Nishant Jindal

Force on vertical wall

$dA = W\,dy$ — Area of differential strip.

Pressure at y is same as at (y+dy) as dy is very small.

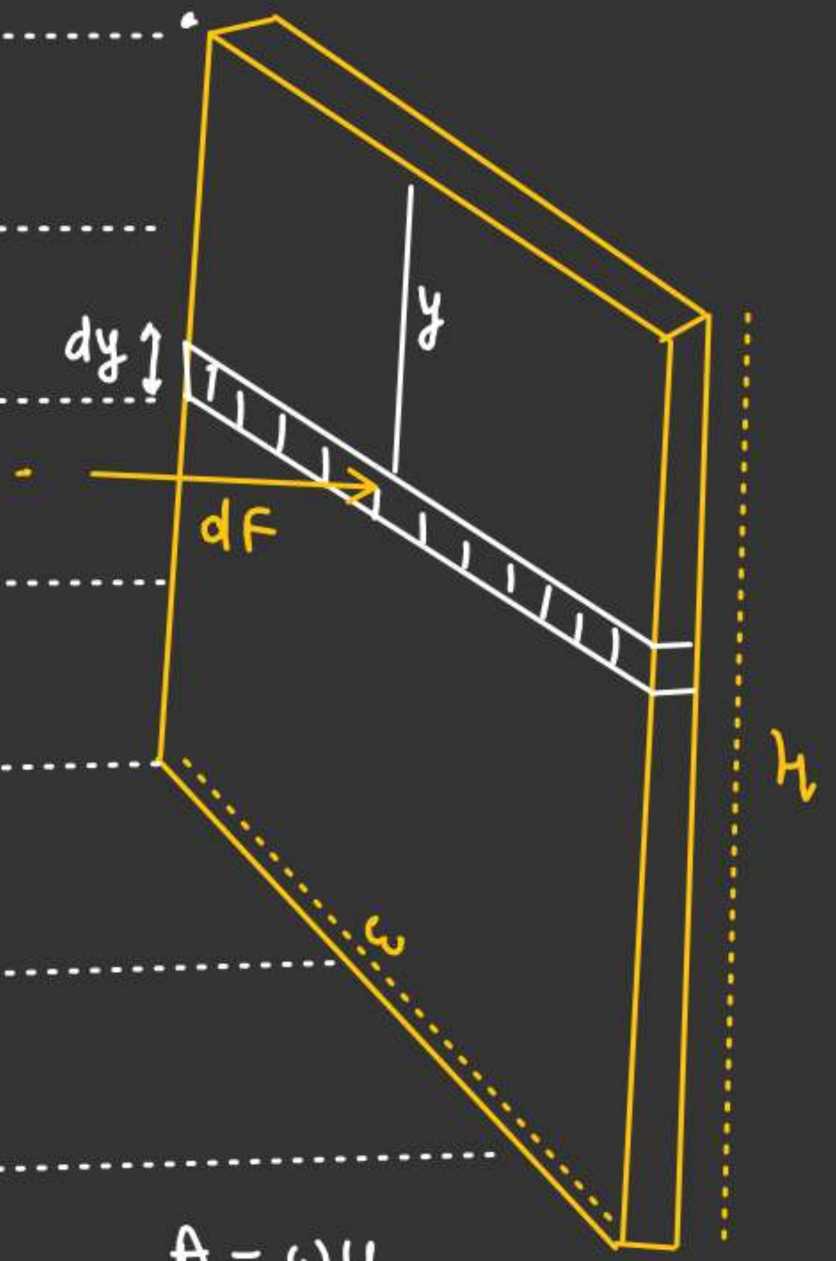
$$P_y = P_{y+dy} = \rho g y + P_{atm}$$

$$\int_0^F dF = \int_0^H P_y \cdot dA$$

$$= \int_0^H (P_{atm} + \rho g y)\,\omega\,dy$$

$$= P_{atm}\,\omega \int_0^H dy + \rho g \omega \int_0^H y\,dy$$

$$F = P_{atm}(\omega H) + \frac{\rho g \omega H^2}{2}$$



$A = \omega H$

Nishant Jindal

Force on vertical wall

$dA = W\,dy$ — Area of differential strip.

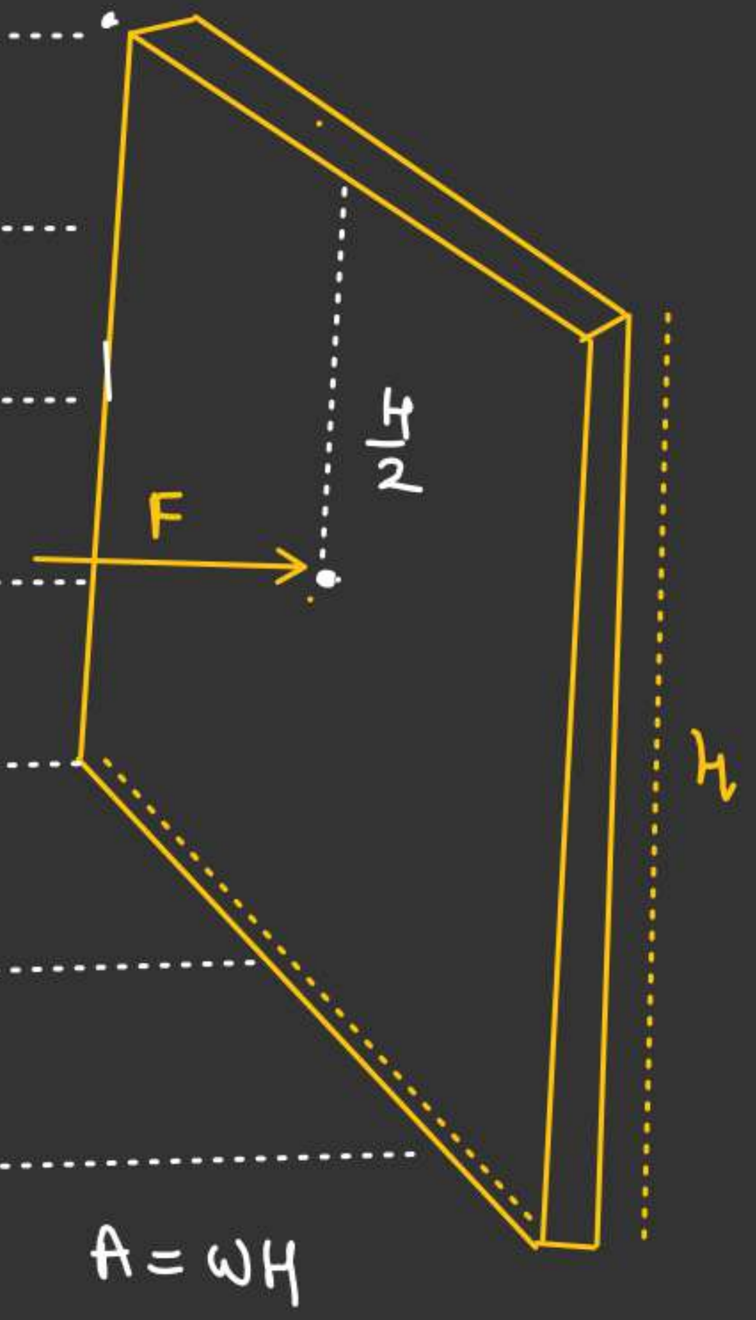
$$F = P_{atm}(\omega H) + \frac{\rho g \omega H^2}{2}$$

