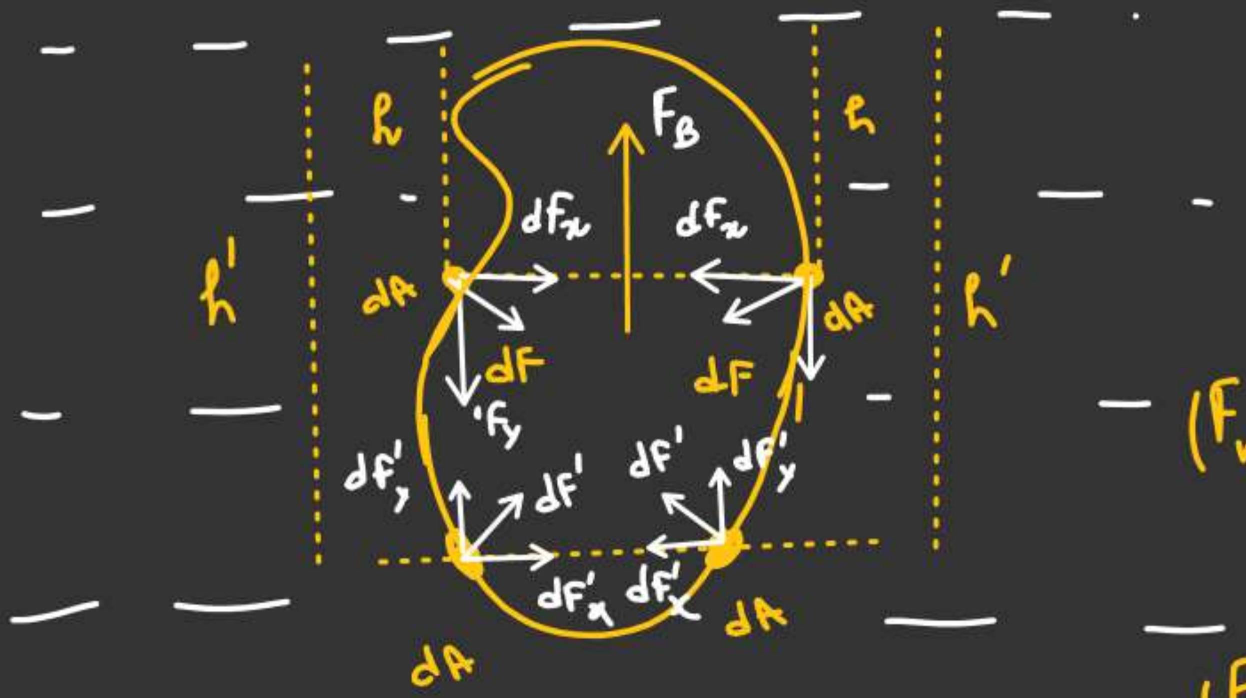
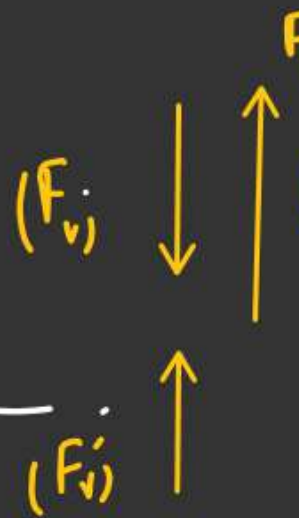
Force of buoyancy

Always acts vertically upward.



