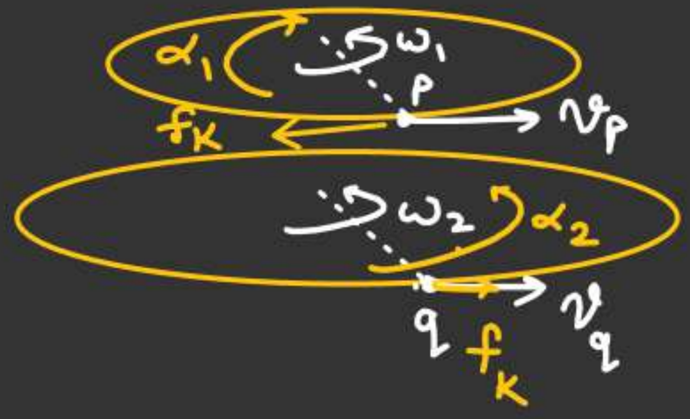
Nishant Jindal

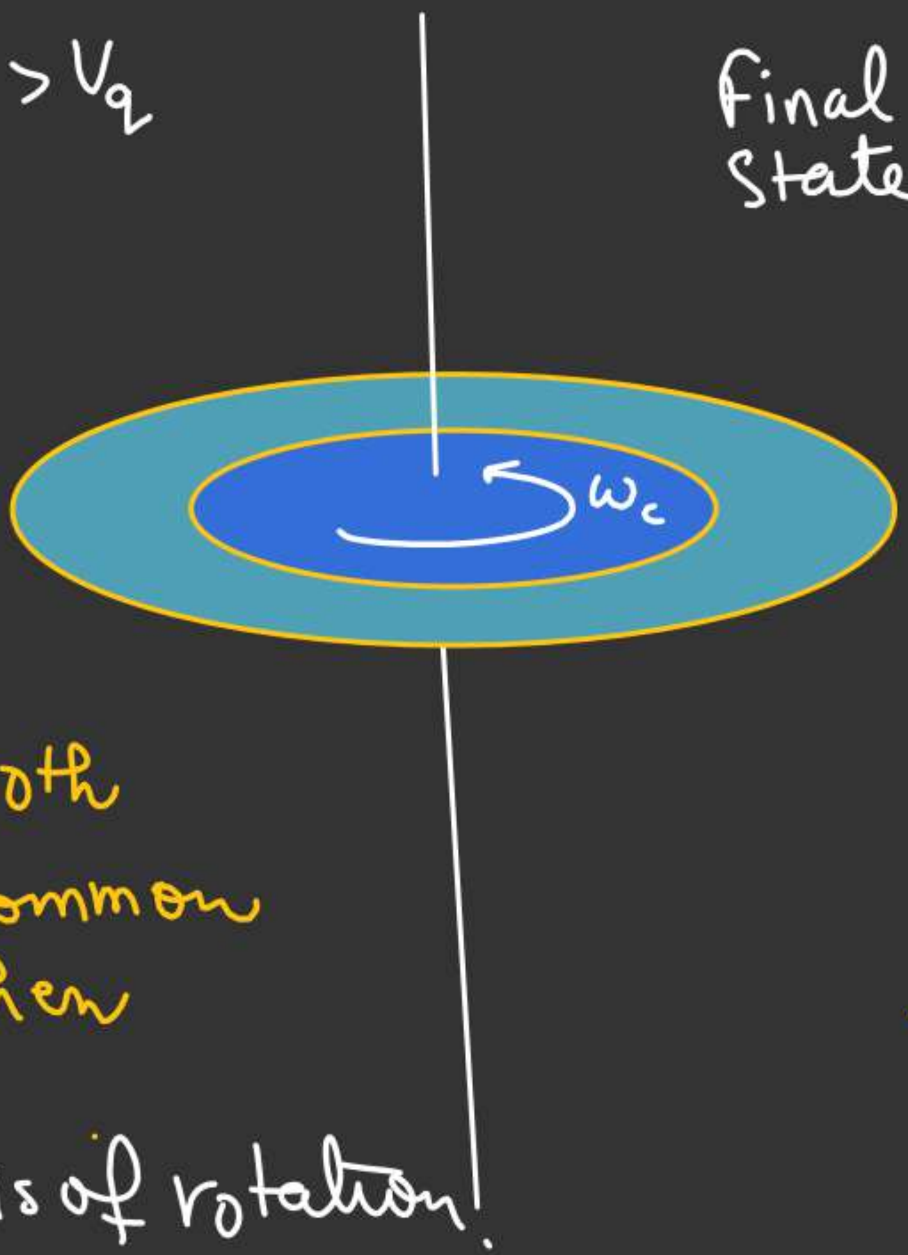
