Fluids

- **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:

$$p = h\rho g$$

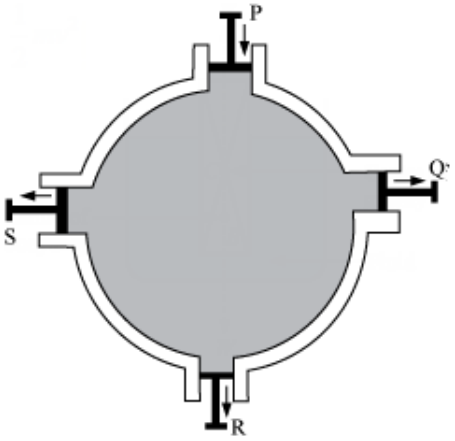
Where, h = Height of column

ρ = Density of fluid

g = Acceleration due to gravity

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

Pascal's law— When pressure is applied on a fluid, it is transmitted equally in all directions, irrespective of the area on which it acts. It always acts at right angles to the surface-containing vessel.



Application of Pascal's law— Hydraulic press, hydraulic brakes, hydraulic lift

- **Atmospheric Pressure**— Force exerted by air surrounding the earth on a unit surface area

Average atmospheric pressure at sea level = 100,000 Pa

- Barometer— Instrument used for measuring atmospheric pressure
- Atmospheric pressure changes with change in height, pressure, and temperature.

- **Liquid Pressure**

1. **Pressure exerted by liquid because of its own weight below its own free surface**
2. Pressure is equally divided below its surface.
3. Pressure increases with depth.
4. Pressure remains the same in a given depth.
5. Pressure is exerted on the sides of the wall.
6. Pressure is transmitted equally in all directions when pressure is exerted on the liquid.

- **Pressure exerted by Gases**

1. **Gases also exert pressure on the walls of the container.**
2. Increasing the volume—lowers the pressure
3. Decreasing the volume—increases the pressure
4. Increasing the pressure—decreases the volume
5. Decreasing the pressure—increases the volume

Hydraulic Machines

- These are based on Pascal's law for transmission of fluid pressure. This law states that the external pressure applied on any part of a fluid contained in a vessel is transmitted undiminished and equally in all directions.

- Hydraulic lift, hydraulic brakes, hydraulic press, etc. are some examples of hydraulic machines.

- **Atmospheric Pressure**— Force exerted by air surrounding the earth on a unit surface area

Average atmospheric pressure at sea level = 100,000 Pa

- Atmospheric pressure changes with change in height, season, and temperature.
- Following two factors are mainly responsible for this decrease in atmospheric pressure with height:

  (1) decrease in height of air column results in a linear decrease in the atmospheric pressure and
  (2) decrease in density of air with height results in a non-linear decrease in atmospheric pressure

Advantages of Mercury Barometer :

- Mercury gives more accurate readings because it does not stick to the glass tube.
- It does not evaporate easily.

Fortin Barometer

It is a modified form of a simple barometer and has the same use as of simple barometer. It also uses mercury as the barometric liquid.

Aneroid Barometer

This barometer is an exception as it has no liquid. It is very light and can be transported from one place to another. It is calibrated to read directly the atmospheric pressure

Uses of Barometer

- Measures atmospheric pressure of a place
- Forecasts weather
- Work as an altimeter to measure height

- Barometer— Instrument used for measuring atmospheric pressure
- **Altimeter**: It is an aneroid barometer and is used only in aircraft to measure its altitude from the sea level.

- **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

$$\text{R.D.} = \frac{W_1}{W_1 - W_2}$$ **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

$$\text{R. D.} = \frac{\text{Weight of solid in air}}{\text{Loss in weight of solid in water}} = \frac{W_1}{W_1 - W_2}$$ R.D.=Weight of solid in airLoss in weight of solid in water=W1 W2

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

$$\text{R. D.} = \frac{\text{Weight of solid in air}}{\text{Loss in weight of solid in liquid}} \times \text{R. D. of liquid}$$ R.D.=Weight of solid in airLoss in weight of solid i

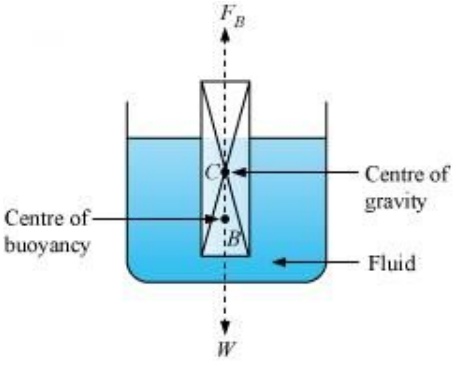
Relative Density of a Liquid Substance by Archimedes' Principle

If a solid is immersed in a liquid or water, it displaces the liquid or water equal to its own volume.

$$\text{R. D.} = \frac{\text{Weight of a liquid displaced by a body}}{\text{Weight of water displaced by the same body}} = \frac{\text{Weight of the body in air} - \text{Weight of the body in liquid}}{\text{Weight of the body in air} - \text{Weight of the body in water}}$$

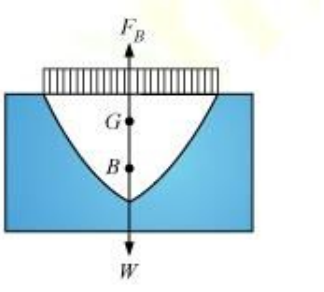
W2W1-W3

Floatation:

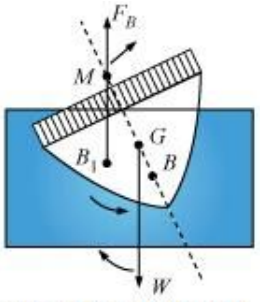


1. When weight of a body is more than buoyant force, the body will drown.
2. When weight of a body is just equal to the weight of fluid displaced, the body will just float.
3. When weight of body is less than fluid displaced, the body will not drown in water. Even if a force is applied on it to drown, it will come up as soon as the force is removed.

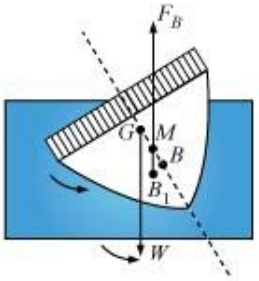
Stability of a floating body



Stable equilibrium



Unstable equilibrium



Unstable equilibrium