Nishant Jindal

VISCOSITY

Def^n :- Property by virtue of which any liquid layer apply tangential force to its adjacent layer.

$$F \propto A\left(\frac{dv}{dy}\right)$$

$$\boxed{F = -\eta A\left(\frac{dv}{dy}\right)}$$

$$\boxed{\frac{dv}{dy} = \frac{v}{y}.}$$

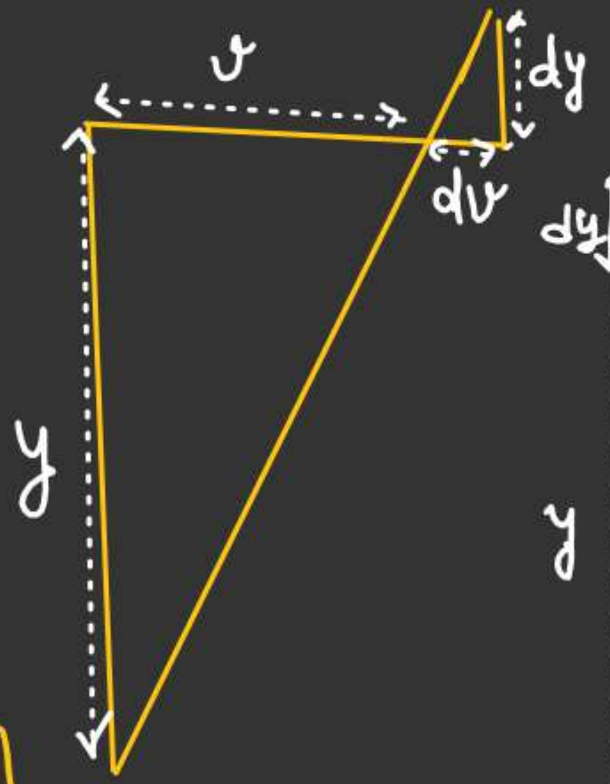
η = coff^n of viscosity

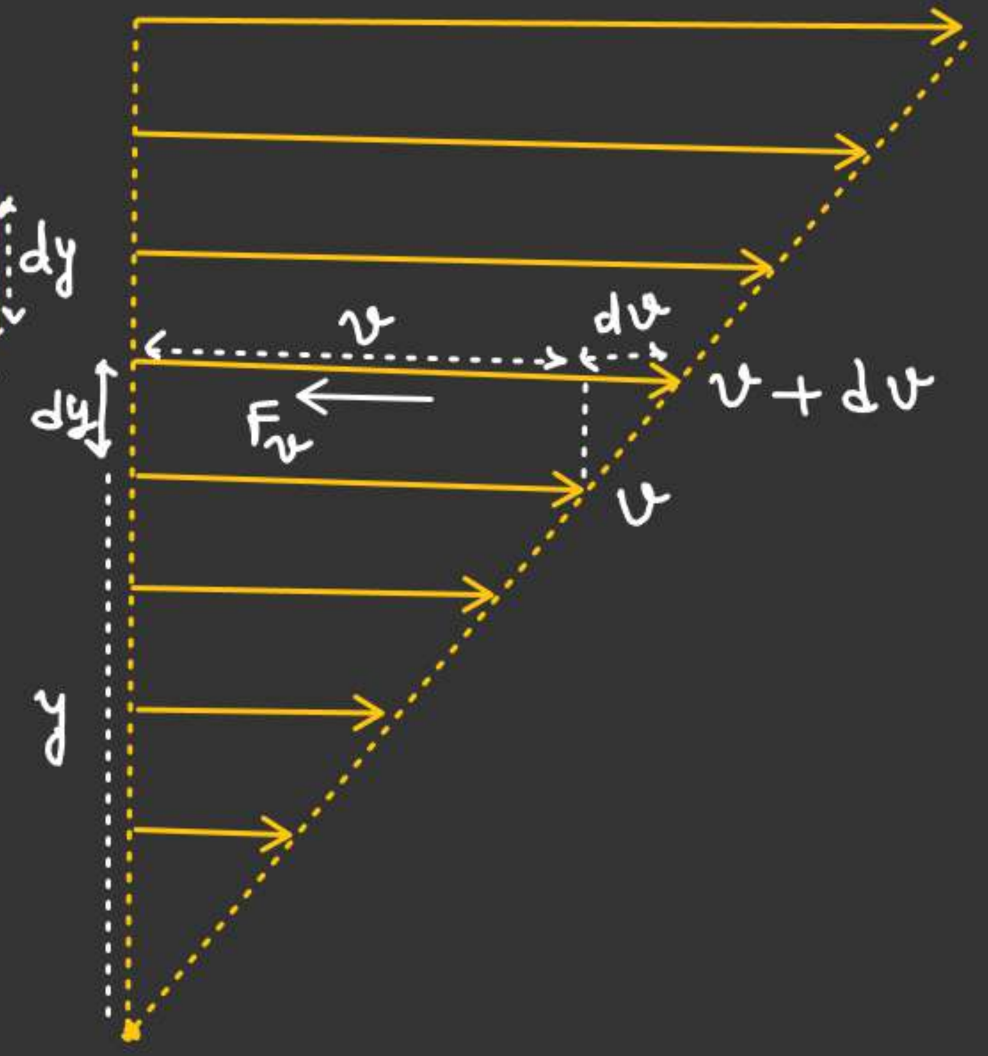
A = Area of layer.