$$F = P_{atm}\cdot A + \left(\rho g \frac{H}{2}\right)(\omega \cdot H)$$

$$F = P_{atm}\cdot A + \begin{pmatrix}\text{Pressure}\\ \text{at COM}\end{pmatrix} \times \text{Area of plate}$$

$P_{atm}\cdot A$ ⇓ Due to Atmospheric pressure

(Pressure at COM) × Area of plate ⇓ Due to Hydrostatic liquid ie thrust



Nishant Jindal

Force on vertical wall

Due to liquid only.

$$dF = P_y \cdot dA$$

$$\int dF = \int \rho g y \cdot dA$$

$$\int dF = \rho g \int y \cdot dA$$

$$y_{com} = \frac{\int dm \cdot y}{\int dm} \qquad dm = \sigma \cdot dA$$

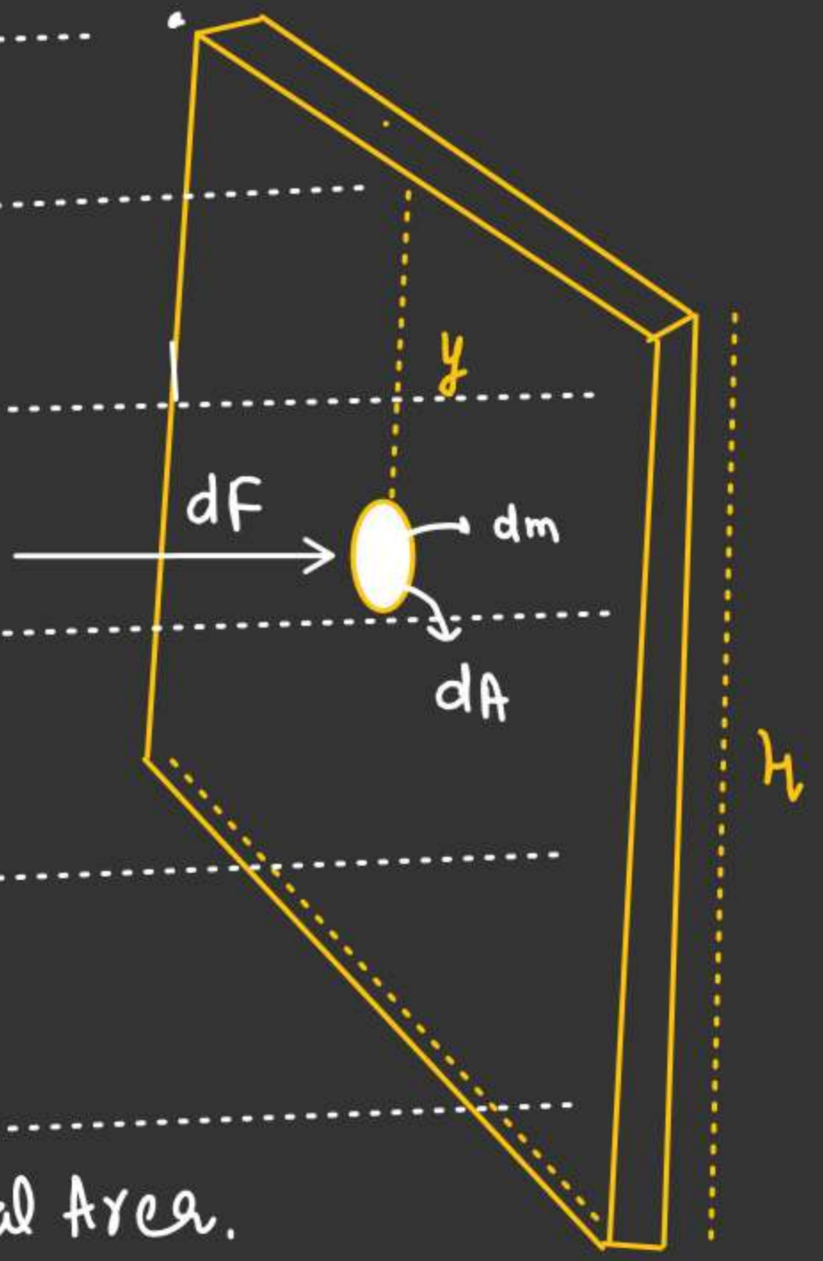
$$y_{com} = \frac{\cancel{\sigma} \int y \cdot dA}{\cancel{\sigma} \int dA} = \frac{\int y \cdot dA}{\int dA}$$

$$y_{com} \cdot A = \int y \cdot dA$$

$$\boxed{F_{net} = \rho g y_{com} \cdot A}$$

A → Total Area.

