NDA-CDS 1 2025

GS

LIVE

PHYSICS

HYDROSTATICS

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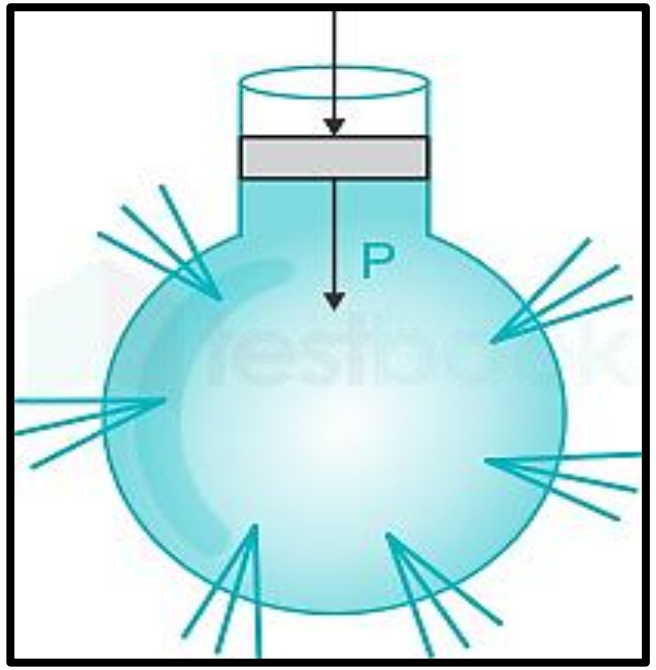
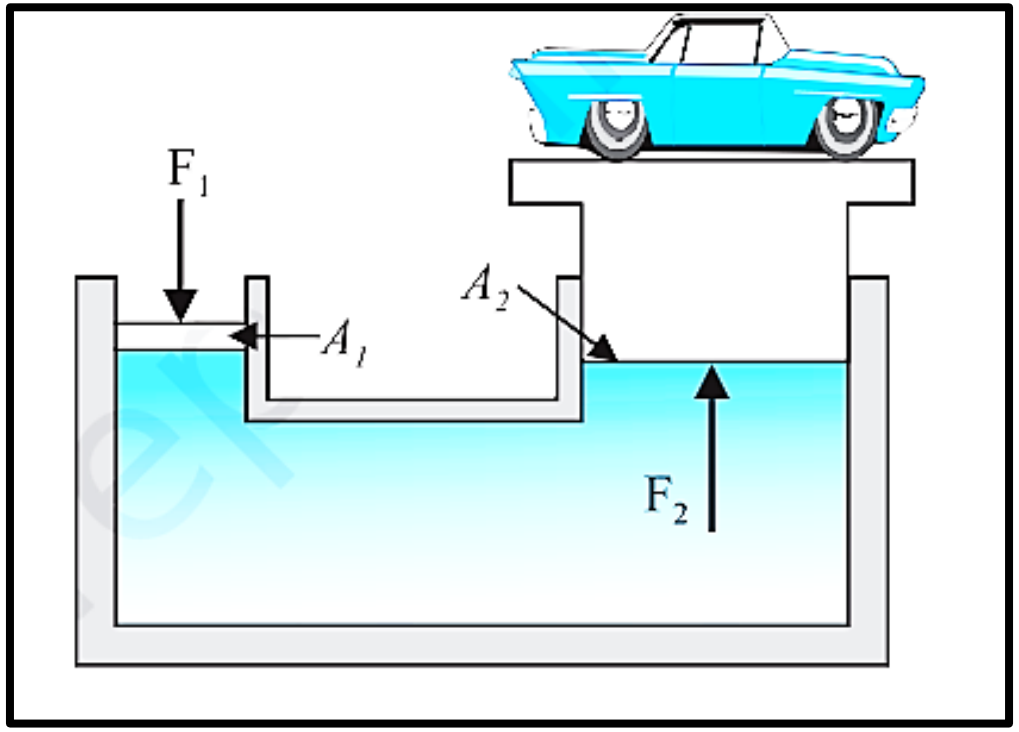
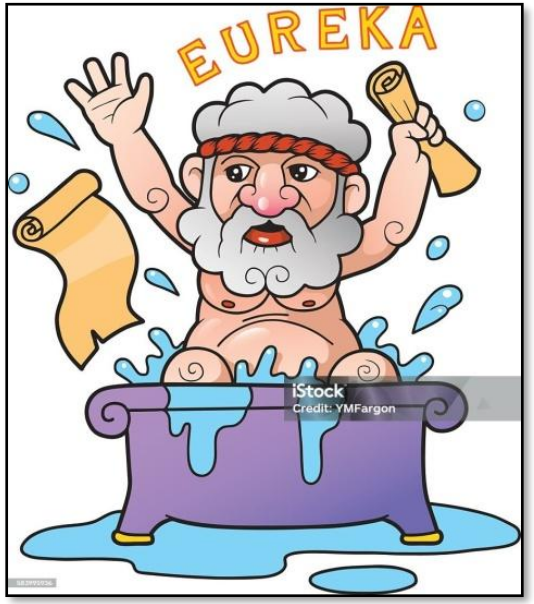
SSBCrack
EXAMS

