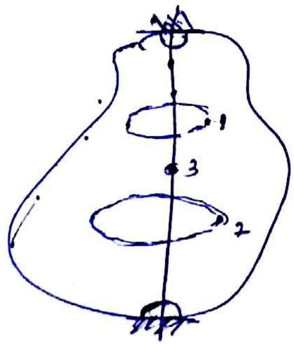
Rotation :-

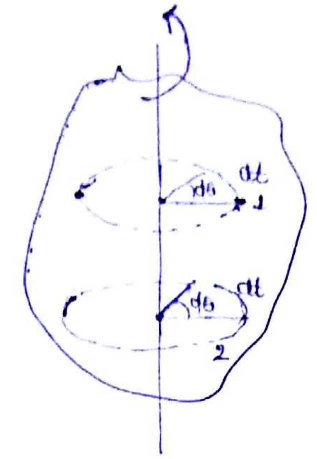
Particle on ~~Rest~~ line -at Rest
other- rotation



$\vec{V} = 0$; $\vec{a} = 0$

In rotation all the particles are in circular motion ~~which~~ [execpt which are lying on axis of rot^n] and their centers will ~~lie~~ lie on a line which should remain fixed called axis of rotation.

kinematic :-

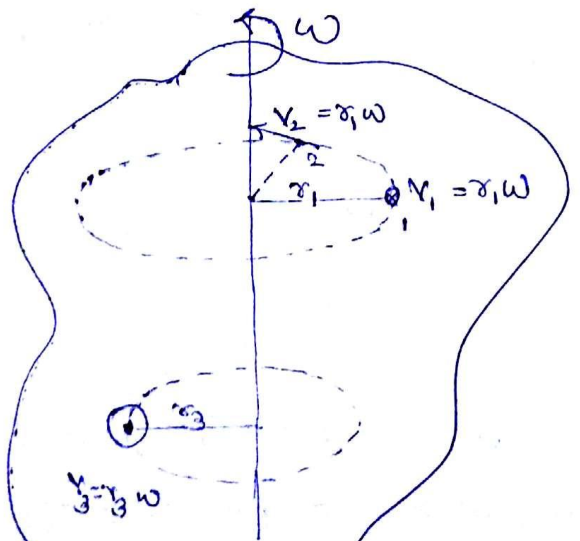


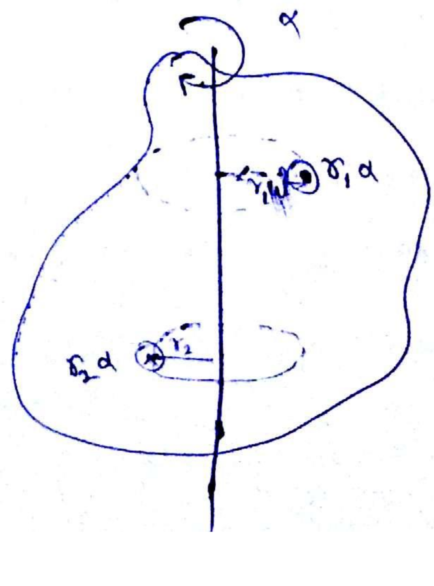
$$\vec{\omega}_1 = \vec{\omega}_2 = \vec{\omega}_3 = \vec{\omega}$$
$$\vec{\alpha}_1 = \vec{\alpha}_2 = \vec{\alpha}_3 = \vec{\alpha}$$

Dir^n of $\vec{\omega}$ & $\vec{\alpha}$ will be along axis of rotation & will be decided by right hand thumb rule.

In rotation $\vec{\omega}$ & $\vec{\alpha}$ will be same for each and every partycal.

$\vec{V}$ & $\vec{a}$



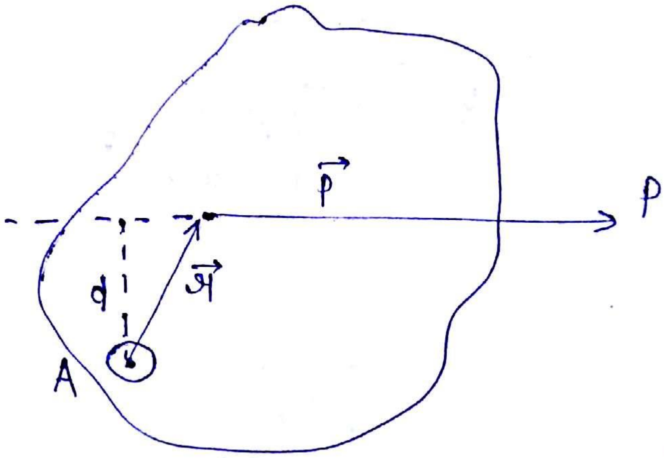


Velocity vector and accⁿ vector of each and every particle are dependent on their location from their ~~position from their~~ axis of rotation and can be calculated by considering their circular motion