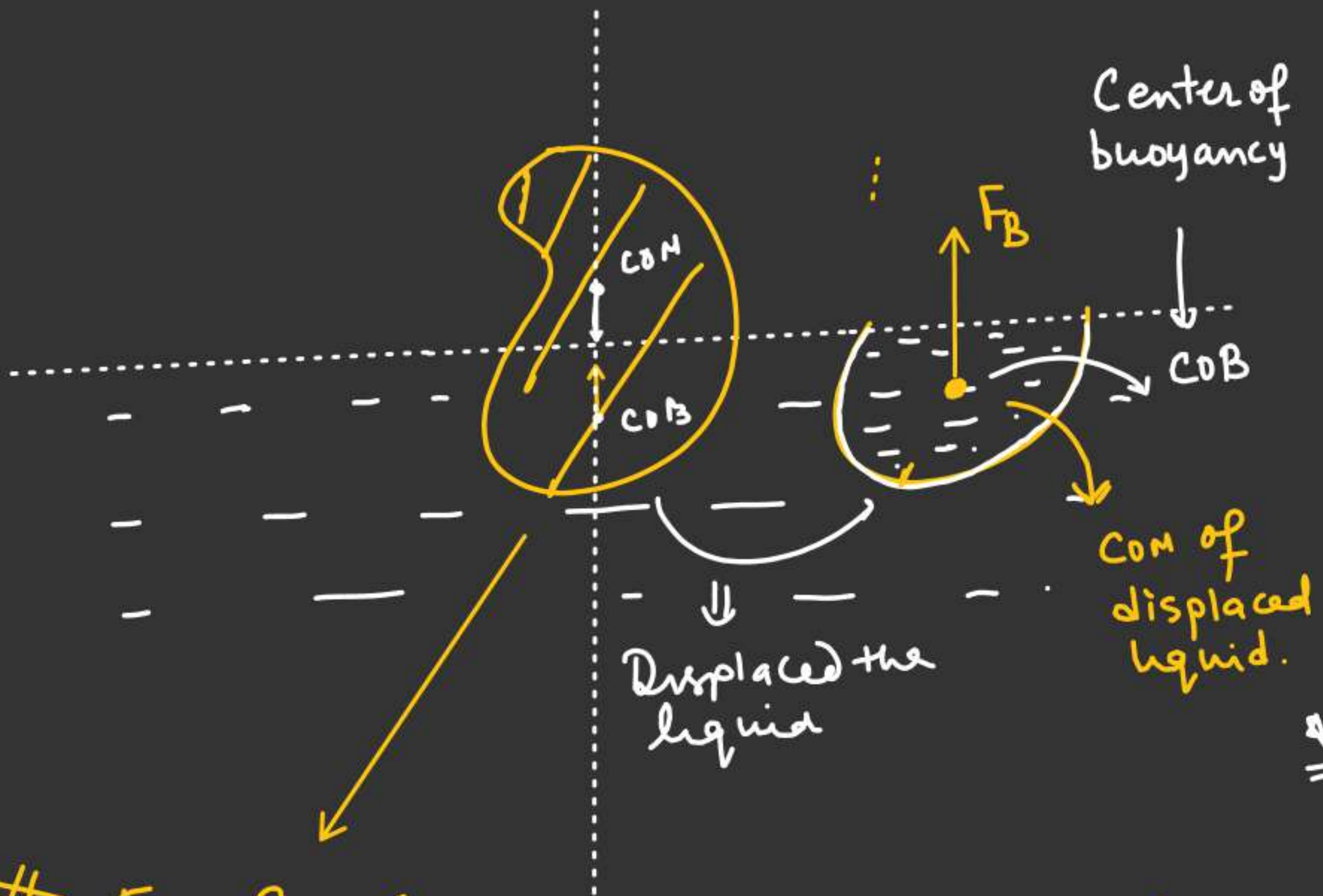
F_B = Resultant Vertical upthrust



$$(F'_v) - (F_v) = F_B$$

$$dF'_y > dF$$

$$h' > h$$



F_B = weight of displaced liquid.

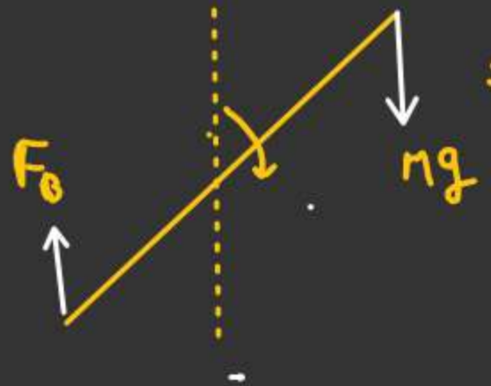
$$\boxed{F_B = V_L \rho_L g}$$

If V_s be the submerged part (डूबा हुआ) of body

$V_L = V_s$.

** When body fully submerged. then COB & COM coincide

For Equilibrium COB & COM both along the same line.



⇒ Unstable

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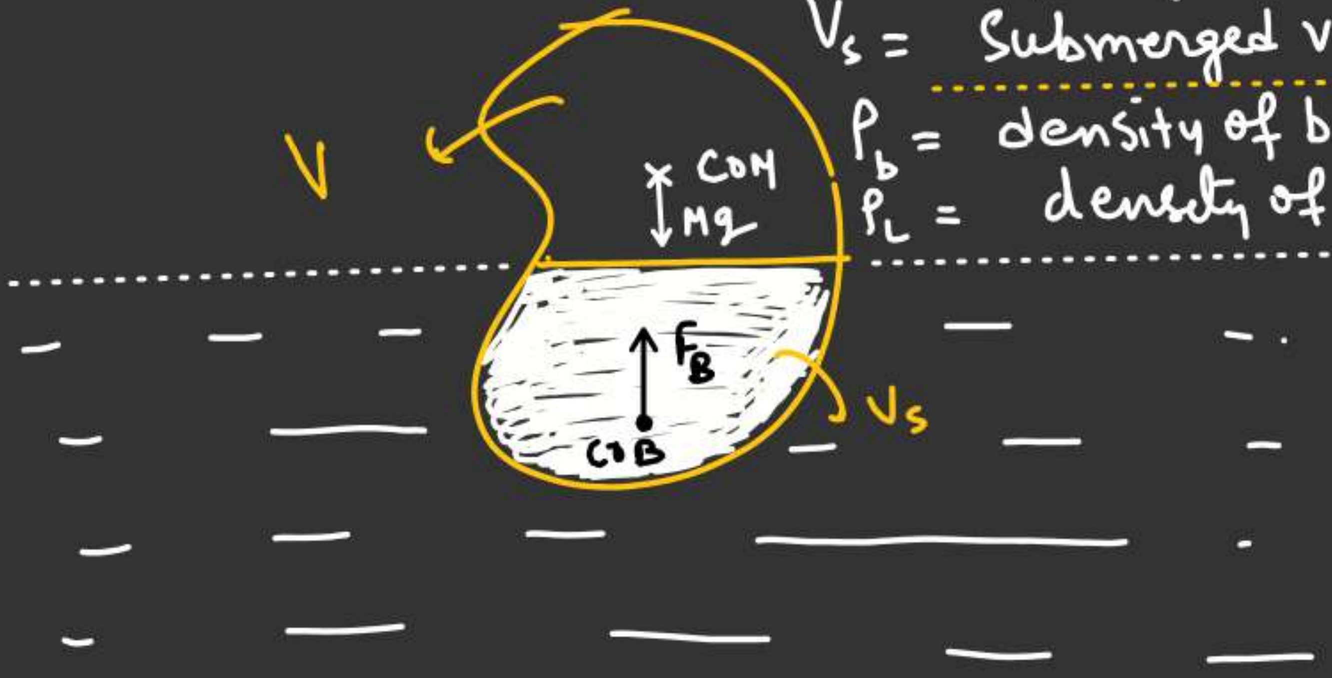
Law of Floatation



