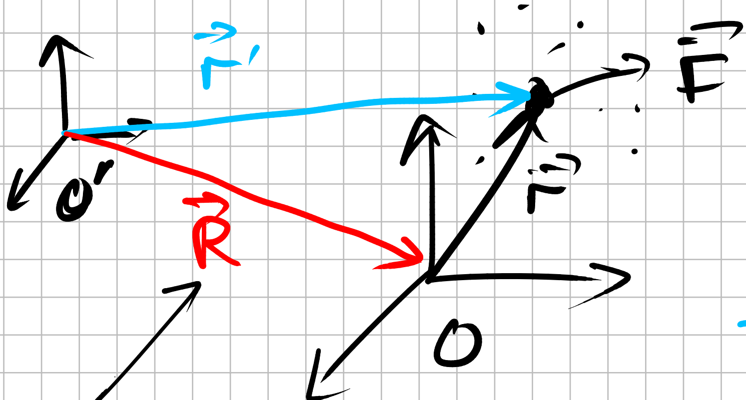
Static equilibrium

$$\sum_i \vec{F}_i = 0 \quad , \quad \sum_i \vec{\tau}_i = 0$$



reference frame change

$$\boxed{\sum_i \vec{\tau}_i = \sum_i \vec{r}_i \times \vec{F}_i = 0}$$

$$\vec{r}_i' = \vec{R} + \vec{r}_i$$

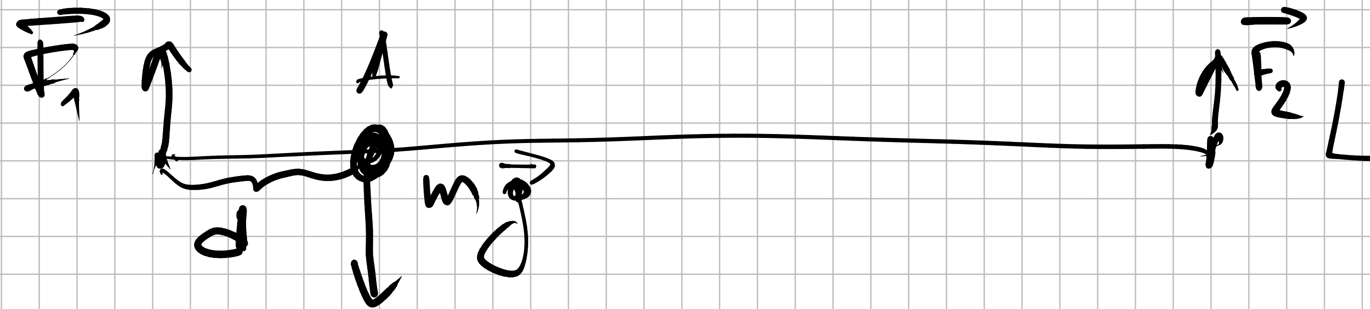
$$\boxed{\sum_i \vec{\tau}_i' = \sum_i \vec{r}_i' \times \vec{F}_i = \vec{0}}$$

$$= \sum_i (\vec{R} + \vec{r}_i) \times \vec{F}_i$$

$$= \sum_i \vec{R} \times \vec{F}_i + \underbrace{\sum_i \vec{r}_i \times \vec{F}_i}_{\sum \vec{\tau}_i = \vec{0}}$$

$$= \vec{R} \times \Big(\underbrace{\sum_i \vec{F}_i}_{0}\Big) + \vec{0} = \vec{0}$$

demo



equilibrium: $\sum \vec{F}_i = m\vec{g} + \vec{F}_1 + \vec{F}_2 = 0$

point A: $\sum \vec{\tau}_i = \vec{\tau}_1 + \vec{\tau}_g + \vec{\tau}_2 =$

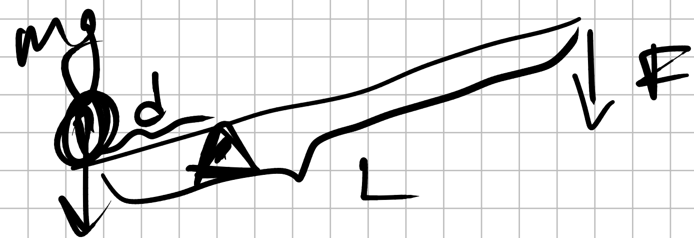
$$= F_1 \cdot d \, \hat{cw} + \vec{0} + (L-d) \cdot F_2 \, \hat{ccw}$$

