Phys 2110-4 4/3/13

Note Title 4/3/2013

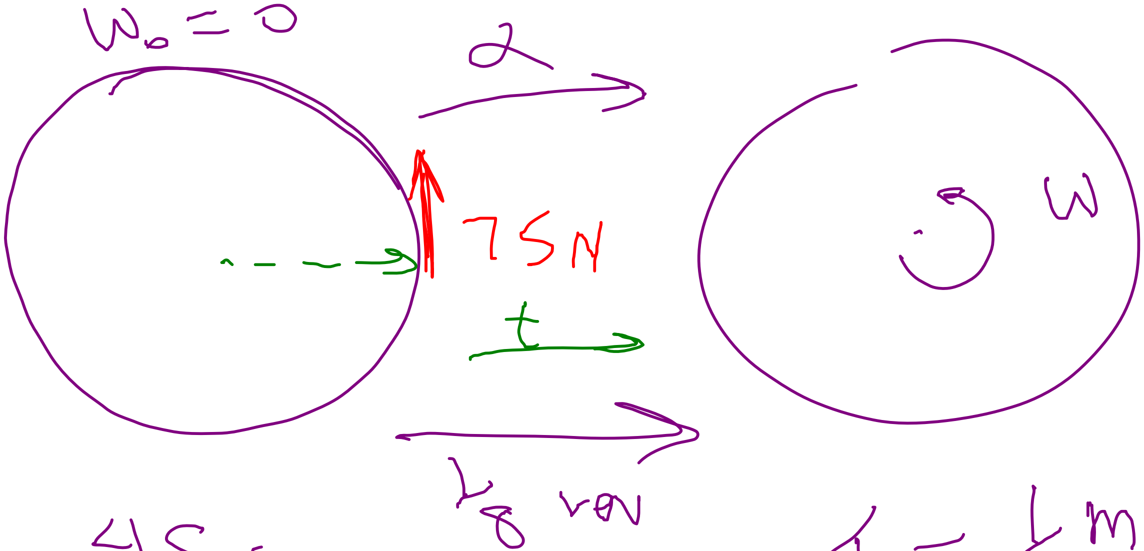
Rotations

$$\tau = I\alpha$$

$$F = ma$$

N's 2nd Law for Rotation.

10.59 Potter's wheel is stone disk 90 cm ~~diameter~~ diameter w/ mass 120 kg. If ~~potter~~ potter foot pushes at outer edge of init. stationary wheel w/ 75-N force for 1/8 of a rev. what is angular speed?



$r = 45\ \text{cm}$

$= 0.45\ \text{m}$

$m = 120\ \text{kg}$

$I = \frac{1}{2} m r^2 = \text{etc.}\ \text{kg m}^2$

$\tau = rF(1) = (0.45\ \text{m})(75\ \text{N})$

etc.

$\alpha = \tau / I$ etc.

$\omega_0,\ \omega,\ \alpha$

$1/8\ \text{rev} = \pi/4 = 45^\circ = \theta$

$\omega^2 = \omega_0^2 + 2\alpha\theta$

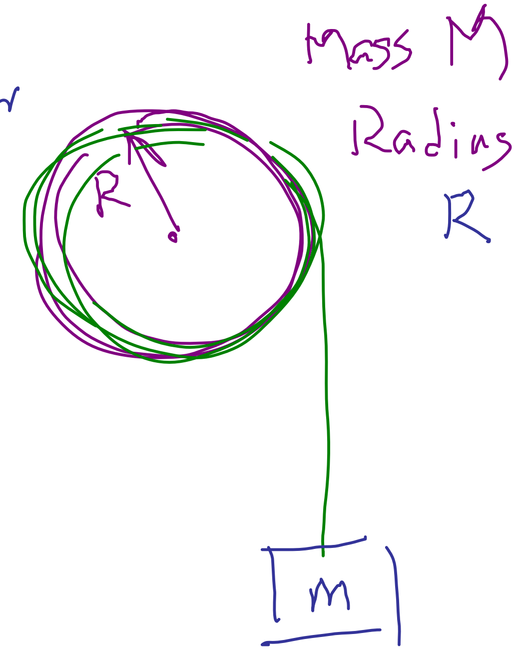
$\Rightarrow \boxed{\omega = 2.1\ \frac{\text{rad}}{\text{s}}}$

