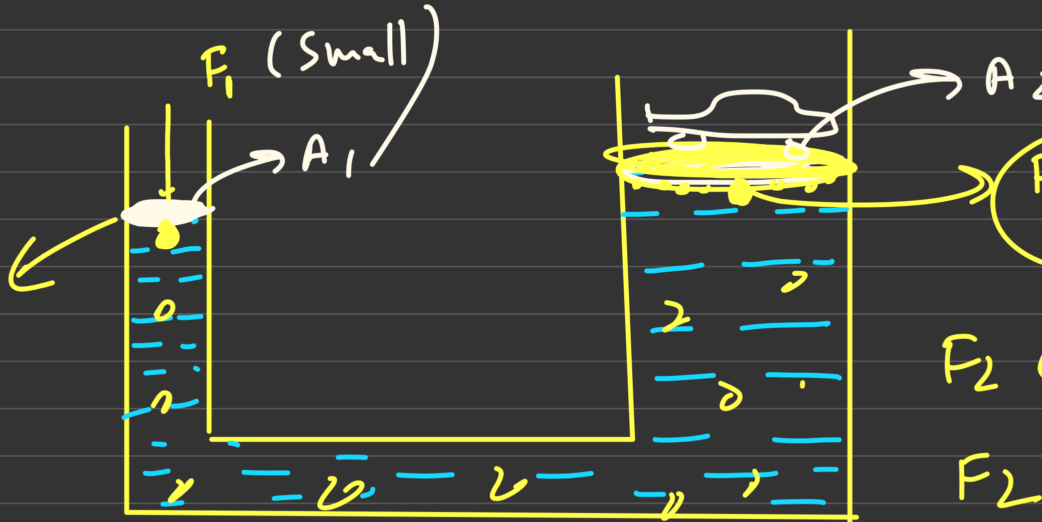
Liquid 2

VMC Vidyamandir Classes SINCE 1986

IIT JEE | MEDICAL | FOUNDATION

Q) Pascals law:

"Hydraulic lift"



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

$$F_1/A_1$$

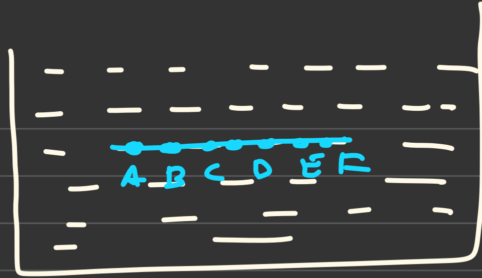
F_2 (extra force)

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

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

$$A_2 >>> A_1$$

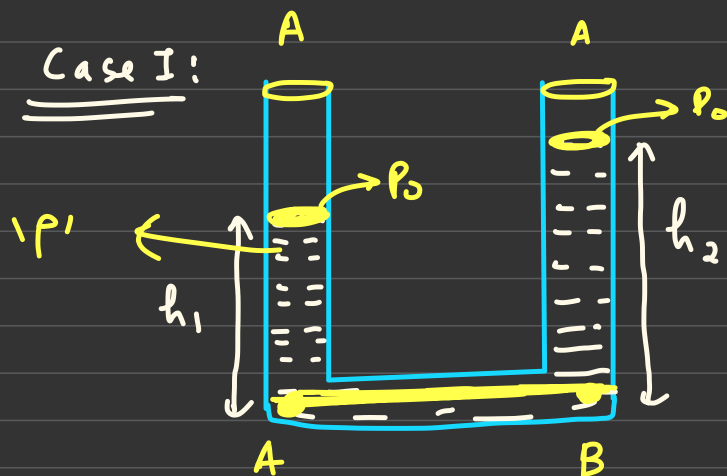
#



$$P_A = P_B = P_C = P_D = P_E = P_F$$

"liquid must be at rest and container also"

Case I:



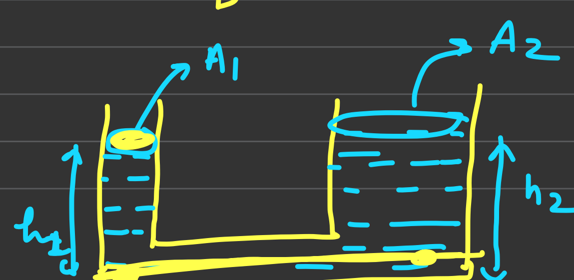
cross-sectional area same

$$P_A = P_B$$

$$\cancel{P_0} + \rho g h_1 = \cancel{P_0} + \rho g h_2$$

$$\boxed{h_1 = h_2}$$

Case II:



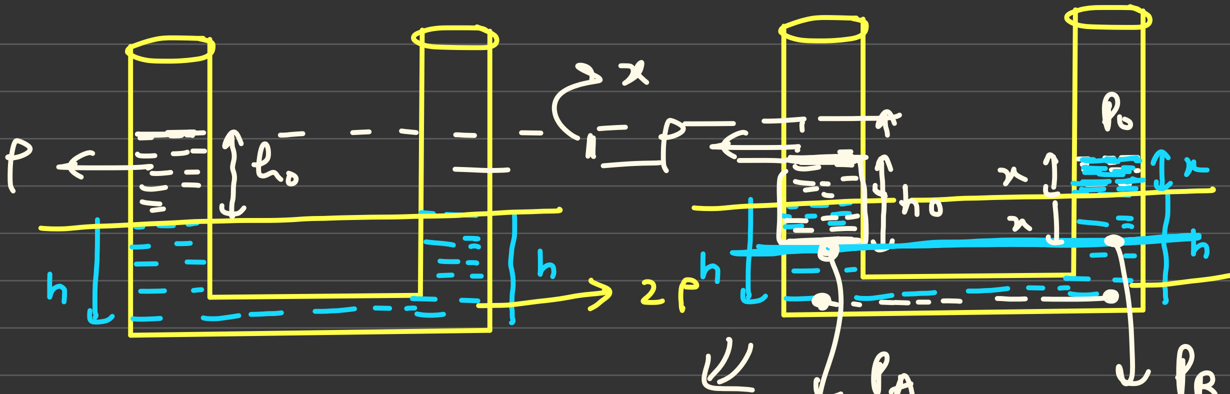
$$P_A = P_B$$

P_A P_B

$$\cancel{P_0} + \rho g h_1 = \cancel{P_0} + \rho g h_2$$

$$h_1 = h_2$$

Case II:



Now, if we pour Extra liquid of different density then find the height?

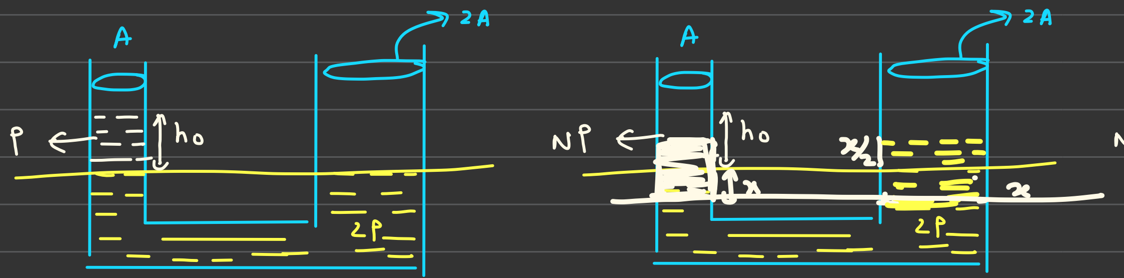
$$P_A = P_B$$

$$\cancel{P_0} + \rho g h_0 = \cancel{P_0} + 2\rho g(2x)$$

$$\rho \cancel{g} h_0 = 4\rho \cancel{g} x$$

$$\Rightarrow \quad \boxed{x = \frac{h_0}{4}} \quad \underline{\underline{\text{Ans}}}$$

Case IV :



Now find change in height of liquid in right arm after pouring (white) liquid

$A \times x = x' \times 2A$ (Volume Con)

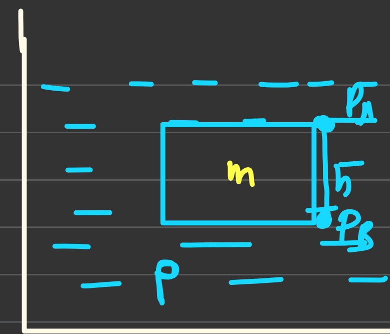
$$x' = x/2$$

$$P_0 + \rho g h_0 = P_0 + 2\rho g\left(x + x/2\right)$$

Solve it

Archimidies Principle:

"When a block is partially or fully immersed in a liquid (Not sinked then the weight of block is equal to weight of liquid displaced by block



$$mg = (V\rho)g$$

Density of liquid

Volume of liquid

$$mg = B$$

"Buoyancy force"

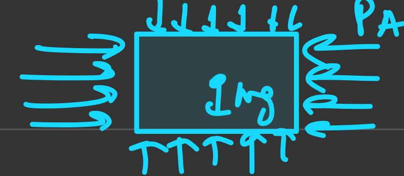
$B = mg$

⇓

upthrust

FBD of block:

