DPP 04

SOLUTION

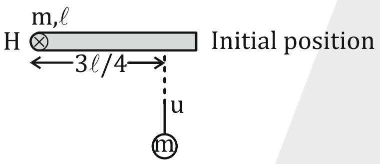
1. Angular momentum is conserved about H because no external force is present in horizontal plane which is producing torque about H.

$$mu\ell = \left(\frac{m\ell^2}{3} + m\ell^2\right)\omega$$

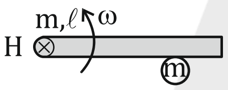
$$\Rightarrow \omega = \frac{3u}{4\ell} = \frac{ku}{(k+1)\ell}$$

$$\Rightarrow k = 3$$

2. From angular momentum conservation about H initial angular momentum = final angular momentum



$$m, u\frac{3\ell}{4} = m\left(\frac{3\ell}{4}\right)^2\omega + \frac{ml^2}{3}\omega$$



$$\Rightarrow \frac{3mu\ell}{4} = m\ell^2\left[\frac{1}{3} + \frac{9}{16}\right]\omega$$

$$\frac{3u}{4\ell} = \left[\frac{16+27}{48}\right]\omega$$

$$\Rightarrow \omega = \frac{36u}{43\ell} = \frac{ku}{(k+7)\ell}$$

$$\Rightarrow k = 36$$

3. By Law of Conservation of Angular Momentum about centre of disc, we have

$$I_1\omega_1 = I_2\omega_2$$

$$\Rightarrow \omega_2 = \left(\frac{I_1}{I_2}\right)\omega_1 = \left[\frac{\frac{1}{2}ma^2}{\frac{1}{2}ma^2 + 2m\left(\frac{a}{2}\right)^2}\right]\omega$$

$\Rightarrow \omega_2 = \frac{\omega}{2} = \frac{\omega}{\beta}$

$\Rightarrow \beta = 2$

4. Mass of cotton pad after time t is

$m = \mu t$

Applying conservation of angular momentum, we get

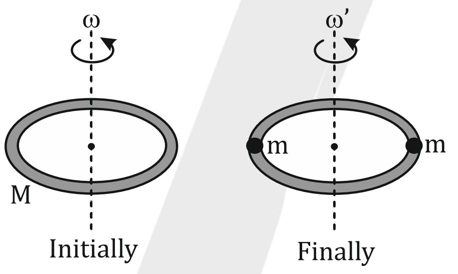
$$\left(\frac{m_0 r^2}{2}\right)\omega = \left(\frac{m_0 r^2}{2} + \mu t r^2\right)\frac{\omega}{2}$$

$$\Rightarrow m_0 r^2 = \frac{m_0 r^2}{2} + \mu t r^2$$

$\Rightarrow t = \frac{m_0}{2\mu}$

5. By Law of Conservation of Angular Momentum

$(MR^2)\omega = MR^2\omega' + 2mR^2\omega'$



$$\Rightarrow \omega' = \left(\frac{M}{M + 2m}\right)\omega$$

6. Conserving the angular momentum : about the hinge

$$mua = \left[\frac{m(a^2 + 4a^2)}{12} + \frac{5}{4}ma^2\right]\omega$$

$\Rightarrow \omega = \frac{3}{5}\frac{u}{a}$

7. By conservation of angular momentum about hinge O.

$L = 1\omega$

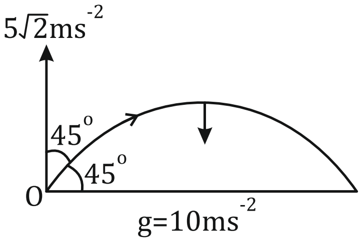
$$mv\frac{d}{2}=\left[\frac{Md^2}{12}+m\left(\frac{d}{2}\right)^2\right]\omega \Rightarrow \frac{mvd}{2}=\left(\frac{md^2}{2}+\frac{md^2}{4}\right)\omega$$

$$\frac{mvd}{2}=\frac{3}{4}md^2\omega \Rightarrow \frac{2}{3}\frac{v}{d}=\omega$$

8-9. The horizontal range

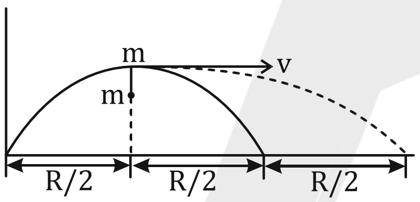
$$R=\frac{2u_xu_y}{g}=\frac{2\times5\sqrt{2}\cos\ 45^\circ\times5\sqrt{2}\sin\ 45^\circ}{10}$$

$R = 5$ m



The time of flight is,

$$T=\frac{2u_y}{g}=\frac{2\times5\sqrt{2}\sin\ 45^\circ}{10}=1\ s$$



The time of motion for first part to reach to maximum height $t=\frac{T}{2}=\frac{1}{2}=0.5$ s

Using conservation of momentum along x-axis, $2m\times5=m\times v+m\times0$

$v = 10\ m\ s^{-1}$

Displacement of other part in 0.5 s along x-axis

$S_x = 10\times t = 10\times0.5 = 5$ m

Total distance of second part from O is,

$$x=\frac{R}{2}+\frac{R}{2}+\frac{R}{2}=3\frac{R}{2};x=\frac{3\times5}{2}=7.5\ m$$