FREE COACHING

NEET 2025

CLASS 11

MOTION IN A STRAIGHT LINE

Lecture 1

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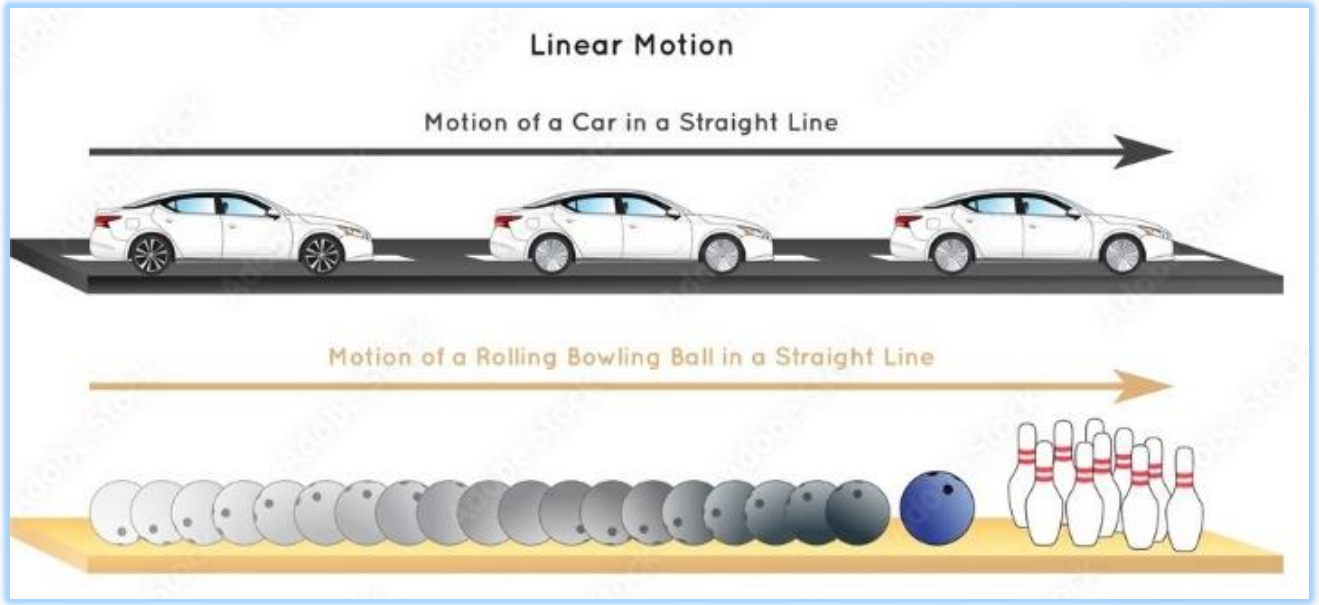
CONTENTS



Motion

- If an object shifts positions over time, it is considered to be in motion.

Motion parameters

- Distance
- Displacement
- Speed
- Velocity
- Acceleration

Distance

- The actual length of the path, described by the particle
- It is a scalar quantity.

- Dimension of distance $[M^0L^1T^0]$
- SI Unit of distance is m

Displacement

The minimum distance between initial and final position of a particle.

(Shortest Distance between 2 points)

- A vector quantity.
- Dimension of displacement $[M^0L^1T^0]$.
- SI Unit of distance is m

Difference between Distance & Displacement

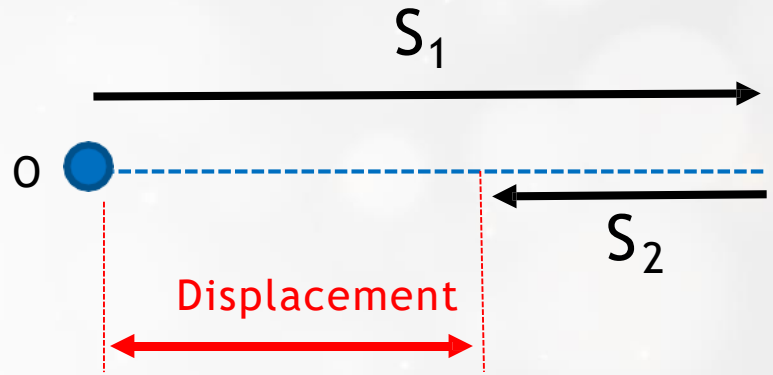
Distance	Displacement
▪ Total length of path covered by a body	▪ Shortest distance between initial & final position
▪ Scalar quantity	▪ Vector quantity
▪ For a closed path , distance travelled is non-zero	▪ For a closed path displacement is zero