$\frac{dv}{dy}$ = velocity gradient

C-G-S unit = poise [grm/cm-s]

S-I-I unit = 10 poise Kg/m-s





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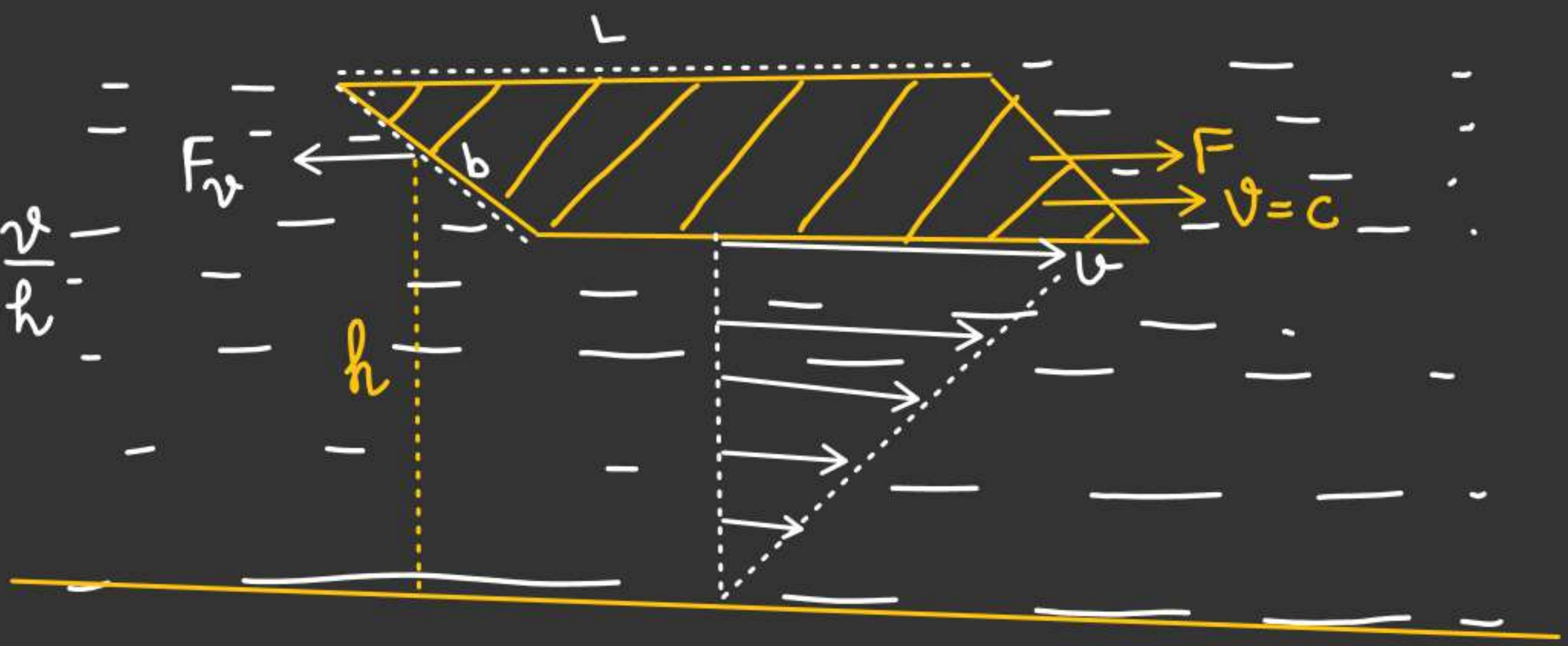
Find F so that plate move with constant velocity.