$\rho g y_{com}$ → Pressure at COM



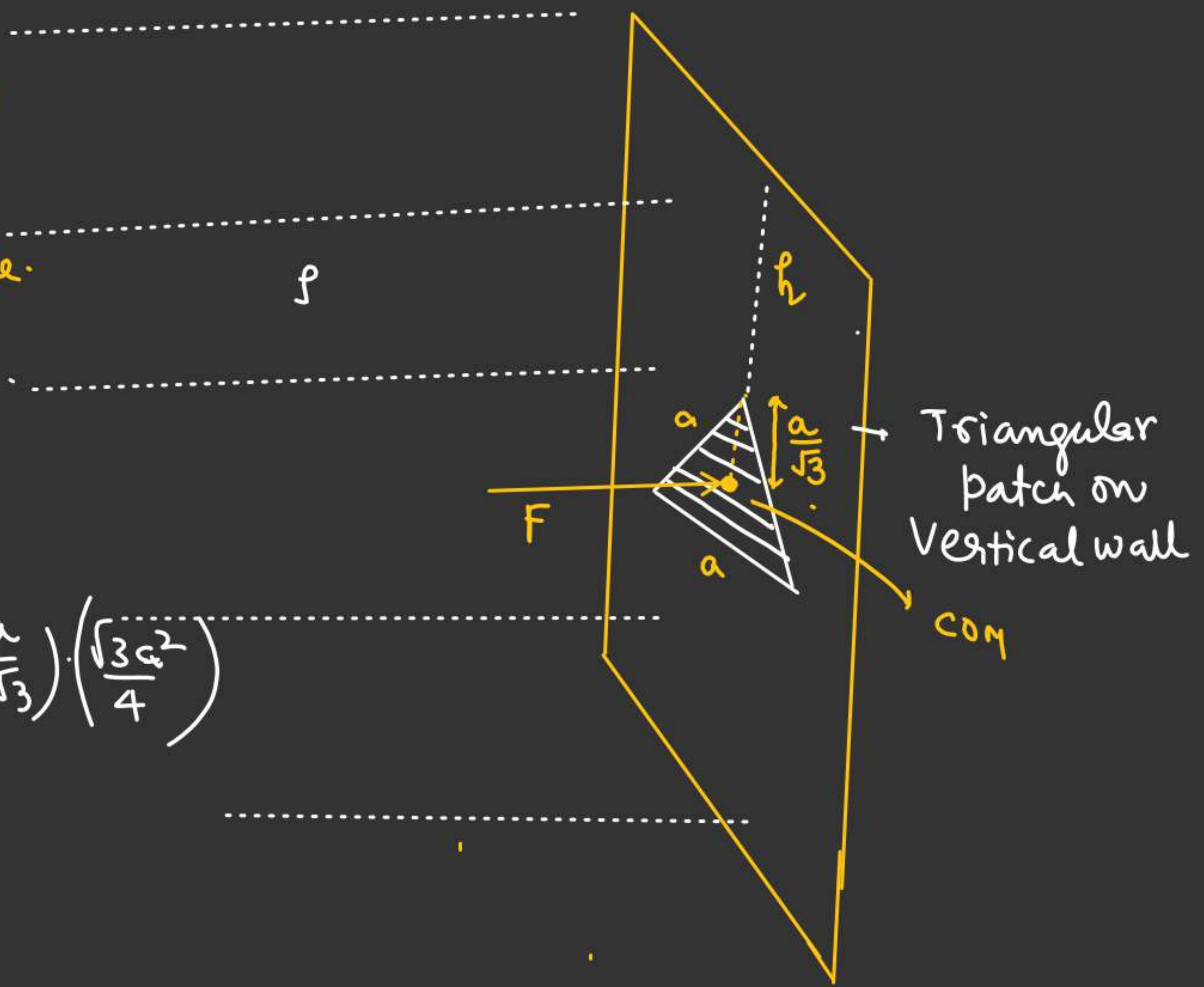
Hydrostatic thrust due to liquid on triangular patch

$$F_{liquid} = \underbrace{\rho g\left(h+\frac{a}{\sqrt{3}}\right)}_{\text{Pressure at COM.}} \times \underbrace{\left(\frac{\sqrt{3}\,a^2}{4}\right)}_{\text{Area of triangle.}}$$

$$F_{atm} = P_{atm}\cdot\left(\frac{\sqrt{3}a^2}{4}\right)$$

$$F_{net} = F_{liquid} + F_{atm}$$

$$= P_{atm}\left(\frac{\sqrt{3}a^2}{4}\right) + \rho g\left(h+\frac{a}{\sqrt{3}}\right)\cdot\left(\frac{\sqrt{3}a^2}{4}\right)$$



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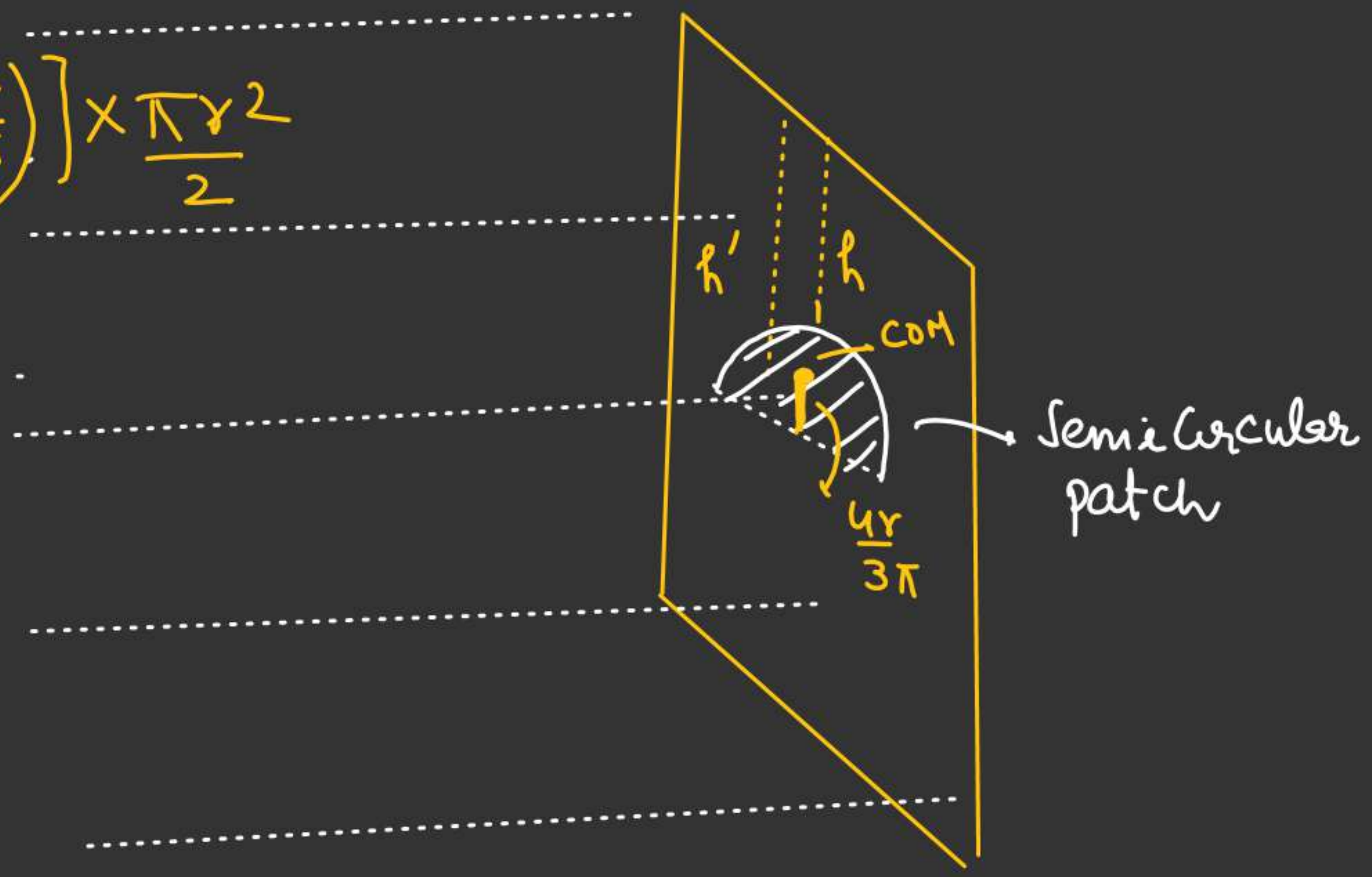
$$h' = h + \left(r - \frac{4r}{3\pi}\right)$$

