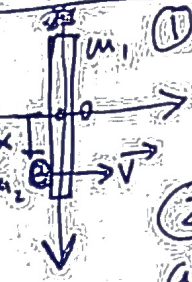
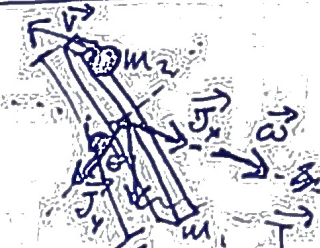
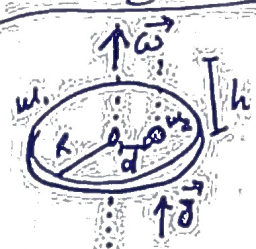
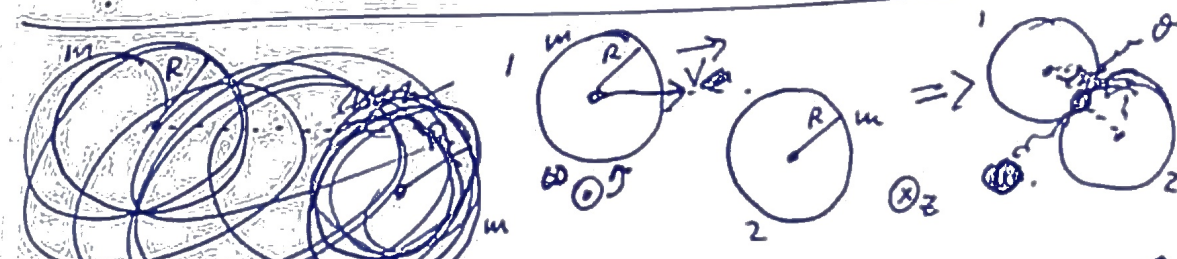


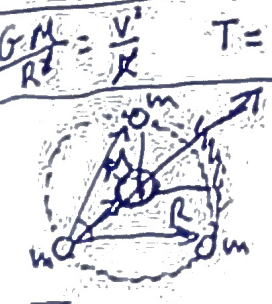
$M_1 = 3kg$ $M_2 = 1.5kg$ $\omega_0 = \frac{9}{5} \text{ rad/s}$
 Conservation of angular momentum
 $L_0 = I\omega_0 = \frac{M_1 R^2}{2} \omega_0 = L_1 = \frac{M_1 R^2}{2} \omega + M_2 R^2 \omega$
 $\frac{M_1 R^2 \omega_0}{2} = \frac{R^2}{2} \omega (M_1 + M_2)$ $\omega = \frac{M_1 \omega_0}{M_1 + 2M_2} = \frac{3}{3+2} \frac{9}{5} \text{ rad/s} = 4.5 \frac{\text{rad}}{\text{s}}$


 ① $m_2 v = (m_1 + m_2) v_{cm}$ $v_{cm} = \frac{m_2}{m_1 + m_2} v$ $r_{cm} = \frac{x m_2}{m_1 + m_2}$
 $(x - r_{cm}) m_2 v = I \omega = (\frac{m_1 l^2}{12} + r_{cm}^2 m_1 + m_2 (x - r_{cm})^2) \omega$ $\omega = \frac{(x - r_{cm}) m_2 v}{I}$
 ② $m_1 = m_2 = m$ $x = \frac{l}{2}$ $r_{cm} = \frac{l}{4}$ $v_{cm} = \frac{v}{2}$
 $\omega = \frac{r v}{\frac{l^2}{12} + r^2}$ $J = \Delta p = m \omega r - m v$


 $J_x = \Delta p_x = -m_2 v$
 $I \omega = I' \omega' + \frac{m_1 l^2}{12} \omega = (\frac{m_1 l^2}{12} + \frac{m_2 l^2}{4}) \omega'$ $\omega' = \frac{m_1 \omega}{m_1 + 3m_2}$
 $J_y = \Delta p_y = \frac{1}{2} m_2 \omega' \frac{l}{2}$ $J = \sqrt{J_x^2 + J_y^2}$ $\theta = \arcsin \frac{J_y}{J}$


 $I \omega = I' \omega'$ $\frac{1}{2} m_1 R^2 \omega = (\frac{1}{2} m_1 R^2 + m_2 d^2) \omega'$ $\omega' = \frac{m_1 R^2 \omega}{m_1 R^2 + 2m_2 d^2}$
 $J_y = m_2 \sqrt{2gh}$ $\text{Impulse angular} = J_d$


 1: $m, R, v=v, \omega=0$
 2: $m, R, v=0, \omega=0$
 1,2: C.M. $\equiv 0, v=v_{cm}, \omega=\omega'$
 $L_i = 0$ $L_f = 0$ $Polo: 0$ $L_i = R m v \sin \theta - I \omega = \frac{1}{2} R m v - \frac{1}{2} m R^2 \omega'$
 $2R \sin \theta = R$ $\sin \theta = \frac{1}{2}$ $\theta = \frac{\pi}{6}$
 $\omega = \frac{2v \sin \theta}{R}$ $\omega = \frac{v}{R}$

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

 $E = m v_{cm} = 0$ $L = 3 R m v_m$
 $\frac{m v^2}{R} = \frac{GMm}{R^2} + \frac{2GMm}{(2R \sin \frac{\pi}{3})^2} = \frac{GMm}{R^2} + \frac{2GMm}{3R^2}$ $v_m = \sqrt{\frac{R}{3} (M + \frac{2}{3}m)}$
 $T = \frac{2\pi R}{v_m}$
 $\frac{1}{\mu} = \frac{1}{M} + \frac{3}{m} = \frac{M+3M}{Mm}$ $\mu = \frac{Mm}{M+3M}$ $E_T = -3 \frac{GMm}{R} + 3 \frac{GM^2}{R\sqrt{3}}$