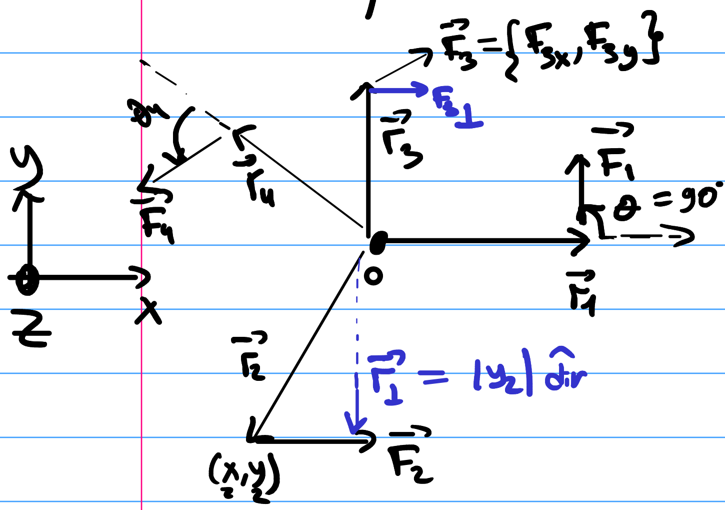
# Torque




$$\vec{\tau} = \vec{r} \times \vec{F} = |r| \cdot |F| \cdot \sin(\theta)\ \widehat{direct}$$

$$= r_\perp \cdot F\ \widehat{dir} = r \cdot F_\perp\ \widehat{dir}$$

$$\vec{\tau}_1 = r_1 \cdot F_1 \cdot \underbrace{\sin(90^\circ)}_{1}\ \widehat{direc}$$

$$= r_1 \cdot F_1 \cdot \widehat{ccw}$$

$$\vec{\tau}_2 = r_\perp \cdot F_2 = |y_2| \cdot |F_2|\ \widehat{ccw}$$

$$\vec{\tau}_3 = r_3 \cdot F_{3\perp} = |r_3| \cdot |F_{3x}|\ \widehat{cw}$$

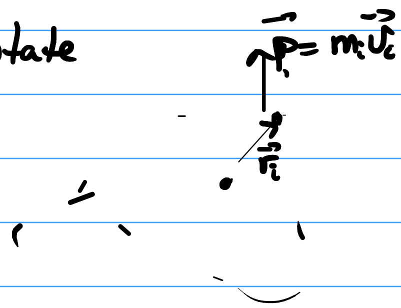
$$= |r_3| \cdot |F_{3x}| (-\widehat{ccw})$$

$$\vec{\tau}_4 = |r_4| \cdot |F_4| \cdot |\sin\theta|\ \widehat{ccw}$$

$$\vec{\tau} \longleftrightarrow \vec{F}$$

$$\vec{\tau}_{net} = I \cdot \vec{\alpha}$$ ! be careful

↑ true if you trying to rotate along axis of symmetry



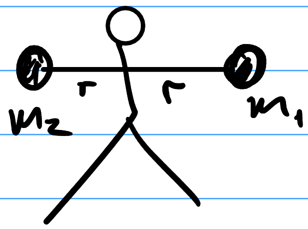

$$\frac{d\vec{L}}{dt} = \vec{\tau}_{net\ external} \iff \vec{F} = \frac{d\vec{p}}{dt}$$

$\vec{L}$ – angular momentum

$$\vec{L} = \sum_i \vec{r}_i \times \vec{p}_i$$

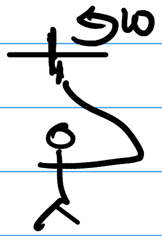
$L =$ const

$$I_i \omega_i = I_f \omega_f$$




$I_1 = m_1 r^2$

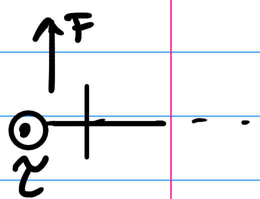
$I_2 = m_2 r^2$



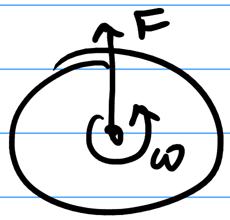

$$I_H \omega_{H_i} + I_W \cdot \omega_{W_i} = I_H \cdot \omega_{H_f} - I_W \cdot \omega_{W_f}$$

($\omega_{H_i} = 0$)

Side




Front



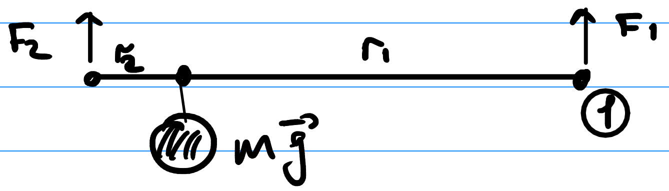

$I_W \Rightarrow \vec{L}_i = I\vec{\omega}_i$ toward us

Static object $\vec{v_i} = 0$

$$L = \sum \vec{r_i} \times m_i \vec{v_i} = 0 = \text{const in time}$$

$\Downarrow$

$$\vec{\tau}_{net} = 0$$




$$(1) = r_1 \cdot mg \ \widehat{ccw} + (-)(r_1+r_2)\cdot F_2 \ \widehat{cw} = 0$$

$$F_2 = \frac{r_1 \cdot mg}{r_1+r_2}$$

$$F_1 = \frac{r_2 \, mg}{r_1+r_2}$$