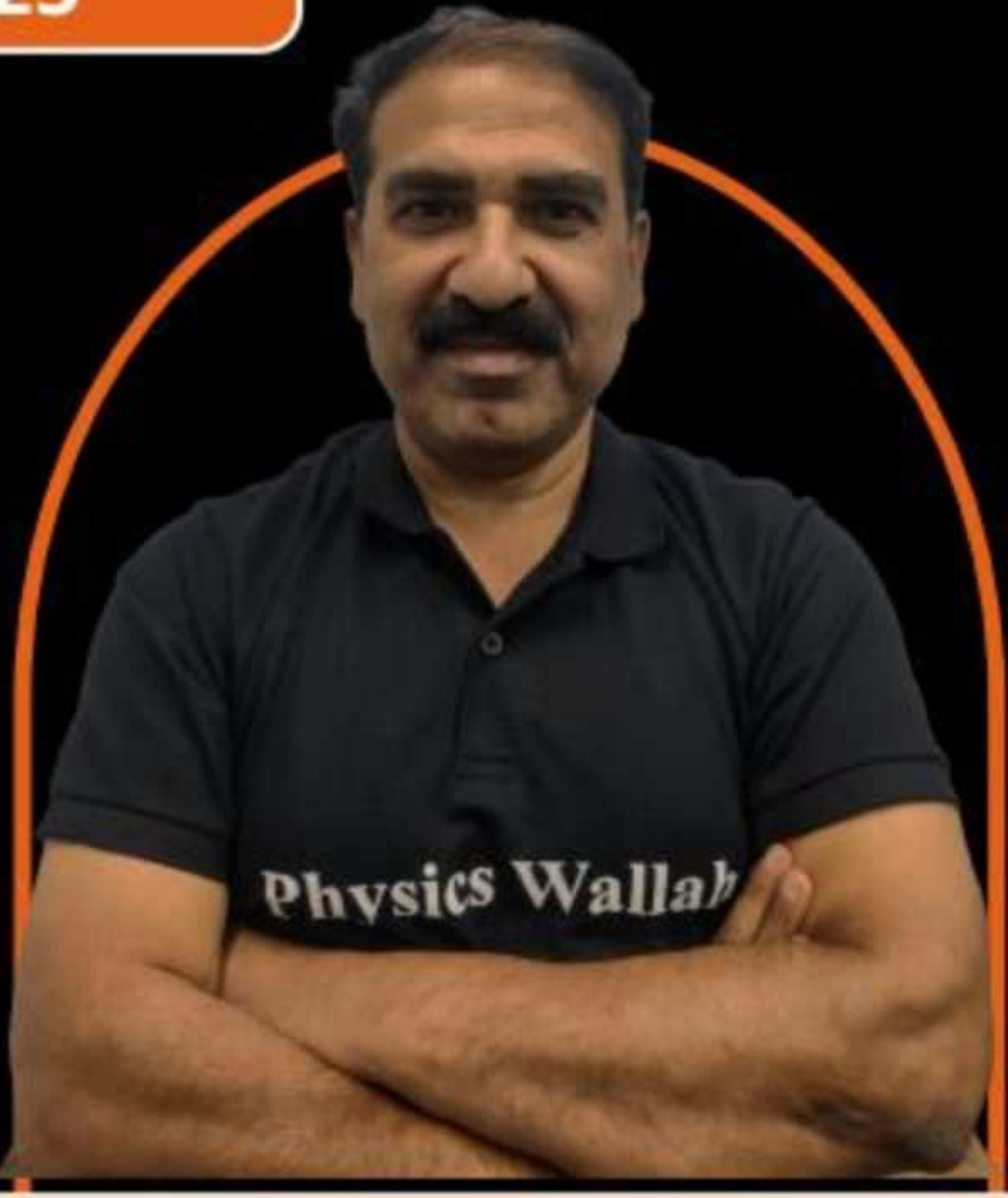
VIDYAPEETH

BATCH CODE: 19-PJ301EA 2025

SUBJECT NAME: Physics

CHAPTER NAME:

