VIDYAPEETH

BATCH CODE: 19-PJ301EA 2025

SUBJECT NAME: Physics

CHAPTER NAME:
Rotational Motion

Lecture No. 04

By- Rajesh Amarnath Sir

:: Rotational Work and Energy

ATDB.uno

Q.19 / P87

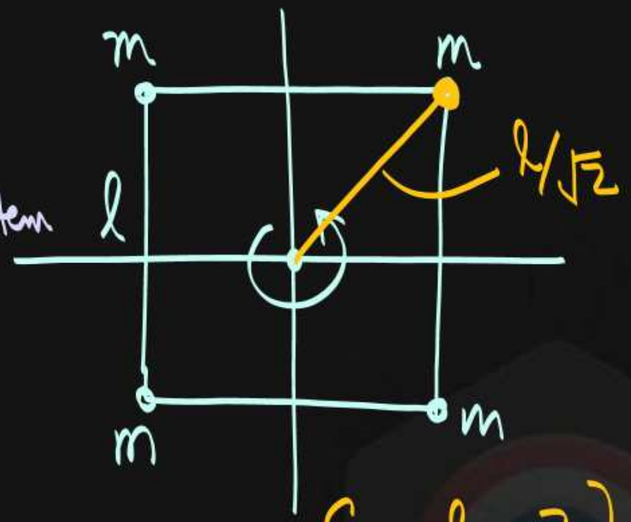
Radius of gyration

Any MI can be written as $I = mk^2$ (m: total mass of system)

