Liquid-1

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IIT JEE | MEDICAL | FOUNDATION

\# Hydrostatics → "liquid is at rest w.r.t container"

\# Hydrodynamics → liquid is moving w.r.t container.

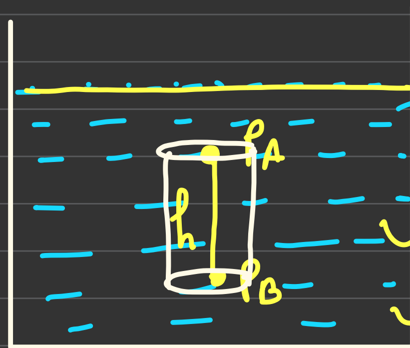
\# Surface Tension → Capillary

\# Viscosity (Stokes law)

(i) Hydrostatics:

Ideal: → "Incompressible"

(a) liquid



→ liquid at rest w.r.t container

→ "liquid"

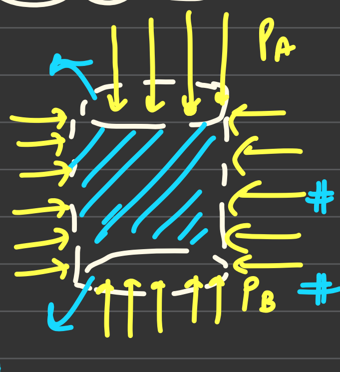
→ ρ (density of liquid)

$$P = \frac{F_\perp}{A}$$

or $F_\perp = PA$

$$P_B = P_A + \rho g h$$

FBD



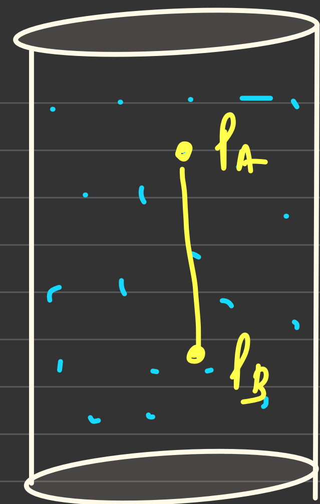
$P_A \times A + mg = P_B \times A$ —— (1)

$$(P_B - P_A)\cancel{A} = \cancel{A} \times h \rho g$$

$$P_B - P_A = \rho g h$$

$$P_B = P_A + \rho g h$$

(ii) gas:



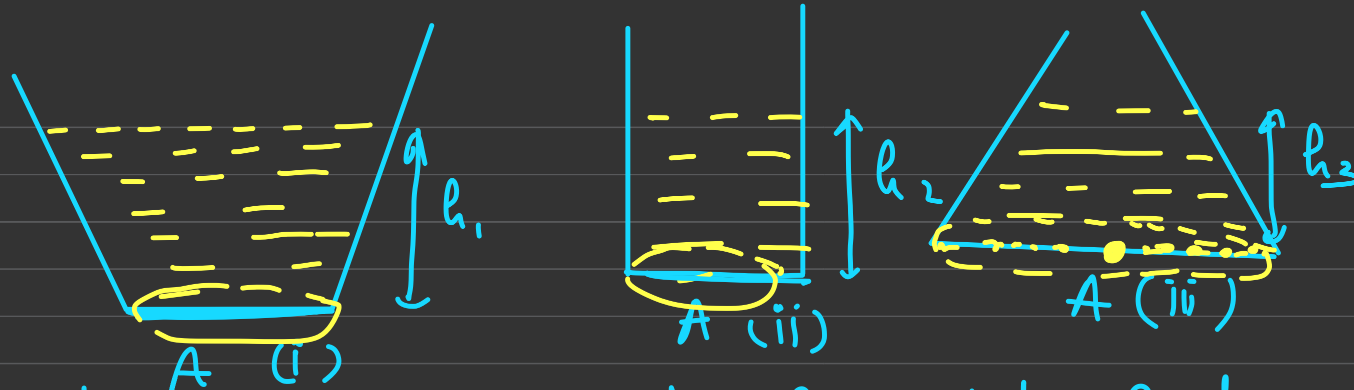
as density is very low

hence $P_B = P_A$

(iii) law of Hydrostatics # A Stationary container having Ideal liquid (fluid), along horizontal line pressure must be same

"rest" ← liquid

Q)



"Same liquid of same amount is pour into each container

which one has maximum pressure at base?

