Physics: A Study of Mechanics & Motion

Section 1: Newton's Laws of Motion

Classical mechanics, the study of the motion of objects, is built upon the three fundamental laws formulated by Sir Isaac Newton.

1. **First Law (The Law of Inertia):** An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.
2. **Second Law (F = ma):** The acceleration of an object is directly proportional to the net force acting upon it and inversely proportional to its mass. The direction of the acceleration is in the direction of the net force.
3. **Third Law (Action-Reaction):** For every action, there is an equal and opposite reaction.

Section 2: Work, Energy, and Power

Energy is the capacity to do work. The principle of conservation of energy states that energy cannot be created or destroyed, only transformed from one form to another.

- **Kinetic Energy (KE):** The energy of motion, calculated as $KE = \frac{1}{2}mv^2$.
- **Potential Energy (PE):** Stored energy due to an object's position or state. For gravity, it is $PE = mgh$.

Work is done when a force causes a displacement, calculated as $W = Fd\cos(\theta)$. Power is the rate at which work is done, $P = W/t$.

Section 3: Momentum and Collisions

Linear momentum (p) is the product of an object's mass and velocity ($p = mv$). It is a vector quantity.

The principle of conservation of momentum is a fundamental law of physics which states that the momentum of a system is constant if there are no external forces acting on the system. This is particularly useful for analyzing collisions, which can be classified as either elastic (kinetic energy is conserved) or inelastic (kinetic energy is not conserved).