k = radius of gyration

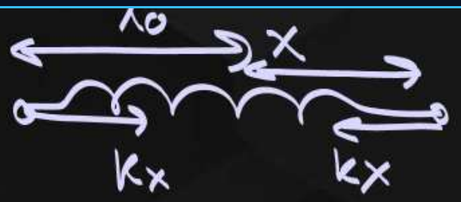
Here $I = 2ml^2 = (4m)k^2$

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



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

$$= 2ml^2$$



$F = kx$ Restoring force

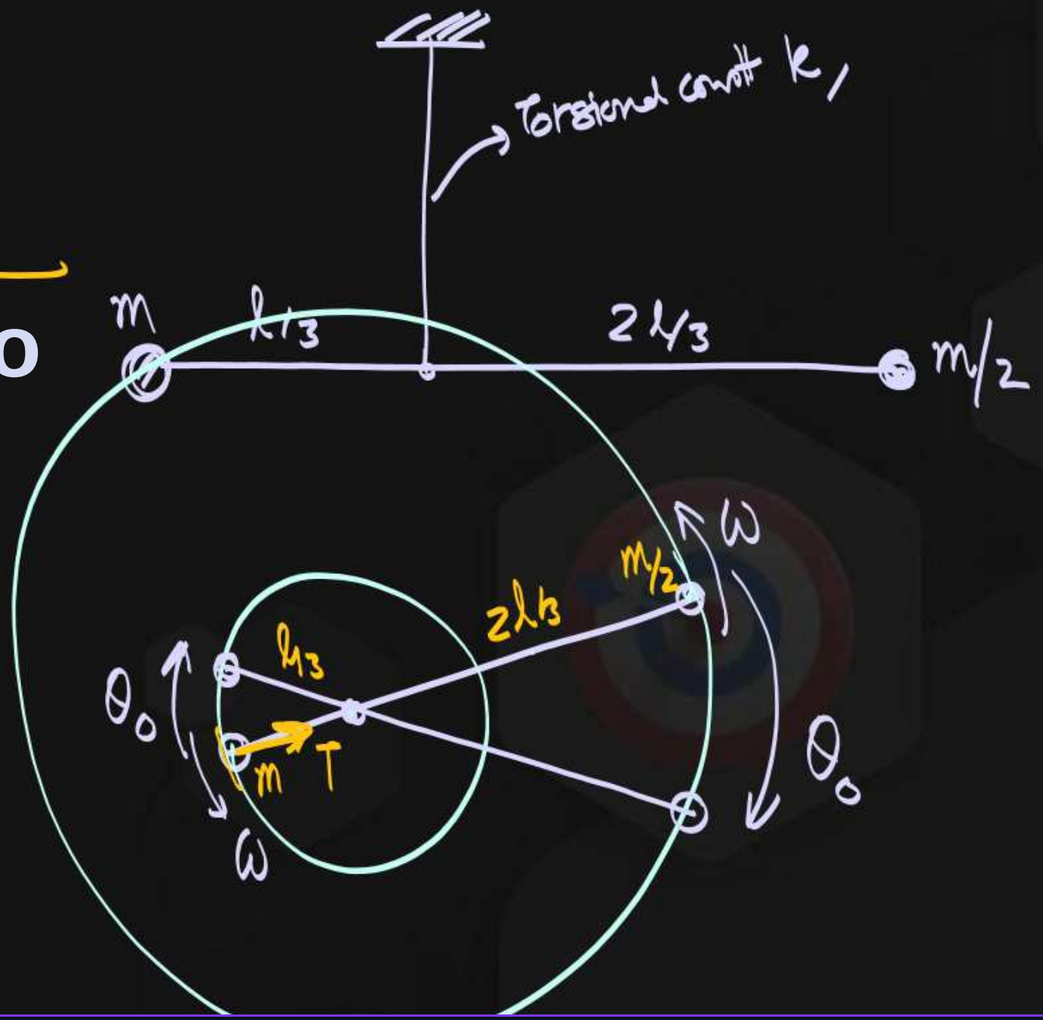
k → force constt or spring constt

$\tau = k \cdot \theta$ Restoring torque

θ → Angle of twist

k → torsional constt

9/1/P98



CoE

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

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

