Phys 2110-3 11/5/10

Note Title 11/5/2010

Chap 10 Rotations (Dynamics)

$$\boxed{\tau_{net} = I\alpha}$$

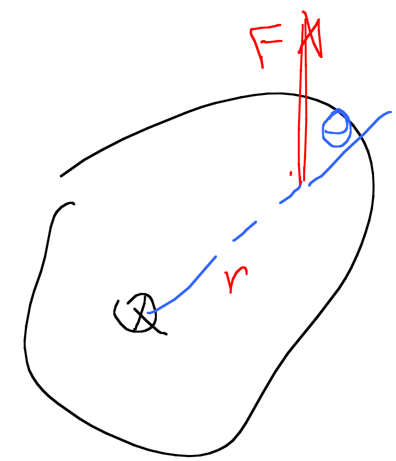
F m a

$$F = ma$$

→ Find net torque

Moment of Inertia

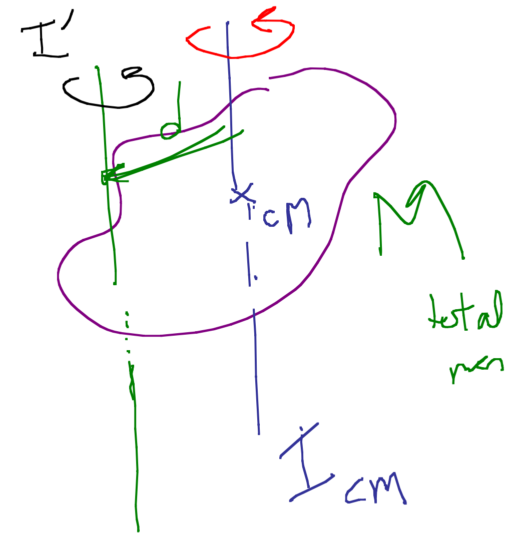
Parallel Axis Theorem



$$\tau = rF\sin\theta$$

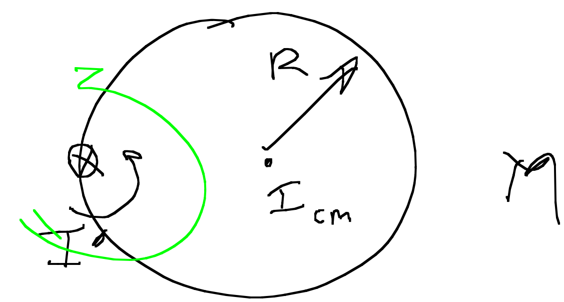
+/−

New axis, parallel to old axis, <u>not</u> thru CM.

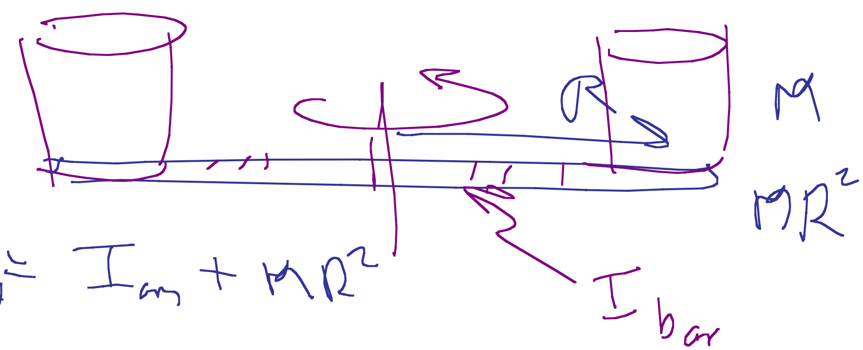


$$I' = I_{cm} + Md^2$$

Example: Uniform disk, axis at edge.