η = coff of viscosity.

$$F_v = \eta(Lb)\left(\frac{dv}{dy}\right)$$

$$\frac{dv}{dy} = \frac{v}{h}$$



$$F_v = \left(\eta(Lb)\frac{v}{h}\right)$$

For constant velocity

$$F = F_v = \left(\eta \frac{Lbv}{h}\right)$$

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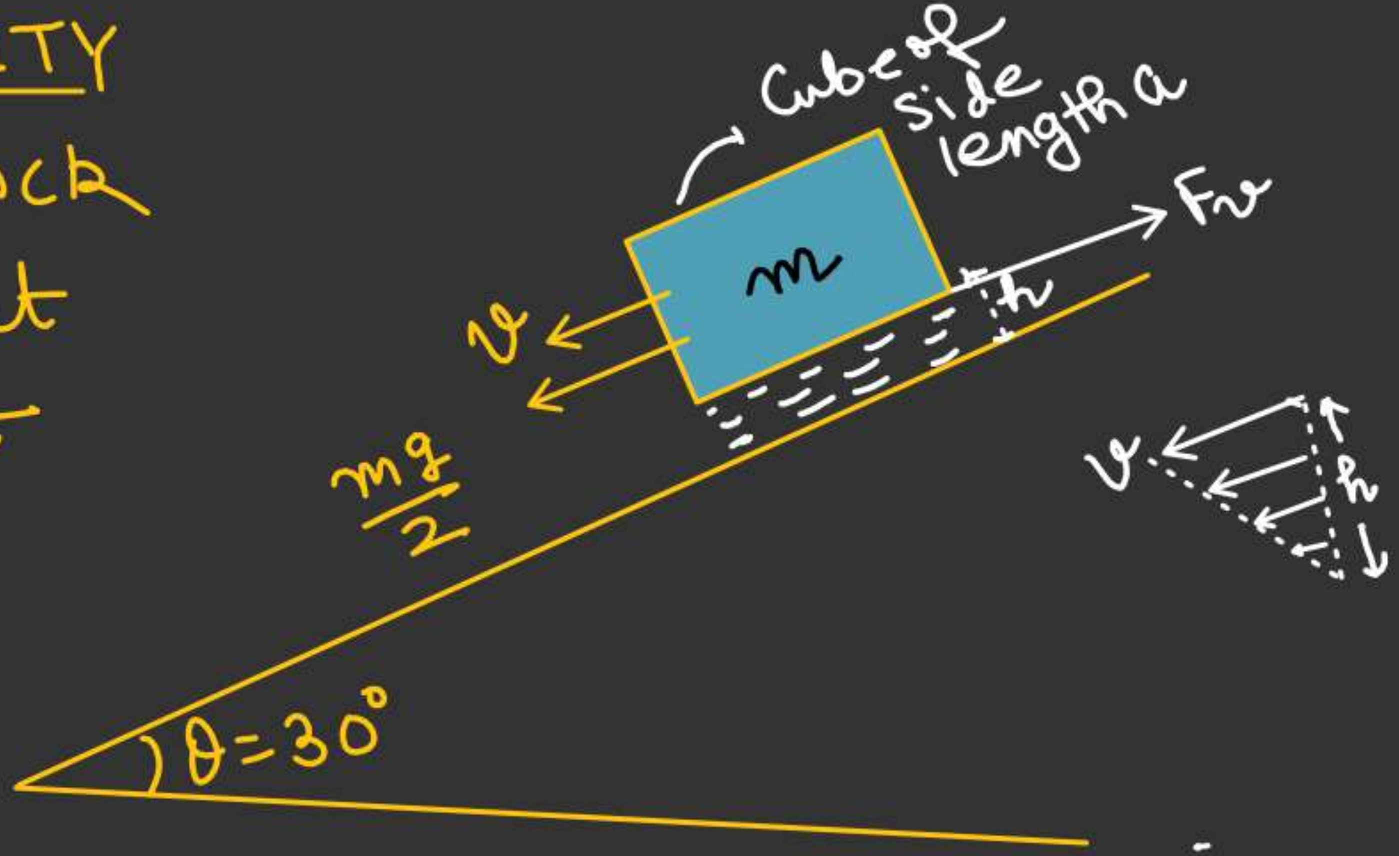
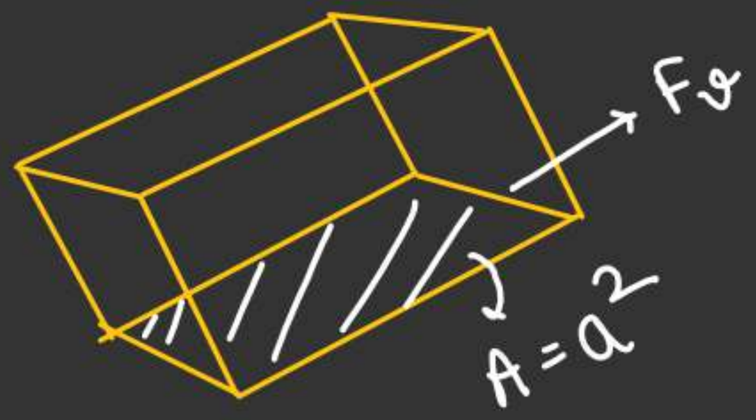
Q: Find η of the liquid b/w block and inclined plane so that block move with constant velocity v m/s.