"Buoyancy force # upward force due to pressure diff"



$$P_A \times A + mg = P_B \times A$$

$$(P_B - P_A) A = mg$$

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

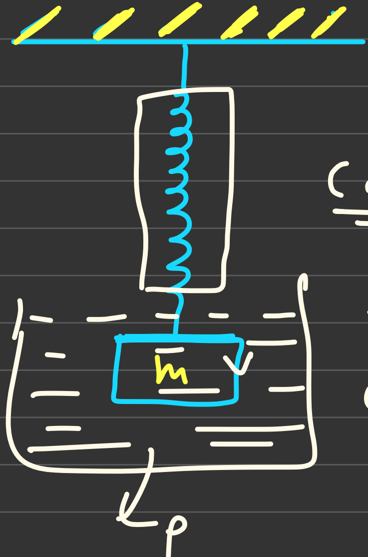
$$\rho g h A = mg$$

$$B = (A \times h) \rho \times g = mg$$

$$B = V_{im} \rho g = mg$$

V immersed | Volume displaced should always less or equal to volume of block

8)



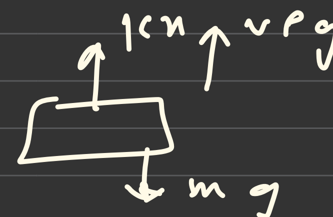
Case I:

$Kx = mg$

Case II:

it always reads 'kx'

#



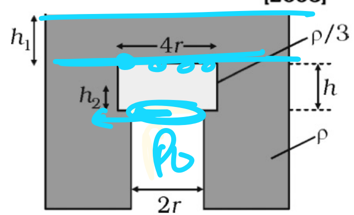
$Kx' + V\rho g = mg$

$Kx' = (mg - V\rho g)$

$kx' < kx$

"it will be less"

PARAGRAPH FOR QUESTIONS 32 - 34 **[2006]**



A cylindrical tank has a hole of diameter 2 r in its bottom. The hole is covered with a wooden cylindrical block of diameter 4 r, height h and density ρ/3.

Situation 1: Initially, the tank is filled with water of density ρ to a height such that the height of water above the top of the block is h_1 (measured from the top of the block).

Situation 2: The water is removed from the tank to a height h_2 (measured from the bottom of the block), as shown in the figure. The height h_2 is smaller than h (height of the block) and thus the block is exposed to the atmosphere.

32. Find the minimum value of height h_1 (in situation 1) for which the block just starts to move up.

(A) $2h/3$ (B) $5h/4$ (C) $5h/3$ (D) $5h/2$

33. Find the height of the water level h_2 (in situation 2) for which the block remains in its original position without the application of any external force.

(A) $h/3$ (B) $4h/9$ (C) $2h/3$ (D) h

34. In situation 2, if h_2 is further decreased, then.

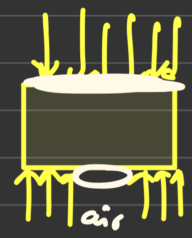
(A) Cylinder will not move up and remains at its original position

(B) For $h_2 = h/3$, cylinder again starts moving up

(C) For $h_2 = h/4$, cylinder again starts moving up

(D) For $h_2 = h/5$, cylinder again starts moving up

"Exception" to Buoyancy



$H = 0$

$$\frac{\rho}{3}(\pi 4r^2 \times h)g + (\cancel{P_0} + \rho g h_1)\pi(2r)^2 = \cancel{P_0 \times \pi r^2} + \{\cancel{P_0} + \rho g(h_1 + h)\}3\pi r^2$$

$$\frac{4}{\rho}\cancel{\rho}\,\cancel{\pi r^2}\,h\,\cancel{g} + \cancel{\rho}\,g\,h_1\,\cancel{\pi}\,4\cancel{r^2} = \cancel{\rho}g(h_1+h)\,3\cancel{\pi r^2}$$

$$\frac{4}{3}h + 4h_1 = 3h_1 + 3h$$

$$h_1 = 3h - \frac{4h}{3}$$

$$\boxed{h_1 = \frac{5h}{3}}$$

it will move just up more

Condition of floating:

According of floating

$$mg = V_{im}\, \rho\, g$$

$$V \times d \times \cancel{g} = V_{im}\, \rho\, \cancel{g}$$

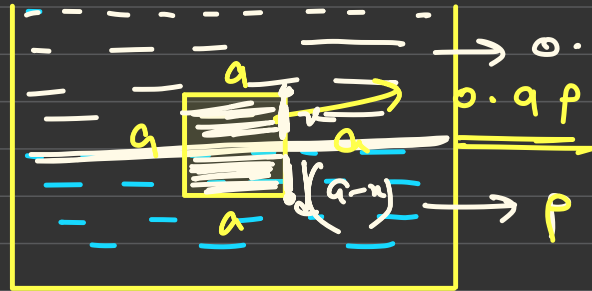
$$\frac{d}{\rho} = \frac{V_{im}}{V} \leq 1$$

"Condition of floating" $\leftarrow$

$$\frac{d}{\rho} \leq 1$$

$$d \leq \rho$$

Q)



find fraction
of volume
which inside
white liquid?

