3. Force and Pressure

- Force is a push or pull upon an object resulting from the object's interaction with another object. The various effects of force are:
- Force can move a body initially at rest.
- Force can bring a moving body to rest.
- Force can change the direction of a moving body.
- Force can change the speed of a moving body.
- Force can change the shape of a body.
- Force can change the size of a body.

- Non-contact force come into play even when the bodies are not in contact.
- **Magnetic force –** Force acting between two magnets or a magnet and a magnetic material (eg. iron, steel, nickel, cobalt etc.). It can be attractive and repulsive.
- **Electrostatic force –** Force due to electric charges. It can be attractive and repulsive.
- **Gravitational force –** It is a kind of attractive force that comes into play because of the mass of a body. (eg. earth's gravitational attraction).

- **Muscular force –** It involves the action of muscles.
  - Animals make use of muscular force to carry out their physical activities and other tasks.
- **Friction –** It is an opposing force that acts between surfaces in contact moving with respect to each other.
  - Frictional force always acts between two moving objects, which are in contact with one another.
  - Frictional force always acts opposite to the direction of motion.
  - Frictional force depends on the nature of the surface in contact.
- **Tension Force -** This force appears in a string, attached to a rigid support, when an object is suspended by it.
- **Mechanical Force** - It involves the force generated by machines.
- **Force exerted during collision -**Two objects push each other with an equal but opposite forces if collision occurs between them. These forces are known as the force of action and force of reaction.
- **Combined Forces** - When two or more forces are acting on the same object.

- Interection of one object with another object results in a force between the two objects.
- The effect of force depends on the magnitude and direction of the force.
- Force applied in the same direction added to one another.
- Force applied in the opposite direction, the net force is given by the difference of two forces.

- **First law of motion**
  - A body at rest remains at rest and a body in uniform motion continues its uniform motion unless an external force is applied.

- **Inertia:**
  - It is the tendency of a body to resist any change in its state of rest or of uniform motion along a straight line.
  - Mass of an object is the measure of its inertia, more is the mass more is the inertia.
  - Types of inertia: Inertia of rest and motion

- **Thrust –** Force acting perpendicular to a surface
- **Pressure** = Perpendicular force per unit area

$$= \frac{\text{Thrust}}{\text{Area}} \left[\text{N/m}^2 = \text{Pascal (Pa)} \right]$$

  - Lesser is the area more is the pressure; this is the reason why we prefer to use sharp knives over the blunt ones to cut objects. This pressure is again the reason why it is difficult to hold a school bag having a strap made of a thin and strong string.

- Liquids exerts pressure on the walls of the container.
- Pressure exerted by liquids increases with depth.
- Liquids exert equal pressure at the same depth.
- The pressure at which water comes out of the holes is directly proportional to its depth.
- Fluid— Substance which can flow and has no fixed shape

- Pressure due to a liquid column of height h:

$$p = h\rho g$$

Where, h = Height of column

ρ = Density of fluid
g = Acceleration due to gravity

- Pressure inside a fluid increases with increase in depth and density of the fluid.

- Water and gas exert pressure on the walls of their container.
- Atmosphere exerts pressure on the surface of the Earth.
- **Atmospheric pressure** = Weight of the atmosphere per unit area.
- Pressure inside our body is equal to the atmospheric pressure and cancels the pressure from out side.
- Air surrounding the Earth – atmosphere
- Air exerts pressure on its surroundings – thrust on unit area is called atmospheric pressure

- **Buoyancy**
  - Buoyant force = Up thrust by a fluid on a partially or fully immersed object is buoyancy or buoyant force. [Depends on fluid density]
  - Buoyant force = Weight of displaced liquid
  - Buoyant force = Volume of the object immersed in liquid × Density of the liquid × Acceleration due to gravity
  - This is the reason why an object immersed in water weighs comparatively lesser than its weight when it is outside water**.**

- **Archimedes' principle**
  - Upward force experienced by a body immersed in fluid = Weight of the displaced fluid
  - Lactometer measures purity of milk

- **Density of a substance-** mass per unit volume**.** It is expressed as

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

  The SI unit of density is kg/m^3.

- If density of body > density of fluid, then the body will sink in the fluid.
- If density of body < density of fluid, then the body will float in the fluid.

(Density of cork) < (density of water), so cork floats.

(Density of iron) > (Density water), so iron sinks.

- Relative density $= \frac{\text{Density of a substance}}{\text{Density of water}}$

Relative Density of a Solid Substance by Archimedes' Principle

R.D. **=W1W1-W2**

where W_1 is the weight of the body in air and W_2 is the weight of the body in water.

(1) Relative density of a solid denser than water and insoluble in it

R.D.=Weight of solid in airLoss in weight of solid in water=W1W1-W2

(2) Relative density of a solid denser than water and soluble in it

R.D.=Weight of solid in airLoss in weight of solid in liquid×R.D. of liquid

Relative Density of a Liquid Substance by Archimedes' Principle

If a solid is immersed in a liquid or water, it displaces the liquid or water equal to its own volume.
R.D.=Weight of a liquid displaced by a bodyWeight of water displaced by the same body=Weight of the body in air - Weight of the body in liquidWeight of the body in air - W2W1-W3