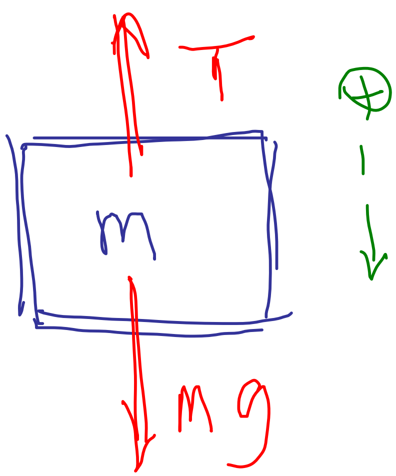
Example 10.9

Pulley w/ mass

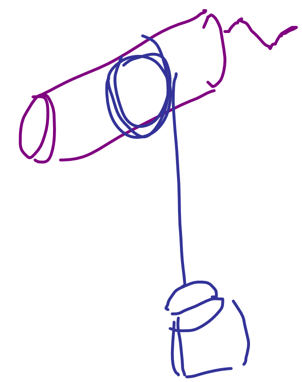
String wrapped around it.

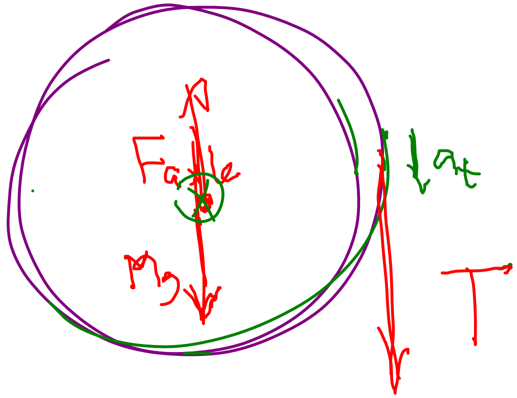
Hang mass from string, mass falls, accl a. Find a





$$\boxed{mg - T = ma}$$





Only the string gives a torque

$$\tau = TR(1) = TR$$

$$\tau = I\alpha \qquad I = \frac{1}{2}MR^2$$

$$\boxed{TR = I\alpha}$$

$$\boxed{mg - T = ma}$$

Unknowns

a, T, α

a is a_t of the pulley

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

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

$$mg - T = ma$$

$$mg = T + ma = I\frac{a}{R^2} + ma$$

$$= a\left[\frac{I}{R^2} + m\right]$$

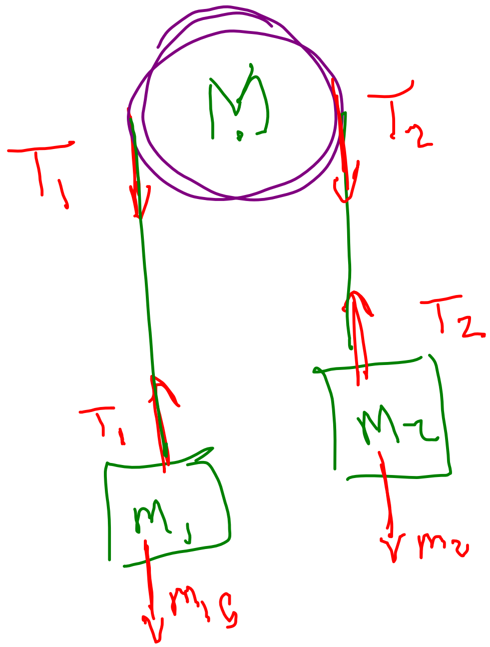
$$a = \frac{mg}{\left[m + \frac{I}{R^2}\right]}$$

$$I = 0 \longrightarrow a = g$$

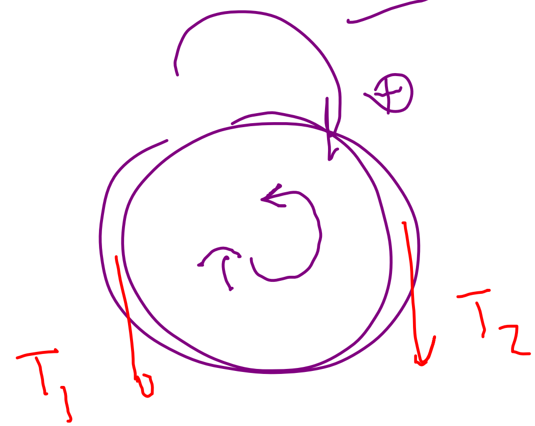
$$I = \frac{1}{2}MR^2$$

$$a = \frac{mg}{\left[m + \frac{1}{2}M\right]}$$

10.48



Tensions on both sides are <u>not</u> the same.