Angular Momentum (L) :- (Moment of momentum)

$\vec{L} = \vec{r} \times \vec{P}$

$\vec{P} = m\vec{V}_{cm}$

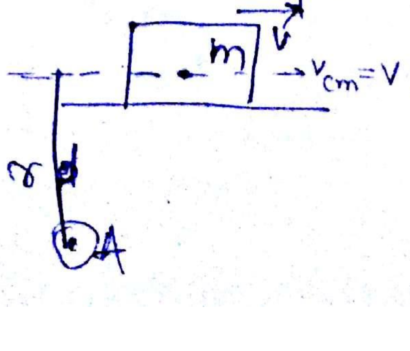


$$\boxed{\vec{L}_A = \vec{r} \times \vec{P}}$$

$$\boxed{|\vec{L}_A| = Pd = mV_{cm}d}$$

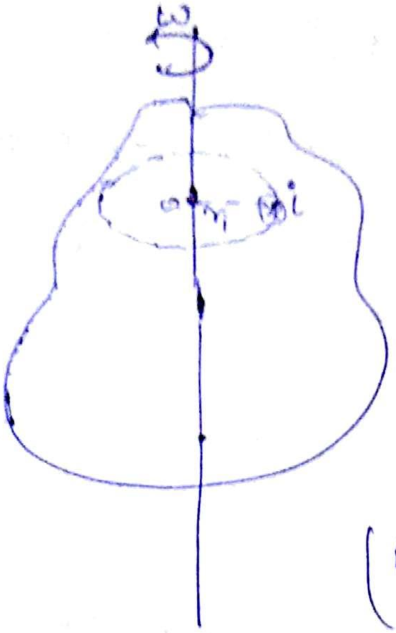
Dirⁿ → ⊥ inward.

Case-1 Rectilinearaly translating body



$$\boxed{L_A = mV_{cm}r = mVr}$$

Case - 2   Pure rotation



$P_i = m\vec{v}_i$

$\vec{v}_i = r_i\omega$

$(\vec{L}_i)_0 = \vec{r}_i \times \vec{P}_i$

$[L_i]_0 = r_i P_i$

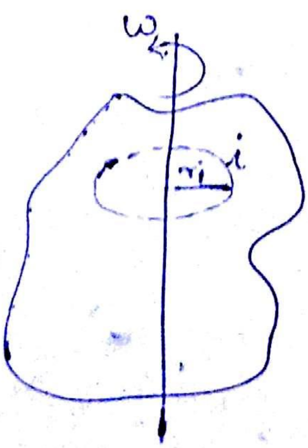
$$\sum_{i=1}^{N} (L_i)_0 = (L)_{\substack{\text{Axis}\\ \text{of rotation}}} = \sum_{i=1}^{N} r_i m_i r_i \omega$$

$$= \omega \sum_{i=1}^{N} m_i r_i^2$$

$$\boxed{(L)_{A.o.r.} = I_{Axis}\,\omega}$$

$$\boxed{\vec{L} = I\vec{\omega}}$$

Kinetic energy :-



$$(K.E.)_i = \frac{1}{2} m_i v_i^2 = \frac{1}{2} m_i (r_i \omega)^2$$

$$K.E. = \frac{1}{2}\omega^2 \sum_{i=1}^{N} m_i r_i^2 = \frac{1}{2} I\omega^2$$

$$\boxed{K.E. = \frac{1}{2} I\omega^2}$$

Similarly

$$\boxed{\text{Torque}, T = I\alpha}$$

$$\boxed{\text{word done} = T\,d\theta}$$

$$\boxed{\text{Power} = \frac{T\,d\theta}{dt} = T\omega}$$

Power = Rate of doing work

$$\text{Power} = \frac{\vec{F}\cdot d\vec{s}}{dt}$$

$$\boxed{\text{Power} = \vec{F}\cdot\vec{V}}$$

Rate of change of Angular Momentum. →

$$\boxed{\frac{d\vec{L}}{dt} = \vec{T}}$$

Conservation of Angular Momentum ($\vec{L}$)

$$\vec{L} \rightarrow \text{Const.}$$

$$\Rightarrow \quad d\vec{L} = 0 , \quad \text{when } \vec{T} = 0$$

If the net torque on a system about a point or line is zero, then angular momentum will remain conserved about the point or line.

$$\frac{d\vec{L}}{dt} = \vec{T}$$

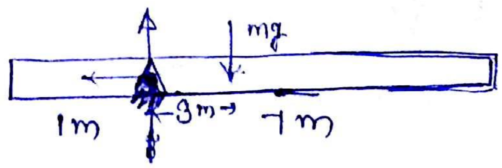
$$\underbrace{\vec{T}\,dt}_{\text{Angular Impluse}} = \underbrace{d\vec{L}}_{\text{change in momentum}}$$