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

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

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

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

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

for no slipping

$$f \leq \mu N_1$$

$$\mu \geq \frac{f}{N_1} = \frac{420}{760} = \frac{21}{38} = 0.55$$

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

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

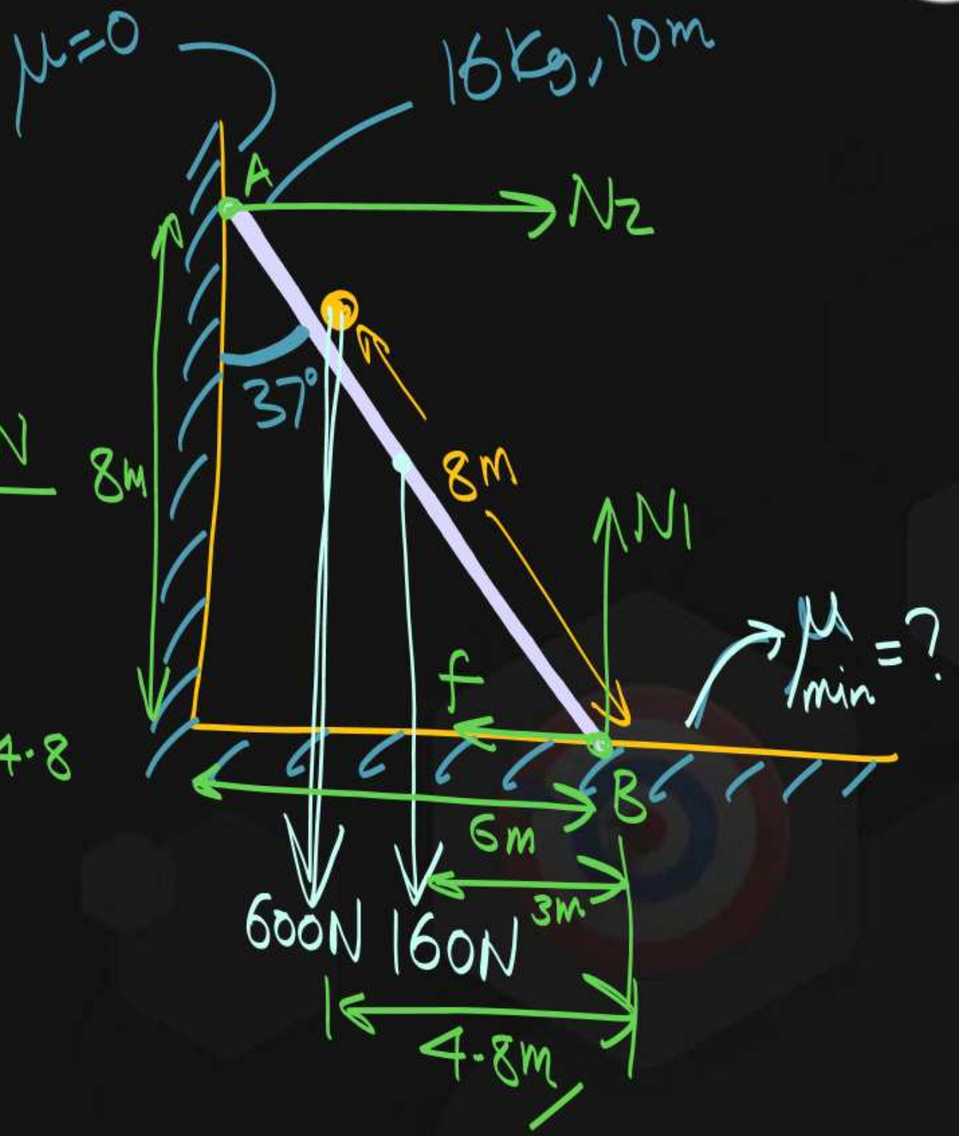
$\sum \tau = 0$ (about A)