Rotational Motion



Lecture No. 04

By- Rajesh Amarnath Sir

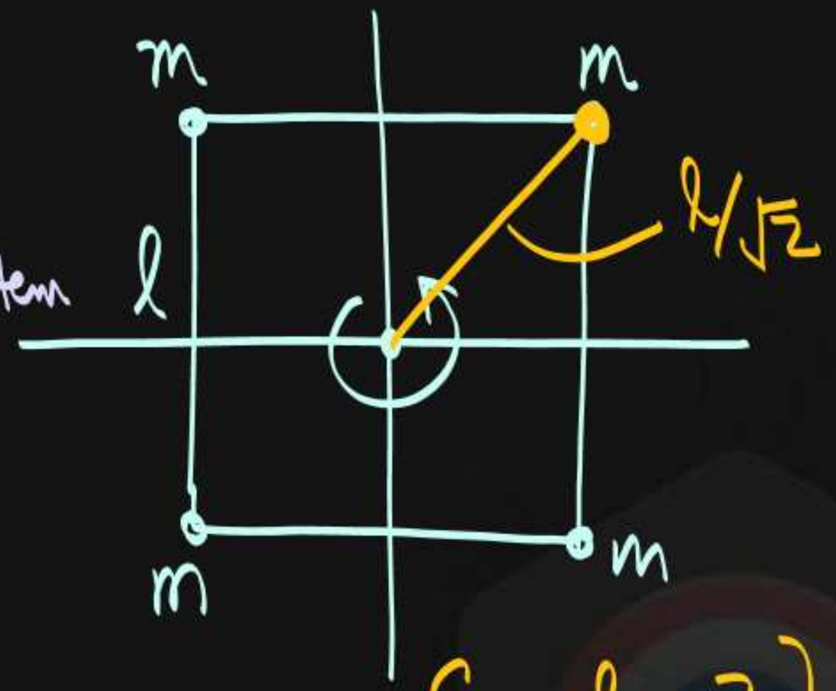
Today's Goal

Subtopic :: Rotational Work and Energy

9/19/P87

Radius of gyration

Any MI can be written as $I = Mk^2$ → M: total mass of system; k called radius of gyration