$h_3 > h_2 > h_1$

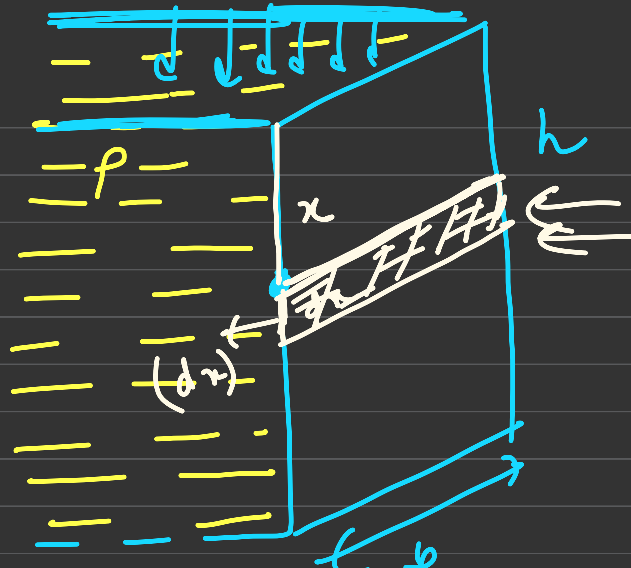
h3 has maximum pressure

$F_3 = P_3 \times A$

$F_2 = P_2 \times A$

$F_1 = P_1 \times A$

Q) "find force exerted by liquid on wall"



P_0 = atmospheric pressure

$dA = b\,dx$

$$dF = \underbrace{(P_0 + \rho g x)\, b\,dx} - P_0 (b\,dx)$$

$$\int dF = \int_0^h \rho g x b\, dx$$

$$F_{net} = \rho g b \int_0^h x\, dx = \left(\rho g b \frac{h^2}{2}\right)$$

force by liquid on wall

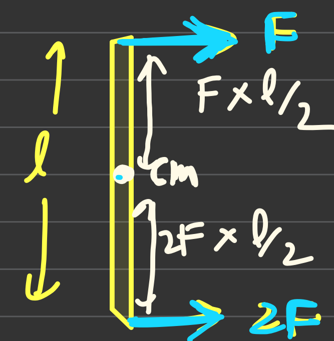
$$= \left(\frac{\rho g b h^2}{2}\right)\frac{h}{3}$$

$F_{net} = F$

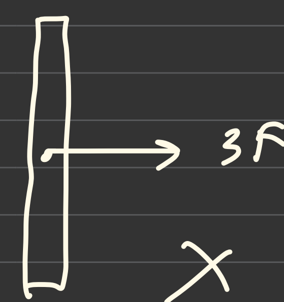
Point of Application of force :

horizontal, frictionless

smooth surface



$\Rightarrow$

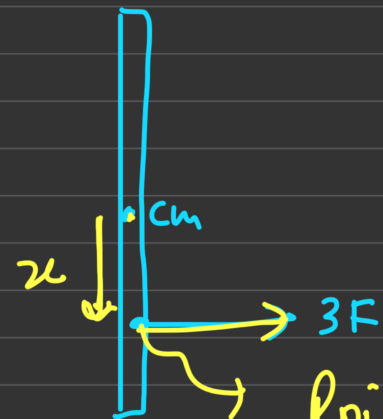


✗ This is wrong

$$(\tau_{net})_{cm} = \left(2F\times \frac{l}{2} - F\times \frac{l}{2}\right)$$ A.C.W

$$= Fl - F\frac{l}{2} = \frac{Fl}{2}$$

A.C.W



Point of Application of force

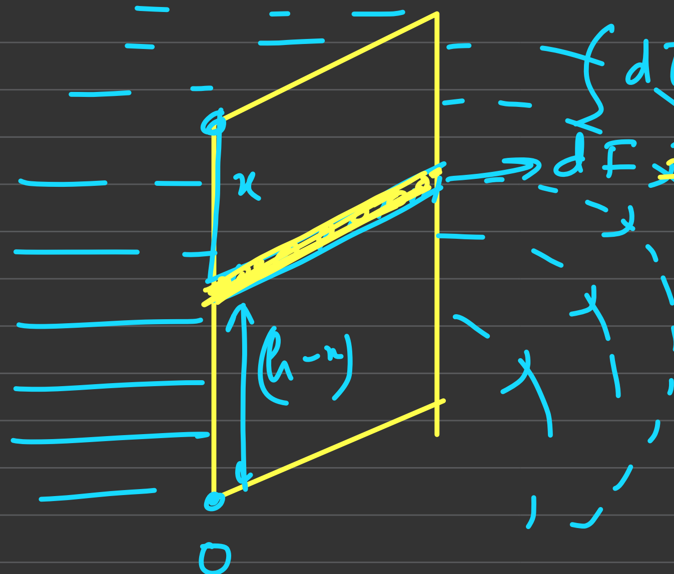
$$3\cancel{F}\times x = \cancel{F}\frac{l}{2}$$