Sol^n.

$$F_v = \frac{mg}{2}$$

$$\eta a^2 \frac{v}{h} = \frac{mg}{2}$$

$$\eta = \left(\frac{mgh}{2va^2}\right)$$

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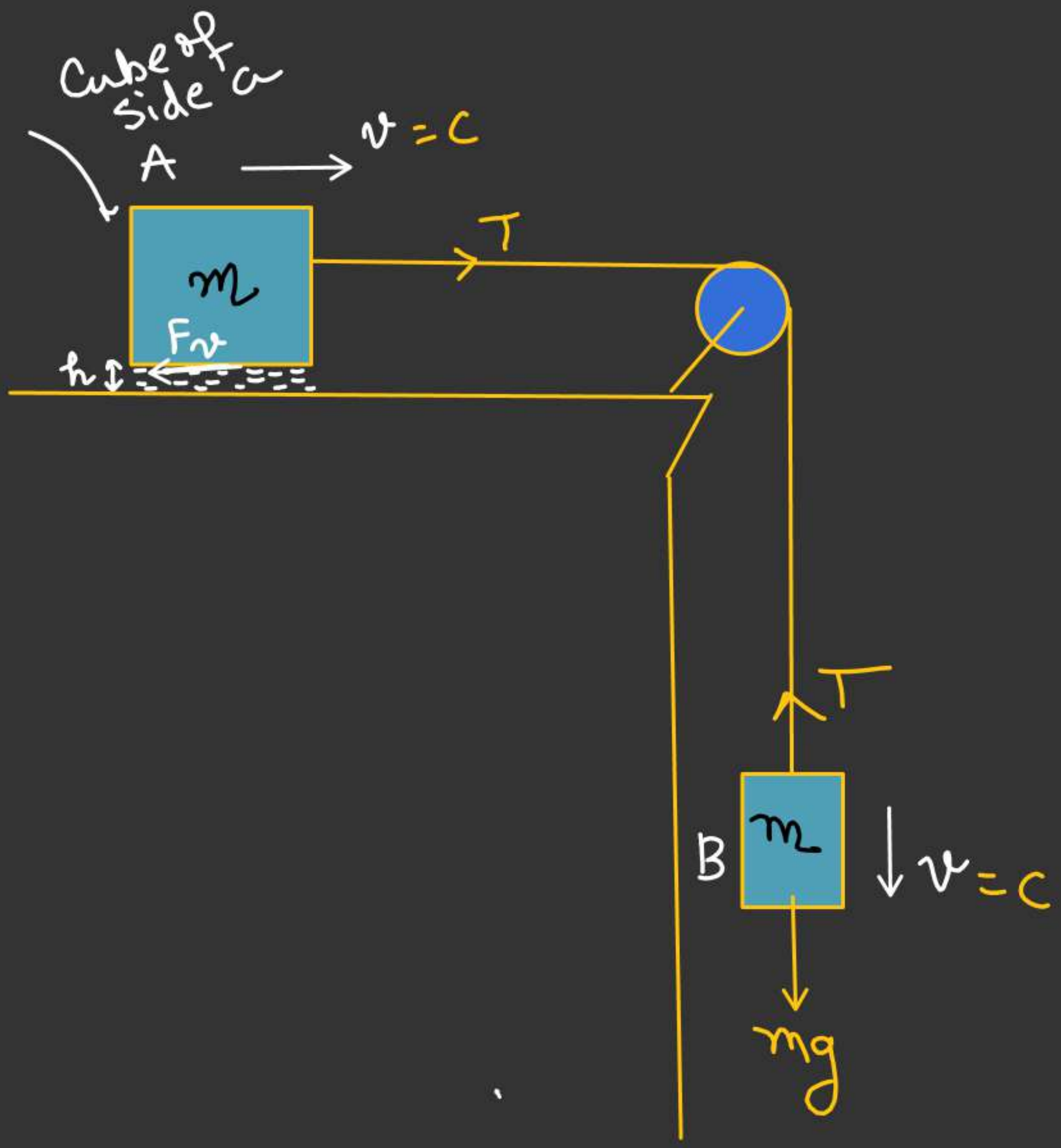
Find η so that both the blocks move with constant velocity.