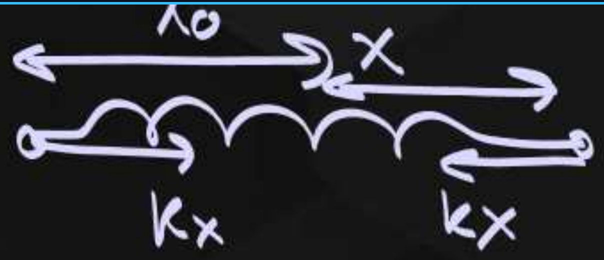


Here $I = 2ml^2 = (4m)k^2$

$$k = l/\sqrt{2}$$

$$I = \left\{m\left(l/\sqrt{2}\right)^2\right\} \times 4$$

$$= 2ml^2$$



$$\boxed{F = kx}$$ Restoring force

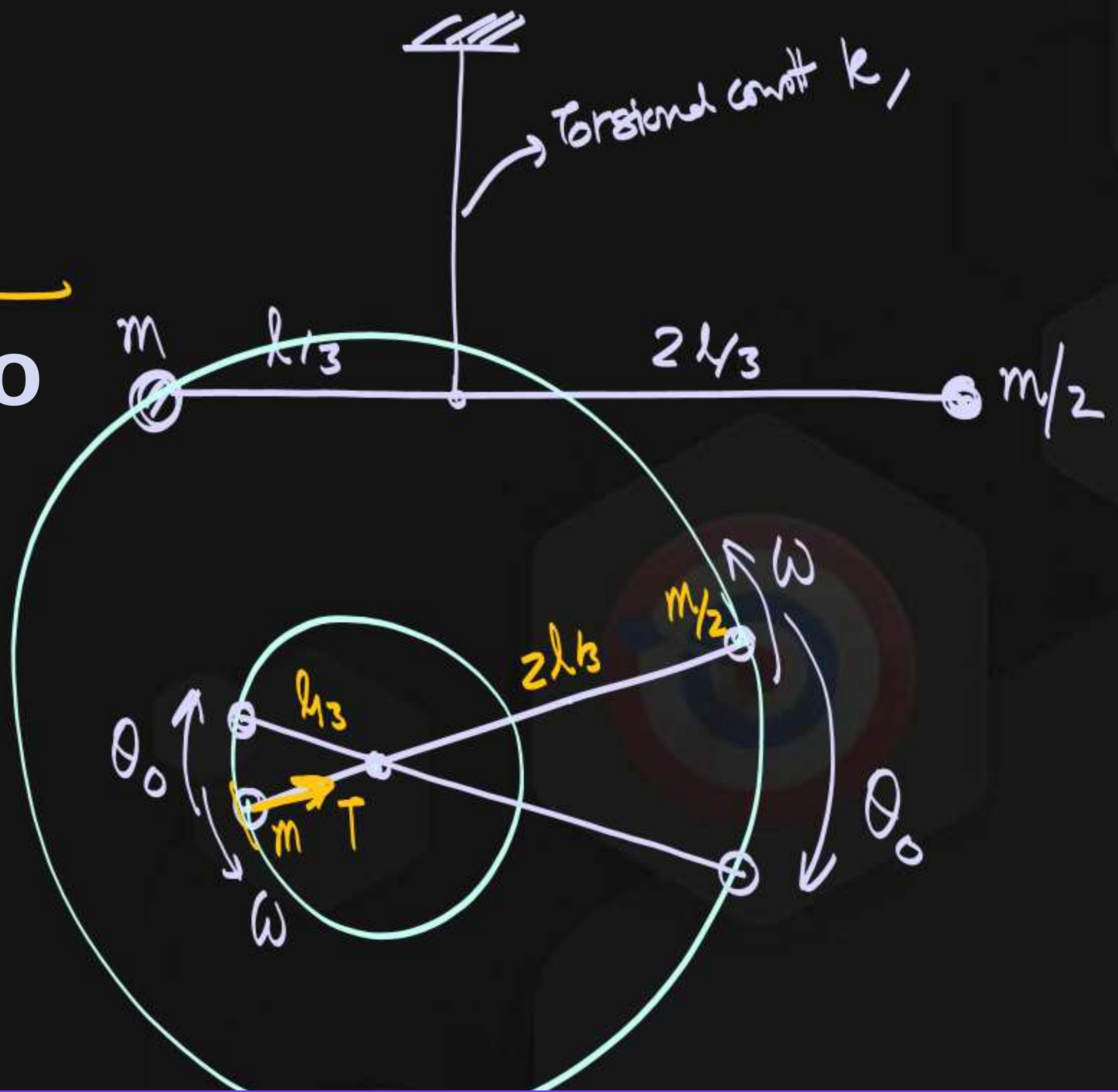
force constt or spring constt

$$\boxed{\tau = k\cdot\theta}$$ Restoring torque

θ → Angle of twist

k → torsional constt

Q1/P98



COE

$$\frac{1}{2}k\theta^2 = \frac{1}{2}I\omega^2$$

$$\cancel{\frac{1}{2}}k\theta^2 = \cancel{\frac{1}{2}}\left(m\cdot\frac{l^2}{9} + \frac{m}{2}\times\frac{4l^2}{9}\right)\omega^2$$