A.C.W

$$x = \frac{l}{6}$$

$$d\tau_0 = dF \times (h-x)$$

$$\int d\tau_0 = \int \rho g x b\, dx (h-x)$$



$$dF = \rho g x b\, dx$$

$$d\tau_0 = \rho g b \int_0^h x(h-x)\, dx$$

$$= \rho g b \left(\frac{x^2}{2}h - \frac{x^3}{3}\right)_0^h$$

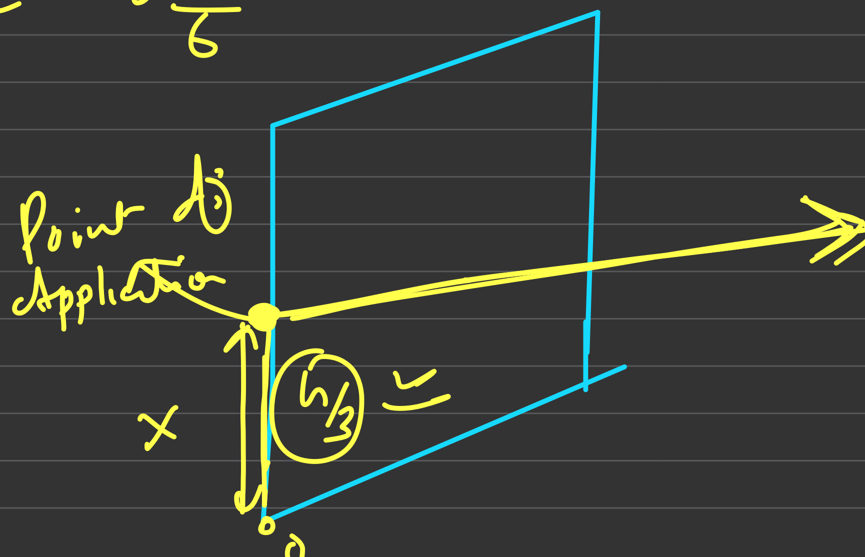
$$= \rho g b \left(\frac{h^3}{2} - \frac{h^3}{3} \right) = \left(\frac{\rho g b h^3}{6} \right)$$

