Rotational kinamatics $\Rightarrow$ discription of the motion only

$\downarrow$

nothing on what causes the motion

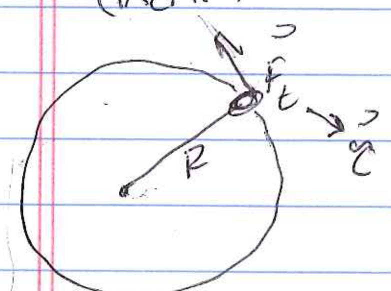
Rotional Dynamics $\rightarrow$ causes the angular ~~motion, velocit~~ motion, velocity, accleration

$$\vec{F} = m\vec{a}$$

~~day~~ dynamics   mass (inertial)   kinamatics

$F \rightarrow$ Torque $\tau = F_t R$

$$\boxed{F_t = F_\perp}$$



accleration $\vec{a} \rightarrow$ angular accleration $\vec{\alpha}$

$$\alpha = \frac{a_t}{R}, \quad a_t = \alpha R$$

mass $m \Rightarrow I$ moment of inertia

$$\boxed{\vec{F}_t = m\vec{a}_t} \qquad \tau = F_t R$$

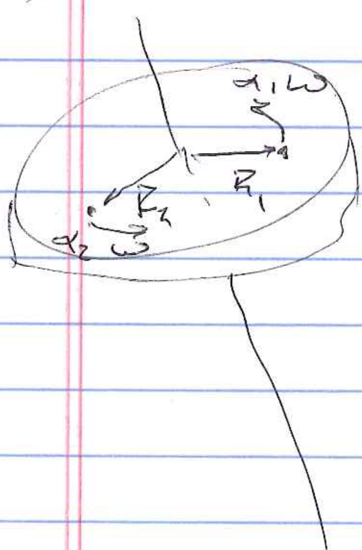
$$\vec{\tau} = F_t R = m\vec{a}_t R = m(\vec{\alpha} R)R$$

$$= (mR^2)\vec{\alpha} = I\alpha$$

$$I = mR^2$$

α CCW $\quad \tau$ - positive $\quad \alpha$ positive

CW $\quad \tau$ - negative $\quad \vec{\alpha}$ negative



disc ~~cost~~
consist of many points
all with the same α, ω

$$\tau_1 = m_1 R_1^2 \alpha$$
$$\tau_2 = m_2 R_2^2 \alpha$$
$$\vdots$$

$$\vec{\tau}_{NET} = (\cancel{m_1 R_1^2}\ m_1 R_1^2 + m_2 R_2^2 + \ldots \ldots)\alpha$$
$$= (I)\alpha$$

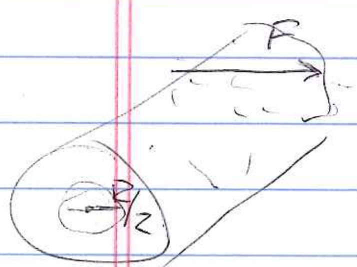
I is known for common gemotries
pg 328 in text Book

$$I_{DISK} = I_{CYLINDER} = \frac{1}{2} M R^2$$

M = TOTAL MASS
R = OUTER RADIUS

$$I_{HOOP} = M R^2$$

EXAMPLE: CYLINDER
M = 2kg
R = 10cm
F = 10N ON THE OUTER DIAMETER



WHAT WILL α BE?

F IS F_t

$$I_{cy} = \frac{1}{2} M R^2 = \frac{1}{2}(2kg)(10cm)^2 = 0.01 kg \cdot m^2$$

$$\tau = F_t R = (10N)(10cm) = 1 N \cdot m$$

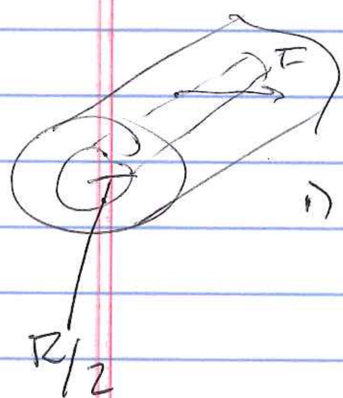
$$\tau = I \alpha \rightarrow \alpha = \frac{\tau}{I} = 100 \frac{rad}{sec^2}$$

$$\frac{rad}{sec^2} = \frac{1}{sec^2}$$

~~What is the force applied~~

$\frac{R}{2}$

$F = 10\ N$ now is applied at a radius of $R/2$



WHAT IS α NOW

1) $I = \frac{1}{2}MR^2$

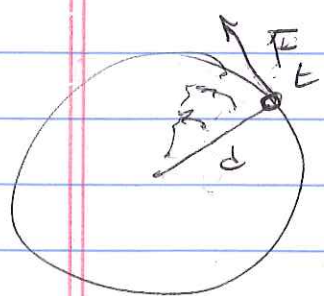
cylinder of same shape size I doesn't change.

$\tau = F_t R \rightarrow F_t \, R/2$

Radius where the forces is applied.

$$\alpha = \frac{\tau}{I} = \frac{F_t \, R/2}{\frac{1}{2}MR^2} = 50 \ \frac{RAD}{sec^2}$$

Work for Rotational Dynamics



$$W = F_t d \cos\theta$$

$$\theta = 0 \Rightarrow \cos\theta = 1$$

$$W = F_t d \quad \text{multiple by } 1 = \frac{R}{R}$$

$$= \underbrace{(F_t R)}_{\tau}\underbrace{\left(\frac{d}{R}\right)}_{\theta}$$

$$\boxed{W = \tau\theta}$$

$$KE_{ROT} = \frac{1}{2} m v_t^2 = \left(\frac{1}{2} m R^2\right)\frac{v^2}{R^2} = \frac{1}{2} I \frac{v^2}{R^2}$$

multiply By $\frac{R^2}{R^2} = 1$

$$I = mR^2$$

$$= \frac{1}{2} I \frac{v^2}{R^2} \qquad = \frac{1}{2} I \omega^2$$

$$\frac{v}{R} = \omega$$

$$W = Fd \longrightarrow W_{ROT} = \tau\theta$$

$$KE = \frac{1}{2}\boxed{m}v^2 \longrightarrow KE_{ROT} = \frac{1}{2}\boxed{I}\omega^2$$