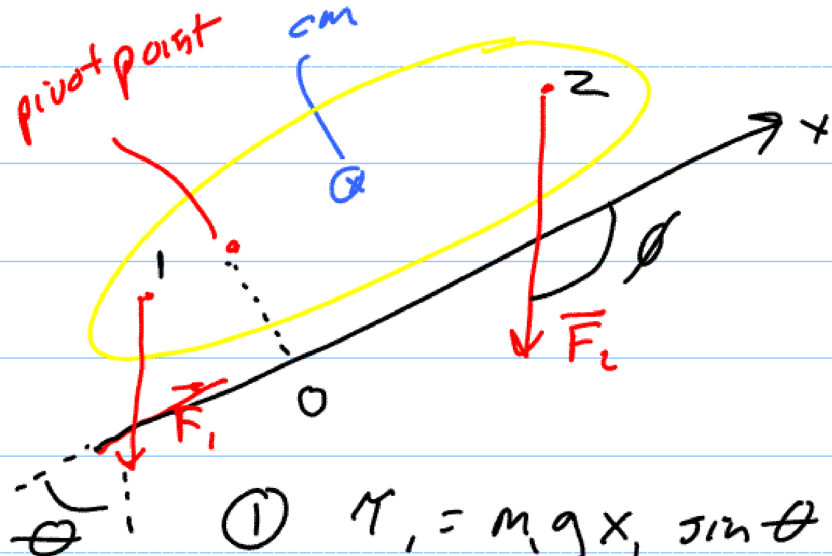
Class 13 - October 26/05

Gravitational Torque

Text: horizontal object

Extend to non-horizontal



① $\tau_1 = m_1 g x_1 \sin\theta \times -1$

② $\tau_2 = -m_2 g x_2 \sin\phi$

$\sin\theta = \sin\phi$

$$\tau_i = -m_i x_i g \sin\phi$$

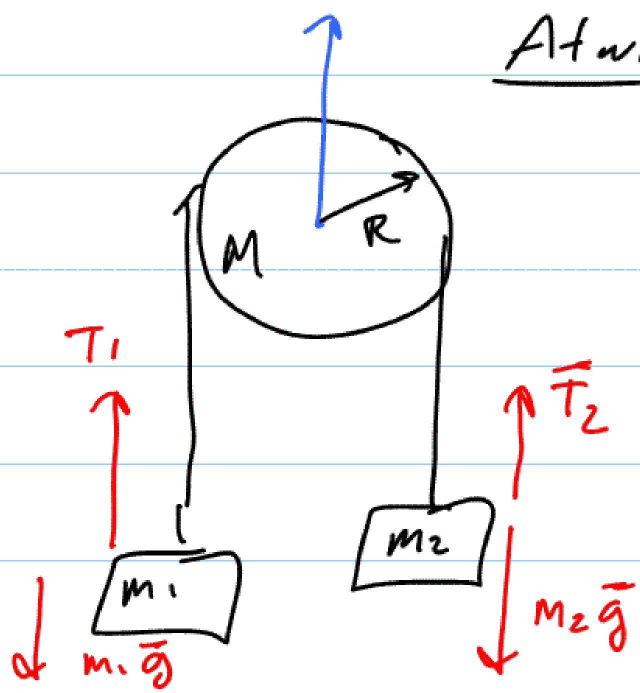
$$\tau_{tot} = -\left(\sum_i m_i x_i\right) g \sin\phi$$

$$M x_{cm} = \sum_i m_i x_i$$

$$\boxed{\tau_{tot} = -M g x_{cm} \sin\phi}$$

§13.5 - Rotation Fixed Axis

Atwood Machine



$m_2 > m_1$

string massless

string does not stretch

$\underline{M = 0}$

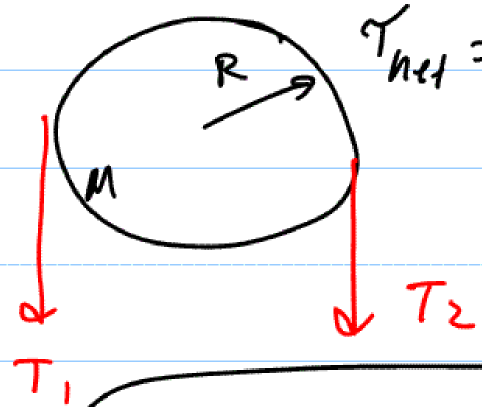
$$\left[\begin{array}{l} m_2 g - T_2 = m_2 a_2 \\ T_1 - m_1 g = m_1 a_1 \end{array}\right]$$

$$a_2 = a_1 \equiv a$$

$$T_1 = T_2$$

$$\boxed{a = \frac{(m_2 - m_1)g}{(m_2 + m_1)}, \ m_2 \text{ down}}$$

$\underline{M \neq 0}$



$$\left.\begin{array}{l} \tau_{net} = T_1 R - T_2 R = I\alpha \\ I = c M R^2 \\ a = -R\alpha \end{array}\right]$$

$$\boxed{a = \frac{(m_2 - m_1)g}{(m_2 + m_1 + cM)}, \ m_2 \text{ down}}$$

§13.6 Equilibrium

Before: $\vec{F}_{net} = 0$

Add: $\tau_{net} = 0$

Rotating: eval τ_{net} about pivot

Not rotating: eval τ_{net} about <u>any</u> point

Forces on Leg

$$\left[\begin{array}{l} F = 1.6\,\overline{W} \\ R = 2.4\,\overline{W} \\ \phi = 13^\circ \end{array}\right]$$

Stationary

$\sim$ right when walking

$$F_{cane} \sim \frac{1}{6} \overline{W}$$

Same Side: $N = \frac{5}{6} \overline{W}$

$$\left. \begin{array}{l} F = 1.3 \overline{W} \\ R = 2.0 \overline{W} \end{array} \right]$$

Opposite Side $x \sim 6 \text{ cm}$

$\vec{N}$ is applied shifted.

cm leg shifted by ~ 3 cm

$$\left[\begin{array}{l} F = 0.6 \overline{W} \\ R = 1.3 \overline{W} \end{array} \right.$$

§13.7. Rotational Energy

trans. $K = \frac{1}{2} m v^2$

rot: $K_{rot} = \frac{1}{2} I \omega^2$

and translating $K_{trans} = \frac{1}{2} m v_{cm}^2$

$$K_{tot} = K_{rot} + K_{trans}$$

$$U_g = Mg\,y_{cm}$$

$$\boxed{\vec{\omega}}$$

$$\vec{L} = I\vec{\omega}$$

$\tau = I\alpha$ $\qquad$ $F = ma$

$\vec{\tau} = \frac{d\vec{L}}{dt}$ $\qquad$ $\vec{F} = \frac{d\vec{p}}{dt}$