V = total volume of body

V_s = Submerged volume

ρ_b = density of body

ρ_L = density of liquid

For body to be in equilibrium

$$F_B = Mg$$

$$V_L \rho_L g = V \rho_b g$$

$$\downarrow$$

$$V_s \rho_L g = V \rho_b g$$

$$\boxed{\frac{V_s}{V} = \frac{\rho_b}{\rho_L}}$$

(I) $V_s < V \Rightarrow \rho_b < \rho_L \Rightarrow$ Body partially Submerged & float

(II) $V_s = V \Rightarrow \rho_b = \rho_L \Rightarrow$ Body fully Submerged & float

(III) $V_s > V \Rightarrow$ Not possible

$\rho_b > \rho_L \Rightarrow$ Body will sink

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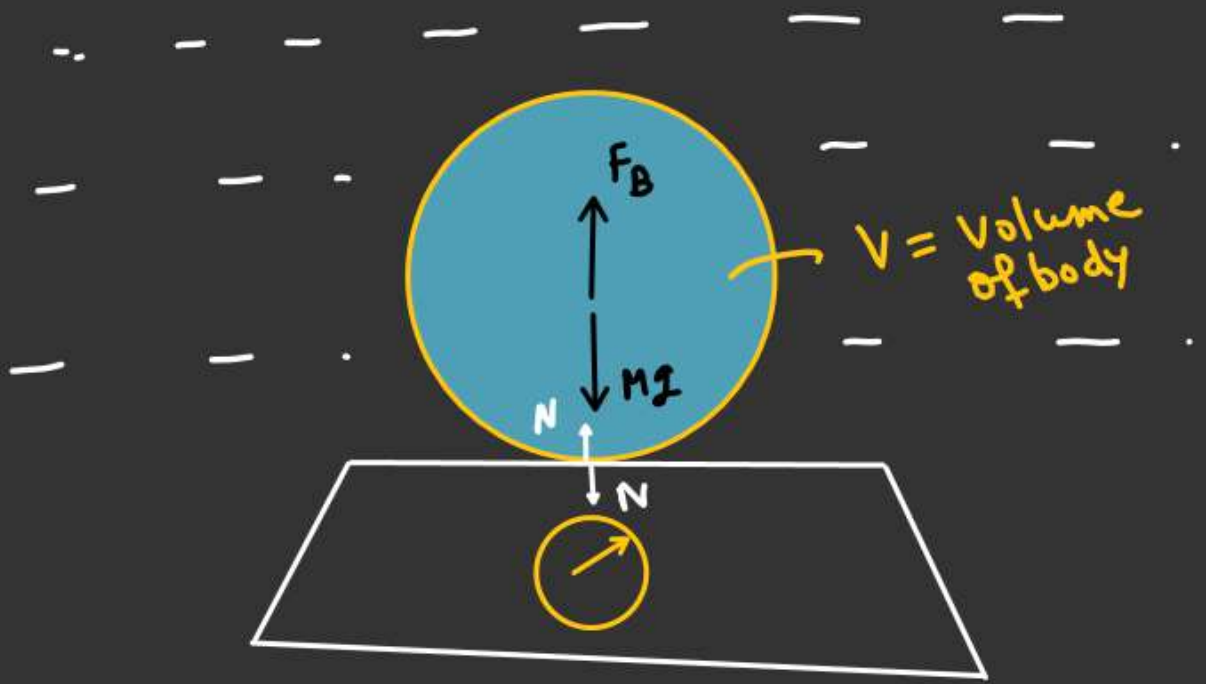
AA:

Concept of Apparant Weight.



