Nishant Jindal

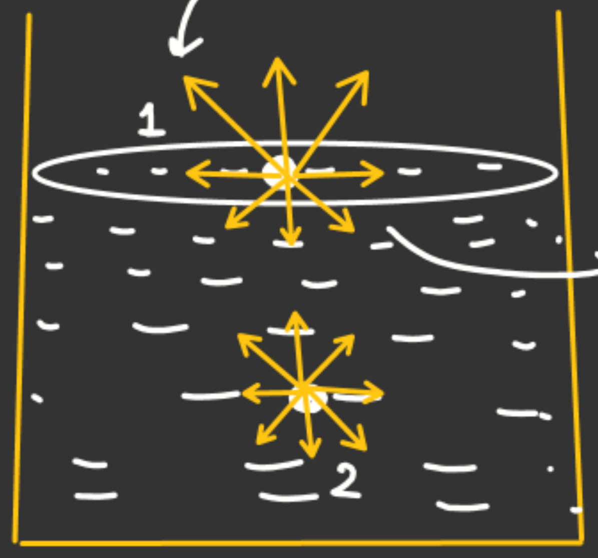
SURFACE TENSION

Two type of forces.

1) Cohesive :- force of attraction b/w molecules of same nature.

2) Adhesive :- force of attraction b/w Molecules of different nature.

Interaction b/w air & liquid Molecule



Interaction b/w liquid-liquid molecule.

For Molecule 2 it is surrounded by liquid molecule so force of cohension. No net force on the liquid layer containing molecule-2.

For Molecule 1 it is interacted with air Molecule as well as liquid-Molecule So there is net force on surface layer. & it acts like a stretch membrane