HYDROSTATICS







WHAT WILL WE STUDY ?

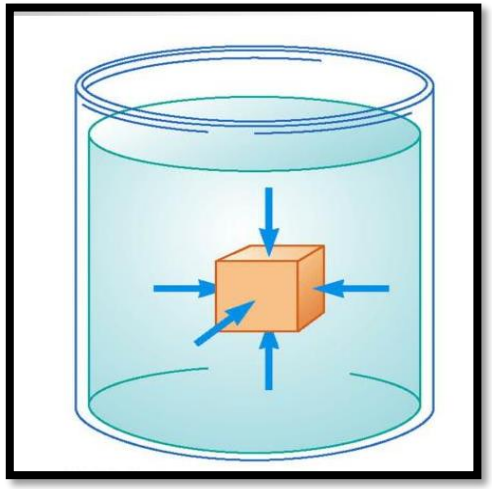
- Pressure
- Pascal’s Law
- Atmospheric Pressure
- Density and Specific Gravity
- Buoyancy and Archimedes Principle

FLUIDS AND PRESSURE

- Fluids are those substances which can flow when an external force is applied on them. Liquids and gases are fluids.
- Pressure of liquid at a point is $p = \frac{\text{Thrust}}{\text{Area}} = \frac{F}{A}$.

Thrust is The total normal force exerted perpendicular by liquid at rest.

- Pressure is a scalar quantity. Its unit is Nm^{-2} or Pascal (Pa).

