Nishant Jindal

VISCOSITY

Def. Property of fluid by virtue of which any two adjacent layer apply trangential force to oppose the relative motion b/w the layers.

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

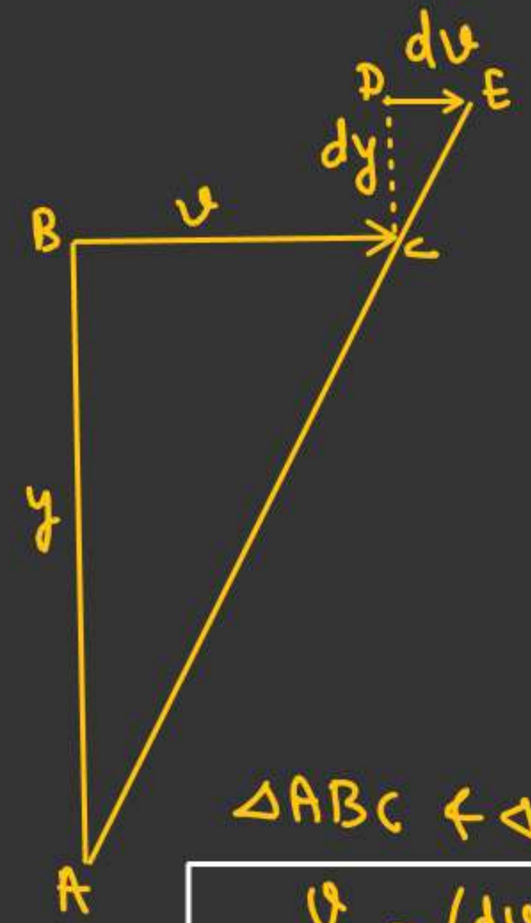
$$\boxed{F = -\eta A\left(\frac{dv}{dy}\right)} \rightarrow \text{[Valid for stream-line flow]}$$

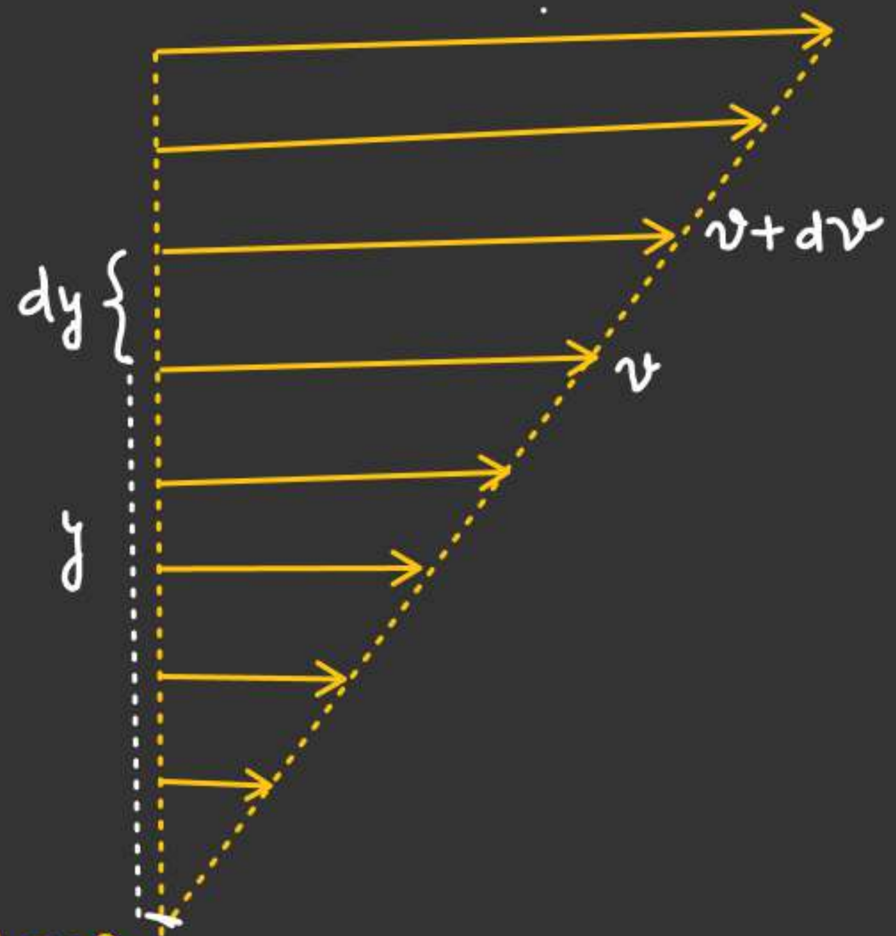
A = Surface area of liquid layer.