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

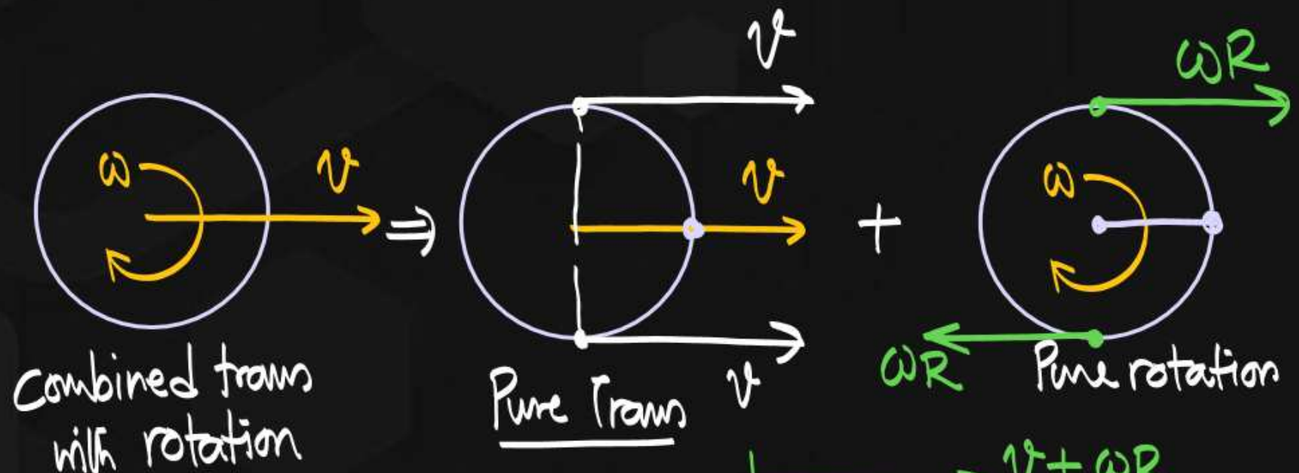
$$N_2 = 60 + 360$$

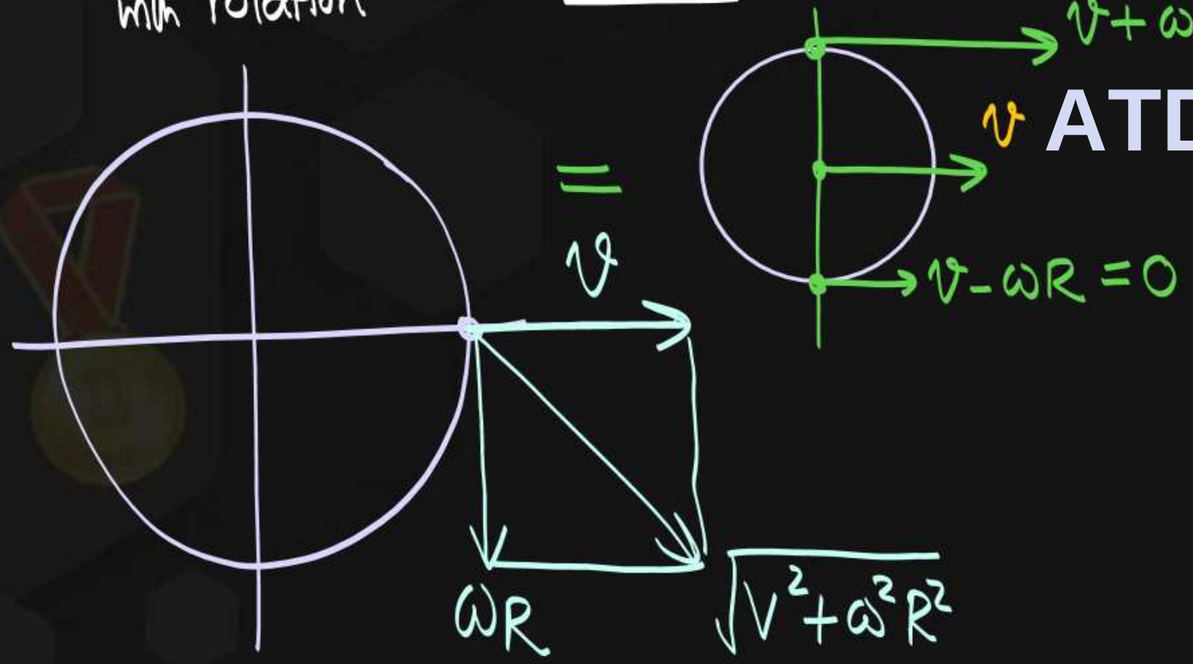
$$= 420\,N$$

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



Constraints in Combined Motion

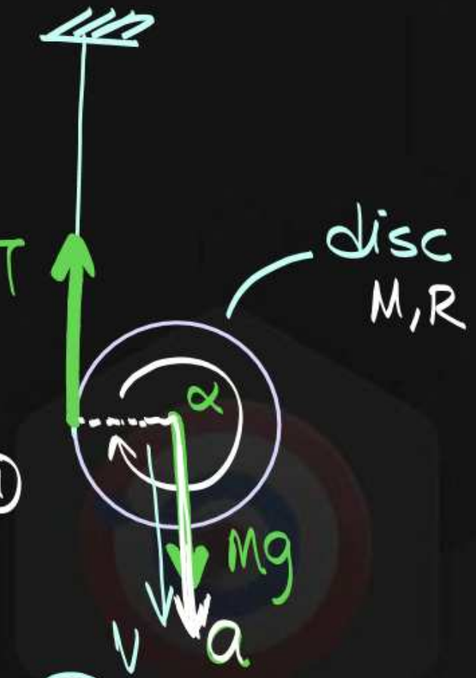




Combined motion
(Rotation with translation)

ex.

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



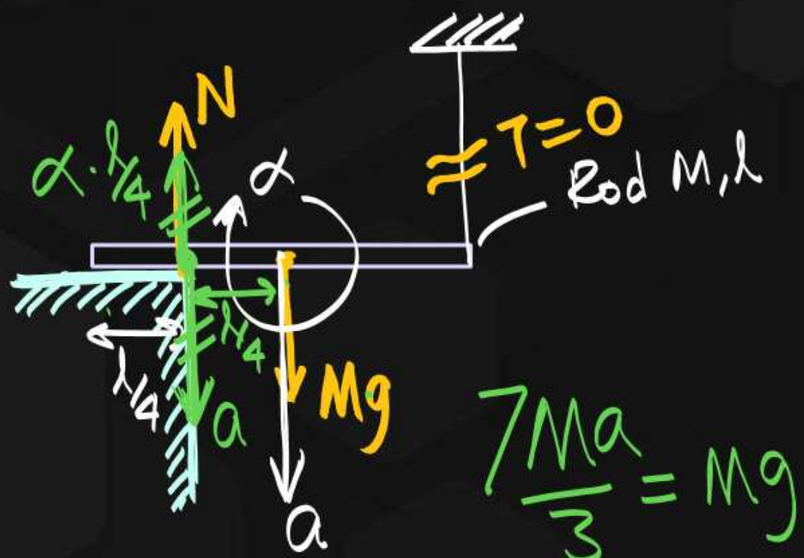
Trans $Mg - T = Ma$ ①

Rotation (About CM)

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

Constraint

rxn on rod just after this.