$$F_{net} = P_{atm}\frac{\pi r^2}{2} + \rho g\left[h + \left(r - \frac{4r}{3\pi}\right)\right] \times \frac{\pi r^2}{2}$$



Nishant Jindal

Find Hydrostatic thrust on the Curve part of hemi Sphere.

$P_{atm} \rightarrow$ Neglected

M-1

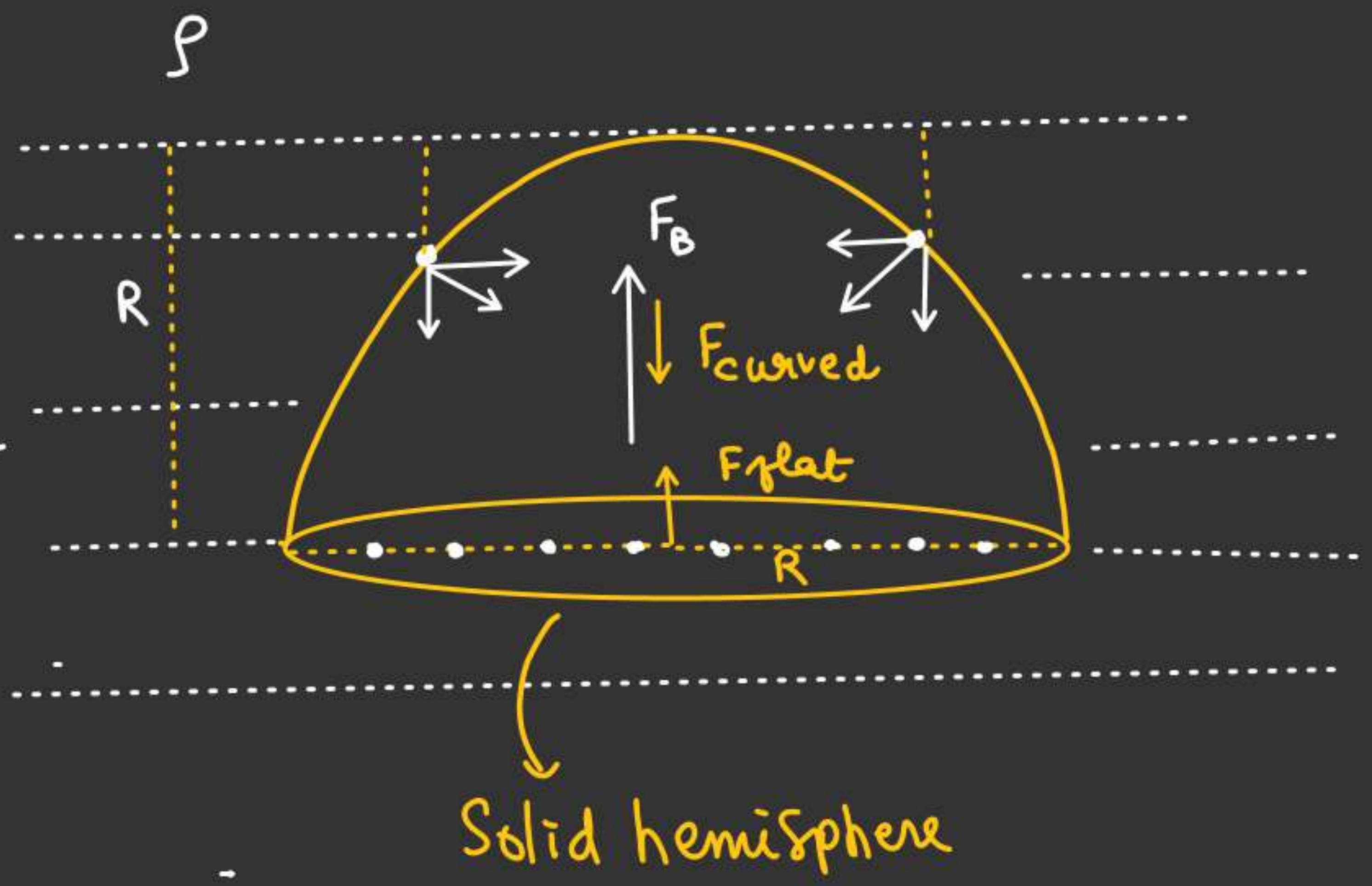
$$F_B = F_{flat\,part} - F_{curve\,part}$$