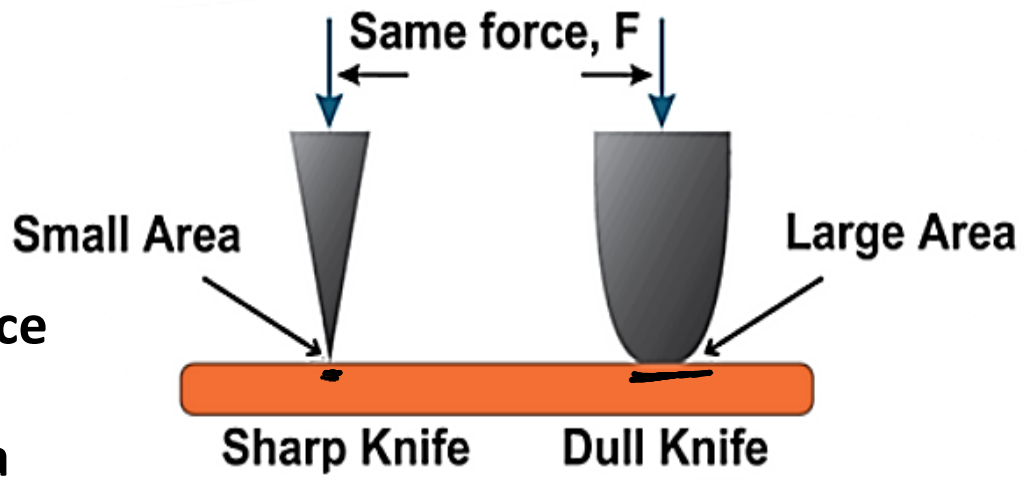


FLUIDS AND PRESSURE

- From the formula of pressure,

$$P = \frac{\text{Thrust (perpendicular force)}}{\text{Area}}$$

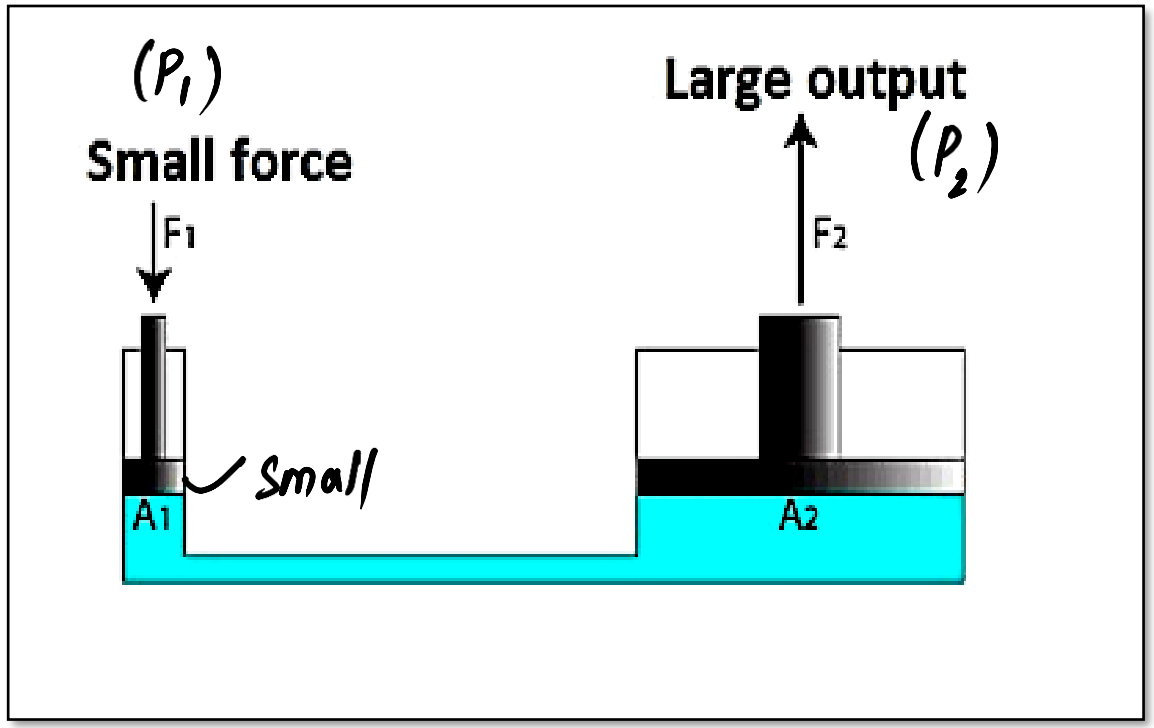
The same force can produce different pressures depending on the area over which it acts. The same force acting on a smaller area exerts a larger pressure while a force on a larger area exerts small pressure.



$$\left(P \propto \frac{1}{\text{Area}} \text{ (if F is same)}\right)$$

PASCAL 'S LAW

- The increase in pressure at a point in the enclosed liquid is transmitted equally in all directions in liquid and to the walls of the container.
- The working of hydraulic lift and hydraulic brakes are based on Pascal's law.



