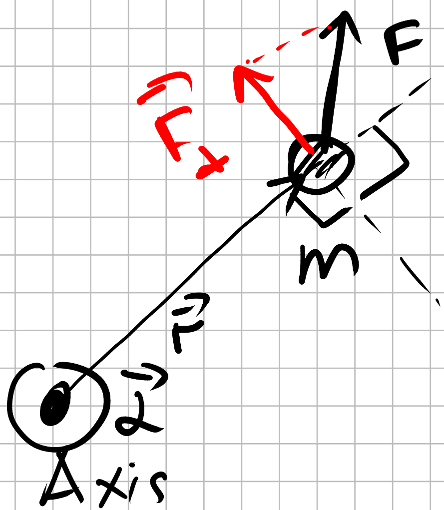
Torque



$$m\,a = F_\perp$$

$$m\,\overbrace{\alpha\cdot r}^{a}\cdot r = F_\perp \cdot r$$

angular acceleration

$$m r^2 \alpha = r \cdot F_\perp$$

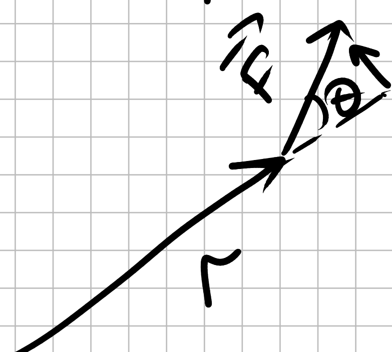
$$I \cdot \alpha = r \cdot F_\perp$$

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

tau

torque

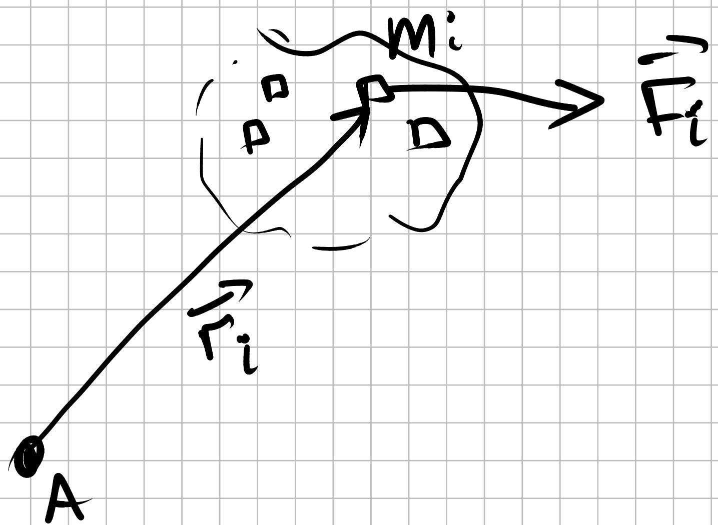
$$|\vec{r} \times \vec{F}| = r \cdot F \cdot \sin\theta$$

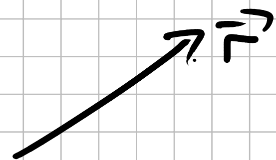
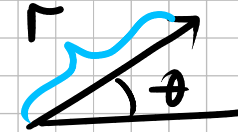