Surface tension $\leftarrow T = \left(\frac{F_T}{L}\right)$

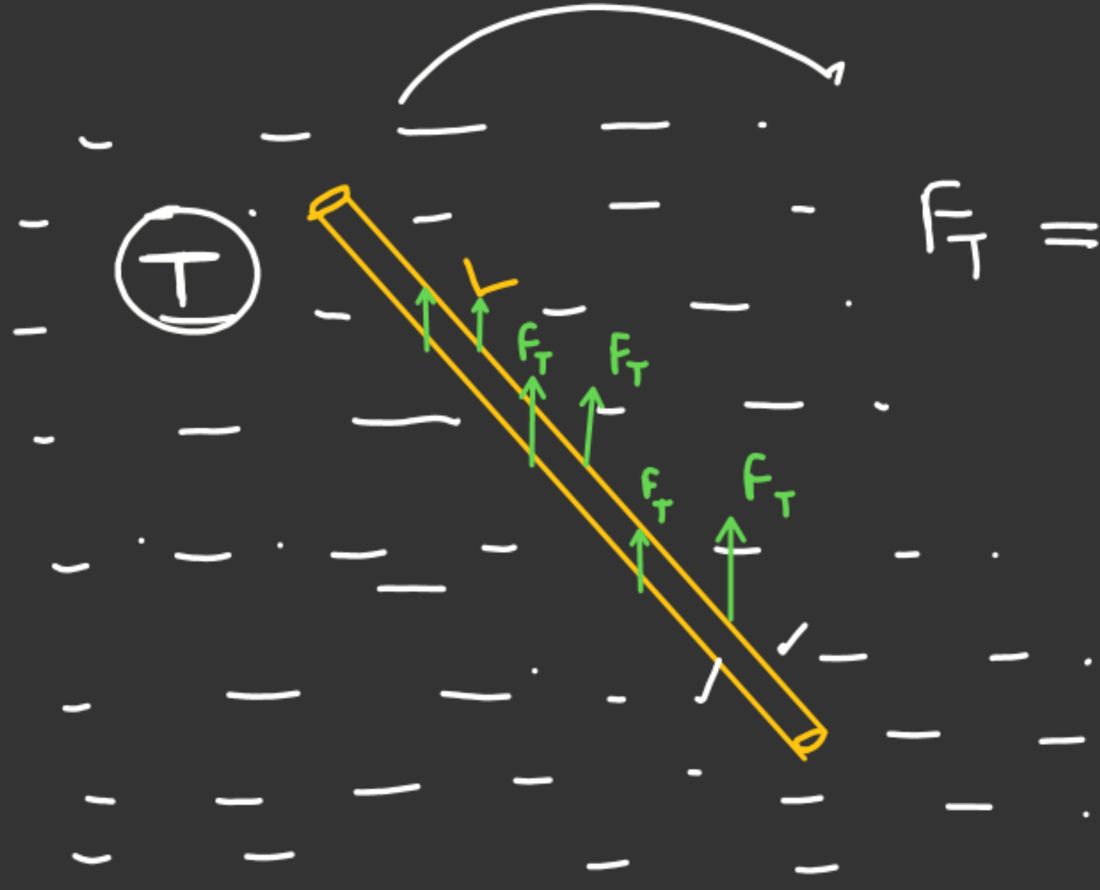
Nishant Jindal

$$\boxed{F_T = T \cdot l_{eff}}$$

$$l_{eff} = (n \times L)$$

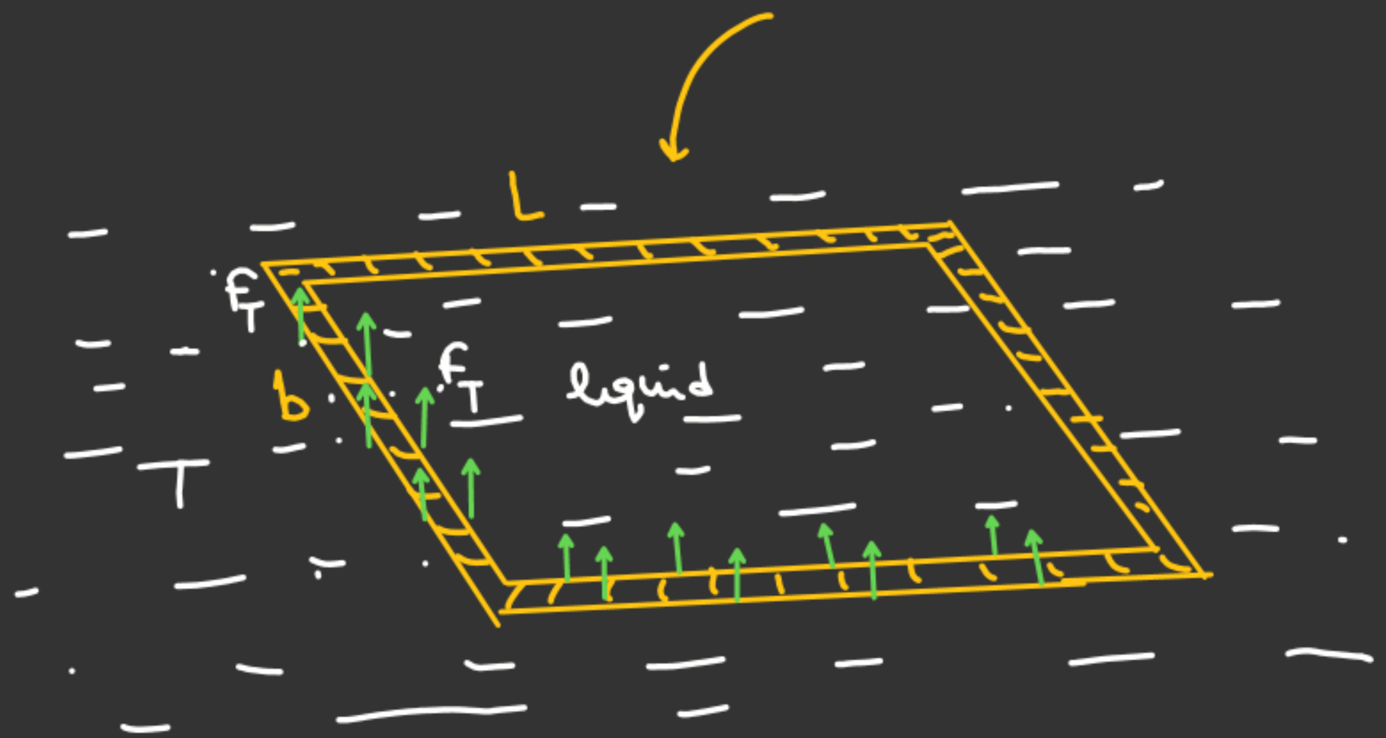
n = No of Contact Surfaces.

Thin Rod



$$F_T = (T\, L \times 2)$$

Rectangular wire frame.



