

## AI Response:

Kinematics is a branch of classical mechanics that deals with the motion of objects.

### Key Concepts

- Displacement (s)**: The change in position of an object. It is a vector quantity.
- Distance**: The total path length traveled by an object in motion. It is a scalar quantity.
- Velocity (v)**: The rate of change of displacement with respect to time. It is a vector quantity.
  - Average Velocity**:  $v_{\text{avg}} = \frac{\Delta s}{\Delta t}$
  - Instantaneous Velocity**: The velocity at a specific moment in time.
- Acceleration (a)**: The rate of change of velocity with respect to time. It is a vector quantity.
  - Average Acceleration**:  $a_{\text{avg}} = \frac{\Delta v}{\Delta t}$
  - Instantaneous Acceleration**: The acceleration at a specific moment in time.
- Time (t)**: The duration over which motion occurs.

### Equations of Motion

For uniformly accelerated motion (constant acceleration), the following kinematic equations apply:

- $v = u + at$ 
  - Where  $v$  is the final velocity,  $u$  is the initial velocity,  $a$  is acceleration, and  $t$  is time.
- $s = ut + \frac{1}{2}at^2$ 
  - Where  $s$  is the displacement.
- $v^2 = u^2 + 2as$
- $s = \frac{(u + v)}{2} t$

### Special Cases

- Free Fall**: When an object is falling under the influence of gravity, the acceleration is constant and equal to  $g$ .
- Projectile Motion**: The motion of an object that is launched into the air and follows a parabolic path.
- Circular Motion**: Motion along a circular path, where objects experience centripetal acceleration.

### Applications

Kinematics is used in various fields, including physics, engineering, robotics, and biology.