$$N = W_{app}.$$

$$N + F_B = Mg.$$

$$N = Mg - F_B$$

$$W_{app} = Mg\left(1 - \frac{F_B}{Mg}\right)$$

$$W_{app} = W_{real}\left[1 - \frac{V\rho_L g}{V\rho_b g}\right]$$

$$\boxed{W_{app} = W_{real}\left[1 - \frac{\rho_L}{\rho_b}\right]}$$

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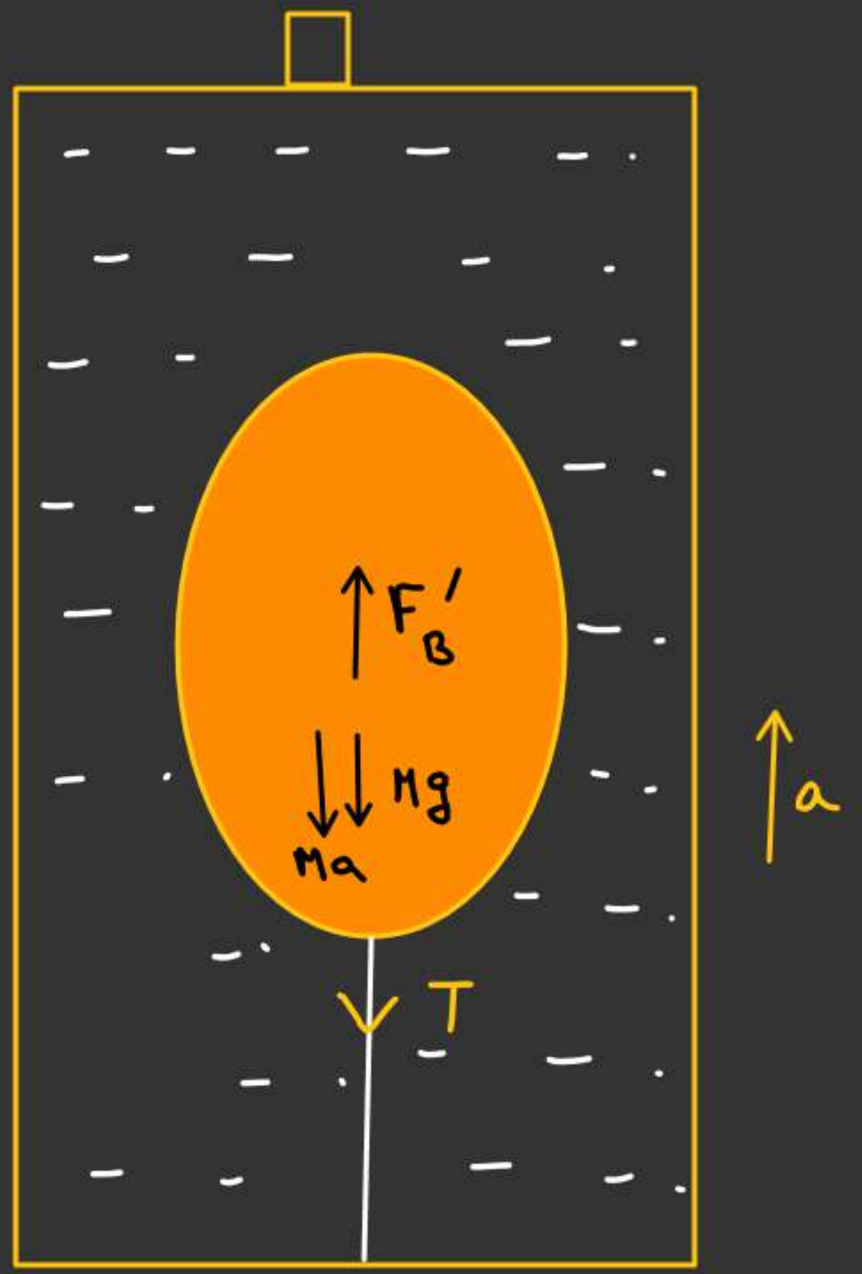
If the whole System is accelerated upward with accleration $a\ m/s^2$.

Find tension.

T_0 = Tension when elivator is stationary.