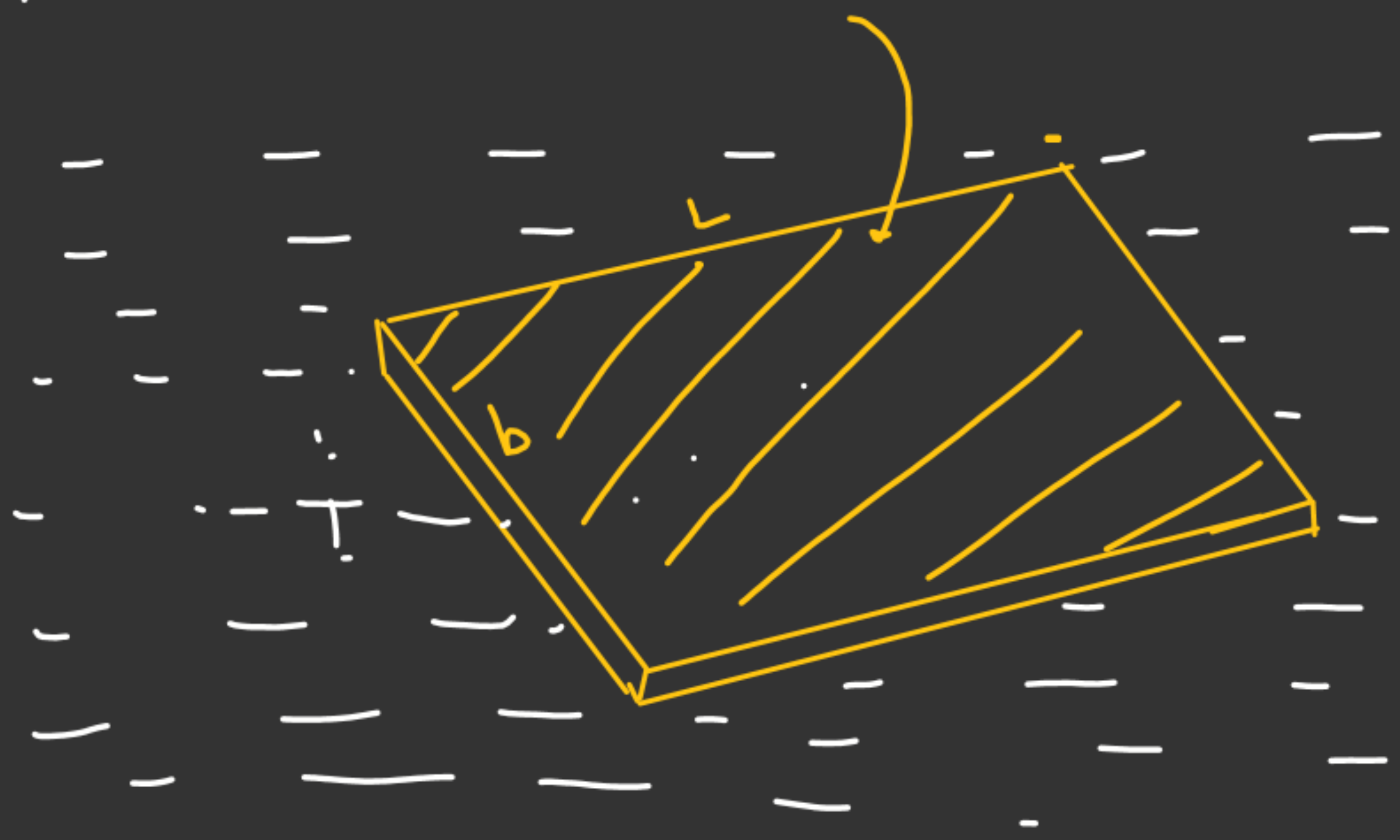
$$F_T = T\,(L+b) \times 2 \times 2$$

$$F_T = 4T\,(L+b)$$

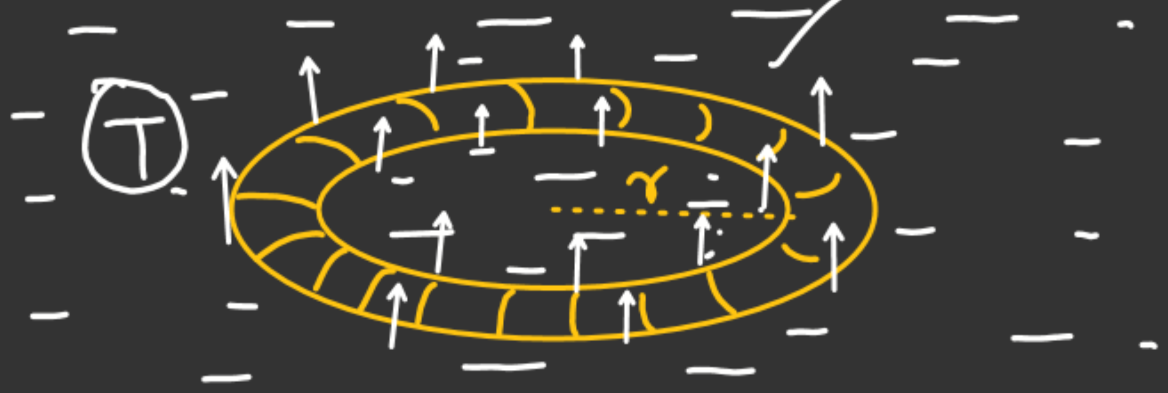
Nishant Jindal

\#

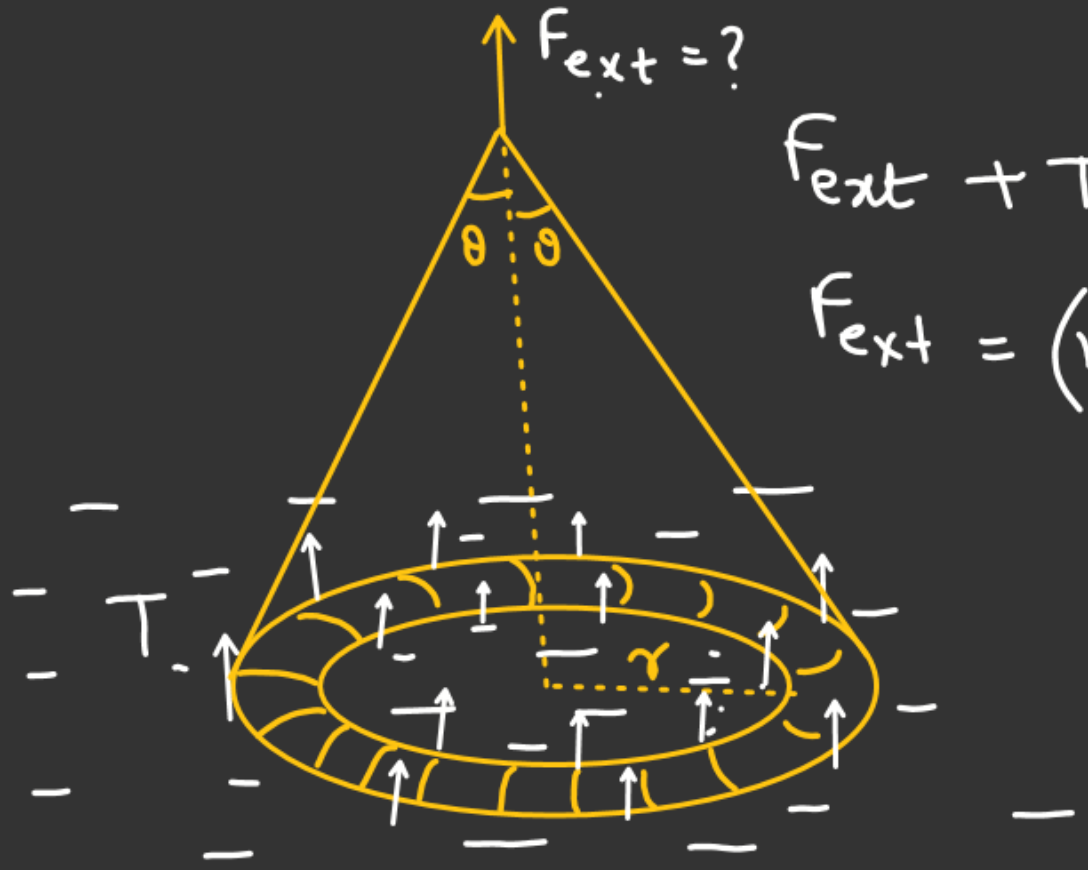
Sheet.