$$F_{curve\,part} = F_{flat\,part} - F_B$$

$$= \rho g R \cdot (\pi R^2) - \frac{2}{3}\pi R^3 \rho g$$

$$= \rho g \pi R^3 - \frac{2}{3}\pi R^3 \rho g$$

$$= \frac{1}{3}\rho g \pi R^3$$

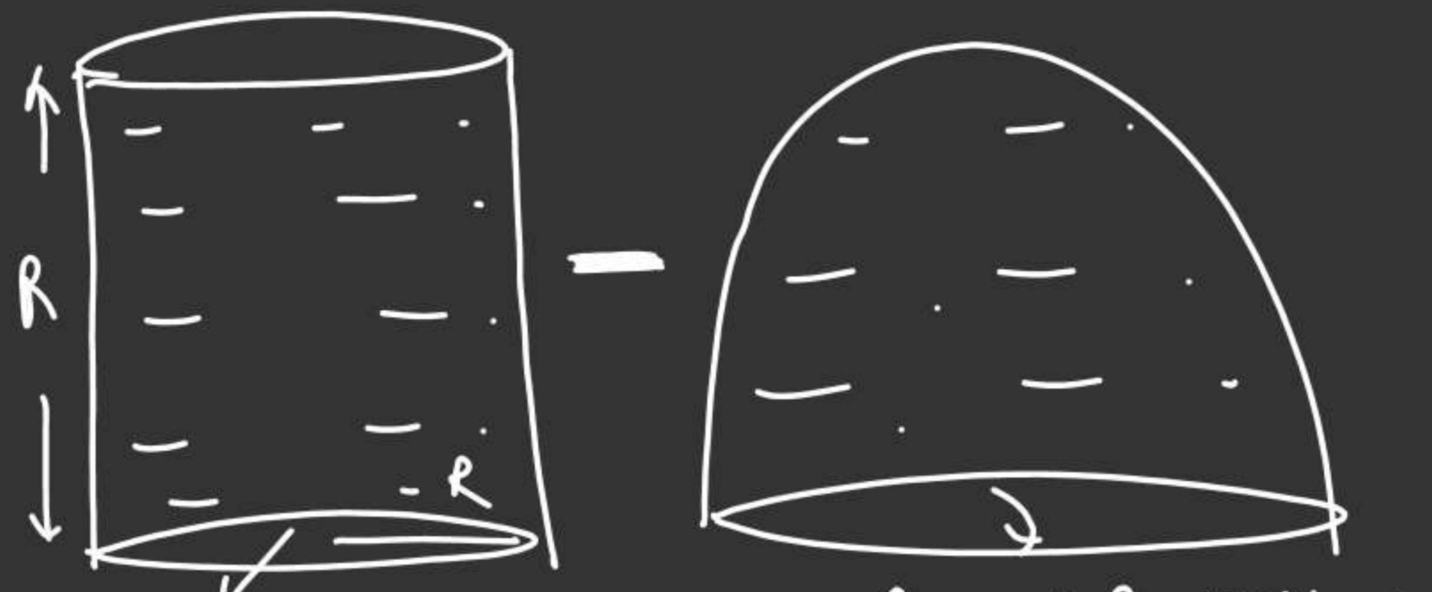


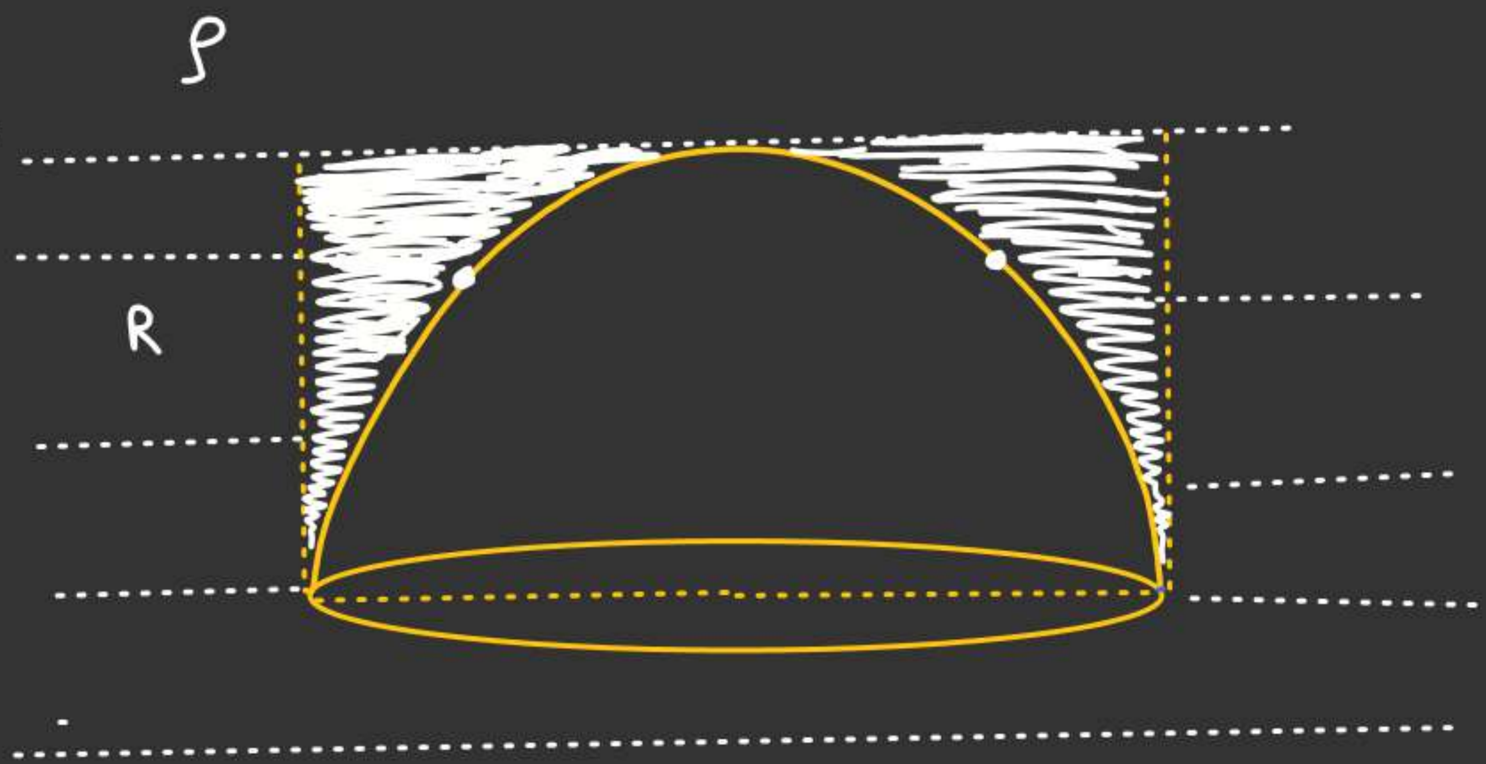
Nishant Jindal

Find Hydrostatic thrust on the Curve part of hemi Sphere.