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

Trans (@ CM) $Mg - N = Ma$ ①

Rot. (About CM) $N = \frac{4Ma}{3}$

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

Constraint $a = \alpha l/4$ ③

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

$\Rightarrow a = \alpha R$ ③

Constraint eqⁿ

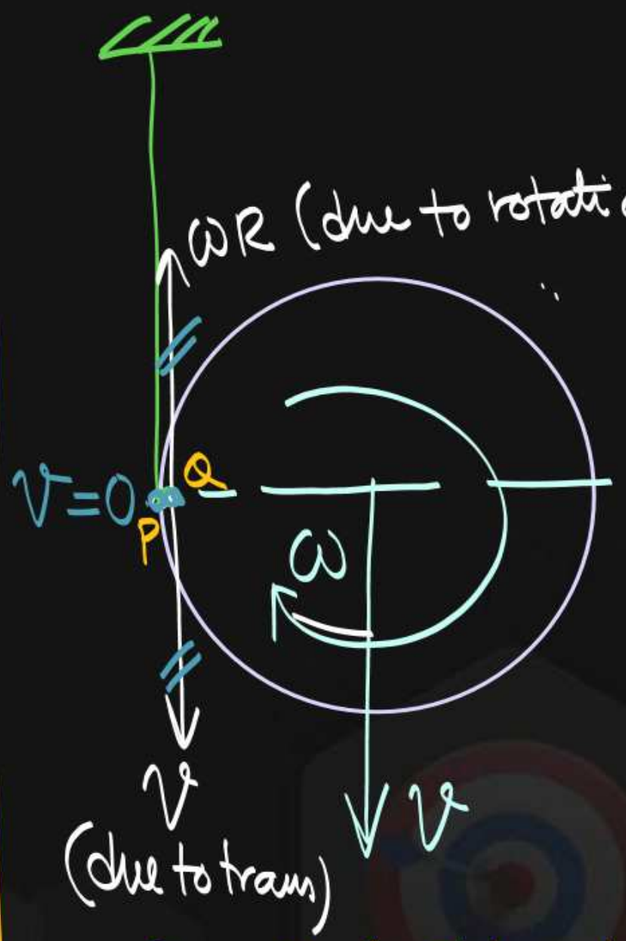
$Mg - T = Ma$ ① $\quad T = \frac{Ma}{2}$

$TR = \frac{MR^2}{2}\alpha$ 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)

$\Rightarrow 0 = v - \omega R$

$\Rightarrow v = \omega R$

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

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

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

$$= mg\, l/2 \sin\theta$$

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

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

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

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

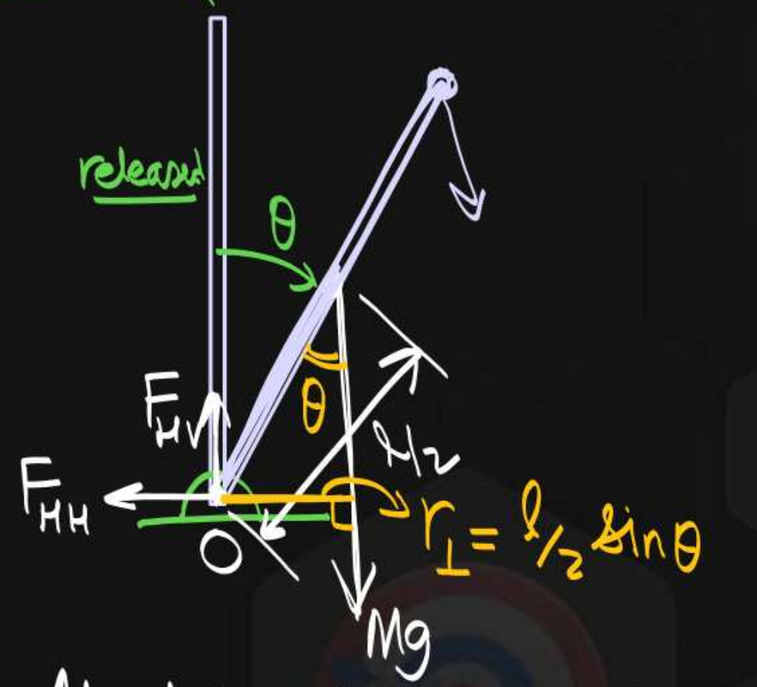
Find tangential acc^n of free end just before it hits the floor.