$$F = T(L+b)\times 2$$



$$F_T = \underline{T\times(2\pi r)\times 2}$$



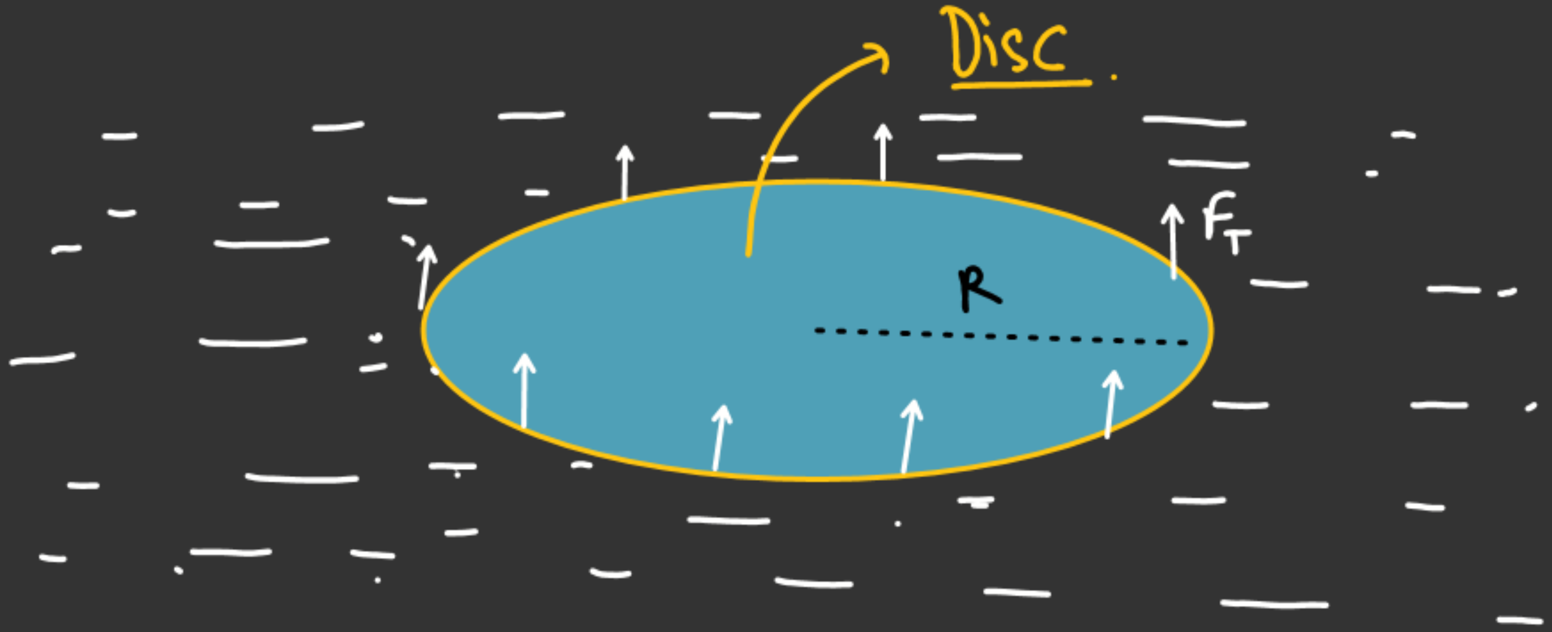
F_T

$$F_{ext} + T\cdot 4\pi R = mg$$

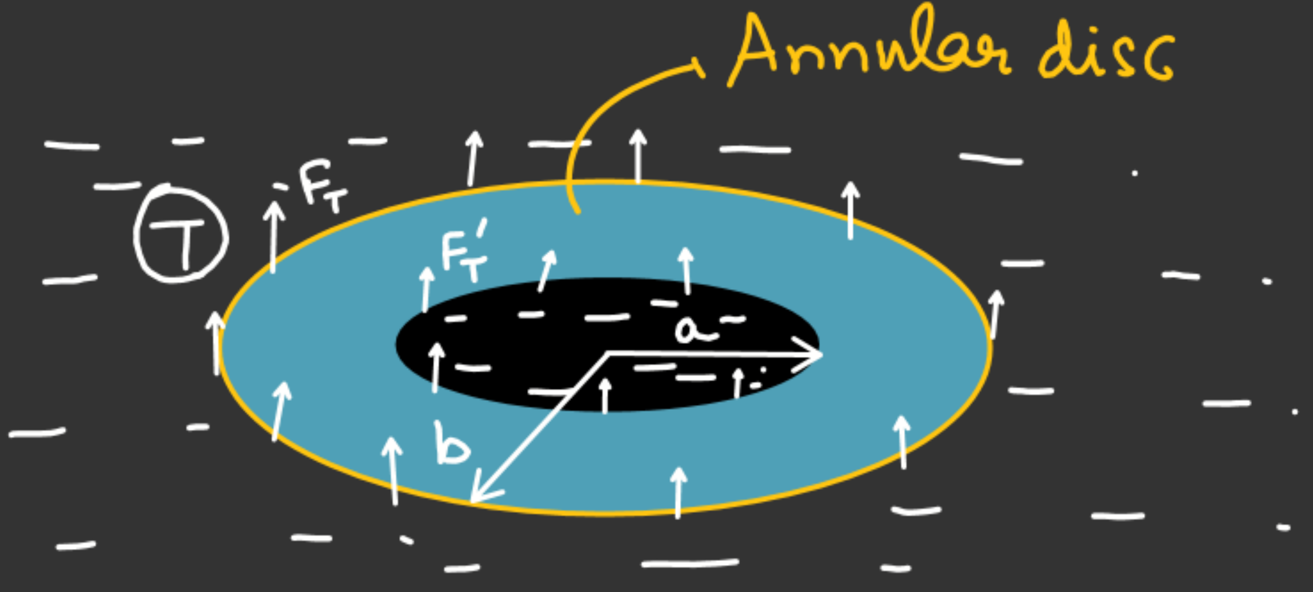
$$F_{ext} = (mg - T\cdot 4\pi R)$$

Nishant Jindal

Find Surface tension force



