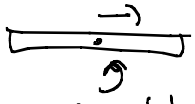
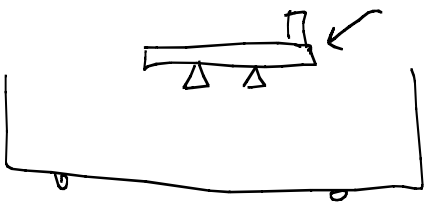
Note Title 4/25/2012

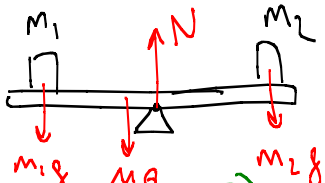
Chp-11 : Equilibrium (lecture)

(i) $\sum \vec{F} = m\vec{a} \Rightarrow \vec{a} = 0$ ⇒ system is in eq. } should hold
(ii) $\sum \vec{\tau} = I\vec{\alpha} \Rightarrow \vec{\alpha} = 0$ } at any point. (be valid)



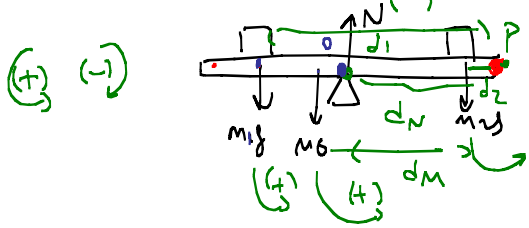
Equil. can be thought only Locally. Almost everything in universe is moving.





$\sum \vec{F} = 0$

$m_1 g + m_2 g + Mg - N = 0$

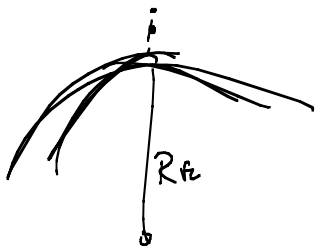


$\sum \vec{\tau} = 0$ at any point.

$+m_2 g d_2 - N d_N + Mg d_M + m_1 g d_1 = 0$

$\sum \vec{\tau}_0 = -m_2 g (d_N - d_2) + Mg (d_M - d_N) + m_1 g (d_1 - d_M) = 0$

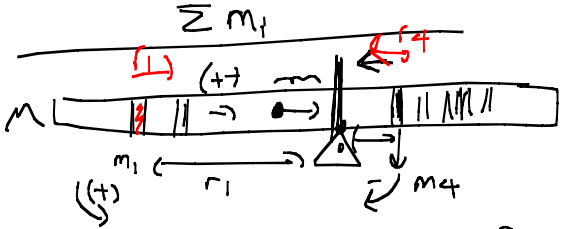
Center of Gravity = Center of Mass



$F = G \frac{M_1 M_2}{R^2}$

$g \Rightarrow R = R_E$

$\vec{r}_{cm} = \frac{\sum m_i \vec{r}_i}{\sum m_i} = \vec{r}_c$



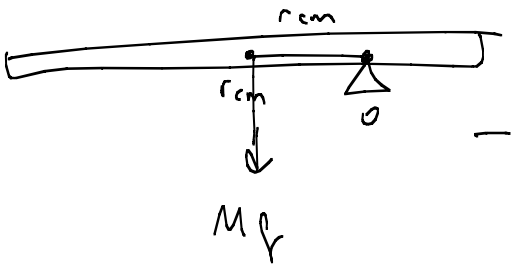
$+m_1 g r_1 + m_1 g r_2 - m_4 g r_4$

$\vec{\tau}_M = \vec{r}_{cm} M_T g$

Ladder

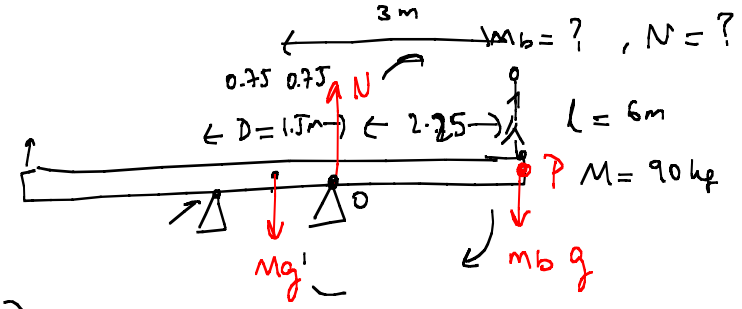
$\frac{\sum m_i \vec{r}_i}{\sum m_i} * \sum m_i g$