η = coffⁿ of viscosity

C.G.S ⟹ Poise [grm/cm-s]

S.I → 10 poise





ΔABC & ΔCDE

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

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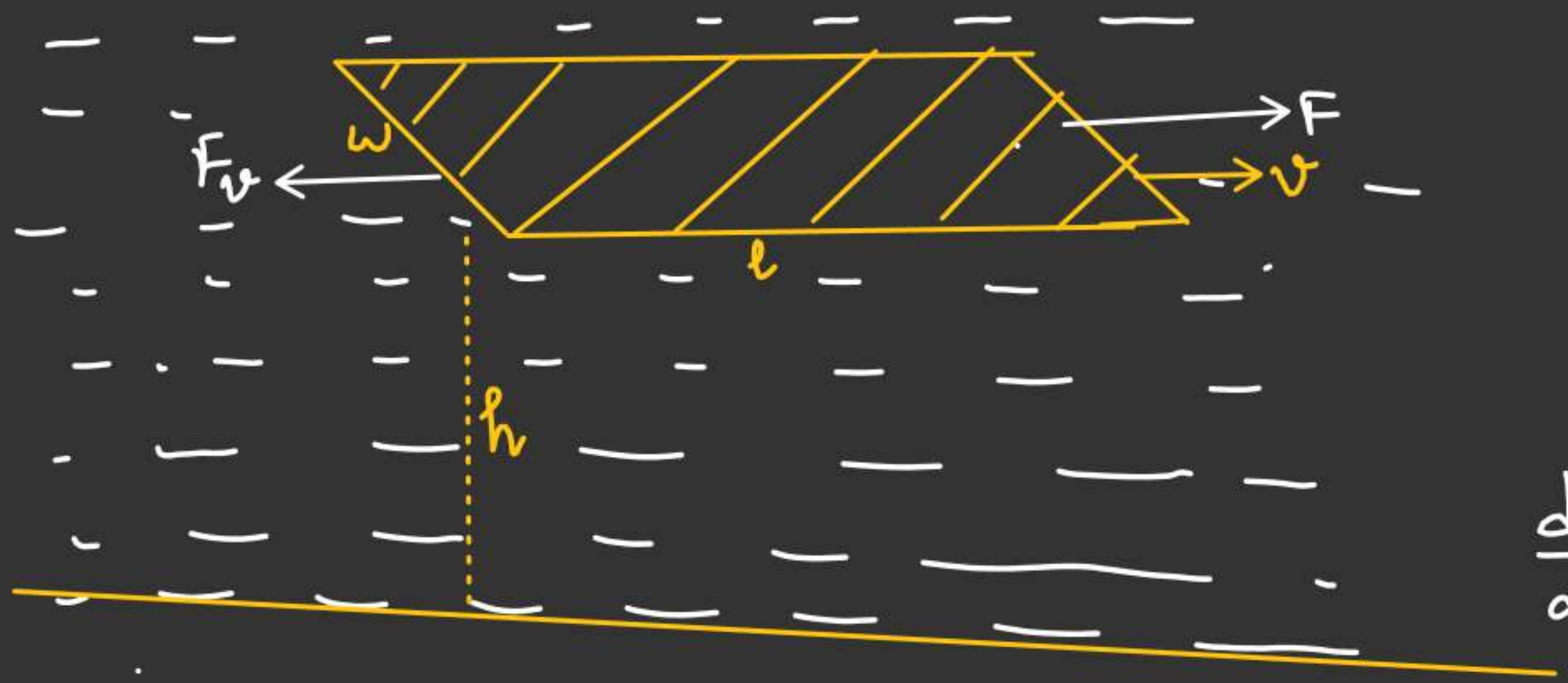
VISCOSITY



Find F so that plate move with constant velocity v.

η = coff of viscosity.