$$F_T = (T \times 2\pi R)$$

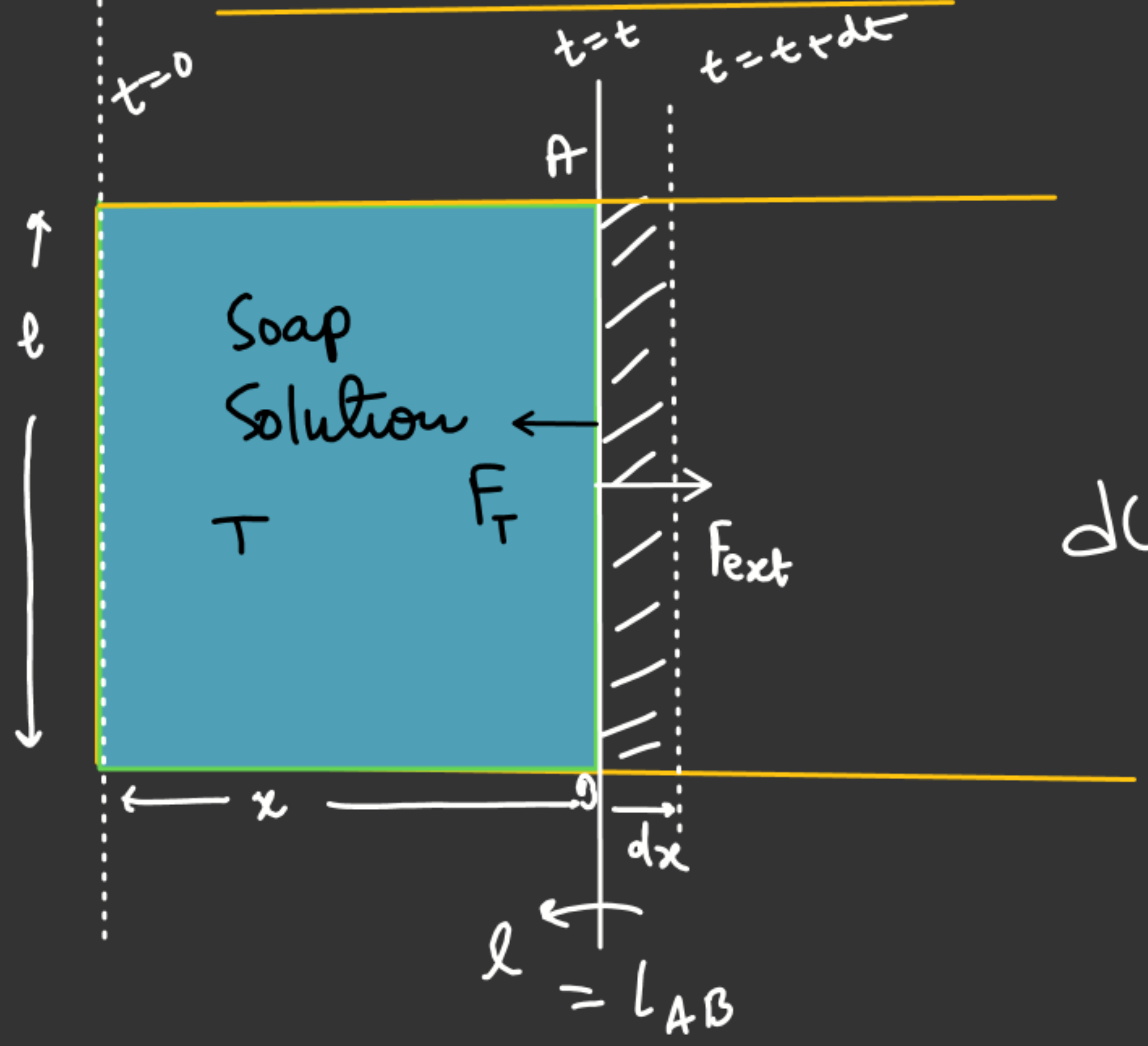


$$(F_T)_{net} = T \times (\underline{2\pi b} + \underline{2\pi a})$$

$$= T \times 2\pi (a+b)$$

Nishant Jindal

Surface Energy



$$T = \frac{\text{Surface energy}}{\text{Area}}$$

For Slider to move very slowly.

