

KARACHI EDU COACHING CENTER • IX PHYSICS

Unit 2: Kinematics

Detailed Study of Motion Without Force • Sindh Textbook Board

Introduction to Mechanics & Kinematics



Mechanics

Branch of physics studying object motion. Divided into Kinematics and Dynamics.



Kinematics

Derived from Greek word '**Kinema**' meaning motion. Studies motion without force reference.

Rest and Motion are Relative States

State of Rest

No position change with respect to surroundings. Example: Car parked near trees.

State of Motion

Continuous position change relative to surroundings. Example: Moving train or bus.

Relative Nature

No absolute rest. Passenger is at rest inside bus but in motion relative to road observer.

Types of Motion

1. Translatory Motion

All points move uniformly along same straight or curved line.
Includes linear, circular, and random motion.

2. Rotatory Motion

Spinning of a body around a fixed axis passing through itself.
Example: Spinning top or wheel.

3. Vibratory Motion

Back and forth motion about a mean position. Example: Clock pendulum or swing.

Sub-types of Translatory Motion

Linear Motion

Motion of a body along a straight line. Example: Train on straight track or bus on straight highway.

Circular Motion

Motion along a circular path.
Example: Artificial satellite orbiting around the Earth.

Random Motion

Irregular zigzag motion. Example: Insects, dust particles, or Brownian motion of gas molecules.

Distance vs. Displacement

Distance

- Total length covered without direction.
- Scalar quantity.
- SI Unit: metre (m).

Displacement

- Shortest distance in a straight line with direction.
- Vector quantity.
- SI Unit: metre (m).

Speed and Velocity

Speed (v)

Distance covered per unit time. Scalar quantity.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} \quad (\text{SI Unit: m/s})$$

Velocity (v)

Rate of change of displacement. Vector quantity.

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}} \quad (\text{SI Unit: m/s})$$

Acceleration

Definition & Formula

The rate of change of velocity of a body is called acceleration. It is a vector quantity.

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

SI Unit: Meters per second square (m/s^2)

Graphical Analysis: Distance-Time Graph

Slope Interpretation

The slope of distance-time graph directly gives the **speed** of the moving body.

States on Graph

- **Horizontal line:** Body at rest.
- **Straight inclined line:** Constant speed.
- **Curved line:** Variable speed.

Speed-Time Graph & Distance

Slope of Speed-Time

The slope of a speed-time graph represents the **acceleration** of the body.

Area Under Graph

The total area enclosed under a speed-time graph gives the total **distance traveled**.

Equations of Motion

First Equation

$$v_f = v_i + at$$

Second Equation

$$S = v_i t + \frac{1}{2}at^2$$

Third Equation

$$2aS = v_f^2 - v_i^2$$

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Freely Falling Bodies

All bodies falling freely under gravity experience a constant acceleration
due to gravity:

$$g = 10 \text{ m/s}^2$$