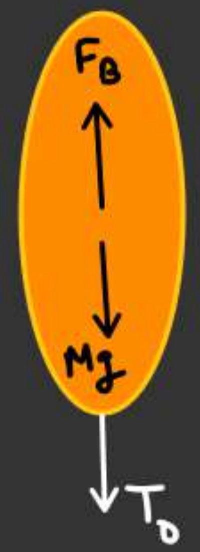


<u>Note</u> :- In acclerated frame for buoyancy also take g_{eff}

$$F_B' = V\rho_L(g+a)$$

$$M = V\rho_b$$

when $a=0$



$$T_0 + Mg = F_B$$

$$T_0 = F_B - Mg$$

$$= Mg\left(\frac{\rho_L}{\rho_b} - 1\right)$$

$$F_B' = M(g+a) + T$$

$$T = F_B' - M(g+a)$$

$$T = V\rho_L(g+a) - V\rho_b(g+a)$$

$$T = V\rho_b(g+a)\left[\frac{\rho_L}{\rho_b} - 1\right]$$

$$T = Mg\left(\frac{\rho_L}{\rho_b} - 1\right)\left(1 + \frac{a}{g}\right)$$

$$T = T_0\left(1 + \frac{a}{g}\right)$$

$$T = T_0\left(1 + \frac{a}{g}\right) \text{ Ans.}$$

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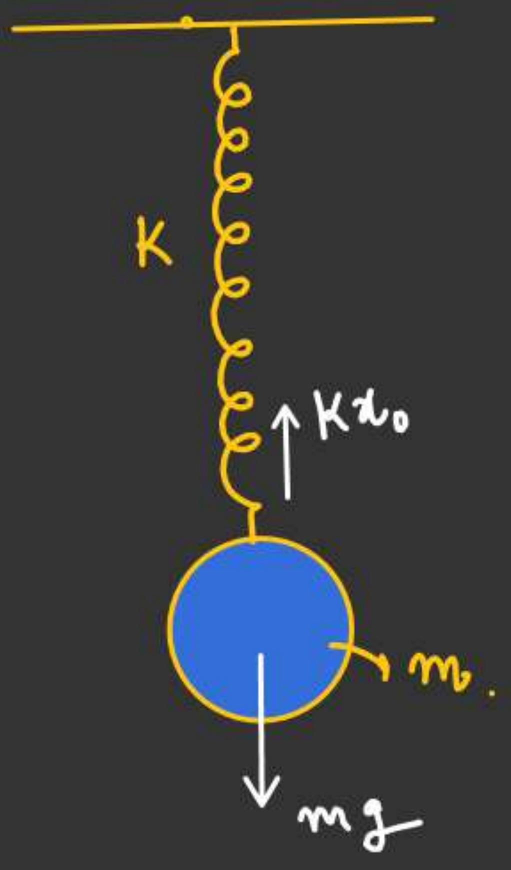
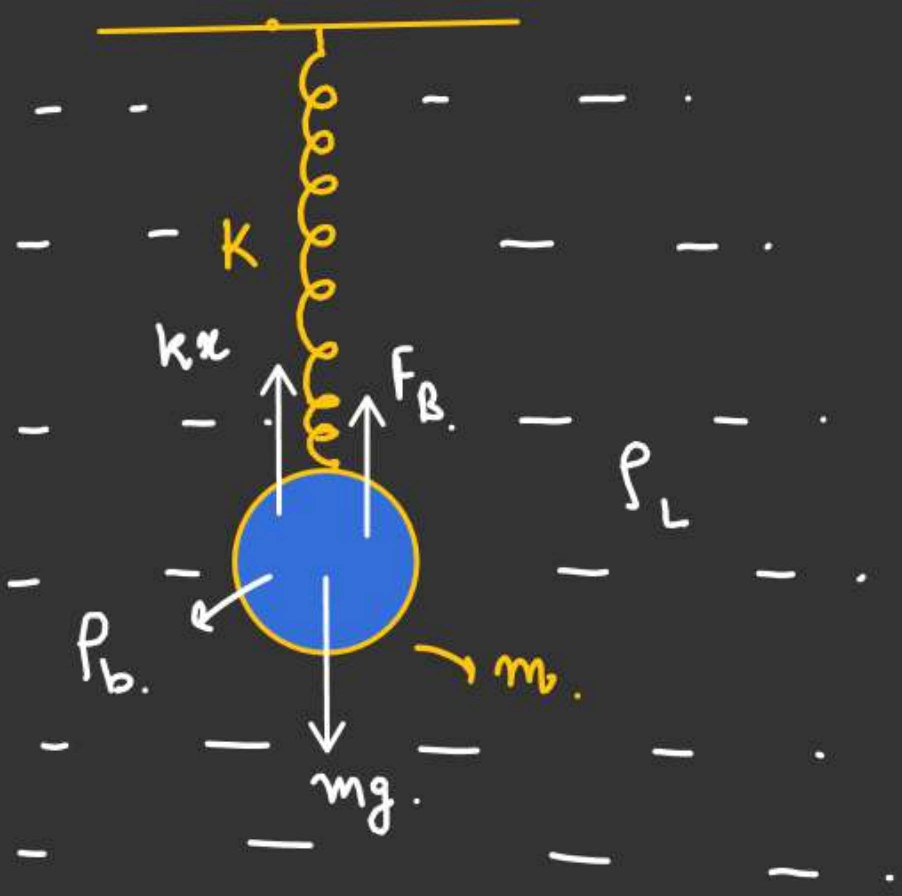


$$Kx_0 = mg$$



At Equilibrium.