$$\Rightarrow \boxed{\omega^2 = \frac{3k}{ml^2}\cdot\theta_0^2}$$

$$\boxed{T = m\omega^2\frac{l}{3}}$$

or $\frac{m}{2}\omega^2\cdot\frac{2l}{3}$

$$= m\times\frac{3k}{ml^2}\cdot\theta_0^2\times l/3$$

$$\boxed{T = \frac{k\theta_0^2}{l}}$$

for no slipping

$$f \leq \mu N_1$$

$$\mu \geq f/N_1 = \frac{420}{760} = \frac{21}{38}$$

$$= 0.55$$

$$N_2 = f \quad (1)$$

$$N_1 = 160 + 600 = 760\,N$$

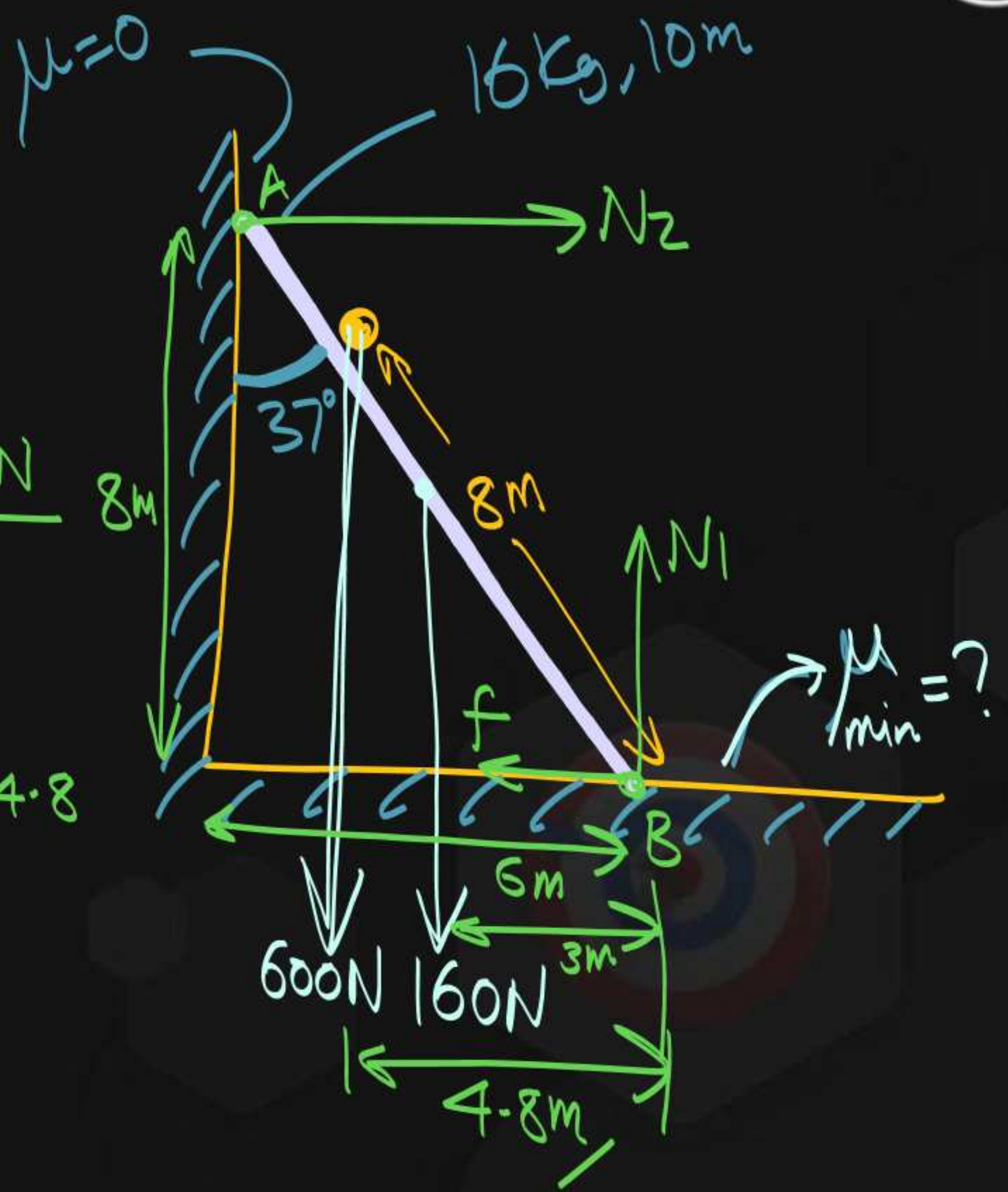
$\sum \tau = 0$ (about B)