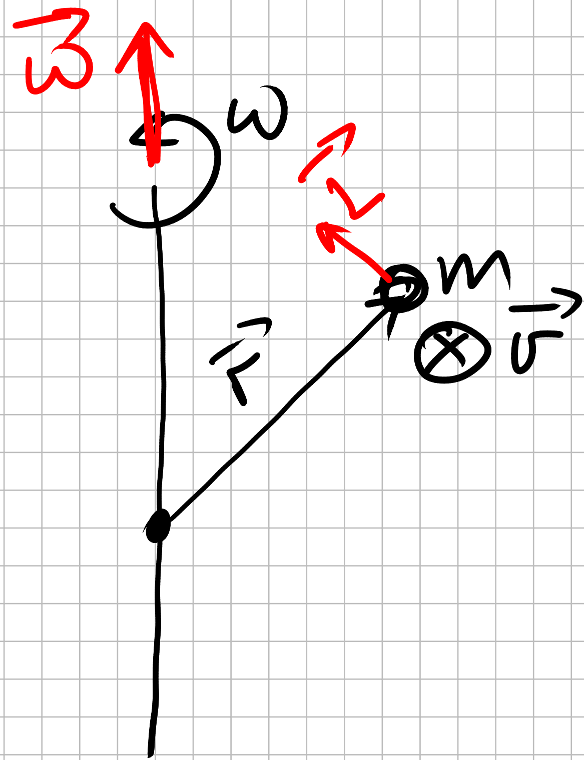
$$F_\perp = F \cdot \sin\theta$$

$$\vec{\tau}_{net} = \sum_i \vec{r}_i \times \vec{F}_i = I \cdot \vec{\alpha}$$

$$\sum_i m_i r_i^2$$

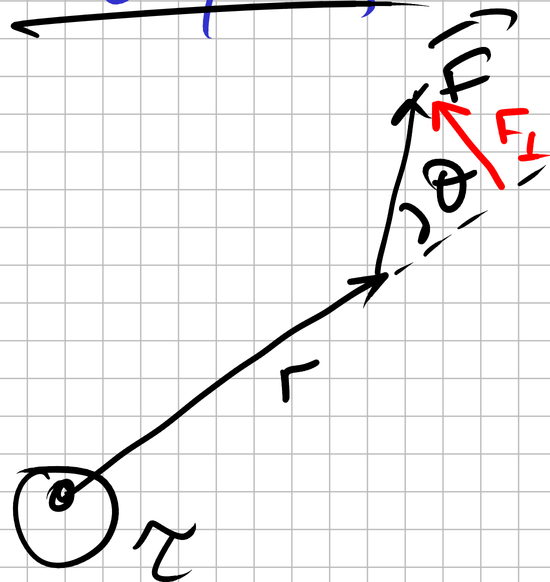


x, y, z	Polar coordinates
$\vec{r}$ 	r, θ 
$\vec{v}$	$\vec{v}_r , \vec{\omega}$ radial 0 for rigid objects with fixed axis of rotation
$K = \frac{m v^2}{2}$	$K = \frac{I \omega^2}{2}$
$m\vec{a} = \vec{F}$	$I\vec{\alpha} = \vec{r} \times \vec{F} = \vec{\tau}$
$\vec{p} = m\vec{v}$ momentum	$\vec{L} = \sum_i \vec{r}_i \times \vec{p}_i = I\vec{\omega}$ true only for symmetric objects sometimes
$\frac{d\vec{p}}{dt} = \vec{F}$	$\frac{d\vec{L}}{dt} = \vec{\tau}_{net}$ angular momentum



$$\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times (m\vec{v})$$
$$= m(\vec{r} \times \vec{v}) =$$
$$= m \cdot r \cdot v \cdot \overrightarrow{\text{direction}}$$

Torques

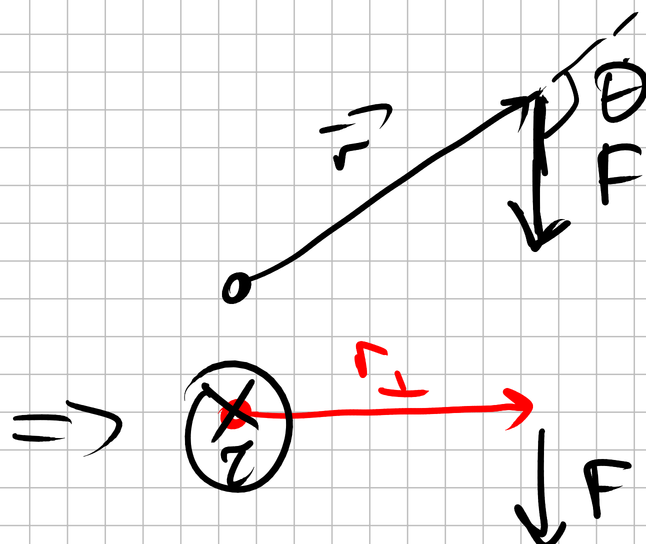


$$I\vec{\alpha} = \vec{\tau}$$

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

$$\tau = r \cdot F \cdot \sin\theta$$

$$= r \cdot F_\perp$$



$$= r_\perp \cdot F$$