$$Kx + F_B = mg$$

$$Kx = (mg - F_B)$$

$$Kx = mg\left(1 - \frac{F_B}{mg}\right)$$

$$Kx = mg\left(1 - \frac{\rho_L}{\rho_b}\right)$$

$$Kx = Kx_0\left(1 - \frac{\rho_L}{\rho_b}\right)$$

$$x = x_0\left(1 - \frac{\rho_L}{\rho_b}\right)$$

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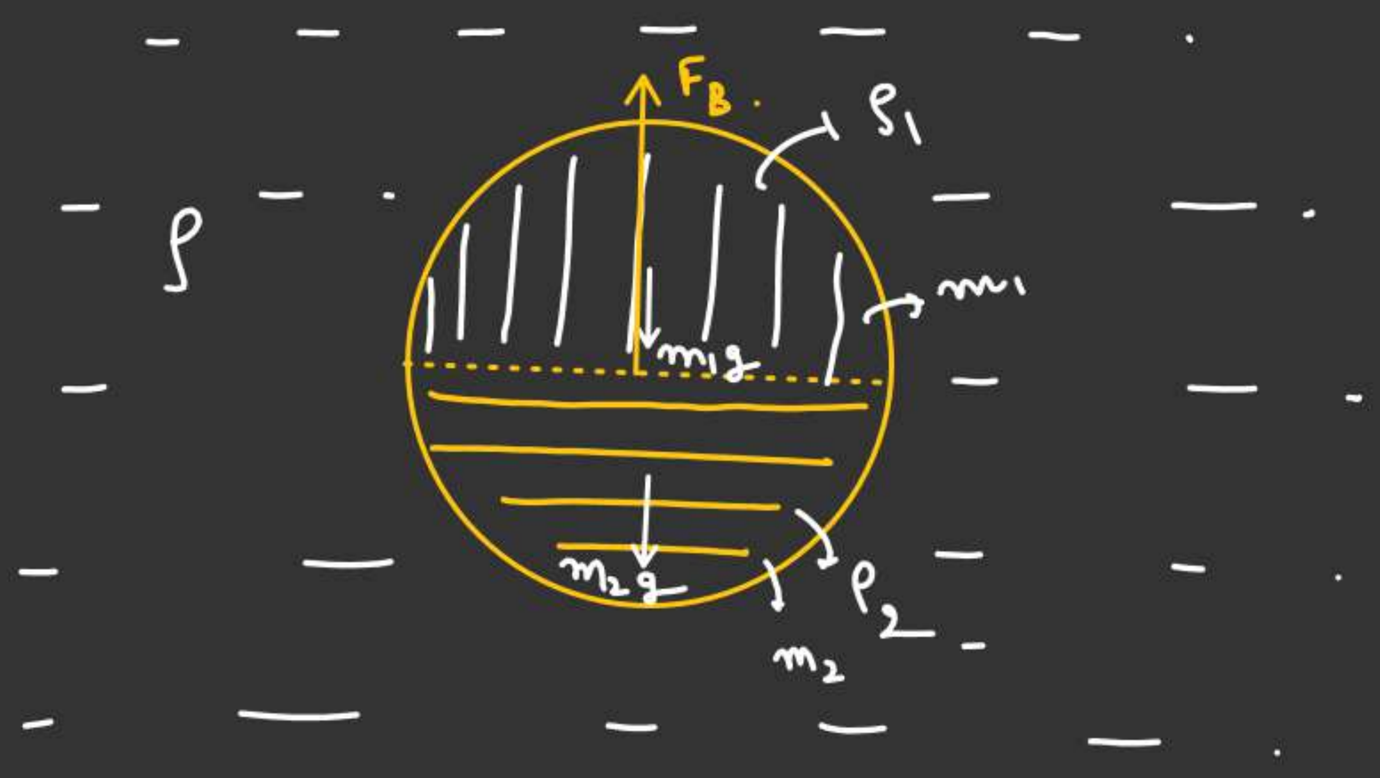
For ball to be in equilibrium
Relation b/w ρ_1, ρ_2 & ρ

V = Total volume.



$$F_B = \underline{m_1}g + m_2 g$$

$$\Downarrow$$

$$V\rho g = \frac{V}{2}\rho_1 g + \frac{V}{2}\rho_2 g$$

$$\rho = \frac{\rho_1 + \rho_2}{2} \checkmark$$

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Relation b/w ρ_1 & ρ_2 for Equilibrium (Translational)