$g\left[m_1 r_1 + m_2 r_2 - m_4 r_4\right]$



$\Rightarrow \sum \tau_0 = M g\, r_{cm}$

Ex:



$\left.\begin{matrix}\sum \vec{f} = 0 \\ \sum \vec{\tau} = 0\end{matrix}\right\} \rightarrow Mg + m_b g - N = 0 \quad (1)$

1st choice

$\sum \vec{\tau}_0 = 0 \Rightarrow -m_b g * 2.25 + Mg * 0.75 = 0 \quad (2)$

$(2) \Rightarrow m_b g * 2.25 = Mg\, 0.75$

$\frac{2.25}{3}$

$m_b = \frac{M}{3} = \frac{90}{3} = 30\ kg$

$(1) \Rightarrow N = Mg + m_b g = 90 * 10 + 30 * 10 = 1200\ N$

2nd choice

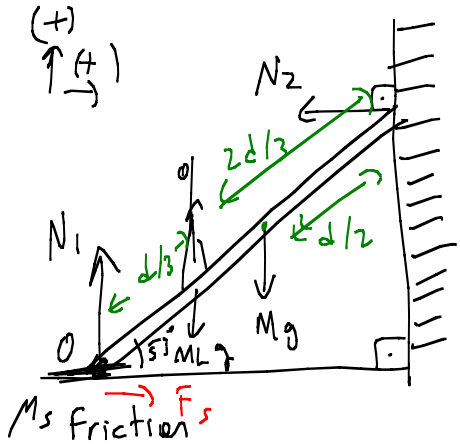
$\sum \vec{\tau}_p = Mg * 3 - N * 2.25 = 0$

$Mg * 3 = N * 2.25$

$\frac{3 * 90 * 10}{2.25} = N = 1200\ N$

$\frac{Mg * 3}{0.75\ \frac{3}{4}}$

Ex:



$\Sigma \vec{F} = 0$

$\Sigma F_x = 0$ (1)

$\Sigma F_y = 0$ (2)

$M_L = 80\,kg$

$M = 18\,kg$

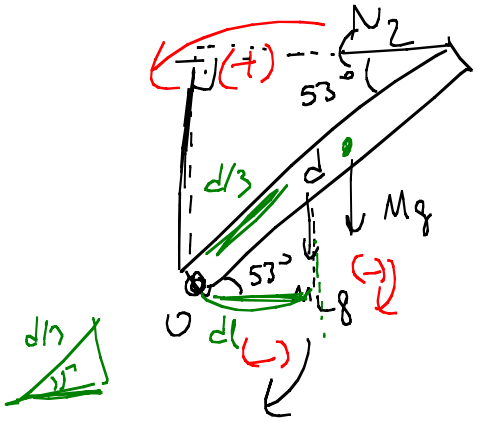
(1) $\Rightarrow$ $F_s - N_2 = 0$

(2) $\Rightarrow$ $N_1 - m_L g - m g = 0$

$N_1 = ?,\ N_2 = ?\quad f_s = ?$

(3) $\Sigma \vec{\tau} = 0$ $\Rightarrow$ choose point O

$\tau_{N_1} = 0$; $\tau_{f_s} = 0$



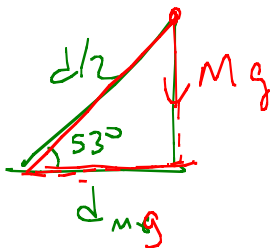
$\tau_{N_2} = +N_2\, d \sin 53°$

$\vec{\tau} = \vec{r} \times \vec{F}$

$\tau_{M_L g} = M_L g$

$dL = \frac{d}{3}\cos 53°$

$d_{Mg} = \frac{d}{2}\cos 53°$



$\Sigma \vec{\tau}_O = N_2 d \sin 53° - m_L g \cos 53° \frac{d}{3} - mg \cos 53° \frac{d}{2} = 0$

(3)