$P_{atm} \rightarrow$ Neglected

M-2 :- Force on the Curvepart is due to weight of the liquid just above the Curve part





Volume of liquid above the curve Surface $= \pi R^2 \cdot R - \frac{2}{3}\pi R^3$

$= \frac{1}{3}\pi R^3$.

$F_{\text{curve part}} =$ Weight of liquid above curve part.

$= \left(\frac{1}{3}\pi R^3\right)\rho \cdot g$

$=$

Nishant Jindal

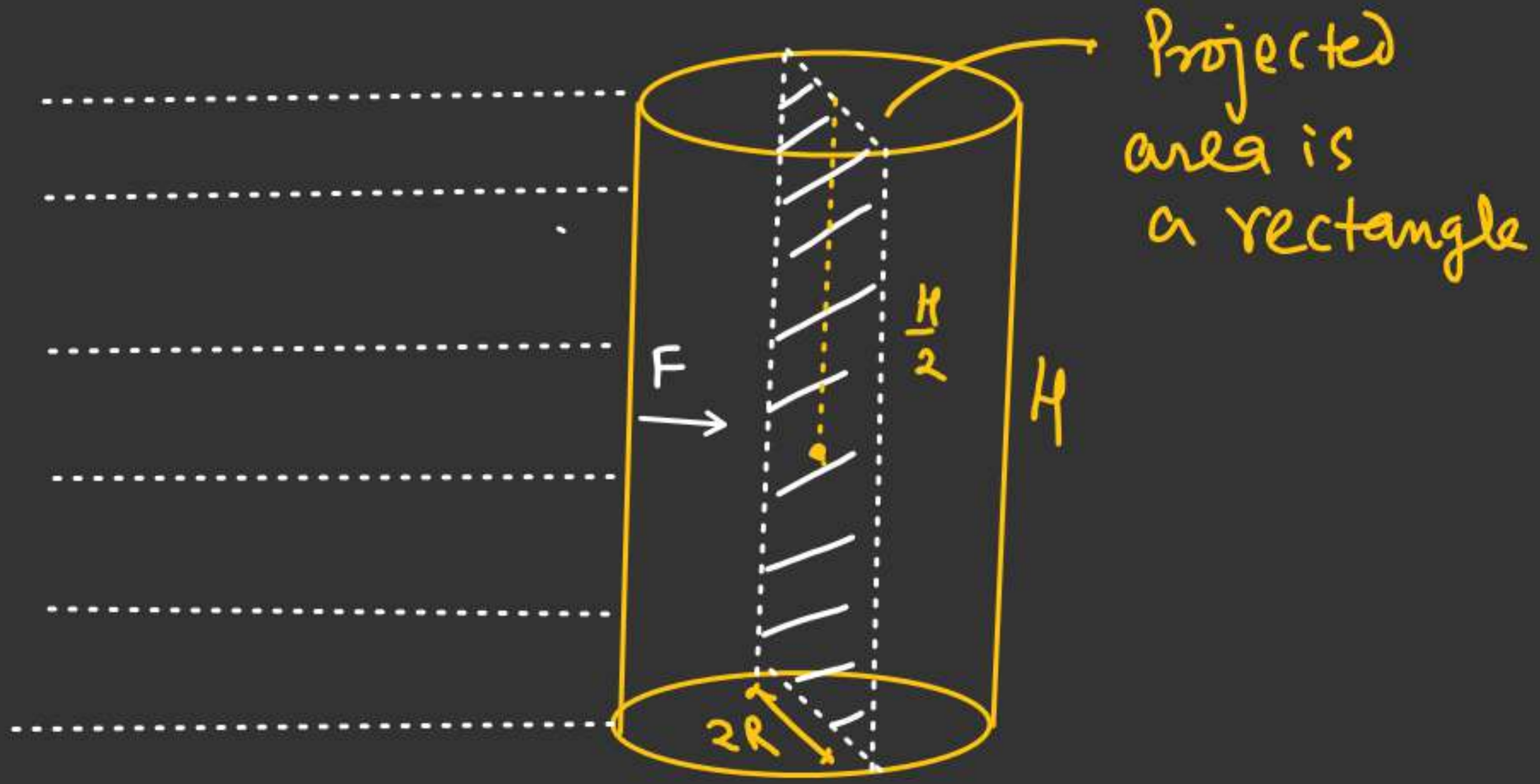
Find hydrostatic thrust on the cylinder.

$$F = \left(\rho g \frac{H}{2}\right)\begin{pmatrix}\text{Projected}\\ \text{area}\\ \perp \text{ to } F\end{pmatrix}$$

$$F = \left(\rho g \frac{H}{2}\right)\begin{pmatrix}\text{Area of}\\ \text{Rectangle}\end{pmatrix}$$