$$N_2 \times 8 = 160 \times 3 + 600 \times 4.8$$

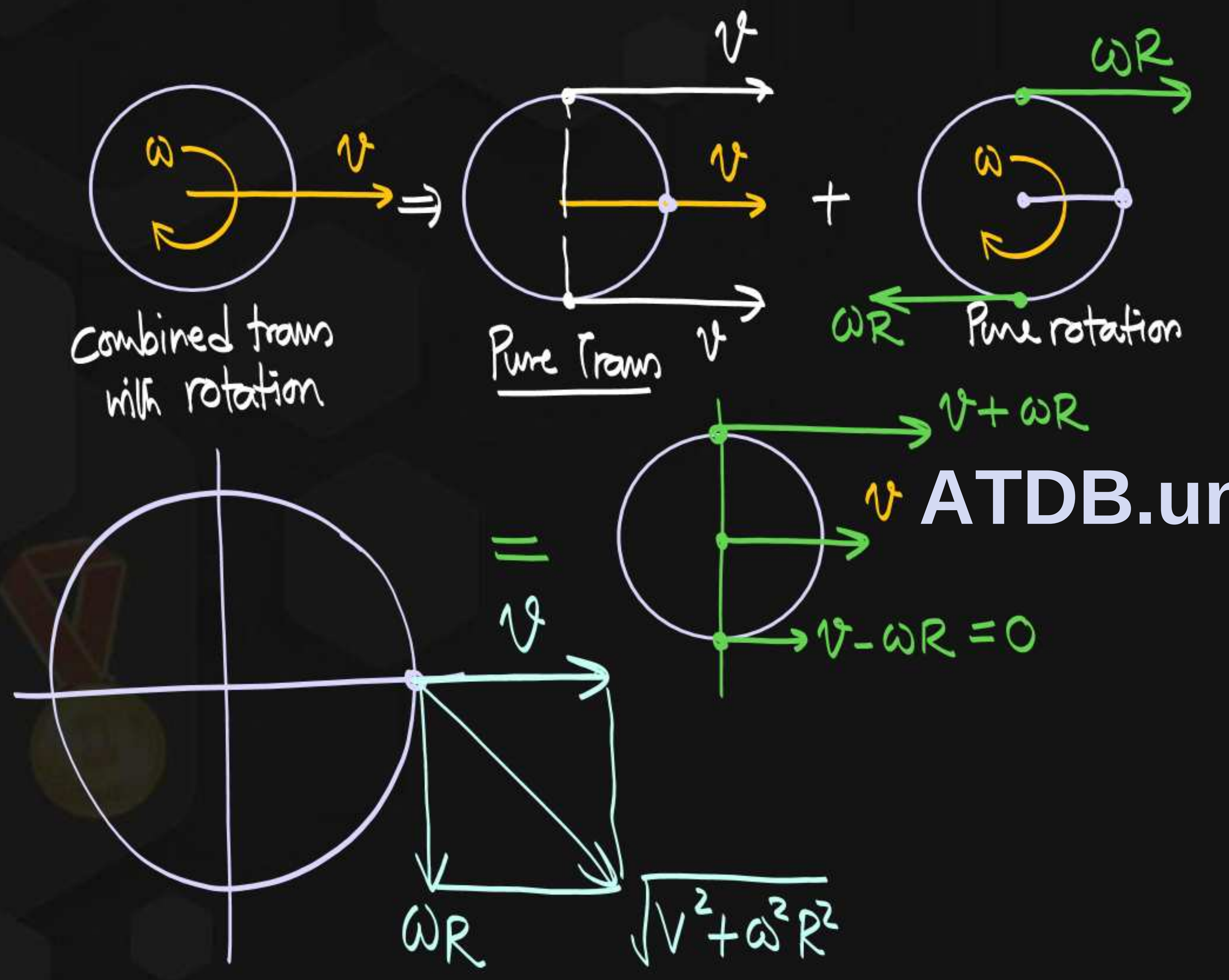
$$N_2 = 60 + 360$$

$$= 420\,N$$

$$\Rightarrow f = 420\,N$$



Constraint eq's in Combined motion

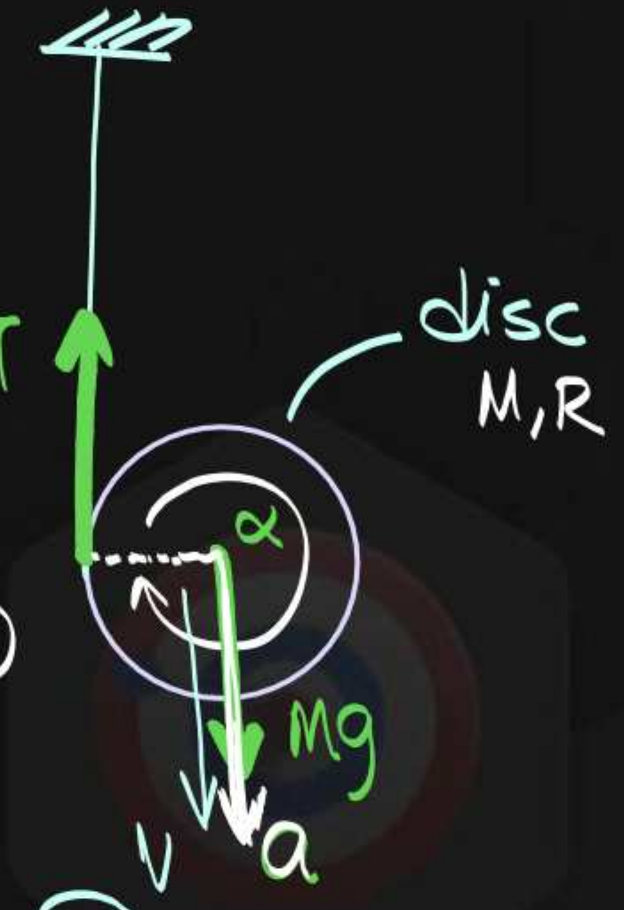


Combined motion

(Rotation with translation)

ex:

Disc is released from rest. Find its acc^n.



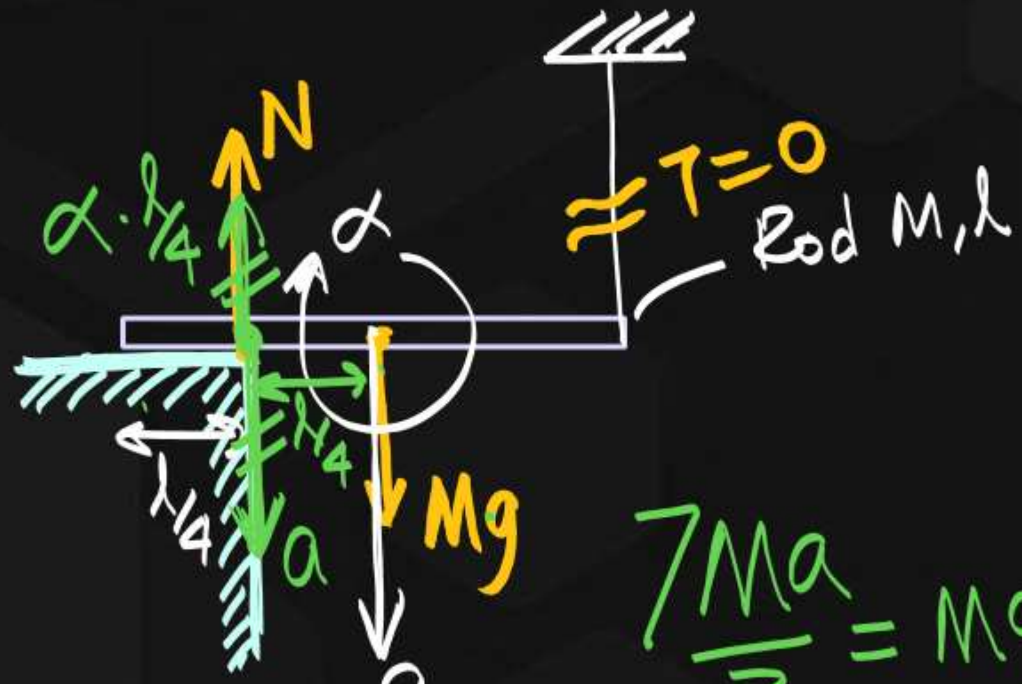
Trans $Mg - T = Ma$ (1)

Rotation (About CM)

$$T \times R = \frac{MR^2}{2}\alpha \quad (2)$$

Constraint

⇒ The string is ... Normal rxn on rod just after this.



$$\frac{7Ma}{3} = Mg$$

Trans (of CM) $Mg - N = Ma$ (1)

$N = \frac{4Ma}{3}$

Rot. (About CM)

$$N \times l/4 = \frac{Ml^2}{12} \times \alpha \quad (2)$$

Constraint $a = \alpha\, l/4$ (3)