ANGULAR MOMENTUM CONSERVATION

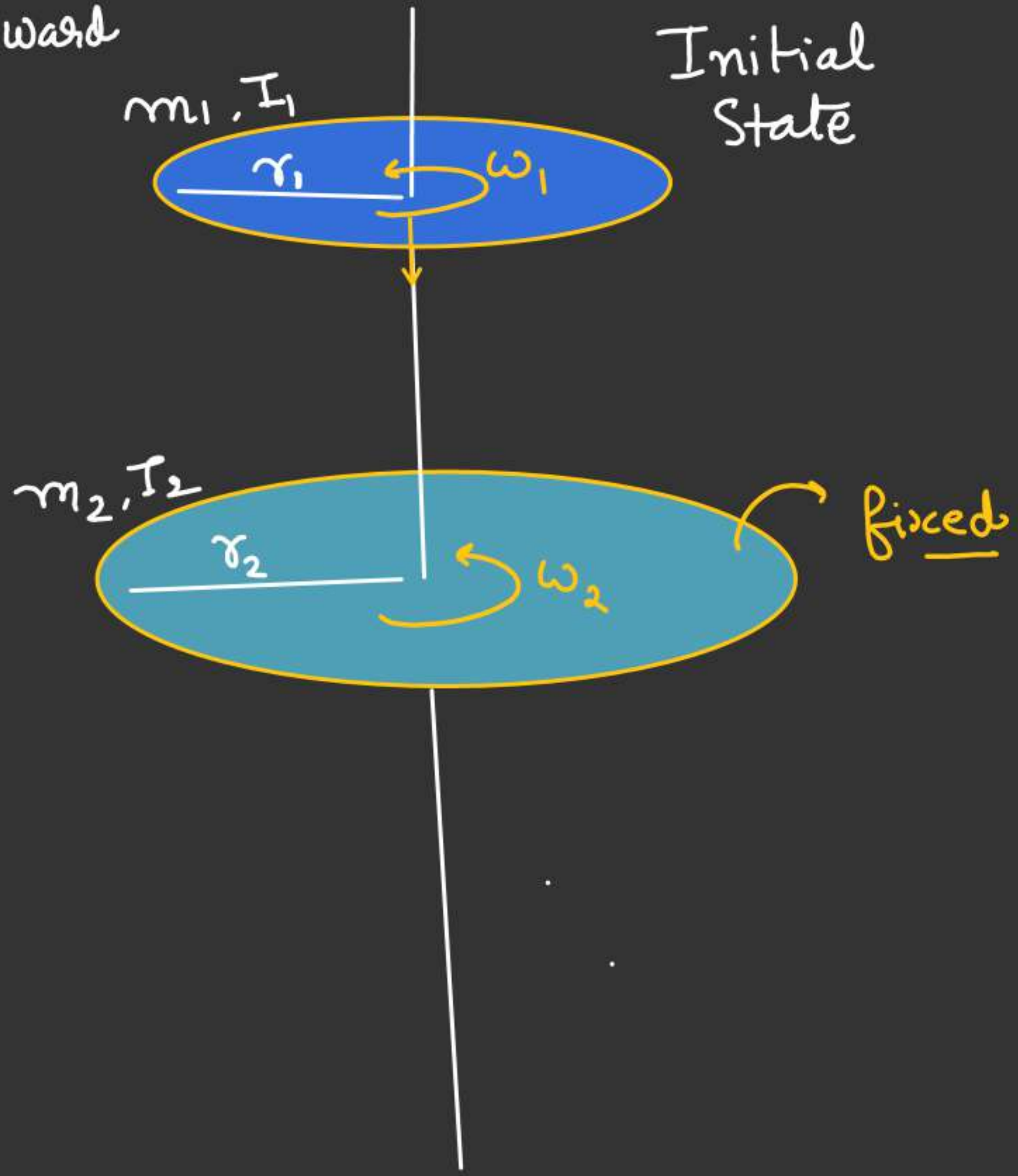
Case of two rotating disc about Common axis of rotation

