Chapter 8: Force and Laws of Motion

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1. What is Force?

- **Definition**: A force is a push or a pull upon an object resulting from the object's interaction with another object.
- **Unit**: Newton (N)

Types of Force Based on Effects:

- **Balanced Force**:
  - Two equal and opposite forces acting on an object.
  - Net force is **zero**.
  - Does **not** change the object's motion.
  - Example: Tug of war with equal strength on both sides.
- **Unbalanced Force**:
  - Forces are unequal.
  - Causes a change in motion (speed or direction).
  - Example: Kicking a stationary football.

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2. Newton's Laws of Motion

⚖ First Law of Motion (Law of Inertia)

Statement: An object remains at rest or in uniform motion in a straight line unless acted upon by an unbalanced external force.

- **Inertia** is the natural tendency of an object to resist a change in its state of motion or rest.
- **Inertia depends on mass**:
  - A heavier object has more inertia.
  - Example: It's harder to push a truck than a bicycle.

🔍 Examples:

- A book on a table stays at rest unless you push it.
- Passengers lurch forward when a car suddenly stops (inertia of motion).

🚀 Second Law of Motion

Statement: The rate of change of momentum of an object is directly proportional to the applied force and takes place in the direction of the force.

Formula:

$F=ma$

Where:

- F = force (N)
- m = mass (kg)
- a= acceleration (m/s^2)

Momentum (p):

$p=mv$

Where:

- p= momentum
- m = mass
- v = velocity

Application:

- A lighter cricket ball is easier to accelerate than a heavy shot put.

💥 Third Law of Motion

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

- Action and reaction forces act on **different bodies**.
- Forces are equal in magnitude, opposite in direction.

Examples:

- A swimmer pushes water backward (action), water pushes the swimmer forward (reaction).
- When a gun is fired, the bullet moves forward, and the gun recoils backward.

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3. Conservation of Momentum

Law: The total momentum of an isolated system (no external force) remains constant if no external force acts on it.

Before collision = After collision:

$$m_1u_1+m_2u_2=m_1v_1+m_2v_2$$

Where:

- m_1, m_2 = masses
- u_1, u_2 = initial velocities
- v_1, v_2 = final velocities

Examples:

- When two balls collide, the total momentum before and after collision remains the same.
- Recoil of a gun: Gun moves backward to conserve momentum when the bullet moves forward.

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4. Important Terms

Term	Definition
Force	A push or pull acting on an object
Inertia	Resistance of an object to change its state
Momentum	Product of mass and velocity (p=mv)
Acceleration	Rate of change of velocity
Recoil	Backward motion of a gun when a bullet is fired

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5. Real-Life Applications of Newton's Laws

- **Walking**: Foot pushes the ground (action), ground pushes back (reaction).
- **Rocket Propulsion**: Hot gases expelled down (action), rocket moves up (reaction).
- **Car Seatbelts**: Prevent forward motion due to inertia during sudden braking.