$F = F_v$

$$\left(F = \eta(lw)\frac{v}{h}\right)$$

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

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Find η if block move with Constant velocity

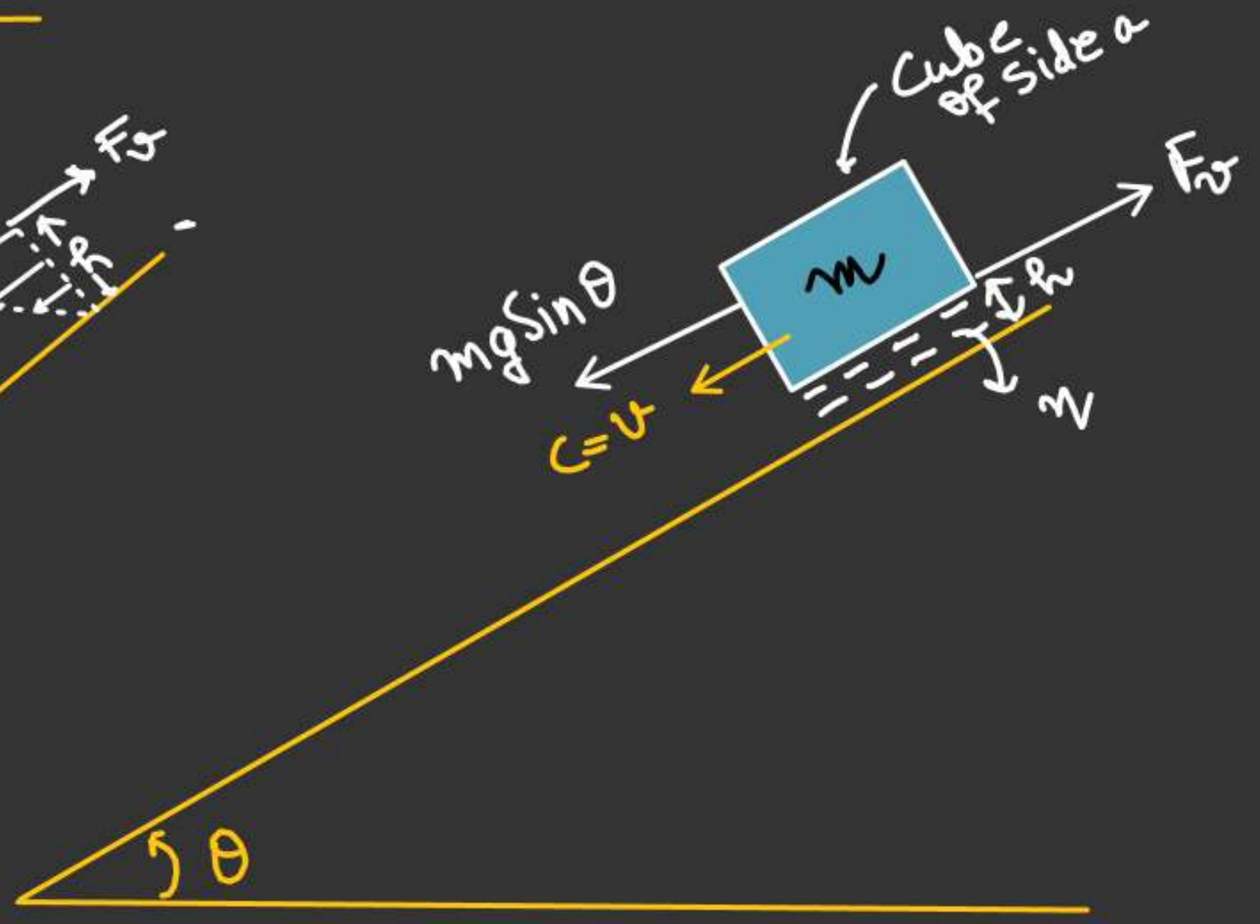
a^2

$$F_v = mg\sin\theta.$$

$$\eta A\left(\frac{v}{h}\right) = mg\sin\theta.$$

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

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



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VISCOSITY

Disc rotating in viscious liquid.

Net torque ??