$N = \frac{4}{3} M \times \frac{3g}{...} - 4Mg$

⇒ $a = \alpha R$ (3)

Constraint eqn

$Mg - T = Ma$ (1) $\quad T = \frac{Ma}{2}$

$TR = \frac{MR^2}{2}\alpha$ (2) $\quad \alpha = \frac{a}{R}$

$a = \alpha R$ (3)

$$a = \frac{2g}{3}$$

$$T = \frac{Mg}{3}$$

$v_P = v_Q$ (∵ string does not slip on disc)

⇒ $0 = v - \omega R$

⇒ $v = \omega R$

$$a_T = \frac{3}{2}\frac{g}{l} \times l$$

$$a = \frac{3g}{2}$$

$$\tau = mg \times r_\perp \quad (\text{about } O)$$

$$= mg\,\frac{l}{2}\sin\theta$$

$$I = \frac{Ml^2}{3} \quad (\text{about } O)$$

$$\alpha = \frac{\tau}{I}$$

$$= \frac{mg\frac{l}{2}\sin\theta}{\frac{ml^2}{3}}$$

$$\alpha = \frac{3}{2}\frac{g}{l}\sin\theta$$

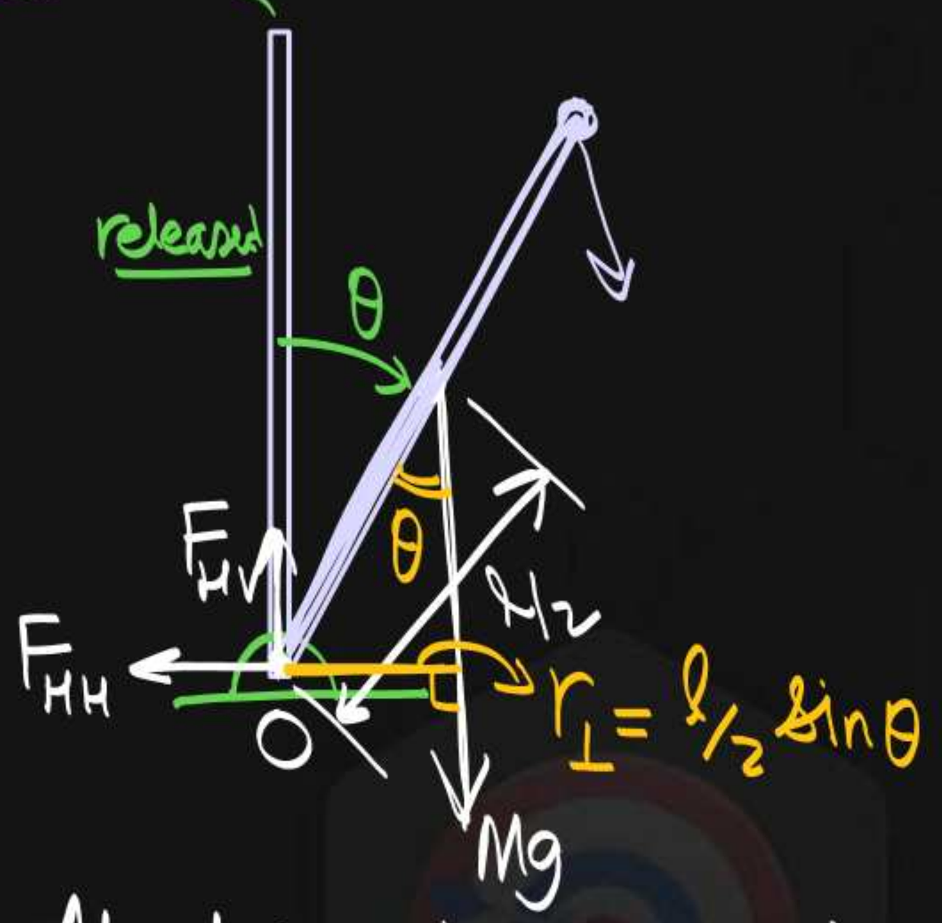
Find tangential accⁿ of free end just before it hits the floor.

Soln $\theta = 90^\circ \Rightarrow \alpha = \frac{3g}{2l}$

$$a_T = \alpha \cdot r \quad (r = l)$$

Ex: find angular accⁿ of rod when it makes angle θ with vertical.