$$f_{ext} = F_T = T \times 2L$$

$$dW_{ext} = F_{ext} \cdot dx$$

$$dU = dW_{ext} = T \times \underline{2} \times \underline{L\,dx}$$

$$\int_0^U dU = 2TL \int_0^x dx$$

$$U = T \times \underline{L \times x} \times \underline{2}$$

$$U = T \times A \times 2$$

$$(U = T \times A_{eff})$$

$A_{eff} = A \times$ No of Contact

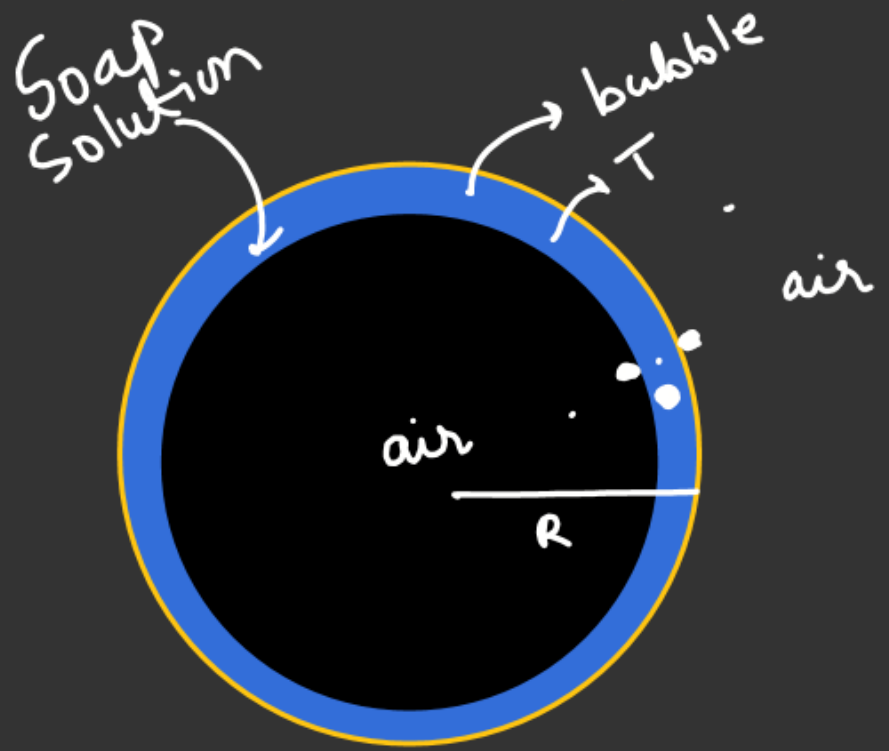
Nishant Jindal

liquid drop

$$\frac{U}{A} = T$$

$$\boxed{\begin{aligned} U_{\text{liquid drop}} &= T \times A \\ &= T \times 4\pi R^2 \end{aligned}}$$