Q.2.11

P.g. 72

$m = 3kg$

$l = 8m$



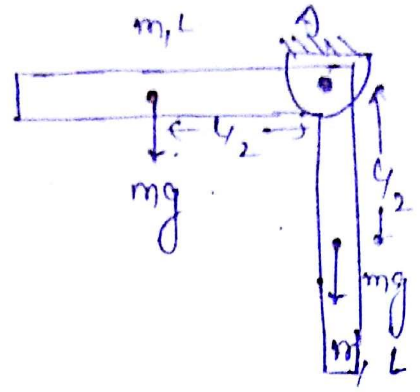
$$T_A = I_A \alpha$$

$$mg \times 3 = \left[I_{cm} + m \times 3^2\right] \times \alpha$$

$$3 \times 9.81 \times 3 = \left[\frac{3 \times 8^2}{12} + 3^2\right] \times \alpha$$

$$\alpha = 2.05 \ \text{rad}/\text{sec}^2$$

Prob.



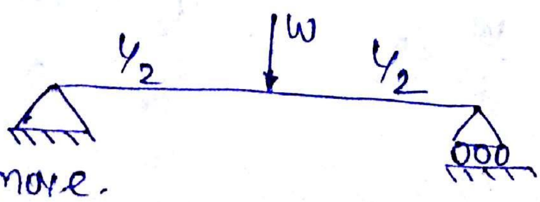
$$T = mg\,l/2 = I_A\,\alpha$$

$$mg\,l/2 = \left[\frac{ml^2}{3} + \frac{ml^2}{3}\right]\alpha$$

$$\frac{\cancel{m}g}{2} = \frac{2}{3}\cancel{m}l\,\alpha$$

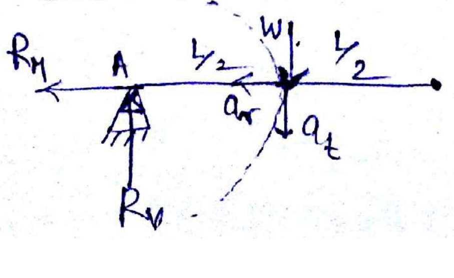
$$\alpha = \frac{3g}{4l}$$

Quest A uniform beam of weight W and length L is simply supported at its both ends if one of the support is suddenly remove then the rxn at other support at the instance of removal is?



one end remove.

Sol^n



$\omega = 0$; $\alpha \neq 0$

$$T_A = I_A \alpha$$

$$W \times \frac{L}{2} = \frac{W}{g} \times \frac{L^3}{3} \times \alpha$$

$$\alpha = \frac{3g}{2L}$$

$\Rightarrow$ $W - R_V \neq 0$

$$W - R_V = \frac{W}{g}(a_{cm})_{(-y)\, dir^n}$$

$$W - R_V = \frac{W}{\cancel{g}} \times \frac{\cancel{L}}{2} \times \frac{3\cancel{g}}{2\cancel{L}} \qquad a_t = \frac{L}{2}\alpha$$

$$\boxed{R_V = \frac{W}{4}} \text{ — Ans}$$

$$R_H = \frac{W}{g}(a_{cm})_{(-x)}$$

$$R_H = \frac{W}{g}(a_{cm})_r$$

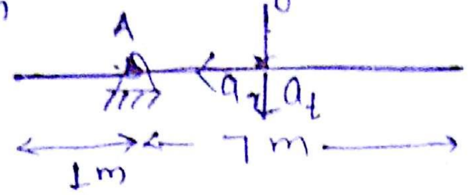
$$R_H = \frac{W}{g}[0] \qquad a_r = r\omega^2$$

$a_r = 0$ Bcz $\omega = 0$.

$$R_H = 0$$

Probm

$m = 3\,kg$
$l = 8\,m$



Find the rxn at the support for the instant shown in fig taking $\omega = 2\ rad/s$

$$T = I\alpha$$

$$mg \times 3 = \left(\frac{ml^2}{3} + m(3)^2\right)\alpha$$

$$3 \times 9.81 \times 3 = \left(\frac{3 \times 8^2}{3} + 3 \times 3^2\right)\alpha$$

$$\alpha = 2.05\ rad/sec.$$

$$(mg - R_V) = m(a_{cm})_t = mr\alpha$$

$$3 \times 9.81 - R_V = 3 \times 3 \times 2.05$$

$$R_V = \underline{10.98\ N}$$

$$R_H = m(a_{cm})_r = mr\omega^2$$

$$R_H = 3 \times 3 \times 2^2$$

$$R_H = \underline{36\ N}$$