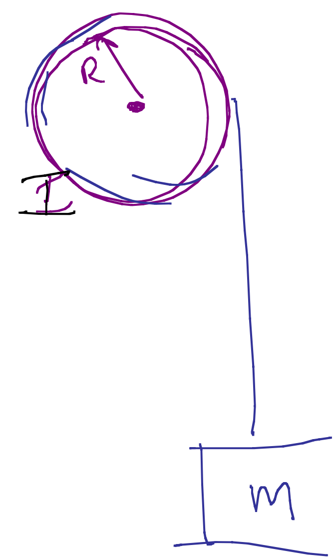
$$I' = I_{cm} + Md^2$$
$$= \frac{1}{2}MR^2 + MR^2$$
$$= \frac{3}{2}MR^2$$



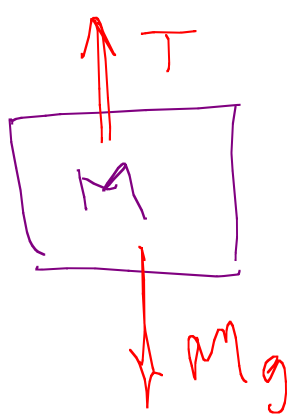
$$I'_{cyl} = I_{cm} + MR^2$$

Example

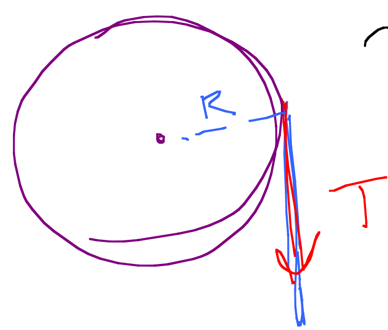
Cylinder rotates on frictionless axle. String wrapped around it, mass M hangs from string. Release mass, find accel. of mass.



DDP



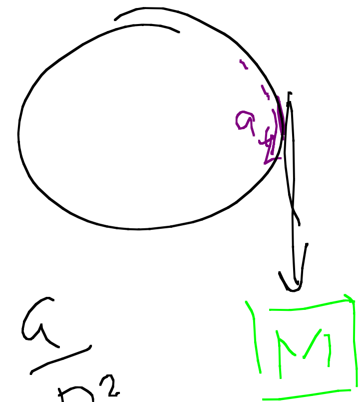
$$Mg - T = Ma$$



$$\tau = TR$$

$$= I\alpha$$

$$Mg - T = Ma \qquad \tau = TR = I\alpha$$



$$\boxed{a = a_t = R\alpha}$$

subs.

$$\tau = I\frac{a}{R} = TR \qquad T = I\frac{a}{R^2}$$

Subs into first

$$Mg - I\frac{a}{R^2} = Ma \qquad \text{(find } a\text{)}$$

$$Mg = \left(M + \frac{I}{R^2}\right)a$$

$$\boxed{a = \frac{Mg}{\left(M + \frac{I}{R^2}\right)}}$$

cylinder $\frac{I}{R} = \frac{1}{2}M$

Kinetic Energy

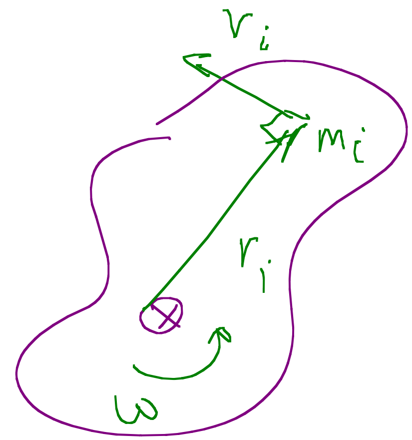
$$K = \sum_i \frac{1}{2} m_i v_i^2$$

$$= \sum_i \frac{1}{2} m_i (r_i \omega)^2$$

$$= \frac{1}{2}\left(\sum_i^N m_i r_i^2\right)\omega^2$$

$$= \frac{1}{2} I \omega^2$$

$$K = \frac{1}{2} I \omega^2$$



$$\boxed{v_i = r_i \omega}$$

$$\boxed{K = \frac{1}{2} m v^2}$$

10.35 A 25-cm diameter circular saw blade has mass 0.85 kg (uniform)

a) what is rotational KE at 3500 rpm?