soap bubble



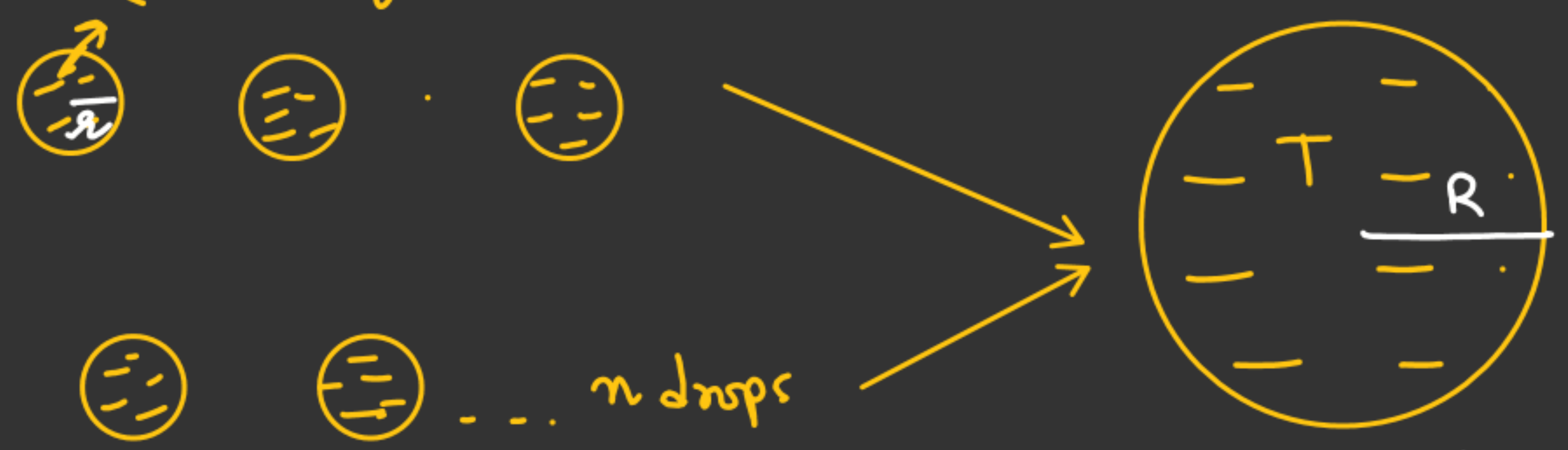
$$U = T \times 4\pi R^2 \times 2$$

$$\boxed{U = T \times 8\pi R^2}$$

Nishant Jindal

Q: n-liquid drops coalsec to form a single bigger liquid drop.

(T = Surface tension)



Bigger drop

Coalsec

⇓

(To Combine)

$\Delta U = ??$

$$U_i = n \times 4\pi r^2 \times T$$

$$\Delta U = U_f - U_i$$

$$\frac{4}{3}\pi r^3 \times n = \frac{4}{3}\pi R^3$$

$$U_f = T \times 4\pi R^2$$

$$= T \cdot 4\pi \left(R^2 - r^2 \times n\right)$$

$$= T \cdot 4\pi \left(r^2 n^{2/3} - r^2 \times n\right)$$

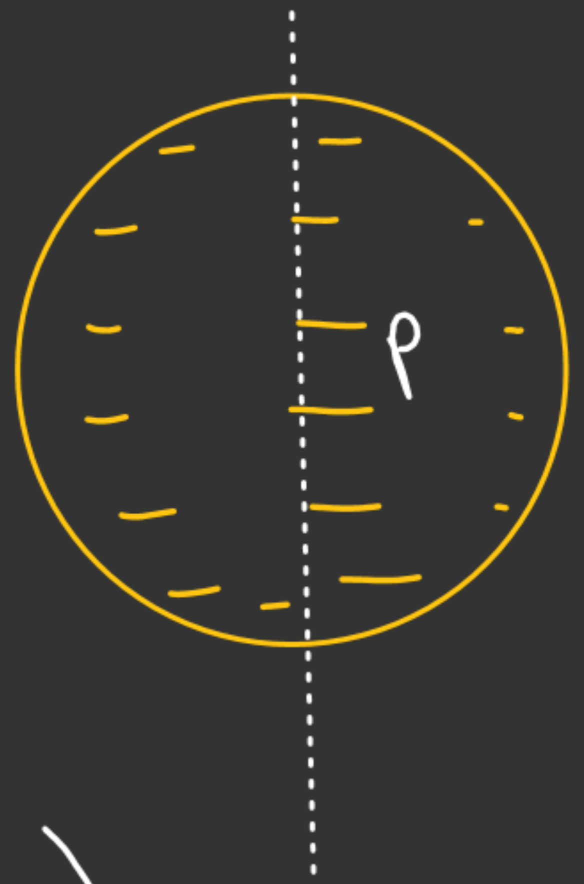
$$\boxed{R = r n^{1/3}}$$

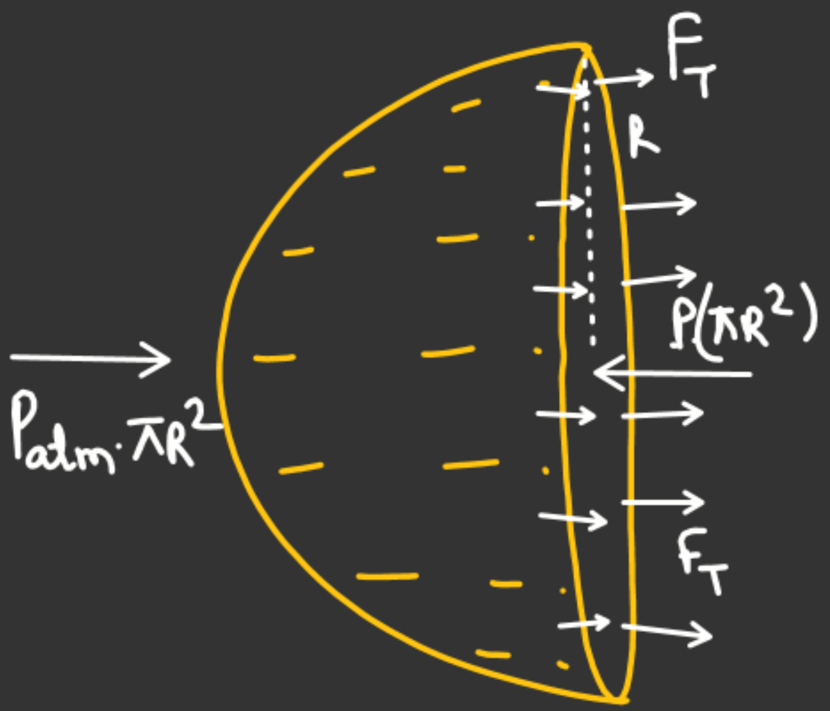
$$\boxed{\Delta U = T(4\pi r^2)\, n \left(n^{-1/3} - 1\right)}$$

Nishant Jindal

EXCESS PRESSURE INSIDE A LIQUID DROP

P_{atm}





For Equilibrium.

