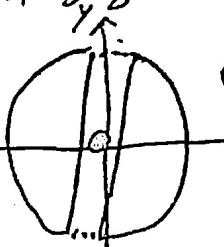


conservation moment angular

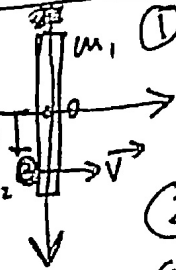
$$L_0 = I \omega_0 = \frac{m_1 r^2}{2} \omega_0 = L_1 = \frac{m_1 r^2}{2} \omega + m_2 r^2 \omega$$

$$\frac{m_1 \omega_0}{2} = \frac{r^2 \omega (m_1 + m_2)}{2} \quad \omega = \frac{m_1 \omega_0}{m_1 + 2m_2} = \frac{9}{18} \frac{\text{rad}}{\text{s}} = 4.5 \frac{\text{rad}}{\text{s}}$$


① $m_2 v = (m_1 + m_2) v_{cm} \quad v_{cm} = \frac{m_2}{m_1 + m_2} v$ ② $r_{cm} = \frac{x m_2}{m_1 + m_2}$

$$(x - r_{cm}) m_2 v = I \omega = \left(\frac{m_1 \ell^2}{12} + r_{cm}^2 m_1 + m_2 (x - r_{cm})^2 \right) \omega \quad \omega = \frac{(x - r_{cm}) m_2 v}{I}$$

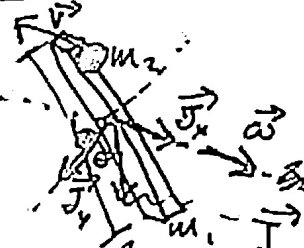
② $m_1 = m_2 = m \quad x = \ell \quad r_{cm} v = I \omega = \left(\frac{m \ell^2}{12} + m r^2 \right) \omega$

$$\omega = \frac{r \cdot v}{\frac{\ell^2}{12} + r^2} \quad J = \Delta P = m \omega r - m v$$


$J_x = \Delta P_x = -m_2 v$

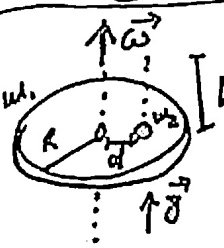
$$I \omega = I' \omega' \quad \frac{m_1 \ell^2}{12} \omega = \left(\frac{m_1 \ell^2}{12} + \frac{m_2 \ell^2}{4} \right) \omega' \quad \omega' = \frac{m_1 \omega}{m_1 + 3m_2}$$

$J_y = \Delta P_y = m_2 \omega' \frac{\ell}{2} \quad J = \sqrt{J_x^2 + J_y^2} \quad \theta = \arcsin \frac{J_y}{J}$



$I \omega = I' \omega' \quad \frac{1}{2} m_1 R^2 \omega = \left(\frac{1}{2} m_1 R^2 + m_2 d^2 \right) \omega' \quad \omega' = \frac{m_1 R^2 \omega}{m_1 R^2 + 2m_2 d^2}$

$J_y = m_2 \sqrt{2gh} \quad \text{Impulse angular} = J_y d$

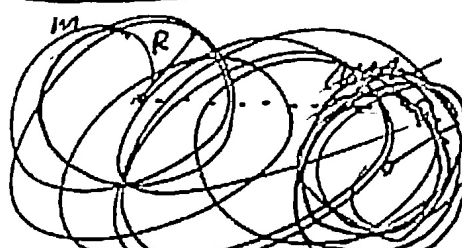


$m_1 v = 2m_2 v_{cm} \quad v_{cm} = \frac{v}{2}$

$L_f = 0 \Rightarrow \frac{m_1 R^2 \omega}{2} = \frac{m_2 R^2 \omega}{2} \quad \omega = \frac{2v \sin \theta}{R} \quad \omega = \frac{v}{R}$

Polo: 0 $L_i = R m v \sin \theta - I \omega = \frac{1}{2} R m v - \frac{1}{2} m R^2 \omega$

$2R \sin \theta = R \quad \sin \theta = \frac{1}{2} \quad \theta = \frac{\pi}{6}$

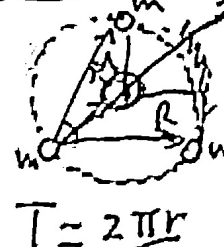


$\frac{GM}{R^2} = \frac{v^3}{R} \quad T = \frac{2\pi R}{v} \quad T^2 = \frac{4\pi^2 R^2}{v^2} = \frac{4\pi^2}{GM} R^3$

$P = m v_{cm} = 0 \quad L = 3 R m v_m$

$\frac{m v^2}{R} = \frac{GMm}{R^2} + \frac{2GMm}{(2R \sin \frac{\pi}{3})^2} = \frac{GMm}{R^2} + \frac{2GMm}{3R^2} \quad v_m = \sqrt{\frac{R}{3} (M + \frac{2m}{3})}$

$T = \frac{2\pi R}{v_m}$



$E_{p0} \quad \frac{1}{\mu} = \frac{1}{M} + \frac{3}{m} = \frac{m+3M}{Mm} \quad \mu = \frac{Mm}{m+3M} \quad E_p = 3 \frac{GMm}{R} \quad \text{or } 3 \frac{Gm^2}{R\sqrt{3}}$