$N_2 \sin 53° = \frac{M_L}{3} g \cos 53° + \frac{mg}{2} \cos 53°$

$$N_2 = \frac{g\cos 53^\circ}{\sin 53^\circ}\left[\frac{ML}{3} + \frac{M}{2}\right] \quad (3)$$

$$F_s - N_2 = 0 \quad (1)$$

$$N_1 - m_L g - m g = 0 \quad (2)$$

$$N_2 = 10 * \frac{3}{4} * \left[\frac{180}{3} + \frac{18}{2}\right] \quad (3)$$

$$\frac{365}{4}\left[\frac{160 + 54}{8}\right]$$

$$N_2 = \frac{5}{4}[214] = 53.5 \times 5$$

$$= 267.5\ N$$

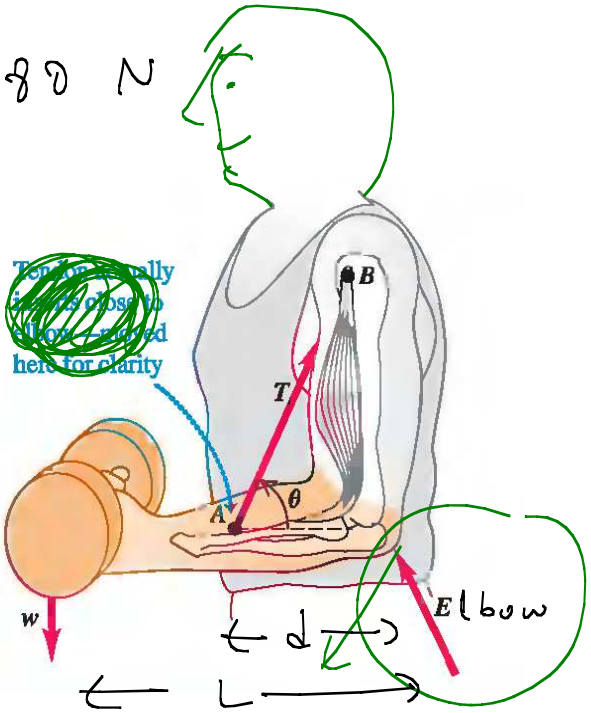
$$F_s \leq N_2 = 267.5\ N$$

$$N_1 = mLg + mg = (M_L + m)g$$

$$(80 + 18)g0$$

$$N_1 = 980\ N$$

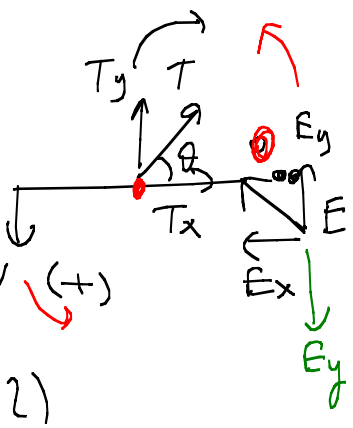
Ex:



dumbell

Guess

$E = ?$ $\quad \sum \vec{F} = 0$ (1) $\quad \sum \vec{\tau} = 0$



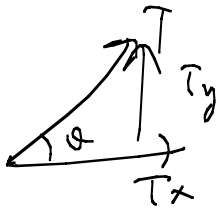
$\sum f_x = T_x - E_x = 0$ (1)

$\sum f_y = T_y - w - E_y = 0$ (2)

intuition

$\sum \tau_o = 0 \Rightarrow +w * L - T_y * d = 0$ (3)

θ, w, L, d



$T_x = T\cos\theta$

$T_y = T\sin\theta$

(1) $= T_x = E_x \Rightarrow T\cos\theta = E_x$

(2) $E_y = -w + T_y = -w + T\sin\theta$

(3) $\Rightarrow wL = T_y d \Rightarrow T\sin\theta = \frac{wL}{d}$

$T = \frac{wL}{d\sin\theta}$ = calculate

$w = 200\ N \quad L = 0.3$

$D = 0.05 \quad \theta = 80^\circ$

$T = \frac{200 * 0.3}{0.05\ \sin 80^\circ} = \frac{60}{0.05\ \sin 80^\circ}$

$\frac{1200}{\sin 80^\circ} \sim 1200\ N$

$2\sin 37^\circ \cos 37^\circ$

$2 * \frac{3}{5}\ \frac{4}{5} = \frac{24}{25} = 0.96 \quad \sin 80 = \sin 2 * 40$

$T \sim 1200\ N$

$F_y = T_y - W = 1200 - 700 \cong 1000\ N$

$T\cos\theta = E_x \Rightarrow \quad 1200\cos 80^\circ = E_x$

$E_x \sim 240\ N$

$\sin 80^\circ = 0.98$

$\cos 80^\circ = \sqrt{1-(0.98)^2}$ $\quad E_x \sim 208\ N$

$\sqrt{(0.02)(1.98)}$ $\quad 240$

$\sqrt{0.04} = 0.2 \sim (0.17)$