$$P \cdot \pi R^2 = F_T + P_{atm} \cdot \pi R^2$$

$$P \cdot \pi R^2 = T \cdot \underline{2\pi R} + P_{atm} \cdot \pi R^2$$

$$P = \frac{2T}{R} + P_{atm}$$

$$F_T = (T \times 2\pi R)$$

$P_1 > P_2$

[Pressure is More on concave Side]

$$\boxed{\underline{P - P_{atm}} = \frac{2T}{R}}$$

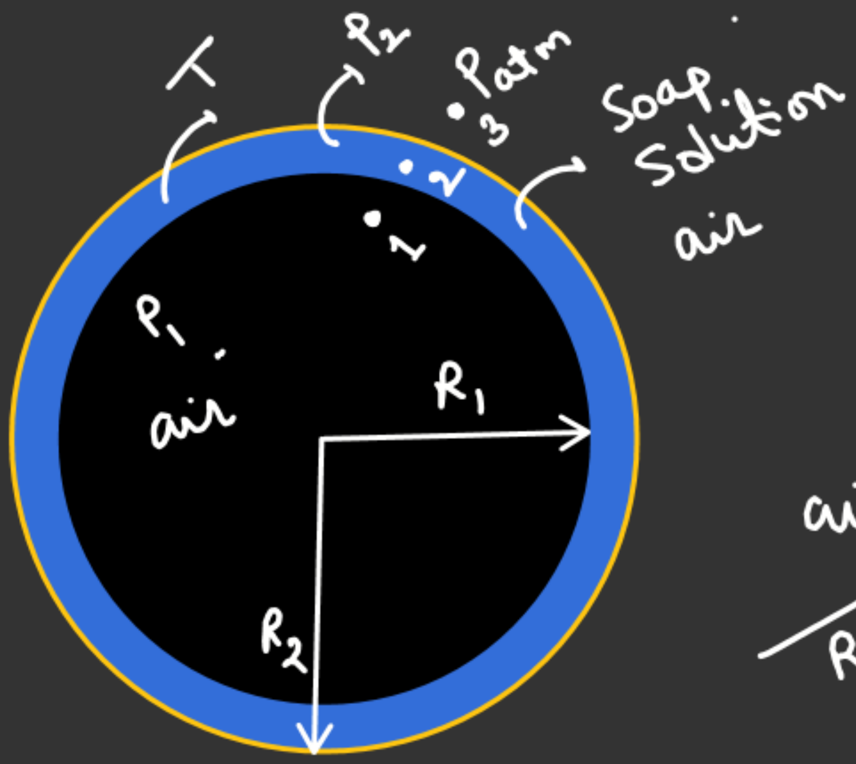
$\Downarrow$

Excess pressure inside a liquid drop.

Nishant Jindal

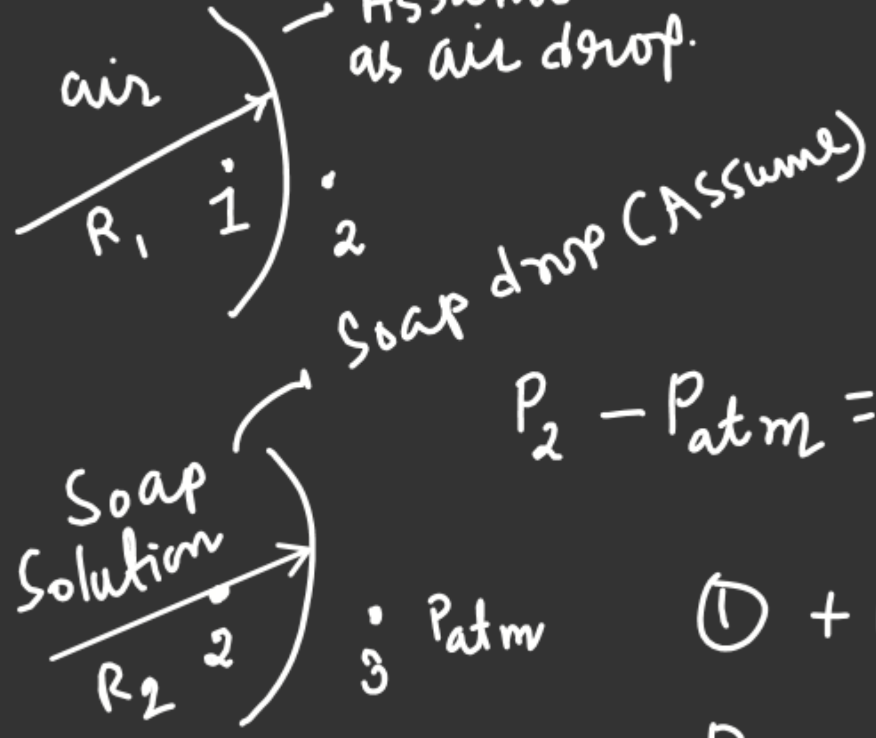
**

Excess pressure inside a Soap bubble



1 – 2

$$P_1 - P_2 = \frac{2T}{R_1} \quad -(1)$$



$$P_2 - P_{atm} = \frac{2T}{R_2} \quad -(2)$$

(1) + (2)

$$P_1 - P_{atm} = 2T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

For bubble, $R_1 \simeq R_2 = R$

**

$$\boxed{P_1 - P_{atm} = \frac{4T}{R}}$$