Distance & Displacement

Displacement

$$\vec{S} = \vec{S_1} + \vec{S_2}$$

- The particle's displacement and distance when its direction of motion changes



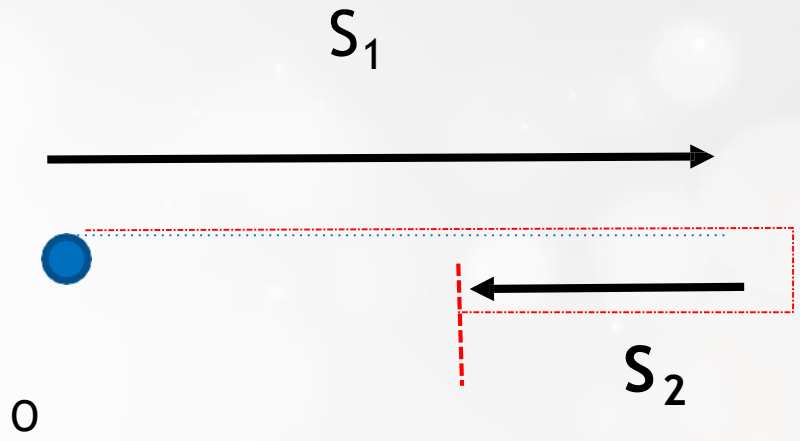
- This can be applied for n number of changes in direction, the net displacement = vector sum of all the displacements.

$$\vec{S} = \vec{S_1} + \vec{S_2} + \vec{S_3} + \dots + \vec{S_n}$$

Distance & Displacement

Net distance

$$|\vec{S_1}| + |\vec{S_2}|$$



- **This can be applied for n number of changes in direction, the net distance travelled is equal to the addition of magnitude of all the displacements**

Example

A body moves along the curved path of a quarter circle. Calculate the ratio of distance to displacement.

A. 11: 7

B. 7 : 11

C. $11 : \sqrt{2} \times 7$

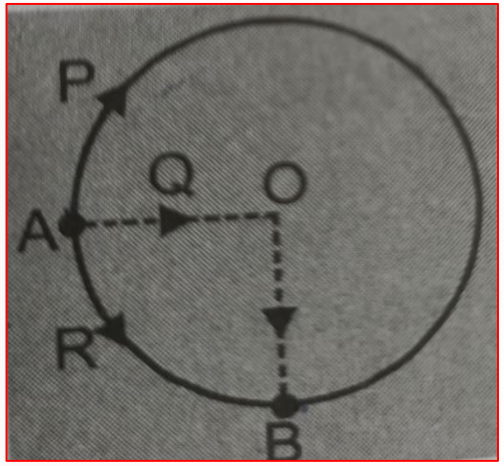
D. $7: 11\sqrt{2}$

Example

Three particles P,Q and R are situated at point A on the circular path of radius 10 m. All three Particles move along different paths and reach point B as shown in figure. Then the ratio of distance traversed by particles P and Q is :

A. $\frac{3}{4}$ B. $\frac{1}{3}$

C. $\frac{3\pi}{4}$ D. $\frac{\pi}{3}$



Average Speed

❖ The ratio of distance covered by a particle and time is called Average Speed

Speed is a scalar quantity

In M.K.S. = m/sec

In C.G.S. = cm/sec

Dimension $[M^0LT^{-1}]$

$$V_{avg} = \frac{\text{total distance}}{\text{time}}$$

Average speed

Average speed

Instantaneous Speed

- When the speed of an object is constantly changing, the instantaneous speed is the speed of an object at a particular moment (instant) in time.

Speed is a scalar quantity
In M.K.S. = m/sec
In C.G.S.= cm/sec
Dimension $[M^0LT^{-1}]$

Average Velocity

- **It is the ratio of total displacement to the total time taken.**

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

Average Velocity vs Average speed

Velocity of a particle when it REVERSES its direction of motion

- For a particle constrained to move in a straight line, it can only change its direction of motion opposite to the original direction of motion.
- If a body (particle) REVERSES direction of motion at a point, its velocity at that point must be ZERO.

  - When you throw a ball up, when it reaches the highest point, it changes its direction of motion and starts coming down

Example

A particle goes from point A to B on a semi circle of radius 1 m in 1 sec.

The average speed
The magnitude of average velocity.

A. π m/s, 2 m/s
b. 2π m/s, 4 m/s
c. $\pi/2$ m/s, 1 m/s
d. 2 m/s, 2 m/s

Example

A car runs at constant speed on a circular track of radius 10 m taking 6.28 s on each lap (i.e. round).
The average speed and average velocity for each complete lap is :

A. Velocity 10 m/s, Speed 10 m/s
B. Velocity zero, Speed 10 m/ s
C. Velocity zero, Speed zero
D. Velocity 10 m/s Speed zero

Average Acceleration

- It is defined as the ratio of the change in velocity to the time interval.

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

Instantaneous Acceleration

- It is the Rate of change of velocity
- A vector quantity
- Unit is m/s^2 in SI system

Instantaneous acceleration

Example

A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2. Its average speed during the complete journey is

(a) $\frac{v_1 + v_2}{2}$ (b) $\frac{v_1 v_2}{v_1 + v_2}$

(c) $\frac{2v_1 v_2}{v_1 + v_2}$ (d) $\frac{v_1^2 v_2^2}{v_1^2 + v_2^2}$ *(Mains 2011)*

Example

A particle moving in a straight line covers half the distance with the speed of 12 m/s. The other half of the distance is covered in two equal time intervals with speed of 4.5 m/s and 7.5 m/s respectively.
The average speed of the particle during this motion is :

A. 8.0 m/s B. 12.0 m/s
C. 10.0 m/s D. 9.8 m/s