(Translational) For Equilibrium

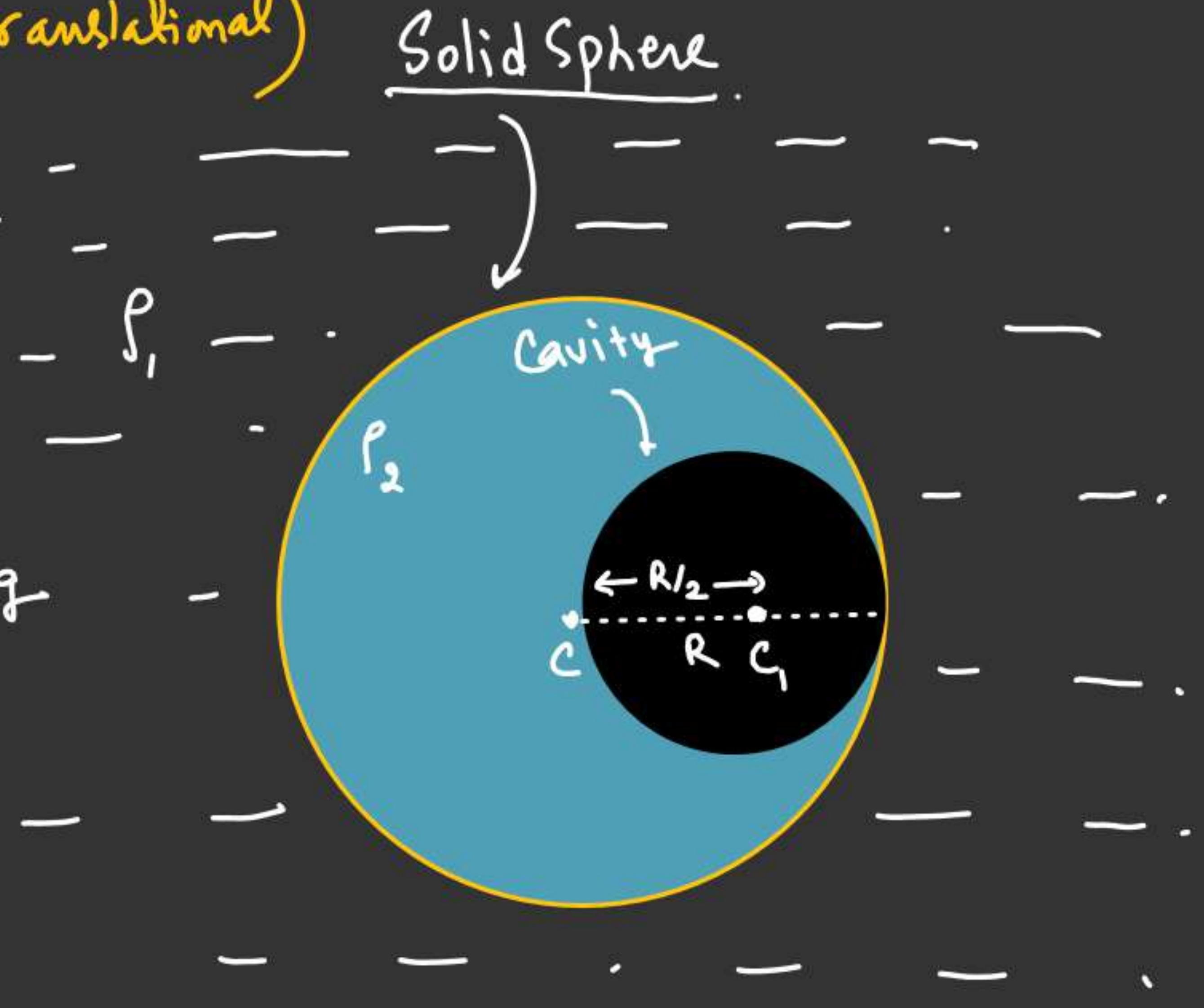
M = Mass of body with Cavity.

$$F_B = Mg$$

$$\left(\frac{4}{3}\pi R^3\right)\rho_1 g = \left[\frac{4}{3}\pi R^3 - \frac{4}{3}\pi\left(\frac{R}{2}\right)^3\right]\rho_2 g$$

$$\left(\frac{4}{3}\pi R^3 g\right)\rho_1 = \left(\frac{4}{3}\pi R^3 g\right)\rho_2\left[1-\frac{1}{8}\right]$$

$$\left(\rho_1 = \frac{7}{8}\rho_2\right)$$



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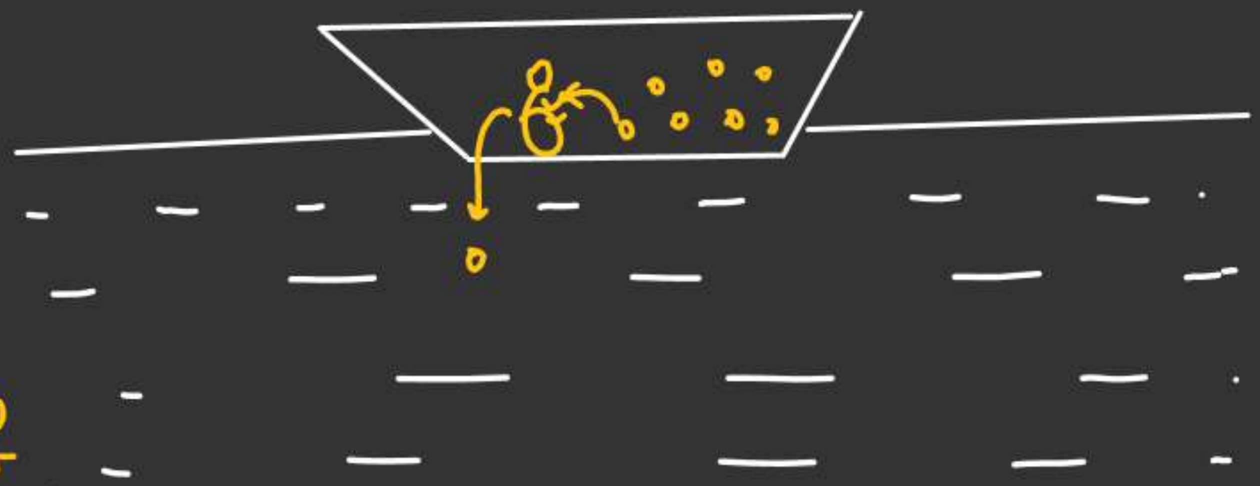
Unloading of Stone from boat

ρ_s = density of stone.

ρ_L = density of liquid.



