Chapter 4

Motion in 1D straight line

- Parameters of straight-line motion
  1. State of Rest & Motion
  2. Frame of Reference
  3. Point Object Position of a Particle Distance Displacement
  4. Speed Velocity Position - Time Graph
- Motion under uniform acceleration
  1. Galileo's Plank Experiment
  2. Average Acceleration
  3. Instantaneous Acceleration
  4. Graphical Form of Instantaneous Acceleration
  5. Motion Under Uniform Velocity
  6. Uniform Acceleration
  7. Acceleration Time - Graph
  8. Equations of Motion
  9. Displacement in N^{th} Second
- Motion under gravity
  1. Motion under Gravity
  2. Assumptions for Motion under Gravity
  3. Numerical on Motion under Gravity
  4. Average speed and Average Velocity
- Equations of motion and problems involving graphical and calculus approach
  1. Equations of motion
  2. Problems involving graphical
  3. calculus approach
- Relative motion in one dimension
  1. Relative position,
  2. Relative motion parameters

PARAMETERS OF STRAIGHT-LINE MOTION

State of Rest & Motion

Rest: An object remains still when it doesn't shift from its spot compared to what's around it over time.

Motion: An object moves when its position shifts in relation to its surroundings and over time.

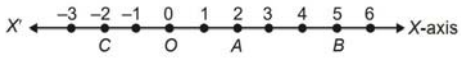
Frame of Reference

The location of an object is described in relation to a chosen standard frame.

Within this frame, an observer can determine the position of another object at any given moment, using a set coordinate system established within the frame.

for example,

The position of particle at O, A, B and C are Zero, +2, +5 and −2 respectively with respect to origin (O) of reference frame.



Point Object Position of a Particle Distance Displacement

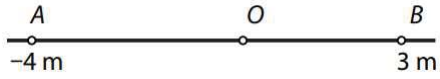
Position, displacement and distance

This module focuses solely on motion along a straight line. In the case of a horizontal line, there are two distinct directions: right and left. Similarly, for a vertical line, the directions are up and down. A point O is selected on the line, serving as the reference point or origin. Distance is measured in meters and time in seconds for convenience.

Position

The line is coordinated and referenced from a point O, known as the origin. Regarding a horizontal line, the convention dictates that positions to the right of O are considered positive, while positions to the left are negative.

Ex.



The position of the particle at B is 3 m.

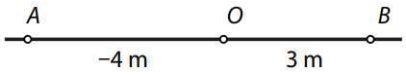
The position of the particle at A is −4 m

The location of a particle is commonly conceptualized as a function of time, denoted by x(t), where x(t) represents the position of the particle at time t.

Displacement

The displacement of a particle traveling along a straight line is defined as the difference in its position. When the particle moves from the position $x(t_1)$ to $x(t_2)$, its displacement over the time interval $[t_1, t_2]$ is represented by $x(t_2) - x(t_1)$. Essentially, the position of a particle is its displacement from the origin.

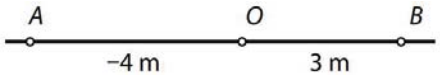
Ex.



If a particle moves from O to B, its displacement is 3 m.
If a particle moves from O to A, its displacement is −4 m.
If a particle moves from A to B, its displacement is 7 m.
If a particle moves from B to A, its displacement is −7 m.
Position and displacement are vector quantities, meaning they possess both magnitude and direction. This module focuses on vectors in one dimension. The direction of a quantity (positive or negative) is indicated by its sign, while its magnitude is represented by its absolute value.

Distance

Distance refers to the "total distance" covered, always non-negative. For instance, in the diagram provided, if a particle moves from A to B and then to O, the particle's displacement is 4 m, while the distance traveled is 10 m.

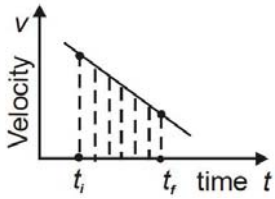


Ex. A particle moves along a straight line so that its position at time t seconds is x (t) meters, relative to the origin. Assume that x (0) = 0, x (3) = 2 and x (6) = −5, and that the particle only changes direction when t = 3. Find the distance travelled by the particle from time t = 0 to time t = 6.

Sol. The distance travelled is 2+7 = 9 meters.

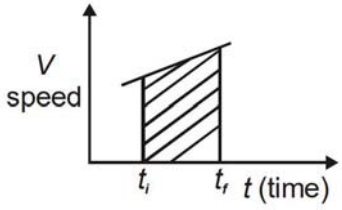
Speed Velocity Position - Time Graph

The area under speed-time graph between t_i and t_f gives distance covered by particle in the interval $t_f - t_i$.



Shaded area = displacement in time $(t_f - t_i)$

The area under the velocity-time graph between t_i and t_f gives the displacement $(x_f - x_i)$ between the two instants.



Shaded area = distance covered in time $(t_f - t_i)$