For block A.

$$T = F_v$$

For block B

$$T = mg$$

$$F_v = mg$$

$$\eta \frac{a^2 v}{h} = mg$$

$$\eta = \left(\frac{mgh}{a^2 v}\right)$$

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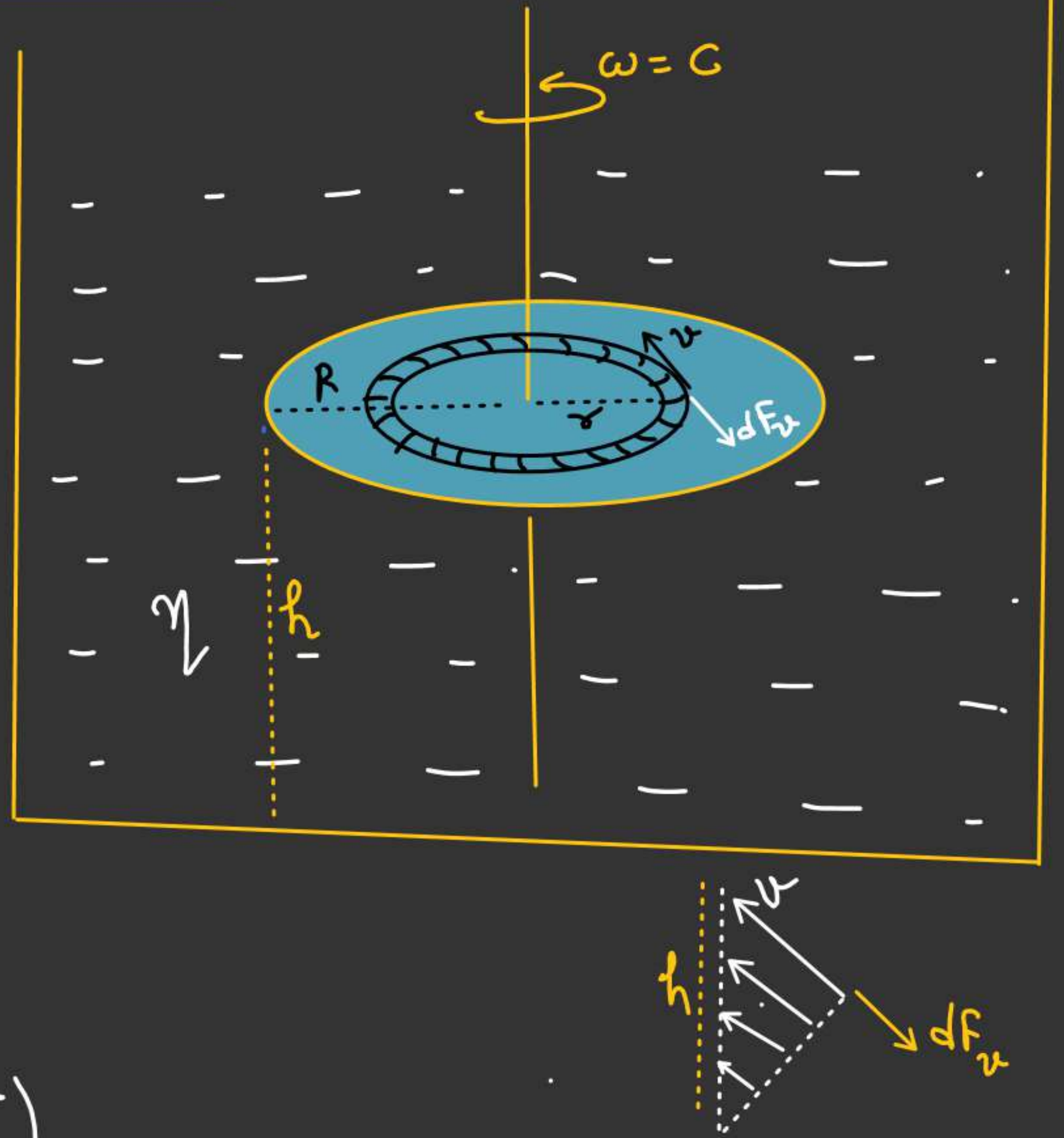
Find net torque acting on the disc to move it with constant angular velocity ω.



$$dF_v = \eta(dA)\left(\frac{dv}{dy}\right)$$

$$dF_v = \eta(2\pi r dr)\left(\frac{r\omega}{h}\right)$$

$$\frac{dv}{dy} = \left(\frac{v}{h}\right)$$

$$\frac{dv}{dy} = \left(\frac{r\omega}{h}\right)$$

$$d\tau = (dF_v)\cdot r$$

$$d\tau = \eta\cdot(2\pi r dr)\frac{r^2\omega}{h}$$

$$d\tau_{net} = 2d\tau = (4\pi\eta r dr)\left(\frac{\omega r^2}{h}\right)$$

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$$d\tau_{net} = \eta(4\pi r\, dr)\frac{r^2\omega}{h}$$

$$\int_0^{\tau_{net}} d\tau = \frac{4\pi\eta\omega}{h}\int_0^R r^3\,dr$$

$$\tau_{net} = \frac{\cancel{4}\pi\eta\omega}{h}\frac{R^4}{\cancel{4}}$$

$$\boxed{\tau_{net} = \frac{\pi\eta\omega R^4}{h}}$$

$$\text{Powe} = (\tau\cdot\omega) \checkmark$$

VISCOSITY

STOKE'S LAW

↓

Viscious force on Spherical body.