$$F = \left(\rho g \frac{H}{2}\right)(2R \cdot H)$$

$$= \underline{\rho g R H^2}.$$

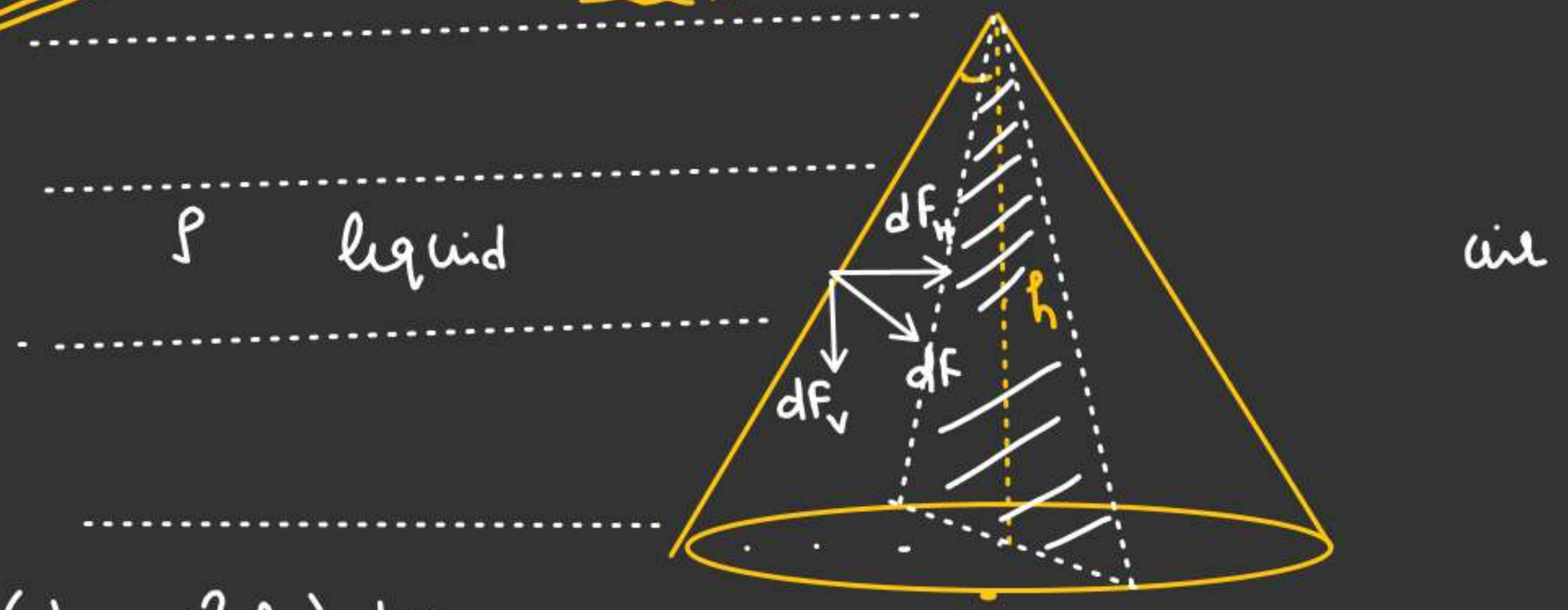


Nishant Jindal

Find Force due to liquid on the Cone.

H-W ✓ (Prove by integration)

$F_{Horizontal} = ?$, $F_{vertical} = ?$

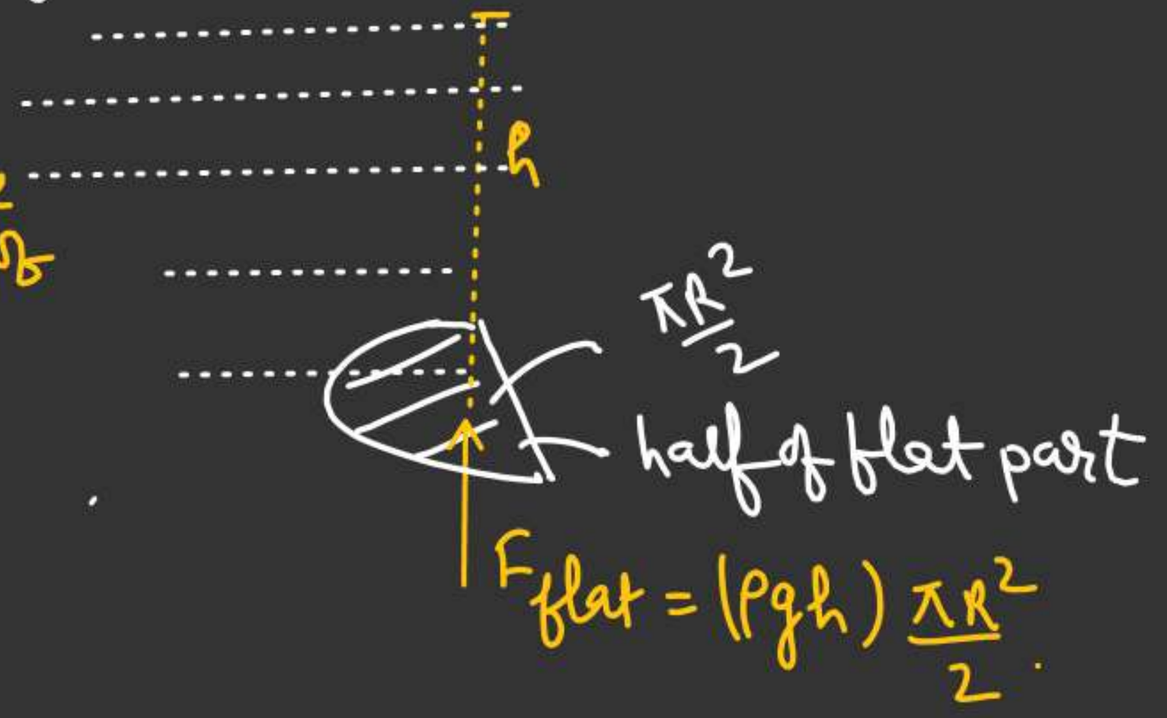


$$F_v = F_{flatpart} - F_B$$

$$= (\rho g h)\left(\frac{\pi R^2}{2}\right) - \underbrace{\left(\frac{1}{3}\pi R^2 h\right)\frac{1}{2}}_{\text{volume of half of Cone}}\rho g$$