upper disc rotating and moving downward

$V_p > V_q$







$\omega_2 \uparrow \; \omega_1 \downarrow$

At the time when both discs attained common angular velocity ω_c then

$f = 0$

$\tau_{net} = 0$ about axis of rotation

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A.M.C

$$L_i = L_f$$

$$\left(I_1\omega_1 + I_2\omega_2\right) = (I_1 + I_2)\omega_c$$

$$\omega_c = \left(\frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}\right)$$

$$K.E_{Rotational} = \left[\frac{1}{2}I\omega^2\right] \checkmark$$

Heat

$$= K.E_i - K.E_f$$

$$= \left[\frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2\right] - \frac{1}{2}\left(I_1 + I_2\right)\omega_c^2$$

$$= \left[\frac{1}{2}I_1\omega_1^2 + \frac{1}{2}I_2\omega_2^2\right] - \frac{1}{2}\cancel{(I_1+I_2)}\frac{(I_1\omega_1 + I_2\omega_2)^2}{\cancel{(I_1+I_2)^2}} = \checkmark$$

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ANGULAR MOMENTUM CONSERVATION

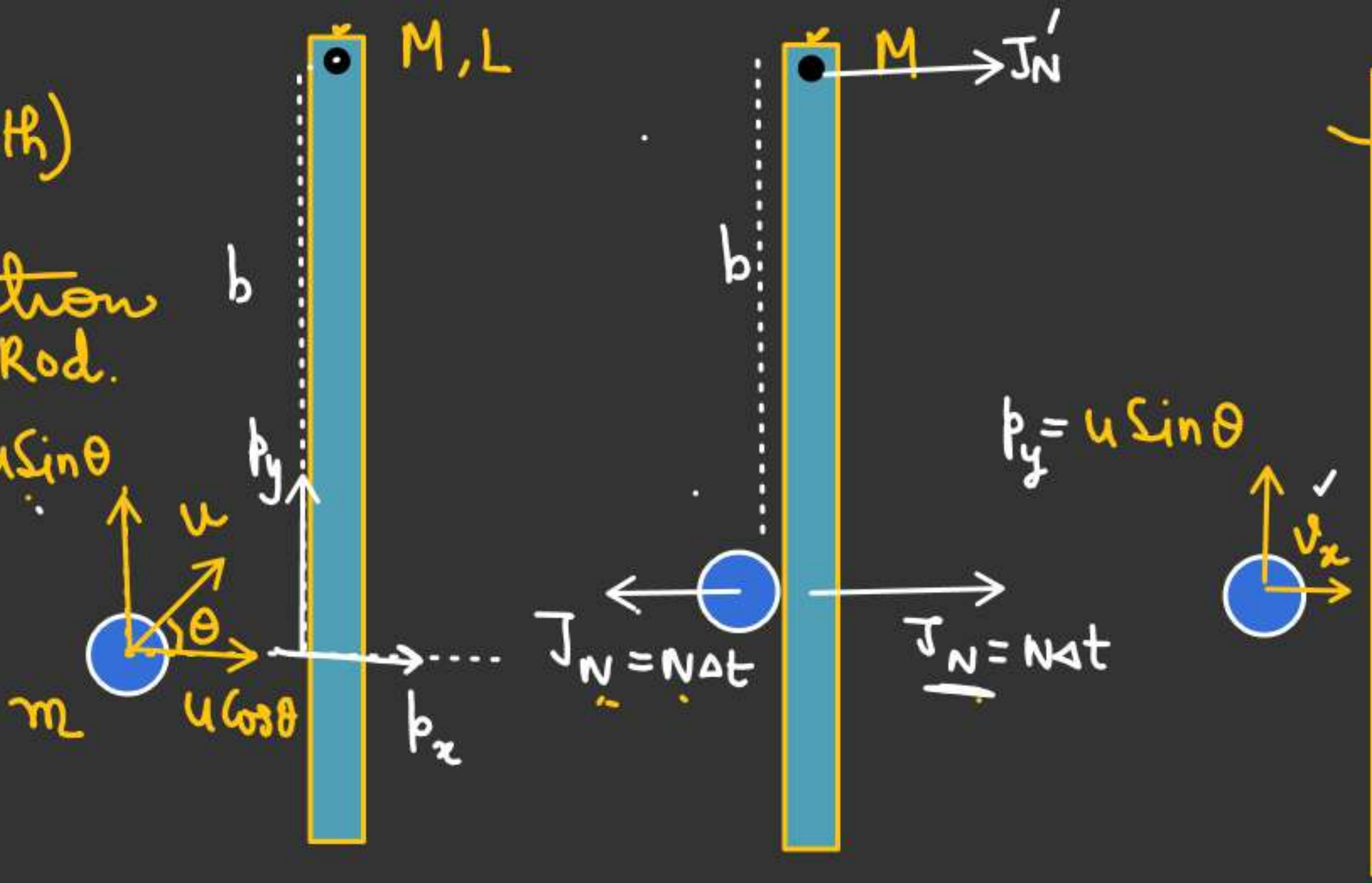
Collision of a Rod with a ball

Case-1 :- Collision of a ball with a hinged rod

(Rod is smooth)

e = Coff of Restitution b/w ball & Rod.

Just before Collision. — During Collision. — Just after Collision.

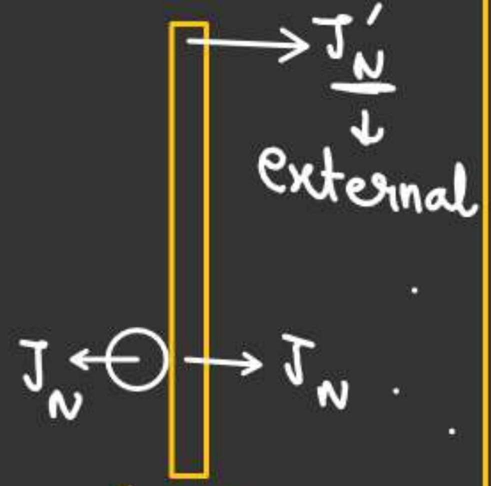


A·M·C about hinged point

$$L_i = L_f$$

$$\boxed{+(mu\cos\theta)b = +mv_x b + \frac{ML^2}{3}\omega}$$

L·M·C not possible for ball + Rod System



$$\boxed{M V_{com}\cdot\frac{L}{2} + I_{com}\cdot\omega \;\rightarrow\; I_{\text{axis of Rotation}}\cdot\omega}$$

ANGULAR MOMENTUM CONSERVATION

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Just before Collision. During Collision. Just after Collision.