$$\boxed{F_v = 6\pi\eta r v}$$

r = radius of Spherical body

v = Velocity of the body

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TERMINAL VELOCTY

$\llcorner$ $\underline{v = C}$, $(F_{net} = 0)$

$\downarrow$

$F_B + F_v = mg$

$F_v = (mg - F_B)$

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

$\Downarrow$

$6\cancel{\pi}\eta \cancel{r} \underline{v_T} = \left(\frac{4}{3}\cancel{\pi} \cancel{r^3} g\right)\rho_b \left(1 - \frac{\rho_L}{\rho_b}\right)$

$$\boxed{v_T = \frac{2gr^2}{9\eta}\underline{(\rho_b - \rho_L)}}$$

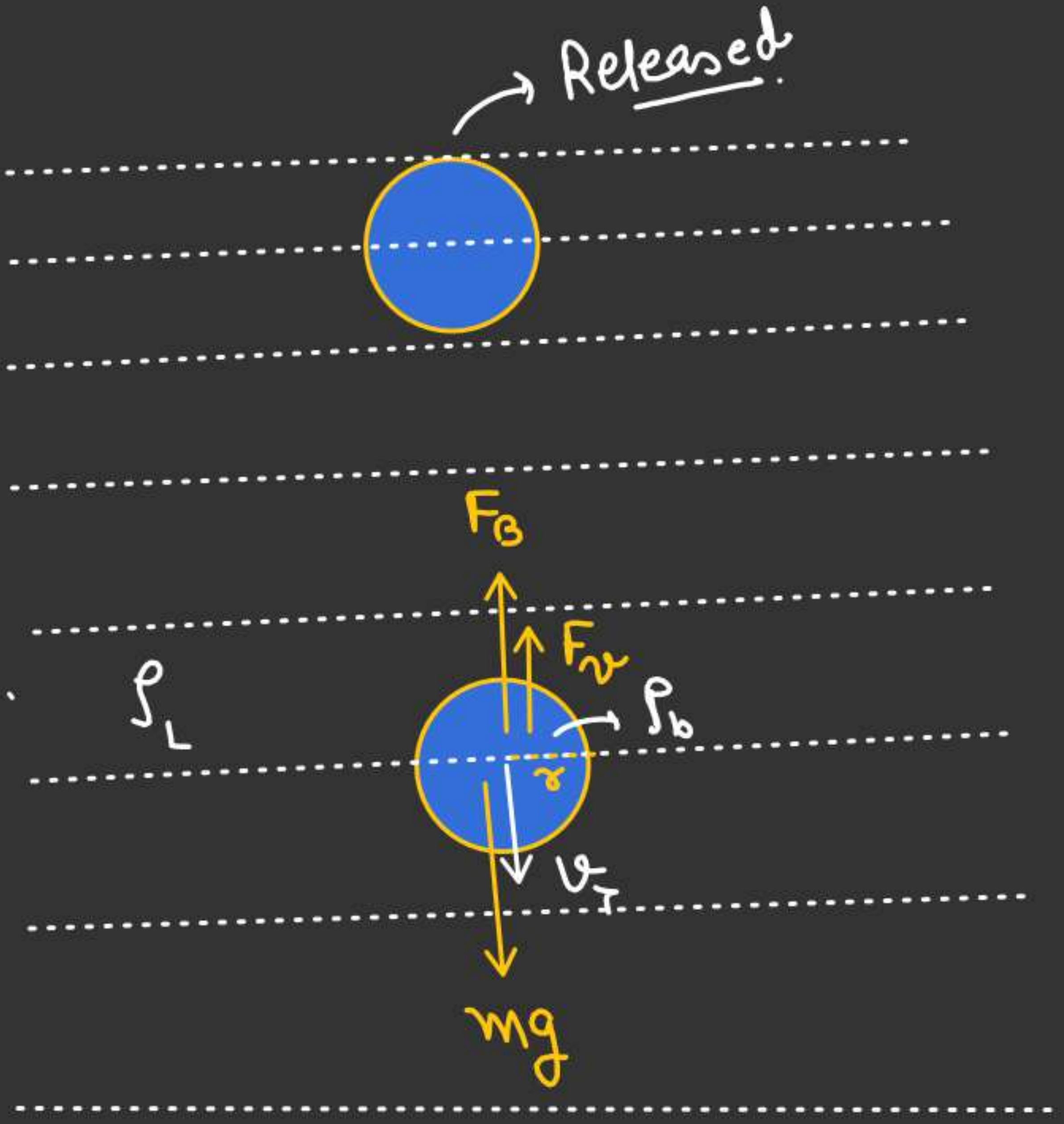
ρ_b = density of body.

ρ_L = density of liquid.