$$\tau_0 = \left(\frac{\rho g b h^3}{6} \right) \quad \text{C.W}$$

$$\frac{\rho g b h^2}{2} x = \frac{\rho g b h^3}{6}$$

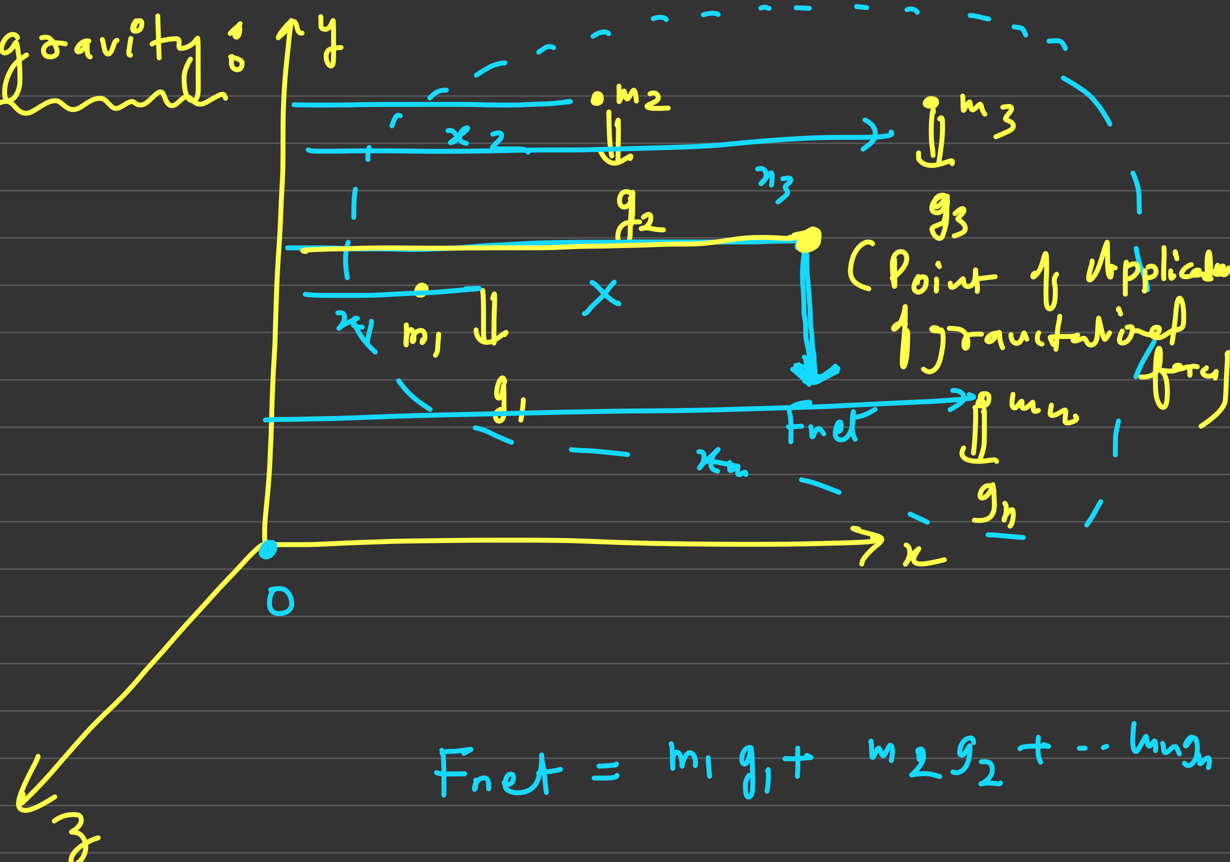
C.W

$$x = \frac{h}{3}$$



$$\left(\frac{\rho g b h^2}{2} \right)$$

Centre of gravity:



$$F_{net} = m_1 g_1 + m_2 g_2 + \cdots m_n g_n$$

due Individual force $\tau_0 = \underline{m_1 g_1 x_1 + m_2 g_2 x_2 + \cdots m_n g_n x_n}$

due net $(\tau_{net})_0 = \underline{(m_1 g_1 + m_2 g_2 + \cdots m_n g_n)\, X}$ c.w

c.w

Point of Application of gravitational $X = \dfrac{m_1 \cancel{g_1} x_1 + m_2 \cancel{g_2} x_2 + \cdots m_n \cancel{g_n} x_n}{m_1 \cancel{g_1} + m_2 \cancel{g_2} + \cdots m_n \cancel{g_n}}$