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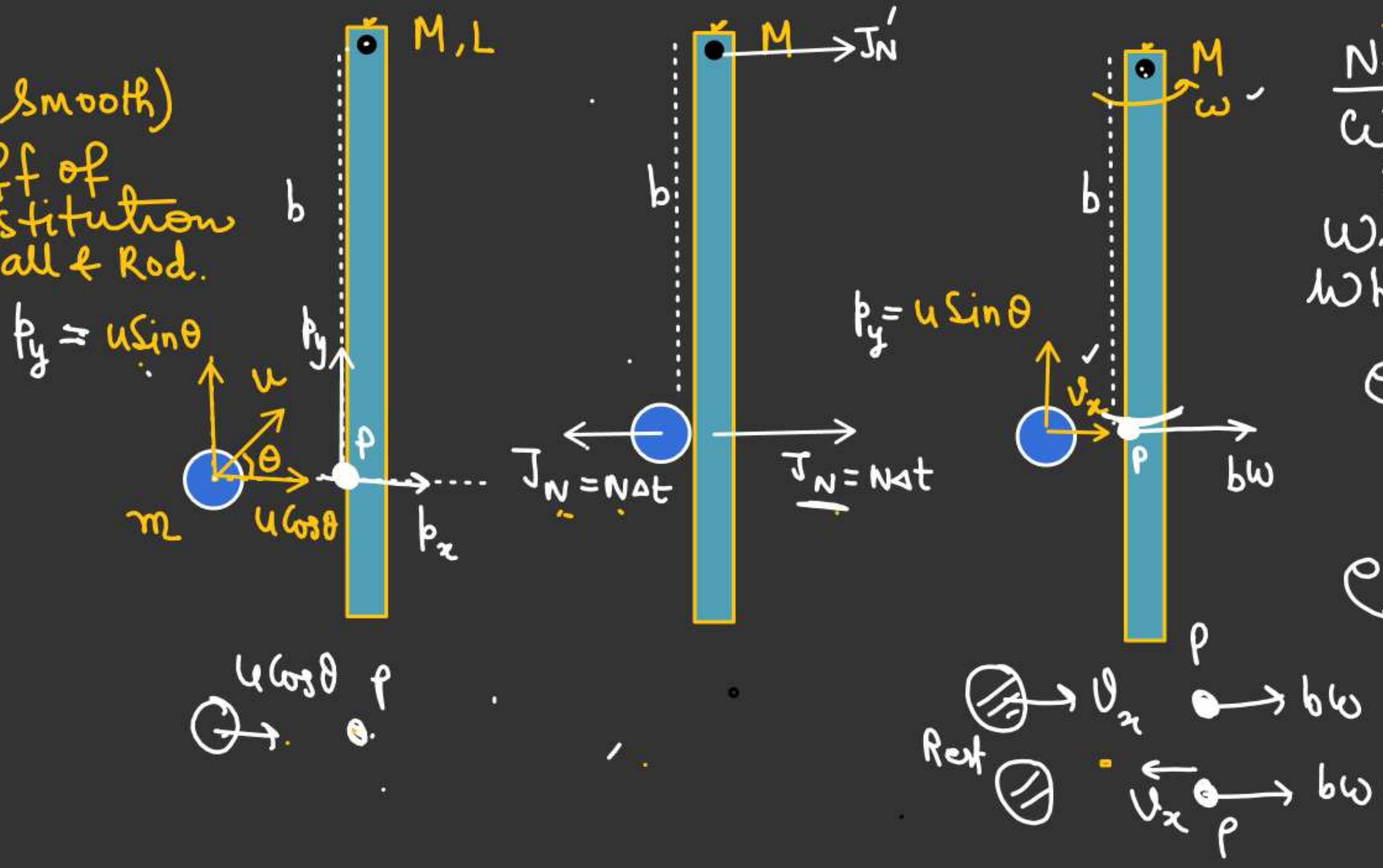

Equation of e

Note :- While writing e. Write relative speed of Seperation or approach w.r.t point on the rod where collision occur.

$$e = \frac{\text{Relative speed of seperation}}{\text{Relative speed of approach}}$$

$$e = \frac{b\omega - v_x}{u\cos\theta}$$

$$\boxed{e\,u\cos\theta = b\omega - v_x} \quad -(2)$$

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ANGULAR MOMENTUM CONSERVATION

Q:

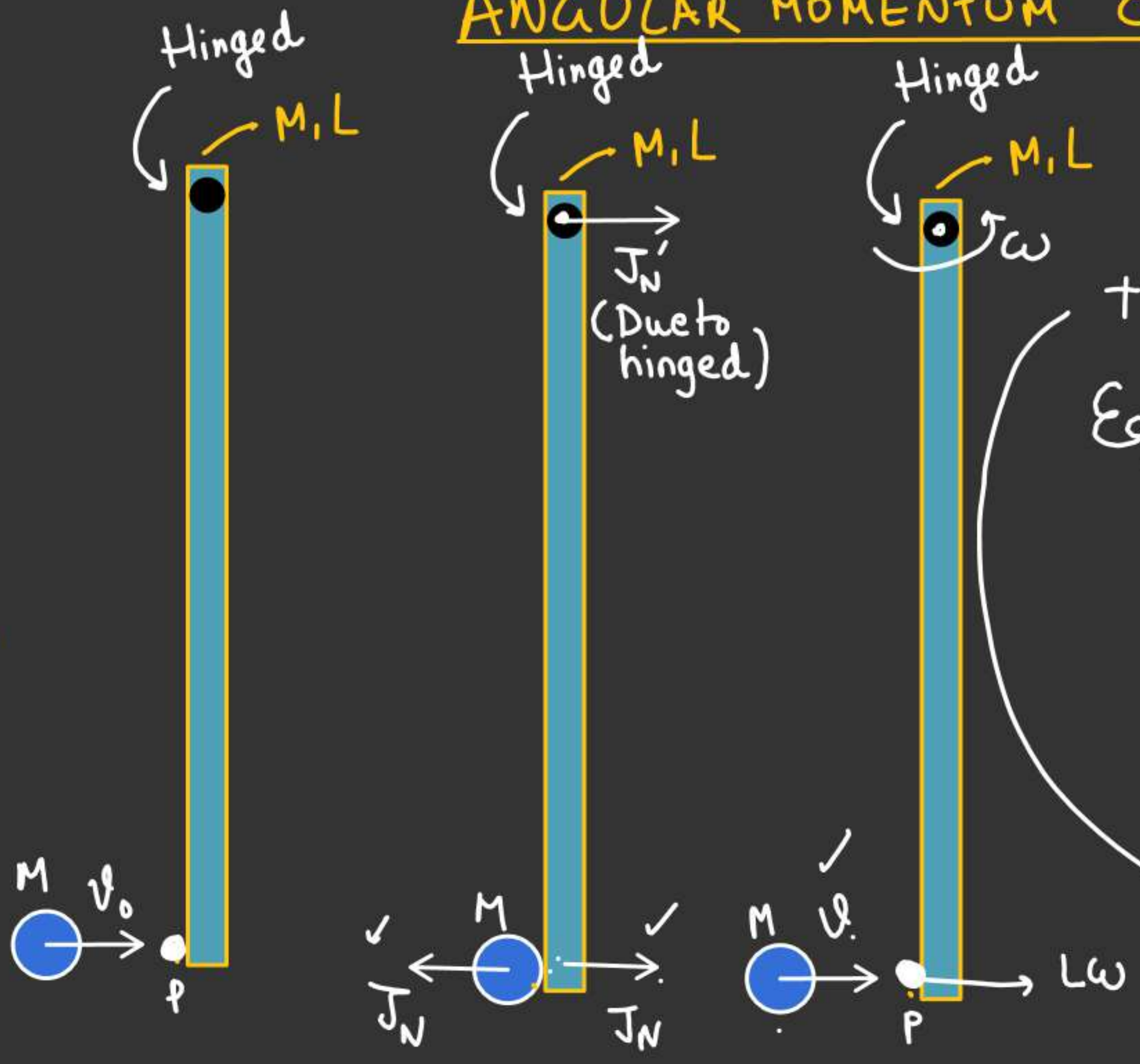
$e = \frac{1}{2}$.

Find

$\omega_{Rod} = ?$

$v_{ball} = ?$

After Collision



A·M·C (about hinged)

$$+ M v_0 L = M v L + \frac{ML^2}{3}\omega \quad — (1)$$

Equation of e

$$\frac{1}{2} = \frac{L\omega - v}{v_0}$$

$$\frac{v_0}{2} = L\omega - v \quad — (2)$$

$$v_0 = v + \frac{L\omega}{3} \quad — (3)$$

$$\frac{3v_0}{2} = \frac{4L\omega}{3} \leftarrow (2)+(3)$$

$$\omega = \left(\frac{9v_0}{8L}\right)$$

$$v = L\omega - \frac{v_0}{2} = \frac{9v_0}{8} - \frac{v_0}{2} = \frac{5v_0}{8} \text{ Ans.}$$