$$\omega = 3500 \text{ rpm}\left(\frac{2\pi \frac{\text{rad}}{\text{rev}}}{60 \frac{\text{sec}}{\text{min}}}\right) = 366.5 \frac{\text{rad}}{s}$$

$$I = \frac{1}{2}MR^2 = \frac{1}{2}(0.85\text{ kg})(0.125\text{ m})^2$$

$$= 6.6\times10^{-3}\text{ kg m}^2$$

$$K = \frac{1}{2}I\omega^2 = \frac{1}{2}(6.6\times10^{-3}\text{ kg m}^2)(366.5/s)^2 \quad \boxed{= 446\text{ J}}$$

b) What avg power must be applied to bring blade from rest to 3500 rpm in 3.2 s

$$P = \frac{\Delta KE}{\Delta t} = \frac{446\text{ J} - 0}{3.2\text{ s}} = \boxed{139\text{ W}}$$

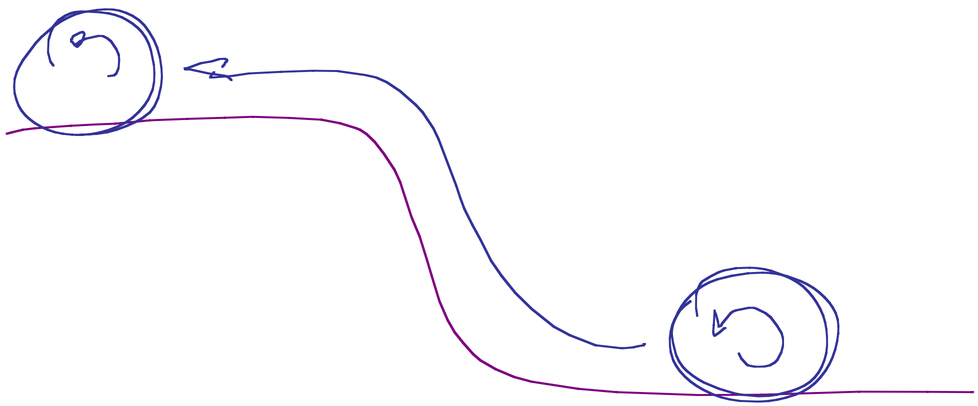
$$\boxed{W_{net} = \Delta K}$$

$$W = \int_{x_1}^{x_2} F\,dx$$

$$W_{rot} = \int_{\theta_1}^{\theta_2} \tau\,d\theta$$

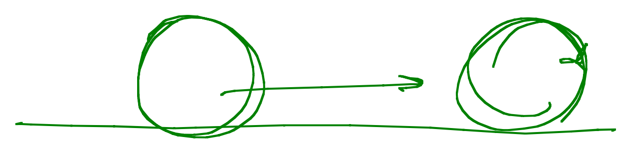
Rot'l
Work-Energy
Thm

Conservation of Energy still true

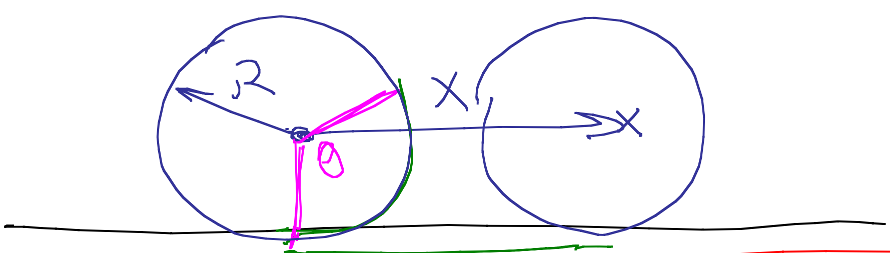


How do we deal with rolling objects?

Rolling Objects



Rolling w/o slipping



$$\boxed{x_{cm} = R\theta}$$

$$\boxed{v_{cm} = R\omega}$$

$$a_{cm} = R\alpha$$