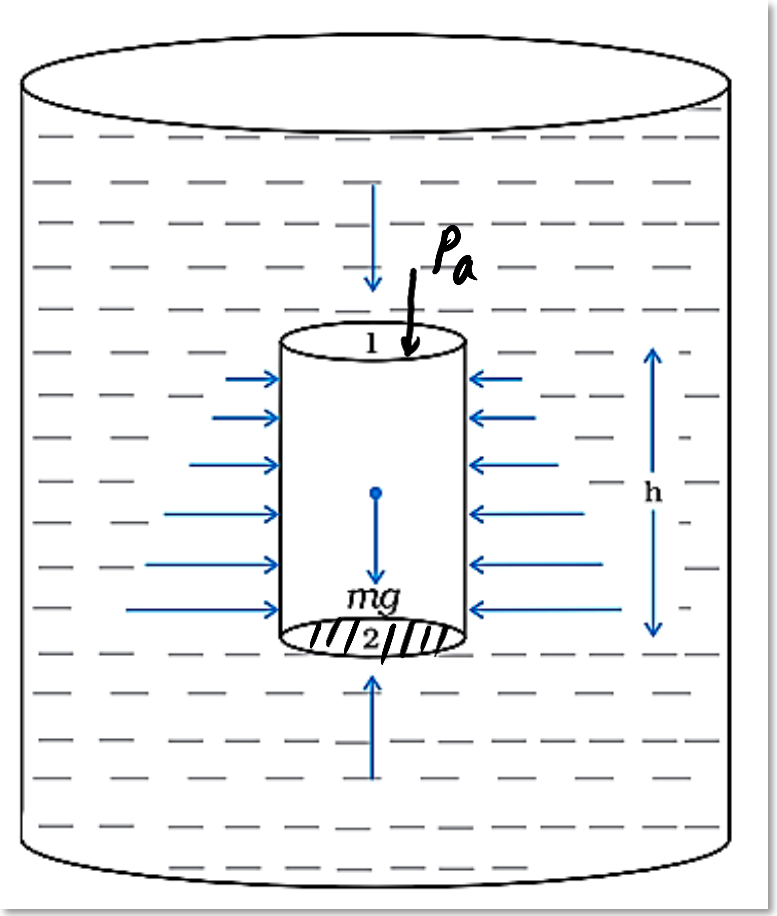
$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_2 = \left(\frac{F_1}{A_1}\right) \times A_2$$ → large area

$\Rightarrow F_2$ becomes large.

Variation of Pressure with Depth



$P_a \rightarrow$ atmospheric Pressure

$$P = \frac{\text{Thrust}}{\text{Area}} = \frac{\text{weight at surface 2}}{\text{Area}}$$

$$= \frac{mg}{\text{area}} = \frac{(\text{density} \times \text{volume}) \times g}{\text{Area}} =$$

$$= \frac{\rho \times (\text{Area} \times \text{height}) \times g}{\text{Area}} = h\rho g$$

$$P_2 = P_a + h\rho g$$

LAWS OF LIQUID PRESSURE

- **Pressure inside a liquid is same at every point on the same horizontal plane.**

$P = h\rho g$

same 'h' ⇒ same P

- **The pressure exerted by the liquid is normal to any surface with which the liquid is in contact.**

considering 'Thrust'.

LAWS OF LIQUID PRESSURE

- The pressure at any point within the liquid is independent of shape of liquid surface as well as the area of liquid surface.

$P = h\rho g$

- Centre of pressure is that point of the body immersed in liquid at which the resultant liquid pressure acts.

Atmospheric Pressure

- The pressure exerted by the atmosphere on earth.
- At sea level, atmospheric pressure is equal to 76 cm of mercury column.

Then, atmospheric pressure

$$= hdg = 76 \times 13.6 \times 980 \text{ dyne/cm}^2$$

$$= 0.76 \times 13.6 \times 10^3 \times 9.8 \text{ N/m}^2$$

$$\boxed{1 \text{ atm} = 1.013 \times 10^5 \text{ Nm}^{-2} \text{ (or Pa)}} \approx 10^5 \text{ Pa}$$

$P = h\rho g$

- Aneroid barometer is used to measure atmospheric pressure.

DENSITY

- For a fluid of mass m occupying volume V , density

$$\rho = \frac{m}{V}$$

- Its SI unit is kg m^{-3}. It is a positive scalar quantity.
- A liquid is largely incompressible and its density is therefore, nearly constant at all pressures.
- The density of water at $4^{o}C$ (277 K) is 1.0×10^{3} kg m^{-3} .

