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

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

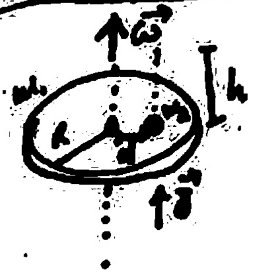
(2) $m_1 = m_2 = m$ $\quad x = r$ $\quad r m v = I\omega = \left(\frac{m\ell^2}{12} + m r^2\right)\omega$

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

$J_x = \Delta p_x = -m_2 v$

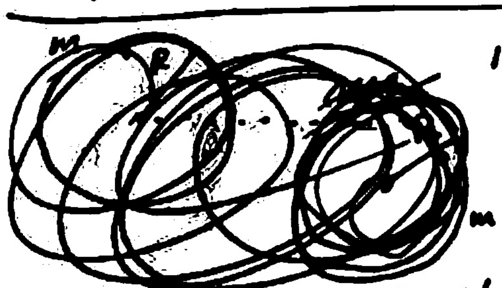
$I\omega = I'\omega'$ $\quad \frac{m_1 \ell^2}{12}\omega = \left(\frac{m_1 \ell^2}{12} + \frac{m_2 \ell^2}{4}\right)\omega'$ $\quad \omega' = \frac{m_1 \omega}{m_1 + 3 m_2}$

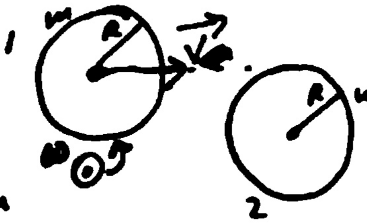
$J_y = \Delta p_y = m_2 \omega' \frac{\ell}{2}$ $\quad J = \sqrt{J_x^2 + J_y^2}$ $\quad \theta = \arcsin \frac{J_x}{J}$



$I\omega = I_1 \omega'$ $\quad \frac{1}{2} m_1 R^2 \omega = \left(\frac{1}{2} m_1 R^2 + m_2 d^2\right)\omega'$ $\quad \omega' = \frac{m_1 R^2 \omega}{m_1 R^2 + 2 m_2 d^2}$

$J = m_2 \sqrt{2gh}$ $\quad$ Impulso angolare $= Jd$





1 : m, R, $v = V$, $\omega = \omega$

2 : m, R, $v = 0$, $\omega = 0$

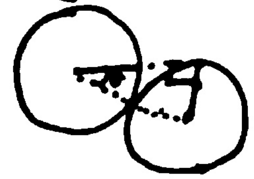
1,2 : $cm = 0$, $v = v_{cm}$, $\omega =$

$m v = 2 m v_{cm}$ $\quad v_{cm} = \frac{v}{2}$

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

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

$\omega = \frac{v}{R}$

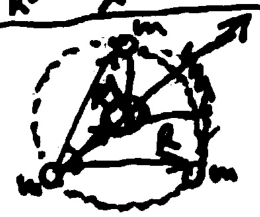


$2 \sin\theta = 1$

$\sin\theta = \frac{1}{2}$

$\theta = \frac{\pi}{6}$

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



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

$\frac{m v^2}{R} = \frac{G M m}{R^2} + \frac{2 G m^2}{(2 R \sin 60°)^2} = \frac{G M m}{R^2} + \frac{2 G m^2}{3 R^2}$ $\quad v = \sqrt{\frac{G}{R}\left(M + \frac{2}{3} m\right)}$

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

E_p: $\frac{1}{\mu} = \frac{1}{M} + \frac{3}{m} = \frac{m + 3M}{Mm}$ $\quad \mu = \frac{Mm}{m + 3M}$ $\quad E_p = -3 \frac{G M m}{R} - 3 \frac{G m^2}{R\sqrt{3}}$