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

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

Ex: find angular acc^n 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

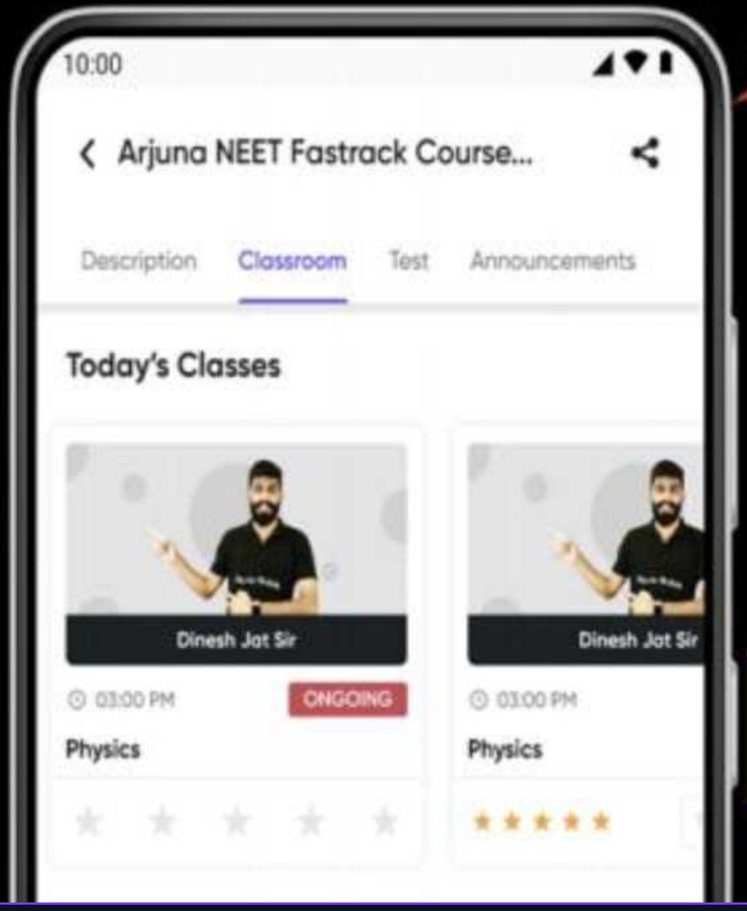
Chap Name ..

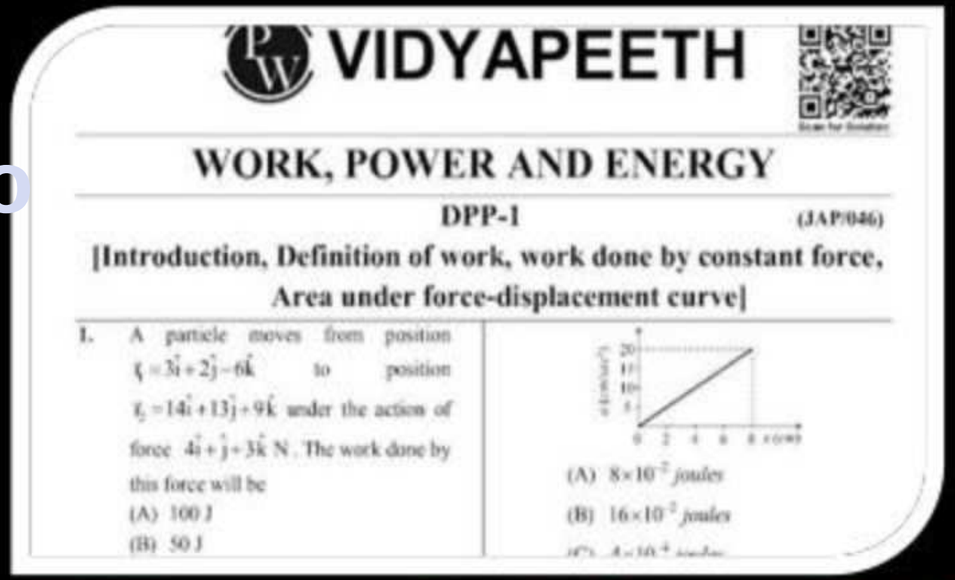
1. Sub Top ..

ATDB.uno

Rate your today's class in the Batch

Solve the DPP and check Solution





VIDYAPEETH

WORK, POWER AND ENERGY

DPP-1 (JAP/046)

[Introduction, Definition of work, work done by constant force, Area under force-displacement curve]

1. A particle moves from position $\vec{r}_1 = 3\hat{i} + 2\hat{j} - 6\hat{k}$ to position $\vec{r}_2 = 14\hat{i} + 13\hat{j} + 9\hat{k}$ under the action of force $4\hat{i} + \hat{j} + 3\hat{k}$ N. The work done by this force will be

(A) 100 J

(B) 50 J

(A) 8×10^{-2} joules

(B) 16×10^{-2} joules

"SCAN" to join our "TELEGRAM" channel

Thank You!!!!

Check your performance through Student Dashboard