RELATIVE DENSITY

- The relative density , or specific gravity of a substance is the ratio of its density to the density of water at 4°C.
- It has no units.

$$\text{Relative density} = \frac{\text{weight of some volume of substance}}{\text{weight of equal volume of water}}$$

$$= \frac{m_s g}{m_w g} = \frac{m_s}{m_w} = \frac{\rho_s V}{\rho_w V} = \frac{\rho_s}{\rho_w}$$

DENSITY OF MIXTURES

- If equal volumes of two liquids of densities d_1 and d_2 are mixed together,

$$d_{mixt.} = \frac{\text{Total mass}}{\text{Total volume}} = \frac{m_1 + m_2}{V + V} = \frac{d_1 V + d_2 V}{V + V} = \frac{V(d_1 + d_2)}{2V}$$

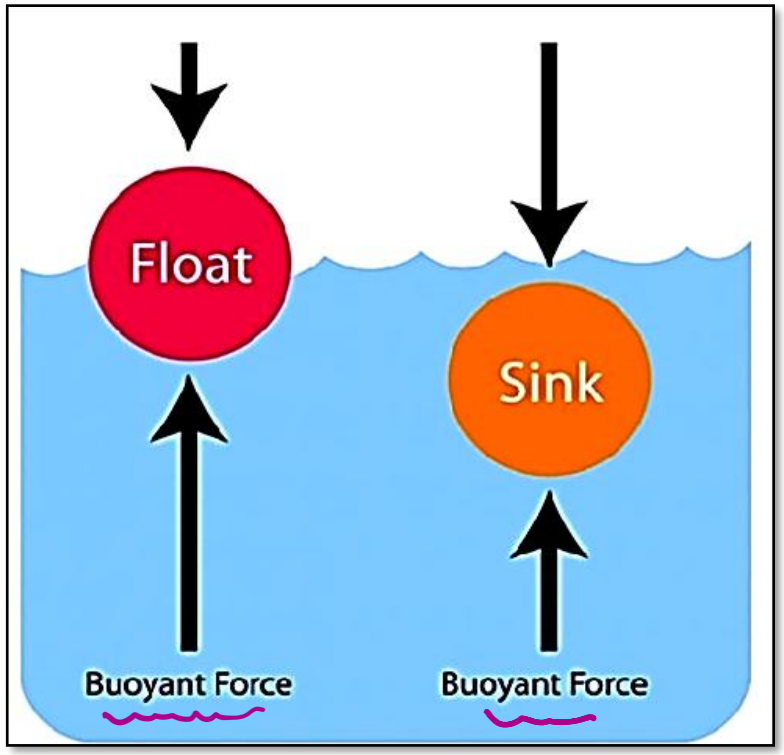
- $\left(d_{mixt.} = \frac{d_1 + d_2}{2}\right)$ (average)

- If two liquids of masses m_1 and m_2 , densities d_1 and d_2 are mixed together

$$d_{mixt.} = \frac{\text{Total mass}}{\text{Total Volume}} = \boxed{\frac{m_1 + m_2}{\frac{m_1}{d_1} + \frac{m_2}{d_2}}}$$

BUOYANCY

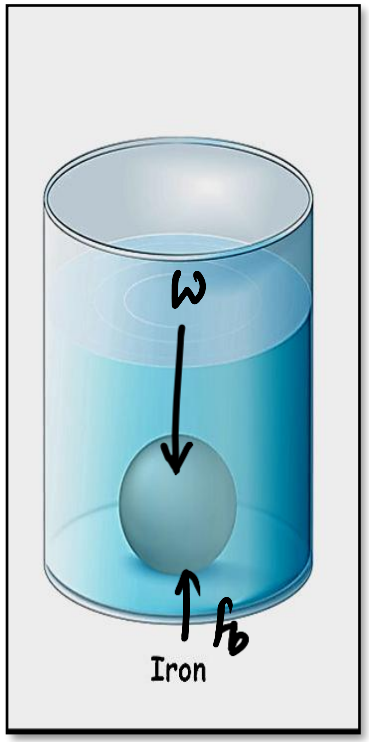
- When a body is partially or fully immersed in a fluid, an upward force acts on it, which is called buoyant force, the phenomena is called buoyancy.