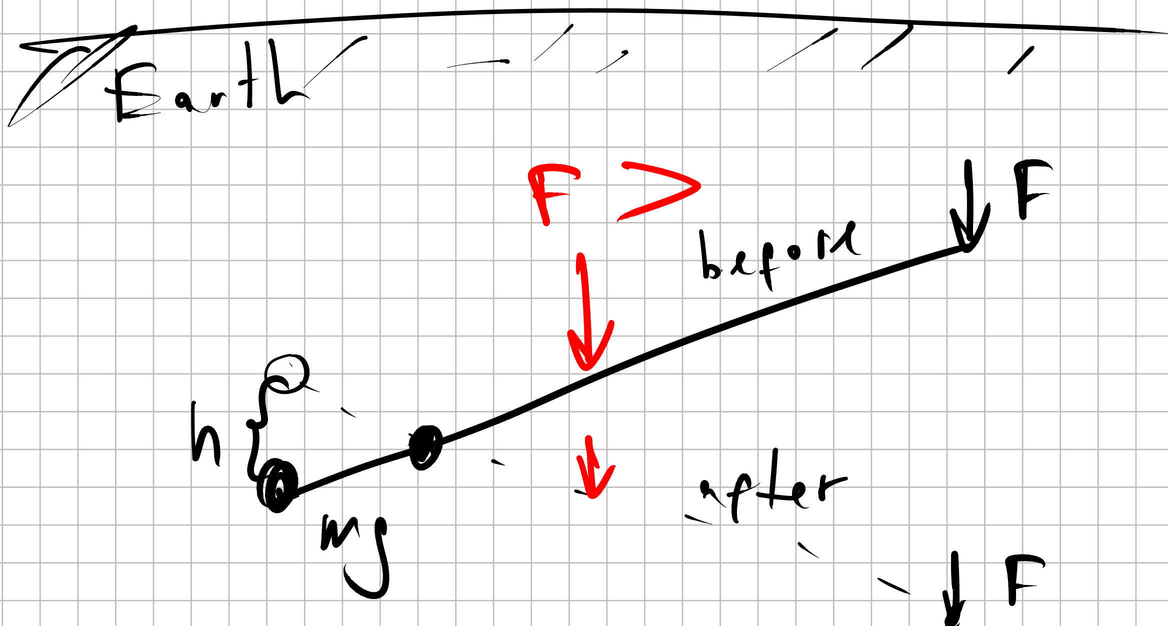
$$0 \cdot \hat{ccw} = \vec{0} = -F_1 d \cdot \hat{ccw} + (L-d) \cdot \vec{F}_2 \cdot \hat{ccw}$$

$$F_1 = \frac{L-d}{d} \cdot F_2$$

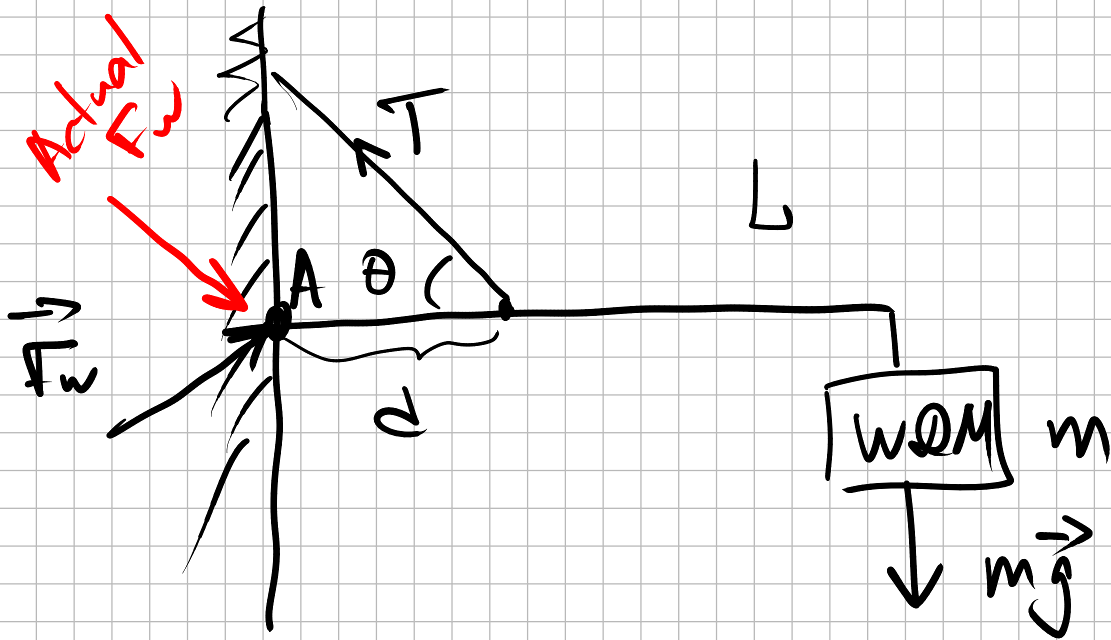
Problem 2

$$F = \frac{d}{L-d}\, mg$$





$$\boxed{W = mgh}$$



$$\sum_i \vec{F_i} = \vec{0} = \vec{T} + m\vec{g} + \vec{F_w}$$

$$\sum \vec{\tau_0} = \vec{0}$$

point A: $\sum_i \vec{\tau_i} = \vec{0}$

$$= d \cdot T \cdot \sin\theta \, \hat{ccw} + L \cdot mg \cdot \hat{cw} + \vec{0}$$

$= -\hat{ccw}$

$$T = \frac{L \cdot mg}{d \sin\theta}$$

$\vec{F_w}$ - ? $\vec{0} = \vec{T} + m\vec{g} + \vec{F_w}$

x: $-T\cos\theta + 0 + F_{xw} = 0$

y: $T \cdot \sin\theta - mg + F_{yw} = 0$

$$-\left(\frac{L}{d}mg - mg\right) = F_{yw}$$