Before unloading let, V be the volume of liquid displaced.

$$V \rho_L g = (M+m)g$$ M = mass of boat + Man.

$$V = \left(\frac{M}{\rho_L} + \frac{m}{\rho_L}\right) \quad -(1)$$ m = mass of stone

After unloading of stone

m = mass of total stone.

$$V_s = \left(\frac{m}{\rho_s}\right)$$

let, V' be the total volume of liquid displaced after unloading of stone

$$V' = V + V_s$$ liquid displaced by stones. $\Rightarrow$ if $\rho_s = \rho_L$ then No change in liquid level

$$V' = \left(\frac{M}{\rho_L} + \frac{m}{\rho_s}\right) \quad -(2)$$

$\rho_s > \rho_L$

$V' < V$ $\Rightarrow$ liquid level decreases.

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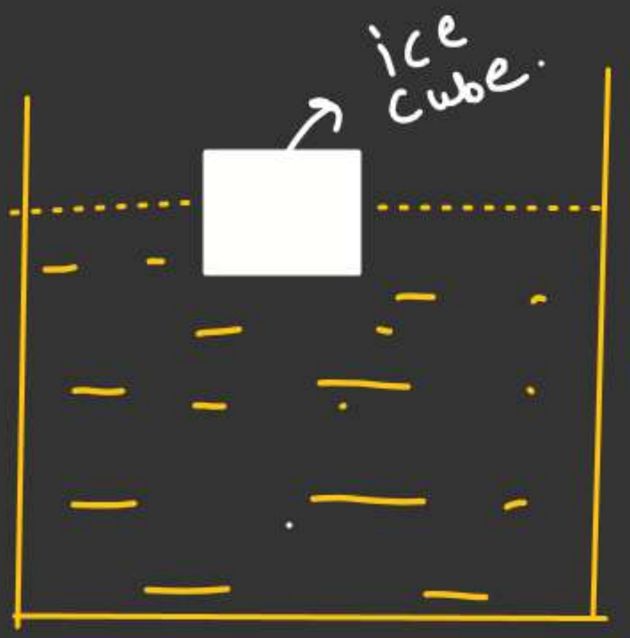
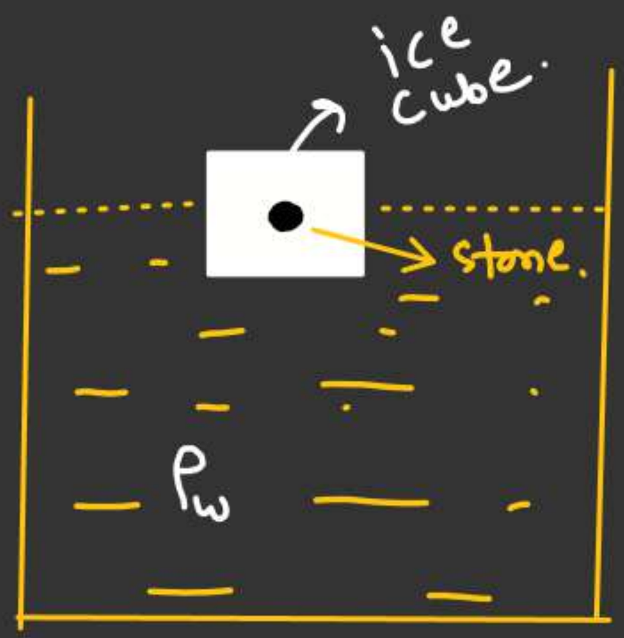
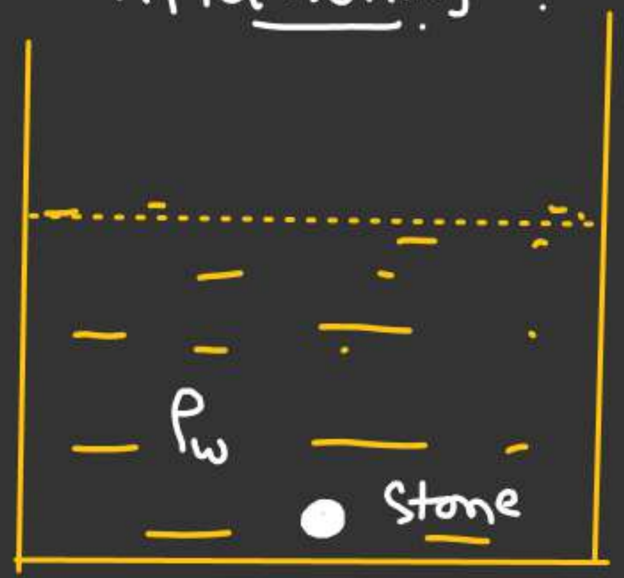


After melting No change in water level.



ρ_s = density of stone

After Melting



After Melting, level of liquid = ??

M = Mass of ice cube

m = mass of stone

$$V_i = \left(\frac{M+m}{\rho_w}\right) = \left(\frac{M}{\rho_w} + \frac{m}{\rho_w}\right) \quad -①$$

V_i ⇐ Initial volume of liquid displaced.

After Melting

$$V_f = \left(\frac{M}{\rho_w} + \frac{m}{\rho_s}\right) \quad -②$$

$\rho_s > \rho_w$

$V_f < V_i$

⇒ liquid level decreases