$$dF_v = \eta(2\pi x\,dx)\left(\frac{dv}{dx}\right)$$

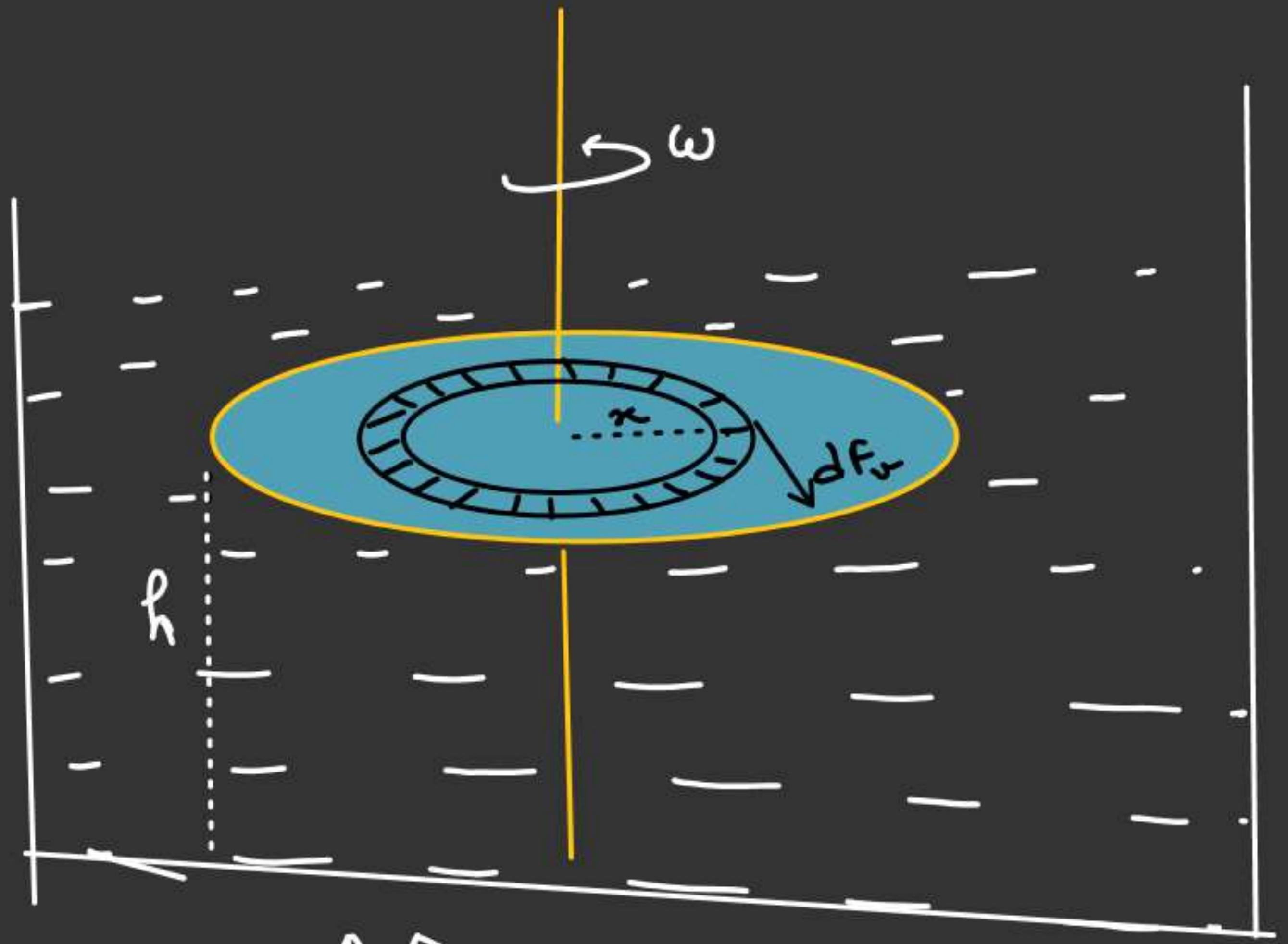
$$\frac{dv}{dx} = \frac{v}{h} = \left(\frac{x\omega}{h}\right)$$