$F_B = V\rho_L g$

$m = V\rho_b$

$\underline{v_T \propto r^2}$



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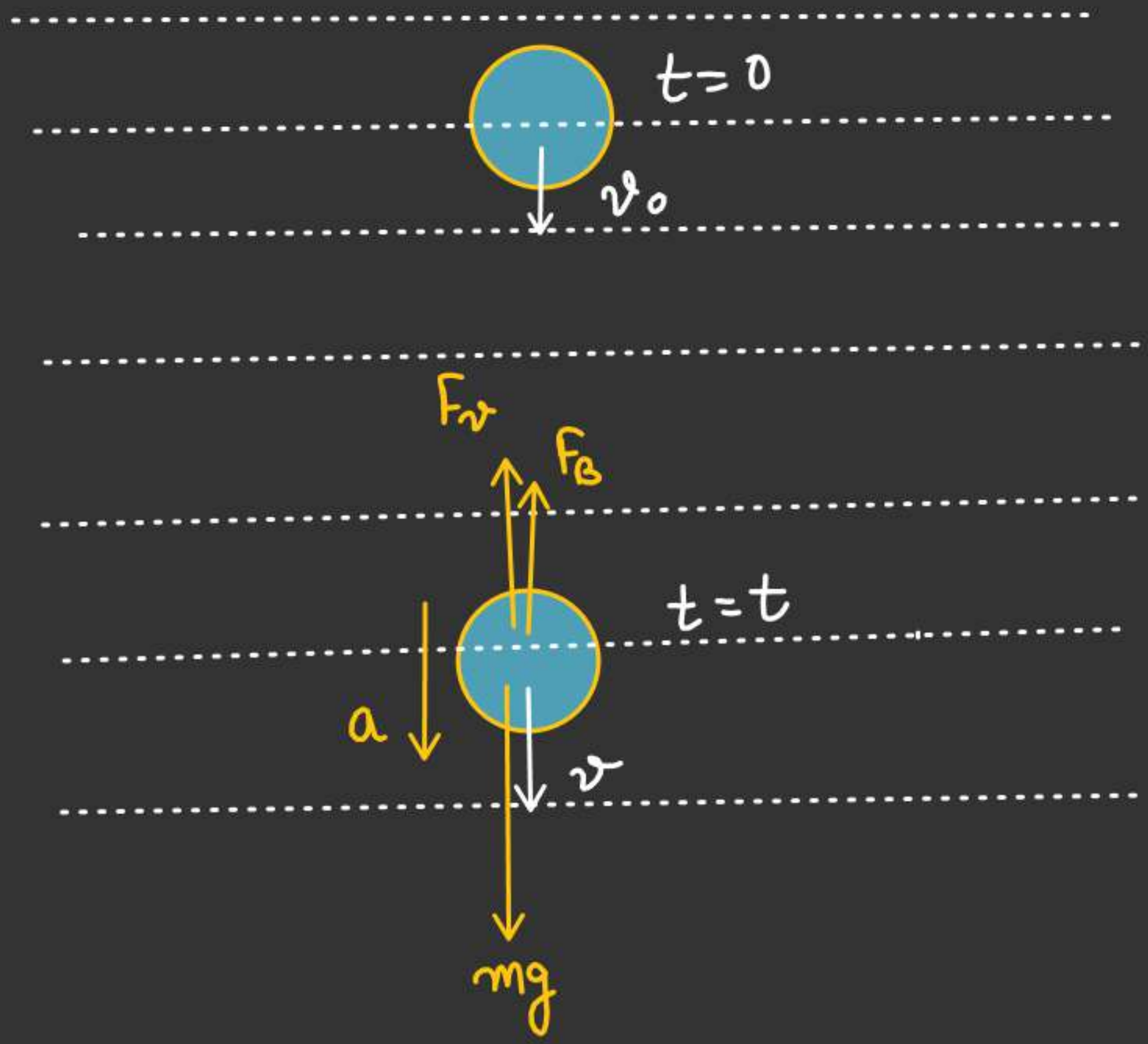
$$mg - (F_B + F_v) = ma$$

