

Torque, Rotational Equilibrium and Statics

① a. $\tau = F_{\perp} d = 130 \text{ N} \sin 36^{\circ} (1.1 \text{ m}) = \underline{84 \text{ Nm}}$
 $\vec{\tau} = \underline{84 \text{ Nm CCW}}$

b. $\tau = F_{\perp} d = 130 \text{ N} \sin 36^{\circ} (0.20 \text{ m}) = \underline{15 \text{ Nm}}$
 $\vec{\tau} = \underline{15 \text{ Nm CW}}$

c. $\tau = F_{\perp} d = 130 \text{ N} \sin 36^{\circ} (0.60 \text{ m}) = \underline{46 \text{ Nm}}$
 $\vec{\tau} = \underline{46 \text{ Nm CW}}$

d. $\tau = F_{\perp} d = 45 \text{ N} \sin 60^{\circ} (0.50 \text{ m}) = \underline{19 \text{ Nm}}$
 $\vec{\tau} = \underline{19 \text{ Nm CCW}}$

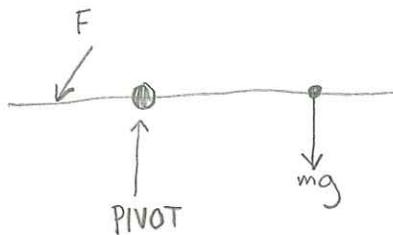
e. $\tau = F_{\perp} d = 45 \text{ N} \sin 60^{\circ} (0.80 \text{ m}) = \underline{31 \text{ Nm}}$
 $\vec{\tau} = \underline{31 \text{ Nm CW}}$

f. $\tau = F_{\perp} d = 45 \text{ N} \sin 60^{\circ} (1.2 \text{ m}) = \underline{47 \text{ Nm}}$
 $\vec{\tau} = \underline{47 \text{ Nm CW}}$

→ g. $\tau = 130 \text{ N} \sin 36^{\circ} (0.35 \text{ m})$
 $\vec{\tau} = \underline{27 \text{ Nm CCW}}$

h. $\tau = 45 \text{ N} \sin 60^{\circ} (0.25 \text{ m})$
 $\vec{\tau} = \underline{9.7 \text{ Nm CW}}$

②



$$\sum \vec{\tau} = 0 \text{ Nm}$$

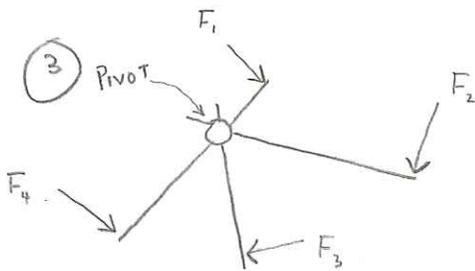
$$\tau_{\text{CW}} = \tau_{\text{CCW}}$$

$$mg (1.20 \text{ m}) = F_1 \cos 49^{\circ} (0.50 \text{ m})$$

$$F_1 = 21.51 \dots \text{ N}$$

$F_1 = 22 \text{ N}$

③



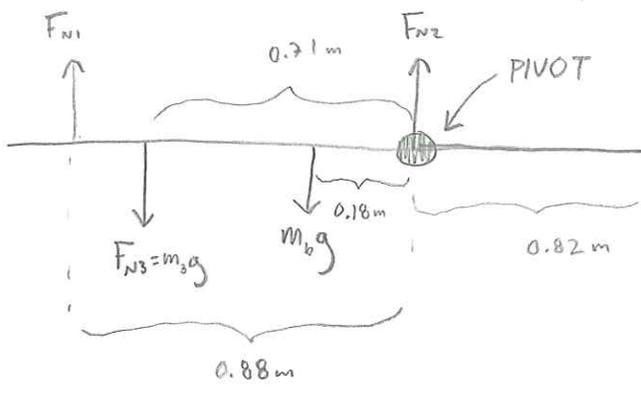
$$\sum \vec{\tau} = \vec{\tau}_1 + \vec{\tau}_2 + \vec{\tau}_3 + \tau_4$$

$$\sum \vec{\tau} = F_1 (0.50 \text{ m}) + F_2 (1.0 \text{ m}) + F_3 (0.6 \text{ m}) - F_4 (0.6 \text{ m})$$

$$\sum \vec{\tau} = 15.2 \text{ Nm CW}$$

$\sum \vec{\tau} = 15 \text{ Nm CW}$

4.



$$\sum \vec{F} = 0$$

$$F_{N1} + F_{N2} = m_3g + m_b g$$

* PIVOT AT RIGHT SUPPORT. WHY?