$$dF_v = (\eta\, 2\pi x\, dx)\left(\frac{x\omega}{h}\right)$$

$$d\tau = (dF_v)\,x$$

$$\int_0^{\tau} d\tau = \frac{2\pi\eta\omega}{h}\int_0^R x^3\,dx$$

$$\tau = \left(\frac{\pi\eta\omega R^4}{2h}\right)$$ ✓



$$P = \vec{\tau}\cdot\vec{\omega}$$

$$\text{Power} = \left(-\frac{\pi\eta\omega^2 R^4}{2h}\right)$$

$\uparrow \hat{\omega}$

$\downarrow \hat{\tau}$

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STOKE'S LAW

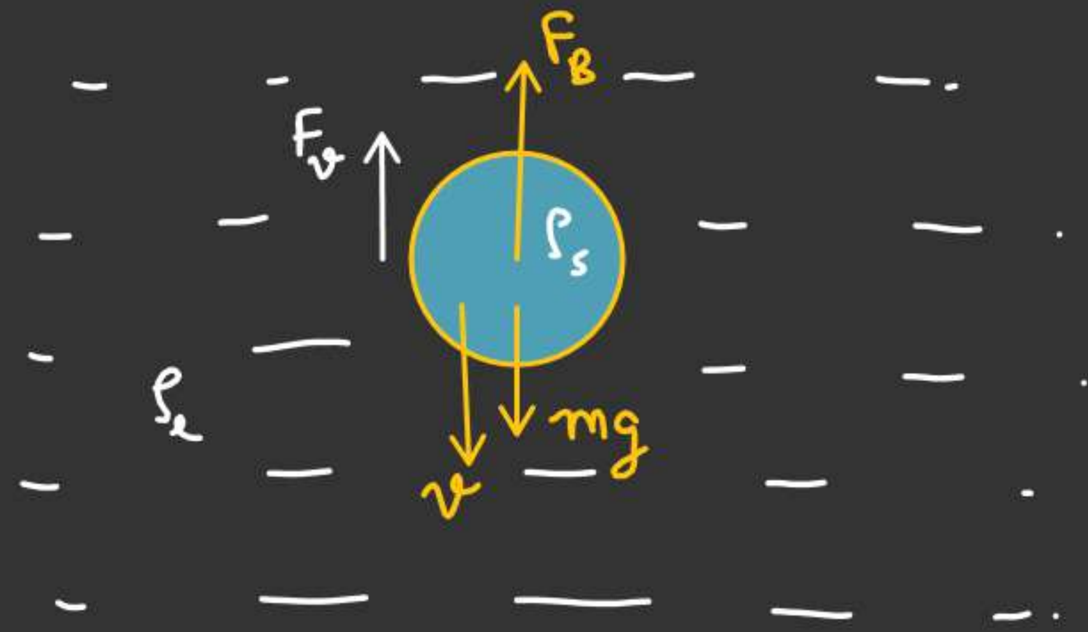
For any Spherical body Viscious force due to liquid on the body is

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

r = radius of Spherical body

v = velocity of spherical body

TERMINAL VELOCITY



$v = C \Rightarrow$ Terminal velocity

$$F_B + F_v = mg$$

$$\Downarrow$$

$$V\rho_l g + 6\pi\eta r v_T = V\rho_s g$$

$$6\pi\eta r v_T = Vg(\rho_s - \rho_l)$$

$$v_T = \frac{\frac{4}{3}\pi r^3 g(\rho_s - \rho_l)}{6\pi\eta r} = \frac{2}{9}\frac{r^2 g}{\eta}(\rho_s - \rho_l)$$

$$\boxed{v_T = \frac{2}{9}\frac{r^2 g}{\eta}(\rho_s - \rho_l)}$$

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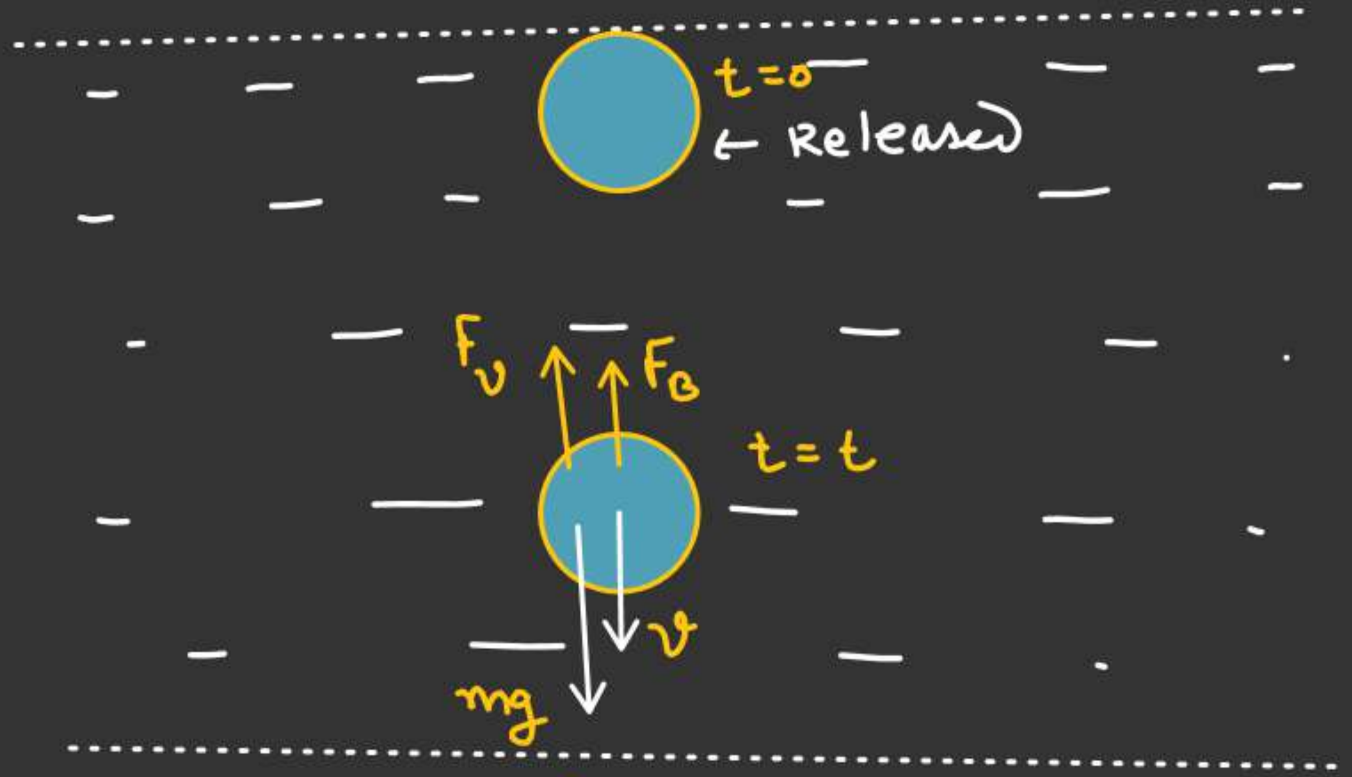
$$mg - (F_B + F_v) = ma$$

