Force and Laws of Motion

Introduction

Force is a push or pull that can change the state of motion, direction, or shape of an object. The laws of motion, given by **Sir Isaac Newton**, explain how objects move when forces act on them. This chapter also introduces the concepts of inertia, momentum, and conservation of momentum.

Force

Definition

A **force** is a push or pull acting on an object.

A force can:

- Start or stop the motion of an object.
- Change its speed.
- Change its direction.
- Change its shape.

SI Unit: Newton (N)

Balanced and Unbalanced Forces

Types of Forces

Balanced Forces:

Balanced forces are equal and opposite. They do not change the state of motion of an object but may change its shape.

Unbalanced Forces:

Unbalanced forces cause a change in the speed or direction of an object. They produce acceleration.

Newton's First Law of Motion

Law of Inertia

Newton's First Law states that **an object remains at rest or continues to move with uniform velocity in a straight line unless acted upon by an unbalanced external force.**

This property of resisting any change in motion is called **inertia**.

Examples:

- Passengers move forward when a moving bus stops suddenly.
- Dust comes out when a carpet is beaten.

Inertia and Mass

Relationship

Inertia is the tendency of an object to resist any change in its state of motion.

- Greater the **mass**, greater is the **inertia**.
- A heavier object is more difficult to move than a lighter one.

Momentum

Definition

Momentum is the quantity of motion possessed by an object.

Formula:

Momentum = Mass × Velocity

p = mv

The SI unit of momentum is **kg m/s**.

Newton's Second Law of Motion

Force and Momentum

Newton's Second Law states that the **force acting on an object is equal to the rate of change of its momentum.**

From this law,

Force = Mass × Acceleration

F = ma

This law explains why a greater force is needed to accelerate a heavier object.

Newton's Third Law of Motion

Action and Reaction

Newton's Third Law states that:

"For every action, there is an equal and opposite reaction."

The action and reaction forces always:

- Act simultaneously.
- Are equal in magnitude.
- Act in opposite directions.

Examples:

- Walking
- Swimming
- Rocket launch
- Recoil of a gun

Law of Conservation of Momentum

Principle

The **total momentum of an isolated system remains constant** if no external force acts on it.

This law is useful in explaining collisions, explosions, and rocket propulsion.

Applications of Newton's Laws

Everyday Uses

Newton's laws are used in many real-life situations:

- Wearing seat belts in vehicles.
- Walking and running.
- Launching rockets.
- Playing sports.
- Moving vehicles and machines.

Key Points

- Force is a push or pull acting on an object.
- Balanced forces do not change the state of motion.
- Unbalanced forces produce acceleration.
- Inertia is the resistance to change in motion.
- Momentum is the product of mass and velocity.
- Newton gave three laws of motion.
- The total momentum of an isolated system always remains constant.

Chapter Summary

This chapter explains the concept of force and Newton's three laws of motion. It also introduces inertia, momentum, and the law of conservation of momentum. These principles help us understand the motion of objects and are widely used in science, engineering, transportation, and everyday life.