text{Total time taken}}$$

$$< v > = \frac{\Delta s}{\Delta t}$$

UNIFORM SPEED (Constant speed)

The equal distance (S) covered by a moving body in equal intervals of time (t) is called uniform speed or constant speed of the body.

Mathematically

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

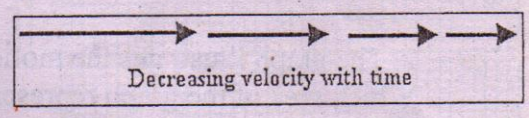
EXAMPLE

A car starts from rest and its speed increases along a straight line with respect to time, then the car is said to posses positive acceleration or just acceleration as shown in the fig.

NEGATIVE ACCELERATION (Retardation or deceleration) ($-\vec{a}$)

The acceleration that is produced by decreasing speed is called negative acceleration or retardation or deceleration ($-\vec{a}$).

EXAMPLE



If a car is moving with a certain speed and then applies brakes, which retarding the speed, then the acceleration is negative acceleration or deceleration or retardation as shown in the fig.

UNIFORM ACCELERATION (constant acceleration)

The acceleration of a body whose velocity changes by equal amount in equal intervals of time is called uniform acceleration.

Acceleration of constant magnitude and unchanging direction is called uniform or constant acceleration.

In a uniformly accelerated motion, a body moves in a straight line with changing speed. Either it moves faster and faster or gets slower and slower. A car that starts from rest and continuously gains speed along a straight path with the acceleration of, say, ($4\ m\ s^{-2}$) has a uniform acceleration.

NON-UNIFORM ACCELERATION (Variable acceleration)

The acceleration of a body whose velocity does not change by equal amount in equal intervals of time is called non-uniform acceleration or variable acceleration.

AVERAGE ACCELERATION ($<\vec{a}>$)

The total change in velocity ($\Delta\vec{v}$) divided by the total time taken (Δt) is called average acceleration of the body.

Suppose in a certain time interval (Δt), the velocity of body changes by ($\Delta\vec{v}$) then

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

$$<\vec{a}> = \frac{\Delta\vec{v}}{\Delta t}$$

In the case of uniform acceleration, the average acceleration is equal to the uniform acceleration.

Q – 7. Define the following terms as used in physics.

Acceleration, Positive acceleration , Negative acceleration , Uniform acceleration , Non –uniform acceleration , Average aacceleration.

Answer :

ACCELERATION ($\vec{a}$)

The time rate of change of velocity is called acceleration of the body ($\vec{a}$).

Acceleration has magnitude as well direction only , therefore acceleration is a vector quantity.

Mathematically,

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

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

$$\boxed{\vec{a} = \frac{\Delta \vec{v}}{\Delta t}}$$

Where ($\vec{a}$) is the acceleration , ($\vec{v}_i$) is the initial velocity , ($\vec{v}_f$) is the final velocity and (Δt) is the time interval.

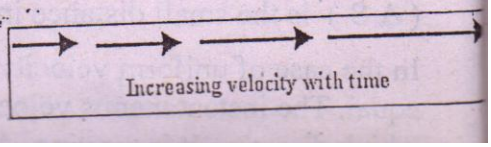
The change in velocity can occur due to change in speed or in direction or in both.

System International unit (S I unit) of acceleration

The system International Unit (SI unit) of velocity is metre per second ($m\,s^{-1}$) and the standard International Unit (SI unit) of time is second (s) so the system International Unit (SI unit) of acceleration becomes metre per second per second which is written as ($m\,s^{-2}$).

POSITIVE ACCELERATION ($\vec{a}$)

The acceleration that is produced by increasing speed is called positive acceleration.



EXAMPLE

The velocity of a truck increases in (20 s) from (10 ms^{-1}) to (100 ms^{-1}). Find the average acceleration of the truck.

SOLUTION

Initial velocity of the truck , v_i = 10 $m\,s^{-1}$

Final velocity of the truck , v_f = 100 $m\,s^{-1}$

Time interval , Δt = 20 s

Average acceleration of the truck , a = ?

Using the equation

$$< a > = \frac{v_f - v_i}{t}$$

$$< a > = \frac{100\ ms^{-1} - 10\ ms^{-1}}{20\ s} = 4.5\ m\,s^{-2}$$

$$< a > = 4.5\ m\,s^{-2}$$

EXAMPLE

A ship is moving at a speed of (56 $km\ h^{-1}$). One second later, it is moving at (58 $km\ h^{-1}$). What is its acceleration ?

SOLUTION

Please note that : (1 km = 1000 m) AND (1 hour = 3600 s)

Initial velocity of the ship, v_i = 56 $km\ h^{-1}$ = 15.55 $m\ s^{-1}$

Final velocity of the ship, v_f = 58 $km\ h^{-1}$ = 16.11 $m\ s^{-1}$

Time interval, t = 1 s

Acceleration of the ship, a = ?

Using the equation

$$a = \frac{v_f - v_i}{t}$$

$$a = \frac{16.11\ ms^{-1} - 15.55\ ms^{-1}}{1\ s} = 0.56\ m\ s^{-2}$$

$$\boxed{a = 0.56\ m\ s^{-2}}$$

EXAMPLE A car is moving with velocity of (120 km hr^{-1}) on motorway. By applying brakes the car comes to rest after covering a distance of (25 m). Calculate its acceleration?

SOLUTION

Please note that : (1 km = 1000 m) AND (1 hour = 3600 s

Initial velocity of the car, $v_i = 120 \text{ km h}^{-1} = 120 \frac{\text{km}}{\text{hr}}$

$$v_i = 120 \left(\frac{1000 \text{ m}}{3600 \text{ s}} \right) = 33.33 \text{ m s}^{-1}$$

Final velocity of the car, $v_f = 0 \text{ km h}^{-1} = 0 \text{ m s}^{-1}$

Distance covered velocity by the car, $S = 25 \text{ m}$

Acceleration of the car, a = ?

Using the equation

$$2 a S = v_f^2 - v_i^2$$

$$a = \frac{v_f^2 - v_i^2}{2 S}$$

$$a = \frac{(0 \text{ ms}^{-1})^2 - (33.33 \text{ ms}^{-1})^2}{2 (25 \text{ m})}$$

$$\boxed{a = -22.21 \text{ m s}^{-2}}$$