

## Chapter 5: Exploring Forces - Detailed Study Notes

### 1. What is a Force?

- **Definition:** In science, a force is simply defined as a push or a pull applied to an object.
- **Interaction is Required:** For any force to come into play, at least two objects must interact with each other.
- **Reciprocal Action:** Whenever two objects interact, each object experiences a force from the other. The moment this interaction stops, the force disappears.
- **Unit of Force:** The standard unit (SI unit) used to measure force is the **newton**. Its symbol is **N**.

### 2. Effects of Force

When a force is applied to an object, it cannot act without causing an effect. A force can do the following:

- **Start Motion:** It can make a stationary object start moving from rest.
- **Change Speed:** It can increase or decrease the speed of an object that is already moving.
- **Change Direction:** It can alter the direction in which an object is moving.
- **Change Shape:** It can change the physical shape of an object (like stretching a rubber band or pressing a balloon).
- **Exam Point:** None of these changes (speed, direction, or shape) can happen without the action of a force. If an object is completely at rest, it means all the forces acting on it are perfectly balancing each other out.

### 3. Types of Forces

Forces are broadly classified into two main categories: **Contact Forces** and **Non-Contact Forces**.

#### A. Contact Forces

These are forces that act only when there is direct physical contact between objects (using hands, ropes, sticks, etc.).

##### 1. Muscular Force:

- This is the force caused by the action of muscles in our body.
- It allows us to perform physical activities like walking, jumping, lifting, and pushing.

- **Internal Uses:** Muscular force is essential for survival; it helps chew food, pushes food down the alimentary canal during digestion, and expands/contracts the heart to circulate blood.
- Animals also use muscular force to carry out heavy tasks for humans.

## 2. Force of Friction (Friction):

- **Definition:** The force that comes into play when an object moves or tries to move over another surface is called friction.
- **Direction:** Friction always acts in the completely opposite direction to the movement of the object. It is what causes a rolling ball or a moving bicycle to eventually slow down and stop.
- **Cause:** Friction is caused by minute irregularities (tiny bumps) on surfaces. When two surfaces touch, these minute irregularities lock into each other and oppose movement.
- **Surface Dependence:** Friction is much greater on rough surfaces compared to smooth surfaces.
- **Fluid Friction:** Air and liquids also exert a force of friction on objects moving through them. To reduce this drag, vehicles like aeroplanes, ships, and high-speed trains are built with specially designed shapes.

## B. Non-Contact Forces

These are forces that can exert an effect on an object from a distance, without any physical contact.

### 1. Magnetic Force:

- This is the force exerted by a magnet on another magnet or on a magnetic material.
- Like poles (North-North) repel each other, while unlike poles (North-South) attract each other.

### 2. Electrostatic Force:

- This is the force exerted by a charged body on another charged or uncharged body.
- **Static Charges:** When certain materials (like plastic and polythene) are rubbed together, they build up electrical charges on their surface.
- There are two types of charges: 'positive' and 'negative'.

- **Rule of Charges:** Similar (like) charges push away or repel each other, while opposite (unlike) charges pull or attract each other.

### 3. Gravitational Force (Gravity):

- This is the pulling force with which the Earth (or any massive body) attracts all objects towards itself.
- Unlike magnetic or electrostatic forces (which can push or pull), gravitational force is **always an attractive force**.
- **Vertical Motion:** When an object is thrown upwards, gravity continuously pulls it down, causing its speed to decrease until it momentarily stops at the top. Then, its speed increases as it falls back down in a straight vertical path.

### 4. Mass vs. Weight

Students often confuse mass and weight, but they are scientifically very different.

- **Mass:** Mass is the actual amount of matter contained inside an object. It is measured in grams (g) or kilograms (kg). **Mass remains the exact same everywhere in the universe.**
- **Weight:** Weight is the actual gravitational force with which the Earth (or another planet) pulls an object. Because weight is a force, its **SI unit is the newton (N)**.
- **Planetary Changes:** Because the gravitational pull is different on different planets, the weight of an object changes depending on where it is. For example, a 1 kg object weighs 10 N on Earth but only 1.6 N on the Moon.
- **Measurement:** Weight is measured using an instrument called a **spring balance**. It has a hook and a spring; when an object is hung, the Earth pulls it down, stretching the spring to indicate the weight.

### 5. Floating and Sinking (Buoyancy)

Why do some heavy things sink in water while other things float?

- **Upthrust / Buoyant Force:** When an object is placed inside a liquid, the liquid applies an upward push on the object. This upward force is called upthrust or buoyant force.
- **The Sinking/Floating Rule:**
  - If the downward gravitational force (weight) is **greater** than the upward buoyant force, the object **sinks**.
  - If the downward gravitational force is **equal** to the upward buoyant force, the object **floats**.

- **Archimedes' Principle:** A famous Greek scientist discovered that when an object is immersed in a liquid, it experiences an upward force that is exactly equal to the weight of the liquid it displaces (pushes aside).
- **Special Example - Pumice Rock:** Pumice is a type of volcanic rock that floats on water. When hot lava cools very quickly, it traps tiny gas and water vapour bubbles inside. This creates a porous, light rock full of air pockets, making it less dense than water, allowing it to float.