$P_A \times A + mg = P_B \times A$

$(P_B - P_A)A = mg$

$\underline{W = B}$

$\Rightarrow mg = \underline{B_1} + \underline{B_2}$

$\Rightarrow [\cancel{a^3} \times 0.9 \cancel{\rho} \times \cancel{g}] = (\cancel{a^2} \times x)\, 0.8 \cancel{\rho} \times \cancel{g} +$
$\cancel{a^2}(a-x) \cancel{\rho} \times \cancel{g}$

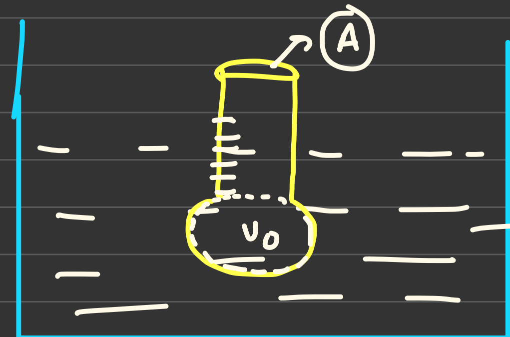
$$\Rightarrow \quad a \times 0.9 = x \times 0.8 + (a - x)$$

$$\Rightarrow \quad a \times 0.9 = x \times 0.8 + a - x$$

$$-0.2x = 0.1a$$

$$x = \frac{a}{2}$$

Hydrometer : "is a device to measure density of liquid"



"Let us assume it is floating"

then $mg = B$

ρ ?

$$mg = (V_{im}\, \rho_L\, g)$$

$$\frac{m\cancel{g}}{(V_0 + x \times A)\cancel{g}} = \rho_L$$

$$\rho_L = \frac{m}{(V_0 + xA)}$$

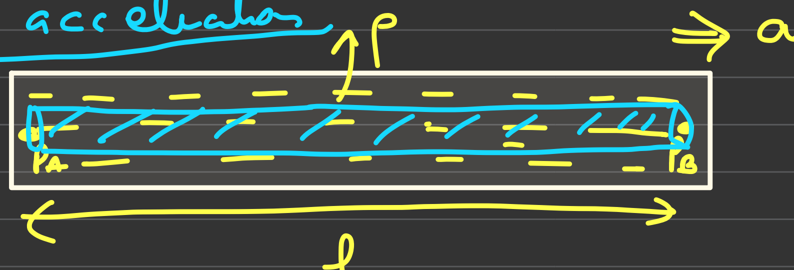
Lactometer : is a device measure density of milk

: Hydrostatics :

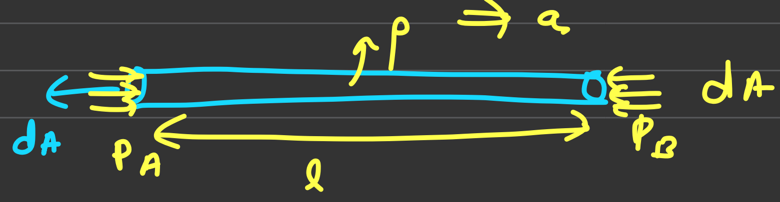
liquid w.r.t Container should be const

find Relation between P_A and P_B

Case I : horizontal acceleration



g



N.S.L:

$$(P_A \times dA - P_B \times dA) = m \times a$$

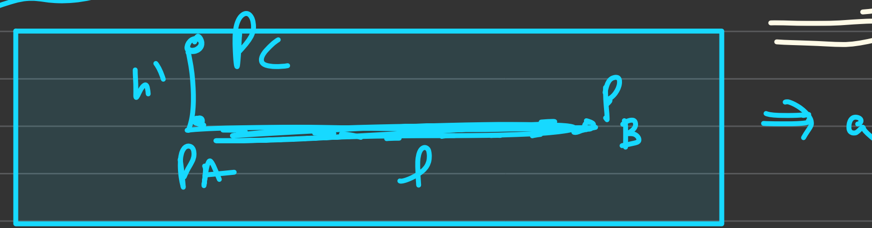
$$(P_A - P_B) \times \cancel{dA} = (\cancel{dA} \times L)\,\rho \times a$$

