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$$H_O = \overbrace{I_O \omega}^{\text{Disk}} + \overbrace{m r^2 \omega}^{\text{Particle}}$$

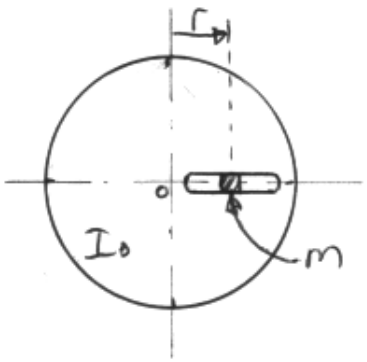
angular momentum

ω const.

$$\Sigma M_O = \dot{H}_O$$

$$M = 0 + \frac{d(m r^2 \omega)}{dt}$$

$$M = 0 + 2 r m \omega \dot{r}$$



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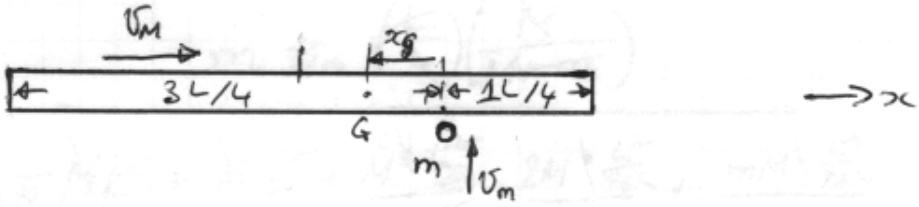
Bar M, L, v_M Particle m, v_m

↑ y



find new centre of mass

$$x_G = \frac{(m)(0) + \frac{L}{4}(M)}{m+M} = \frac{L}{4}\left(\frac{M}{M+m}\right)$$

x momentum : $M v_M + m(0) = (M+m) v_x$

$$\Rightarrow v_x = \frac{M v_m}{M+m}$$

y momentum : $M(0) + m v_m = (M+m) v_y$

$$v_y = \frac{m v_m}{(M+m)}$$

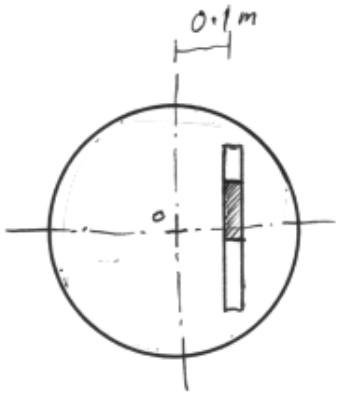
ang momentum $_G$: $m v_m \frac{L}{4}\left(\frac{M}{M+m}\right) = \left[\frac{1}{12}ML^2 + M\left(\frac{L}{4} - \frac{M\frac{L}{4}}{M+m}\right)^2 + m\left(\frac{M\frac{L}{4}}{M+m}\right)^2\right]\omega$

ω = lots of algebra & rearrangement gives

$$\omega = \frac{12 v_m}{L}\left[\frac{m}{(4M+7m)}\right]$$

for system (overall)

$\Sigma M_O = 0 \quad \therefore H_O$ is const (angular momentum)

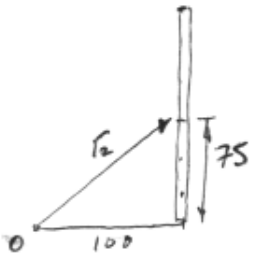


$$I_{O_{DISK}} = mr^2 = (3.6)(0.15)^2$$

$$I_{BAR_1} = \frac{1}{12} m l^2 + m(0.1)^2$$
$$= \frac{1}{12}(0.9)(0.15)^2 + (0.9)(0.1)^2$$

$$I_{BAR_2} = \frac{1}{12}(0.9)(0.15)^2 + (0.9) r_2^2$$
$$= \frac{1}{12}(0.9)(0.15)^2 + (0.9)(0.125)^2$$

$$I_{O_1} \omega_1 = I_{O_2} \omega_2$$



$$\left[(3.6)(0.15)^2 + \frac{1}{12}(0.9)(0.15)^2 + (0.9)\left(\frac{0.1}{0.15}\right)^2\right] 600$$
$$= \left[(3.6)(0.15)^2 + \frac{1}{12}(0.9)(0.15)^2 + (0.9)\left(\frac{0.125}{0.15}\right)^2\right] \omega_2$$

$$r_2 = \sqrt{(100)^2 + (75)^2}$$
$$= 125 \text{ mm}$$

$$\omega_2 = \frac{600\left[4 + \frac{1}{12} + \left(\frac{0.1}{0.15}\right)^2\right]}{\left[4 + \frac{1}{12} + \left(\frac{0.125}{0.15}\right)^2\right]}$$

$\omega_1 = 600$ rev/min

$$\omega_2 = (600)(0.948) = 569 \text{ ~~rad/s~~ rpm}$$

Friction is internal, so presence of friction in slot would have no effect on result.