$$\underbrace{(mg - F_B)} - F_v = ma$$

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



$$a - bv = m\frac{dv}{dt}$$

$$m\int_0^v \frac{dv}{a-bv} = \int_0^t dt$$

$$\frac{\ln[a-bv]_0^v}{-b} = \frac{t}{m}$$

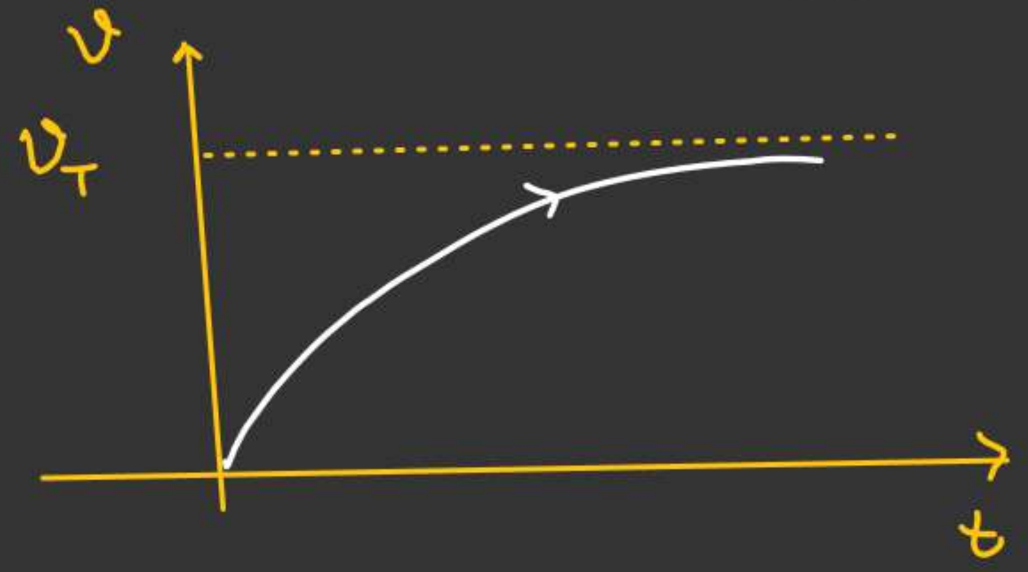
$$\ln\left(\frac{a-bv}{a}\right) = -\frac{bt}{m}$$

$$a - bv = a e^{-\frac{bt}{m}}$$

$$v = \frac{a}{b}\left(1 - e^{-\frac{bt}{m}}\right)$$

v_T at $t \to \infty$

$$v_T = \frac{a}{b}$$



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Critical velocity

$$\boxed{v_c = \frac{R\eta}{\rho r}}$$

$r =$ radius of pipe.

$\rho =$ density of liquid.

$R =$ Reynold's No.

$R < 2000 \Rightarrow$ Laminar flow

$2000 < R < 4000 \Rightarrow$ Turbulent flow.