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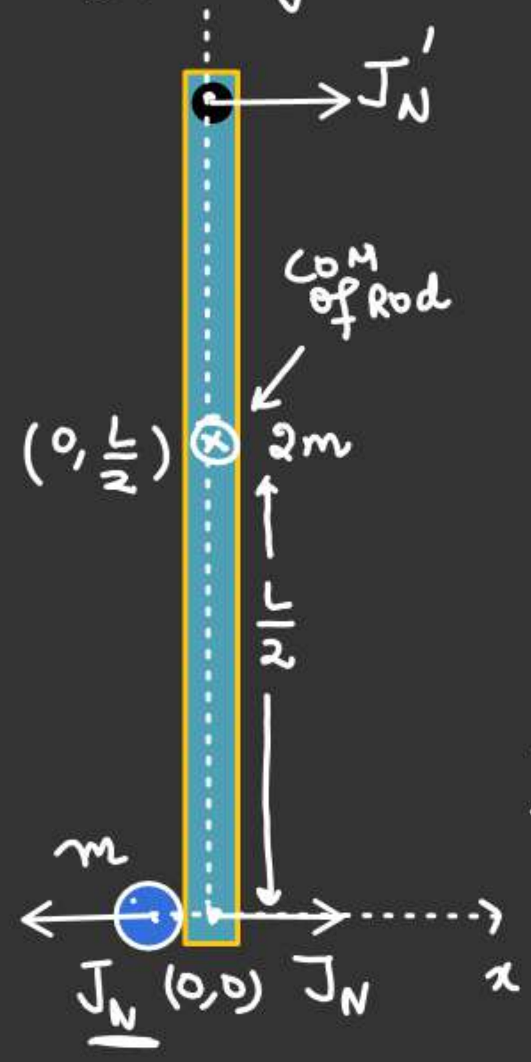
$e = 0$ (given)

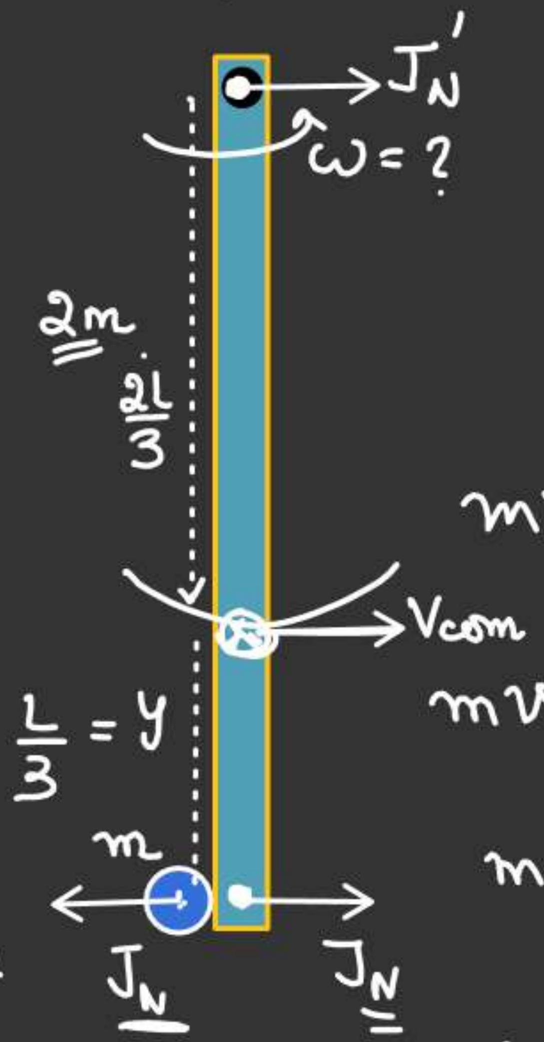
$\omega_{rod} = ?$

$v_{com} = ?$ Just after Collision

During Collision.



After Collision (just)



$$y_{com} = \frac{m(0) + 2m(L/2)}{m + 2m}$$

$$y_{com} = \left(\frac{L}{3}\right).$$

A.M.C of System about hinged point.

$$L_i = L_f$$

$$mv_0L = (I_{system})\omega$$

$$mv_0L = (I_{Rod} + I_{ball})\omega$$

$$mv_0L = \left[\frac{(2m)L^2}{3} + mL^2\right]\omega$$

$$mv_0L = \left[\frac{2mL^2}{3} + mL^2\right]\omega$$

$$\left(\frac{3v_0}{5L} = \omega\right) \text{Ans.}$$

$$V_{com} = \frac{2L}{3}\omega = \frac{2L}{3} \times \frac{3v_0}{5L} = \frac{2v_0}{5} \text{ Ans.}$$