Rod M, l



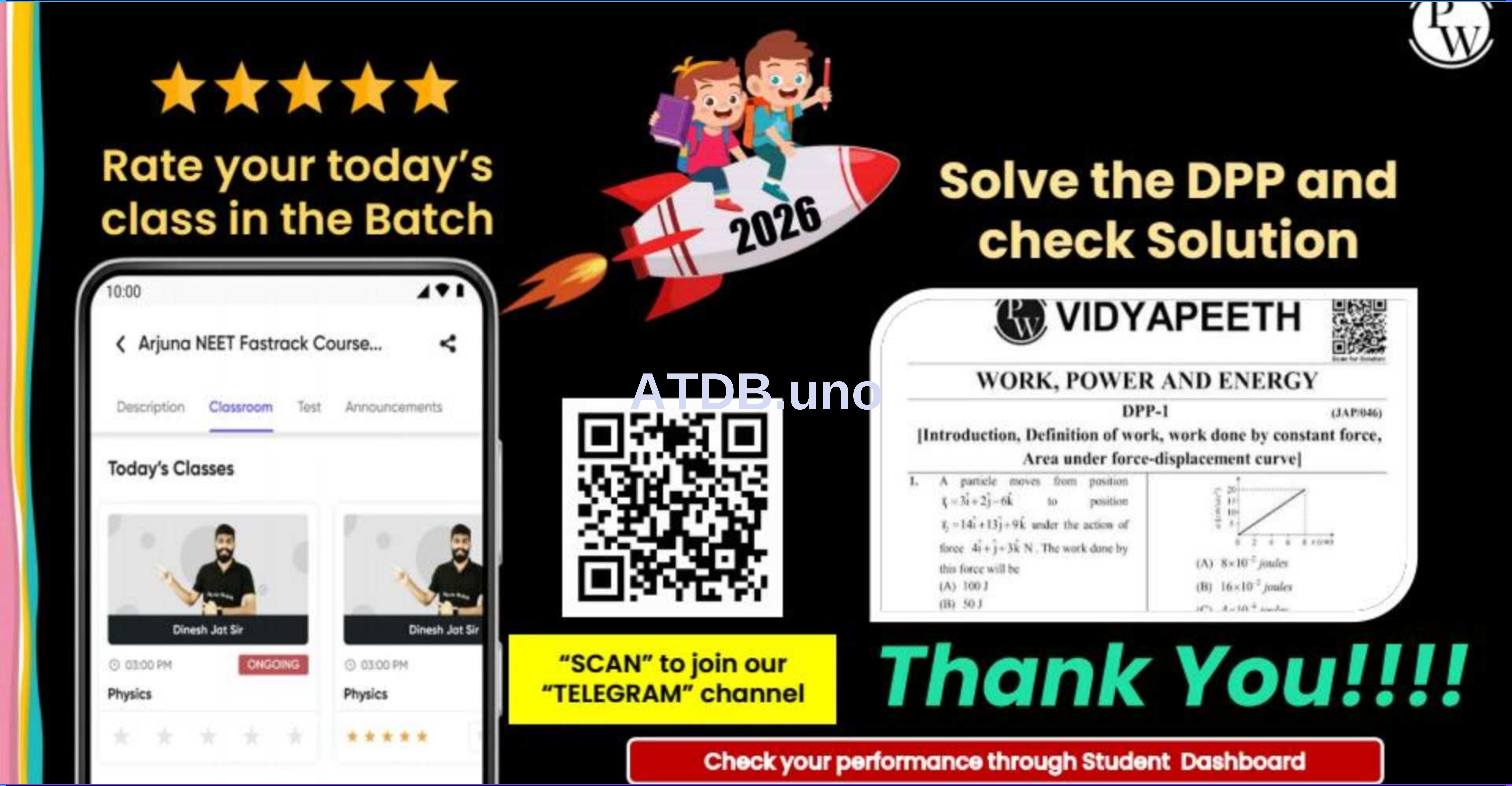
About O rod is in pure rotation

$$\tau = I\alpha$$

Next Lecture's Goal

Chap Name :

1. Sub Top :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