$$= \frac{\rho g h \pi R^2}{2} - \frac{\pi R^2 h \rho g}{6}$$

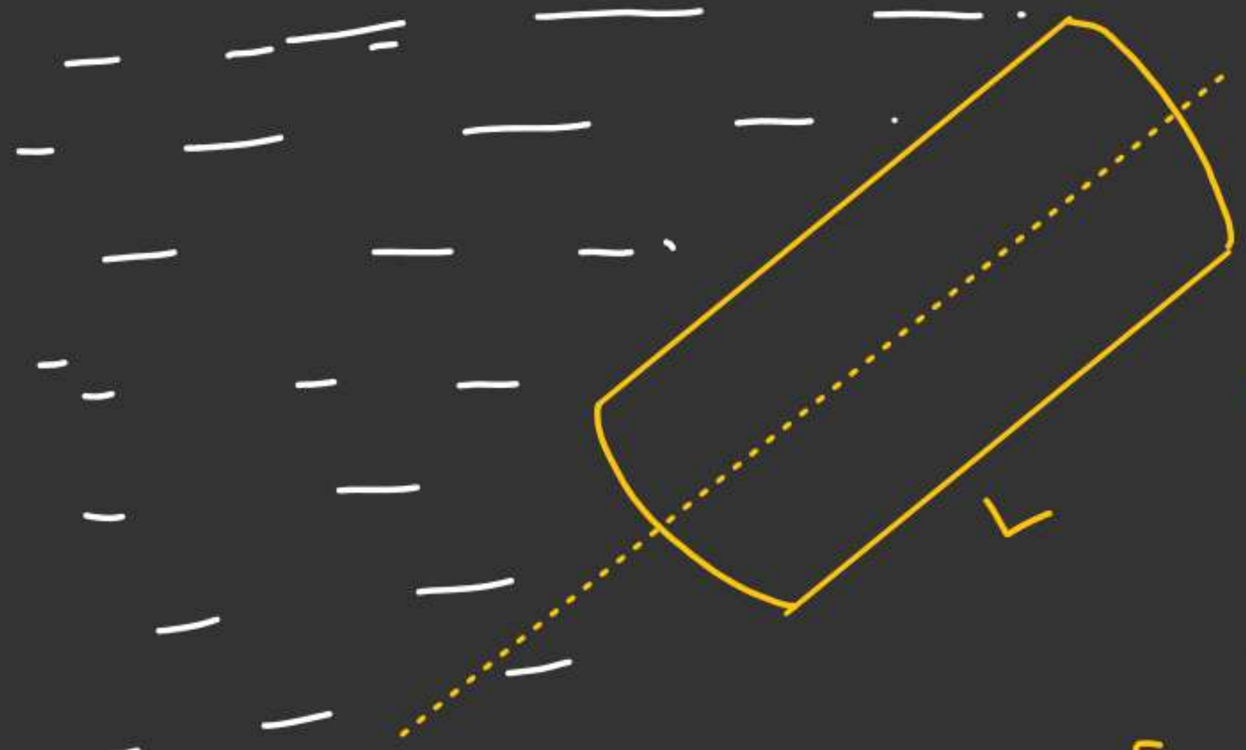
$$= \left(\frac{\rho g h \pi R^2}{3}\right)$$

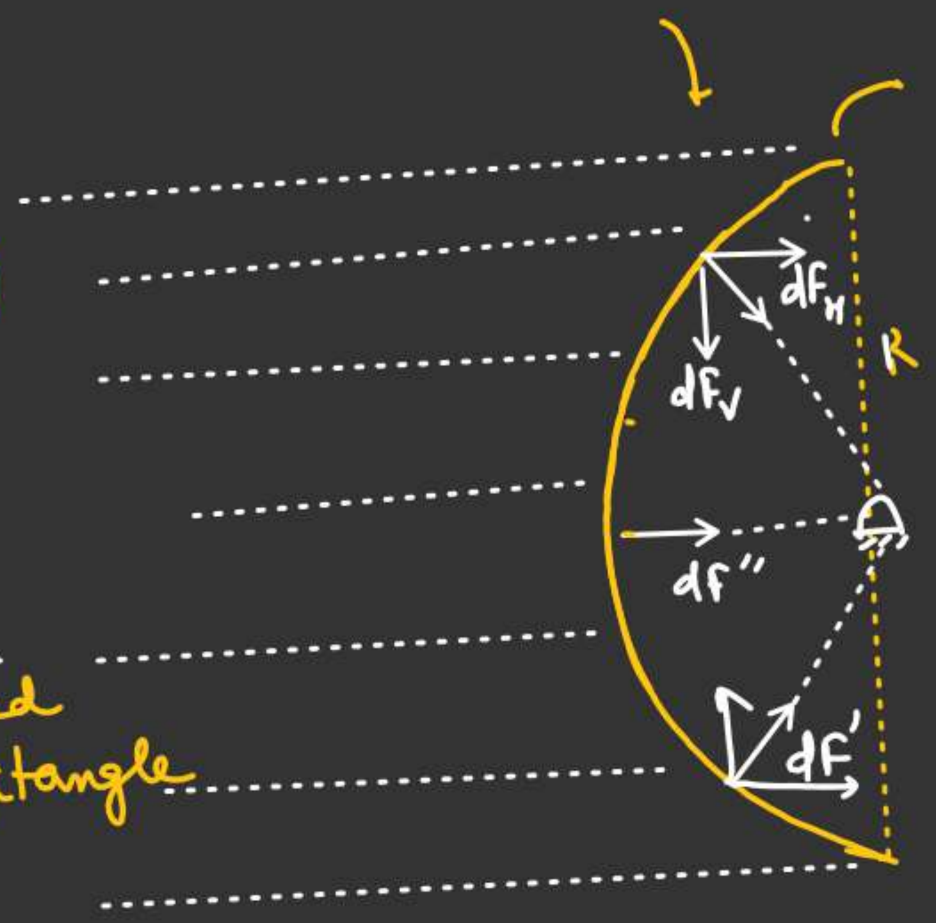


Nishant Jindal

1) Find net hydrostatic torque on the dam ✓

2) Find hydrostatic force (Net)



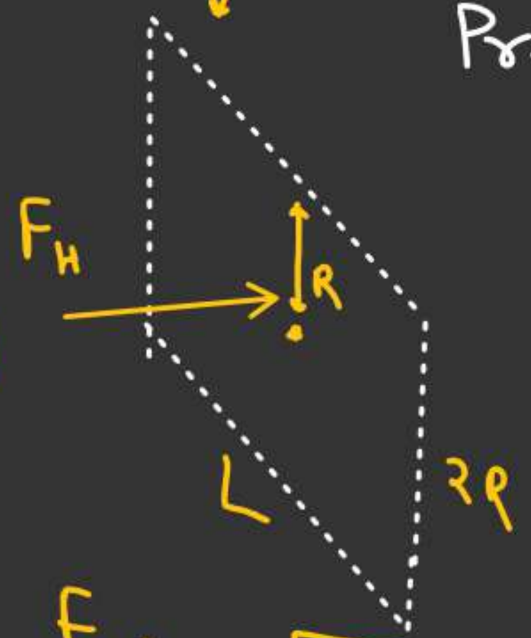


Cylindrical

Free to Rotate

length of Cylinder is L.

projected Area Rectangle



$$F_H = (\rho g R)(L \times 2R)$$

$$F_H = \underline{2\rho g R^2 L}$$

Pressure force Normal to Curve Surface so it passes through hinge.

No net torque.

$$F_V = F_B = \left(\frac{\pi R^2 L}{2}\right)\rho g$$

$$= \frac{\rho g \pi R^2 L}{2}$$

$$F_{net} = \sqrt{F_V^2 + F_H^2} \checkmark$$