$$P_A - P_B = \rho a l$$

$$\boxed{P_A = P_B + \rho a l}$$ Same liquid

Very Important

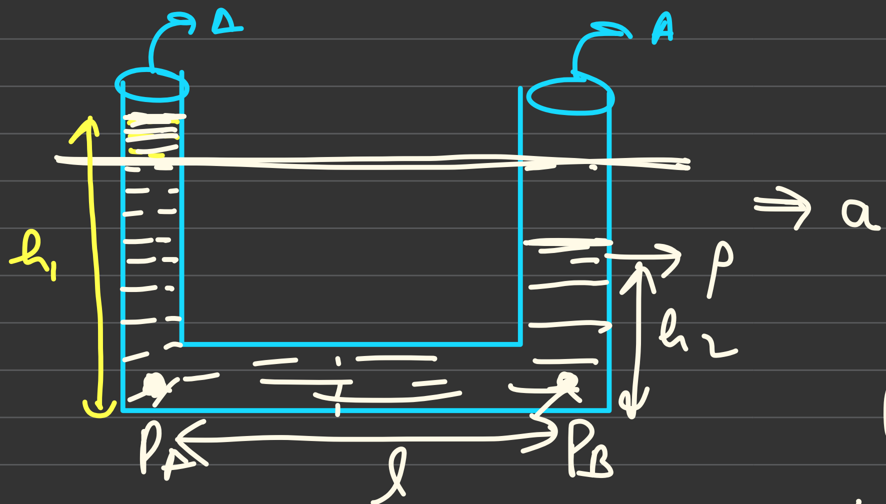
$P_A > P_B$



$$P_C + \rho g h' = P_A$$

$$P_A - P_B = \rho \times a \times L$$

Q)



$$P_A - P_B = \rho a l$$

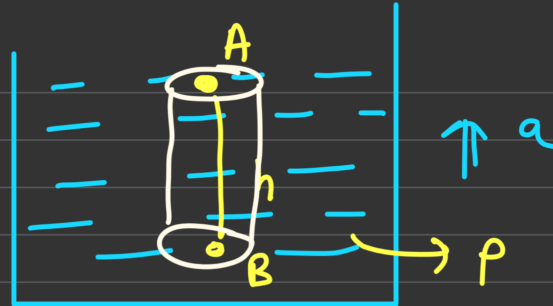
$$\cancel{P_0} + \rho g h_1 - (\cancel{P_0} + \rho g h_2) = \rho a l$$

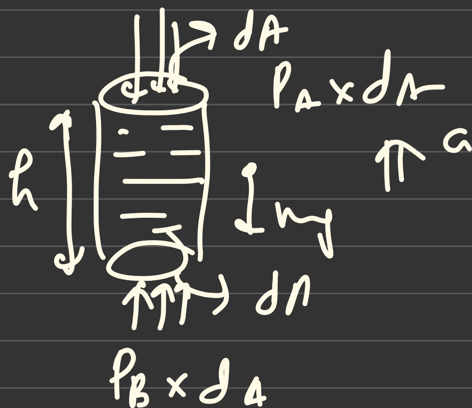
$$\cancel{\rho} g (h_1 - h_2) = \cancel{\rho} a l$$

$$\boxed{h_1 - h_2 = \frac{a l}{g}}$$

Ans

Q)





$$P_B \times dA - mg - P_A dA = ma$$

$$(P_B - P_A)\, dA = mg + ma$$

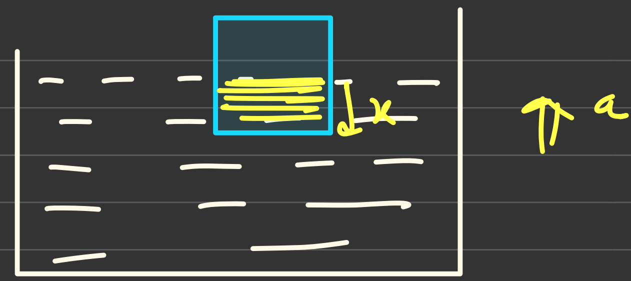
$$(P_B - P_A)\, \cancel{dA} = \cancel{dA} \times h\rho g + \cancel{dA} \times h\rho a$$

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

$$\underline{P_B = P_A + h\rho g + h\rho a}$$

Q)

Home



Case I : "if block is floating"

let us ass x part is immersed

Case II : if container is accelerated upward with acceleration 'a'

then immersed part is (x')

then

A) $x' > x$

B) $x' < x$

C) $x' = 2x$

D) $x' = x$