- ① Eliminate F_{N2} from torque calculation
- ② Distances were given relative to that point.

$$\sum \tau = 0$$

$$\tau_{\text{cw}} = \tau_{\text{ccw}}$$

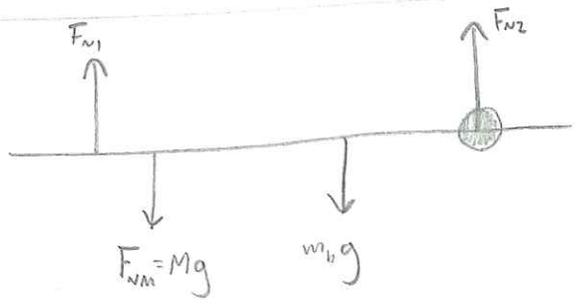
$$\tau_{N1} = \tau_3 + \tau_b$$

$$F_{N1}(0.88\text{ m}) = m_3g(0.71\text{ m}) + m_b g(0.18\text{ m})$$

$$F_{N1} = 25.725\text{ N}$$

so... $F_{N2} = m_3g + m_b g - F_{N1}$ (from dynamics) $F_{N2} = 13.475\text{ N}$

$F_{N1} = 26\text{ N} \quad F_{N2} = 13\text{ N}$



$$\sum \vec{F} = 0$$

$$F_{N1} + F_{N2} = Mg + m_b g \quad (2 \text{ unknowns!})$$

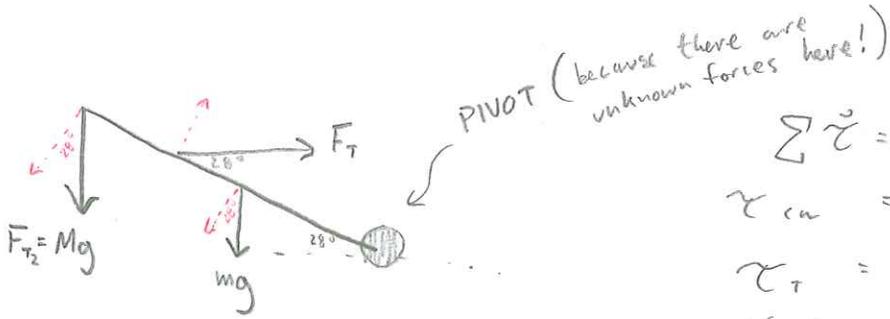
$$\sum \tau = 0$$

$$\tau_{\text{cw}} = \tau_{\text{ccw}}$$

$$F_{N1}(0.88\text{ m}) = Mg(0.71\text{ m}) + m_b g(0.18\text{ m})$$

$M = 6.0\text{ kg}$

6.



$$\sum \tau = 0 \text{ Nm}$$

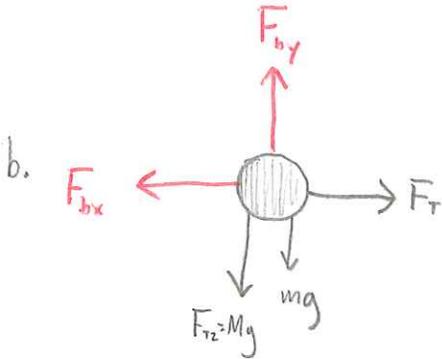
$$\tau_{ccw} = \tau_{cw}$$

$$\tau_T = \tau_m + \tau_n$$

$$F_T \sin 28^\circ (1.3 \text{ m}) = 11 \text{ kg} (9.8) \cos 28^\circ (1.80 \text{ m}) + 3 \text{ kg} (9.8) \cos 28^\circ (0.90 \text{ m})$$

$$F_T = 319.0001428 \text{ N}$$

$$F_T = 320 \text{ N}$$



to be in equilibrium, there must be an upward force to balance Mg and mg and a leftward force to balance F_T . THESE MUST COME FROM THE BASE!

$$\sum \vec{F}_x = 0$$

$$F_{bx} = F_T$$

$$F_{bx} = 319.0001428 \text{ N}$$

$$\sum \vec{F}_y = 0$$

$$F_{by} = Mg + Mg$$

$$F_{by} = 137.2 \text{ N}$$

$$F_b = \sqrt{F_{bx}^2 + F_{by}^2} = 347.2534105$$

$$\theta = \tan^{-1} \left(\frac{F_{by}}{F_{bx}} \right) = 23.27224283^\circ$$

$$\vec{F}_b = 350 \text{ N} [23^\circ \text{ above } -x]$$