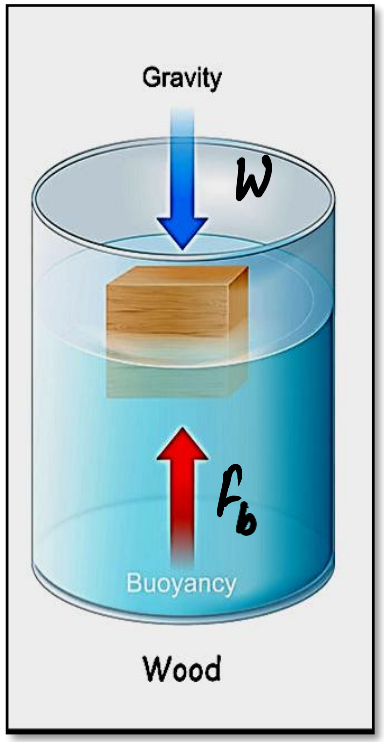
LAWS OF FLOATATION

→ Weight of body (W)

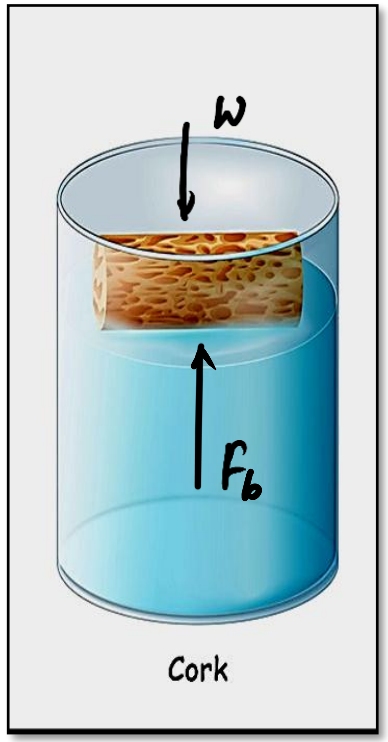
→ Upthrust / Buoyant Force (F_b)



$W > F_b$



$W \simeq F_b$



$W < F_b$

ARCHIMEDES PRINCIPLE

- When a body is partially or fully immersed in a liquid, it loses some of its weight and it is equal to the weight of the liquid displaced by the immersed part of the body.

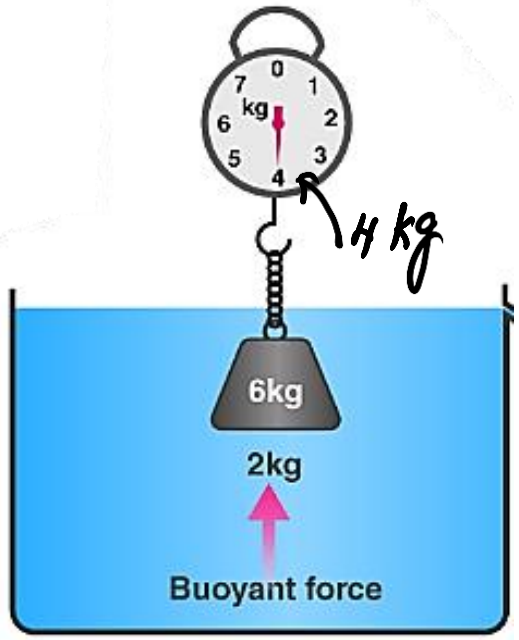
$$\text{Apparent weight} = \text{Actual weight} - \text{Upthrust} = mg\left(1 - \frac{\rho}{d}\right)$$

ρ → density of fluid (liquid)

d → density of body,

$(d > \rho$

$\left(\frac{\rho}{d} < 1\right)$



Apparent weight < Actual weight

SUMMARY

- Pressure
- Pascal’s Law
- Density and Relative Density
- Buoyancy
- Archimedes Principle

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GRAVITATION & HYDROSTATICS MCQ

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