$$(mg - F_B) - F_v = ma$$

$$\underbrace{(mg - F_B)}_{A} - \underbrace{6\pi\eta r}_{B} v = ma$$

$$A - Bv = ma$$

$$A - Bv = m\left(\frac{dv}{dt}\right)$$



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$$A - Bv = m\frac{dv}{dt}$$

$$\int_{v_0}^{v}\frac{dv}{A-Bv} = \frac{1}{m}\int_0^t dt$$

$$\left[\frac{\ln(A-Bv)}{-B}\right]_{v_0}^{v} = \frac{1}{m}t$$

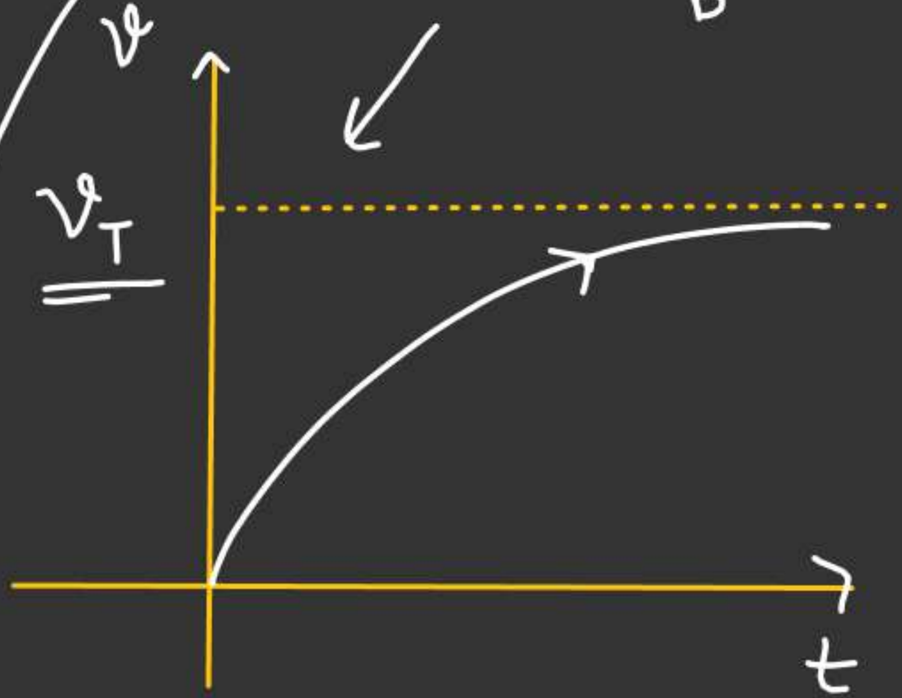
$$\ln\left(\frac{A-Bv}{A-Bv_0}\right) = -\frac{B}{m}t$$

$$A - Bv = (A - Bv_0)\,e^{-\frac{B}{m}t}$$

$$v = \frac{A}{B} - \frac{(A-Bv_0)}{B}e^{-\frac{B}{m}t}$$

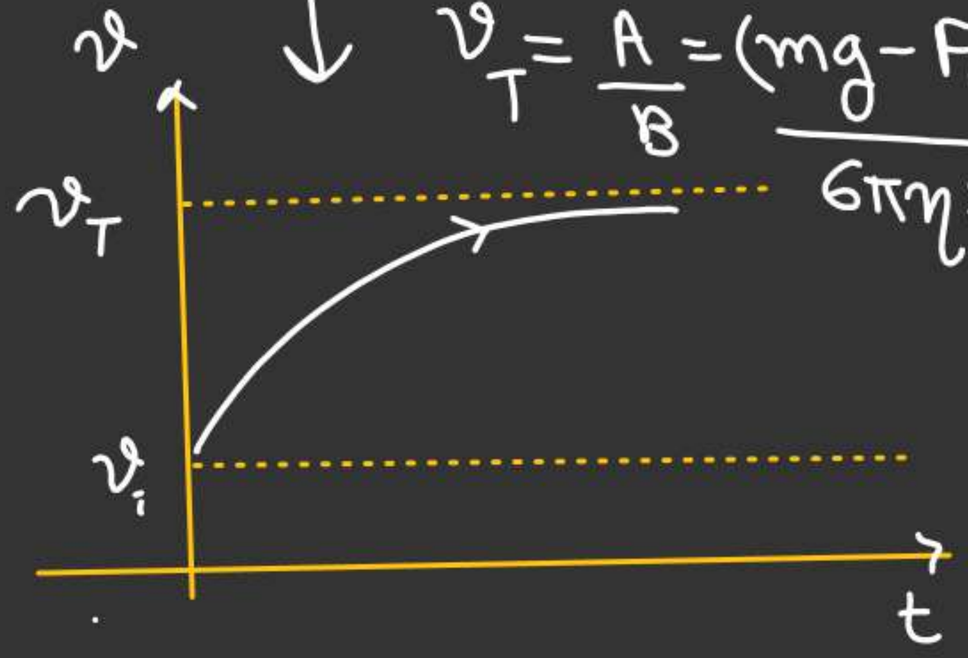
If $v_0 = 0$ i.e. body released.

$$v = \frac{A}{B}\left(1 - e^{-\frac{B}{m}t}\right)$$



At $t \to \infty$.

$$v_T = \frac{A}{B} = \frac{(mg - F_B)}{6\pi\eta r}$$



VISCOSITY

JEE Mains PYQ

Prefer the book in which PYQ is Chapterwise & topic wise.