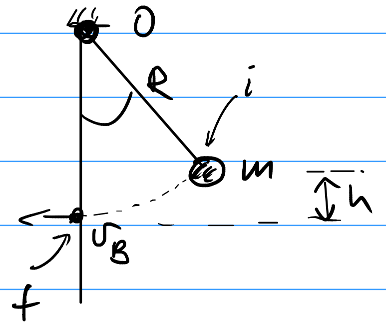



$$\Delta E = 0$$

$$\Delta K + \Delta U = 0$$

$$\frac{m v_f^2}{2} - \cancel{\frac{m v_i^2}{2}}^{\to 0} + \underbrace{(m g y_f - m g y_i)}_{-mgh} = 0$$

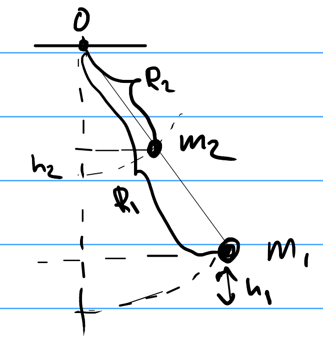
$$\frac{\cancel{m} v_f^2}{2} = \cancel{m} g h \quad \Rightarrow v_f = \sqrt{2gh}$$

$$\Delta E = 0$$

$$\Delta K + \Delta U = 0$$

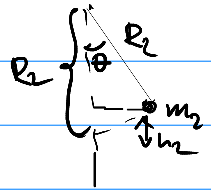
$$I \frac{\omega^2}{2} - mgh = 0$$

$$(\cancel{m} R^2)\frac{\omega^2}{2} - \cancel{m} g h = 0 \qquad \underbrace{R\omega}_{\parallel\; v_f} = \sqrt{2gh}$$




$$\frac{I\omega_f^2}{2} - \frac{I\omega_i^2}{2} = -\Delta U = m_2 g h_2 + m_1 g h_1$$

$$= m_2 g R_2 (1-\cos\theta) + m_1 g R_1 (1-\cos\theta) =$$




$$h_2 = R_2 - R_2\cos\theta = R_2(1-\cos\theta)$$

$$= \underbrace{(m_1+m_2)}_{M_T} \cdot \underbrace{\frac{(m_2 R_2 + m_1 R_1)}{m_1+m_2}}_{= R_{CM}} g(1-\cos\theta)$$

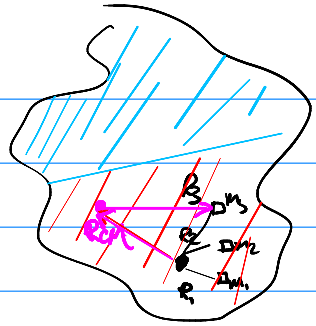
$$= M_T R_{CM} (1-\cos\theta) g$$

$$I = \sum_i m_i R_i^2 = m_1 R_1^2 + m_2 R_2^2$$

$$\Delta K = -\Delta U$$

$$\underbrace{\frac{m_1 R_1^2 + m_2 R_2^2}{1}}_{= I} \cdot \frac{\omega_f^2}{2} = M_T R_{CM} (1-\cos\theta) g$$

with respect to axis of rotation



$$\vec{r}_{CM} = \frac{1}{M_T} \sum m_i \vec{r}_i$$

$$I = \sum_i m_i R_i^2 = I_B + I_R$$

$$I = \sum_i m_i R_i^2 = \sum_i m_i \left(\vec{R}_{CM} + \vec{r}_i\right)^2$$

$$\vec{R}_i = \vec{R}_{CM} + \vec{r}_i$$

$$I = \sum_i m_i \vec{R}_{CM}^{\,2} + \sum_i m_i \vec{r}_i^{\,2} + 2 \sum m_i \vec{R}_{CM} \cdot \vec{r}_i$$

$$= M_T \vec{R}_{CM}^{\,2} + I_{\substack{\text{with} \\ \text{Respect} \\ \text{to CM}}} + 2 \sum_i \frac{m_i \vec{r}_i}{M_T} \cdot M_T$$

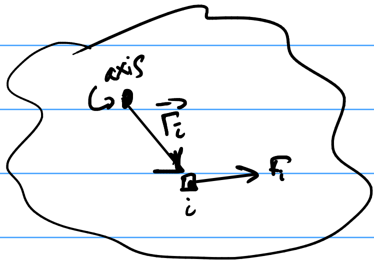
$= 0 \Leftrightarrow \vec{r}_{CM}$ – origin

$$\boxed{I = M_T \cdot R_{CM}^2 + I_{\substack{\text{with} \\ \text{respect} \\ \text{to CM position}}}}$$

$\boxed{\text{Parralel -axis theorem}}$

# Torque

$$\vec{\tau}_{net} = \vec{\tau}_{total} = \sum_i \vec{r}_i \times \vec{F}_i \iff I \cdot \vec{\alpha} = \vec{\tau}_{net}$$




$$|\vec{r} \times \vec{F}| = r \cdot F \cdot \sin\theta$$
$$= r \cdot F_{\perp_i} = r_{\perp} \cdot F_i$$