Centre of gravity

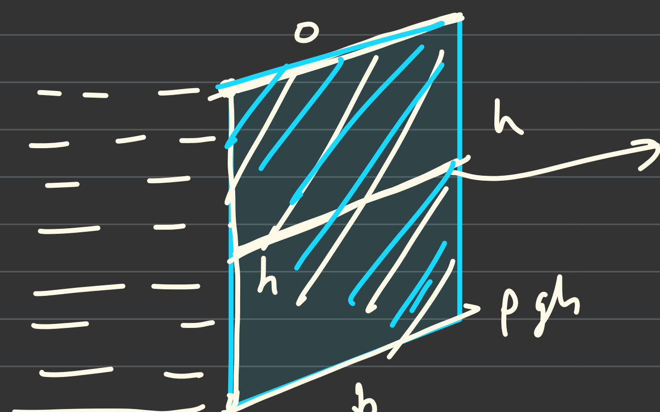
if in Uniform gravitational field

$\underline{g_1 = g_2 = g_3 = g_n}$

$$x_{cm} = X = \frac{m_1 x_1 + m_2 x_2 + \dots m_n x_n}{m_1 + m_2 + \dots m_n}$$

$\left\{ \text{C. of gravity} = \text{COM} \right\}$

In uniform gravitation

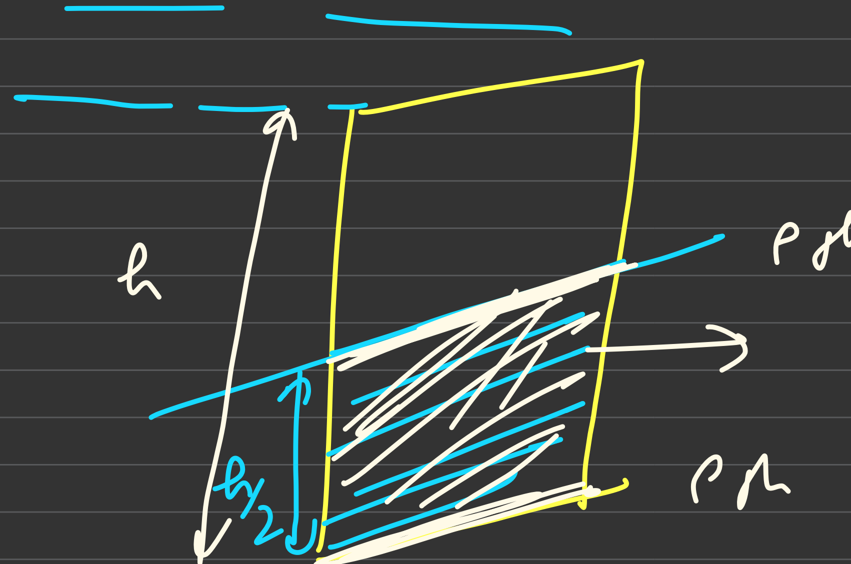


$$\frac{\rho g h + 0}{2} = \left(\frac{\rho g h}{2}\right)$$

$$\text{Force} = \left(\frac{\rho g h}{2}\right) h b$$

(ii)

$$= \left(\frac{\rho g b h^2}{2}\right)$$



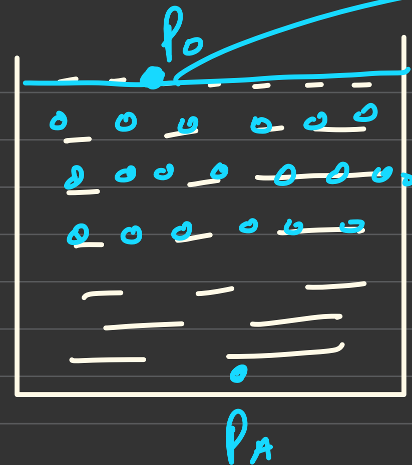
$$= \frac{\rho g \frac{h}{2} + \rho g h}{2}$$

$$\left(\frac{3\rho g h}{4}\right)$$

$$F_{net} = \left(\frac{3\rho g h}{4}\right)\left(\frac{h}{2} b\right)$$

$$\underline{\underline{F_{net}}} = \left(\frac{3\rho g h^2 b}{8}\right)$$

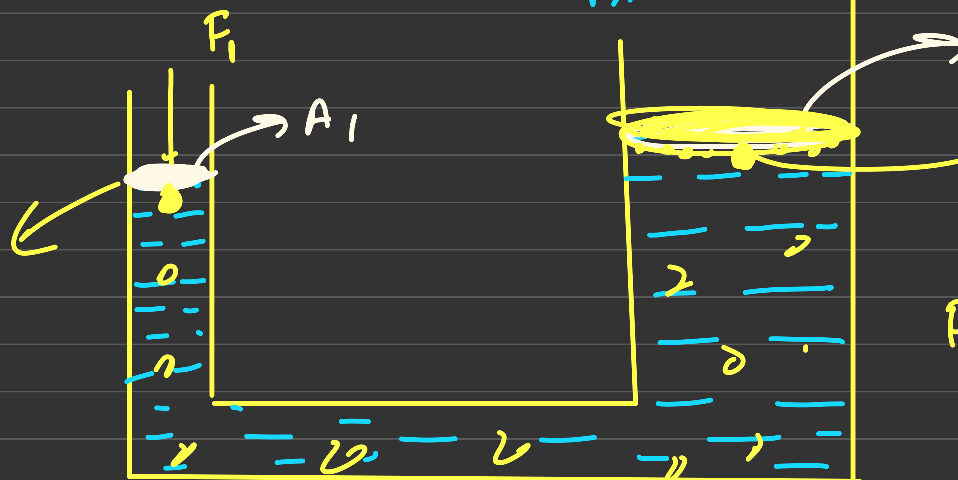
Pascal's law:



$P_0 + dP$

$A_2 >>> A_1$

Ex#



$P_1 = \frac{F_1}{A_1}$

F_1/A_1

F_2 (extra force)

$F_2 = \left(\frac{F_1}{A_1}\right) A_2$

"Hydraulic lift"

$$F_2 = \left(\frac{A_2}{A_1}\right) F_1$$

$$A_2 >>> A_1$$

$$F_2 >> F_1$$