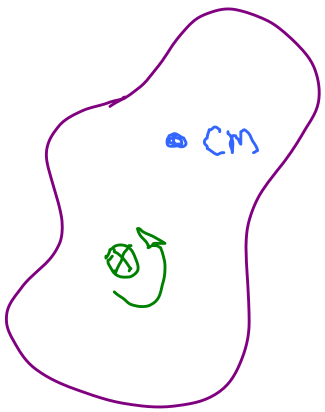


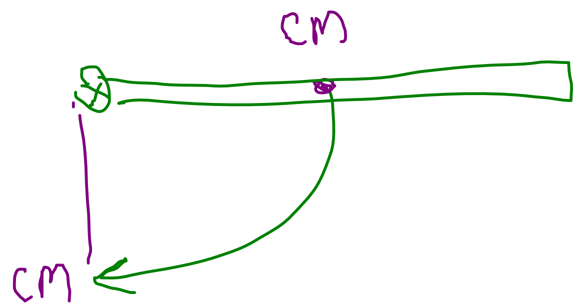
$$\tau = T_2 R - T_1 R$$

$$\tau_{net} = 0 = T_2 R - T_1 R + \tau_{motor}$$

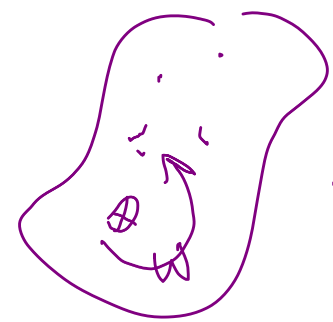
Energy (Kinetic)

Potential Energy is given by (vertical) pos of CM.



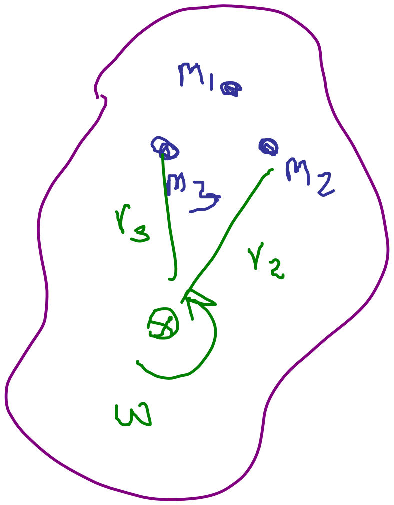


Kinetic Energy $K = \frac{1}{2}mv^2$



$v = r\omega$

Derive the kinetic energy of rotating obj.



$$K = \sum_i K_i \qquad i = \text{mass point}$$

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

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

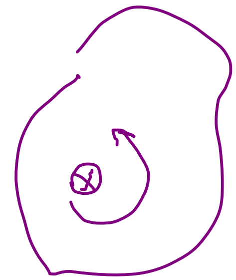
$$= \frac{1}{2} \sum_i m_i r_i^2 \omega^2$$

$$= \frac{1}{2} \omega^2 \left[\sum_i m_i r_i^2\right] = \frac{1}{2} \omega^2 I$$

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

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

$$\boxed{K_{rot} = \frac{1}{2} I \omega^2}$$



Work-Energy Thm

$$W = \int F \, dx$$

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

WE Thm for rot'n

$$\Delta K_{rot} = W_{rot}$$

10.34 A 25-cm-diameter circ saw blade has mass 0.85 kg, uniform disk.

a) What's its rot'l kinetic energy at 3500 rpm

$$\omega = 3500 \frac{rev}{min} \cdot \frac{2\pi \text{ rad}}{1 \text{ rev}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = \sim \text{ rad/s}$$

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

$$= 446 \text{ J}$$

1ch

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

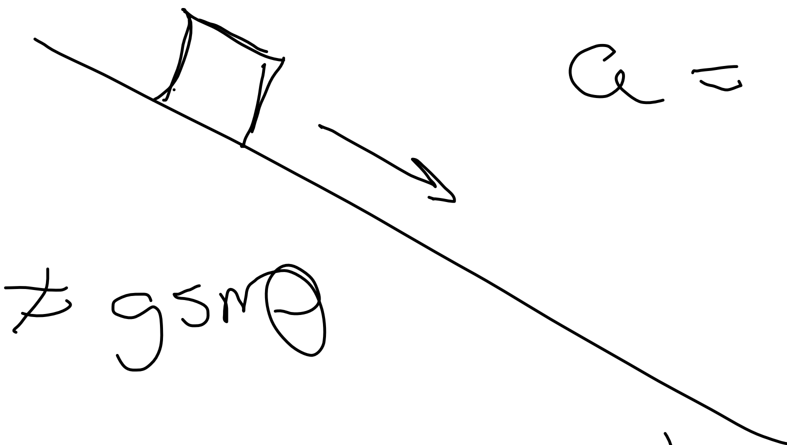
$$P = \frac{W}{\Delta t} = \frac{446 \text{ J}}{3.2 \text{ s}} = 139 \text{ W}$$

Chap 11

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

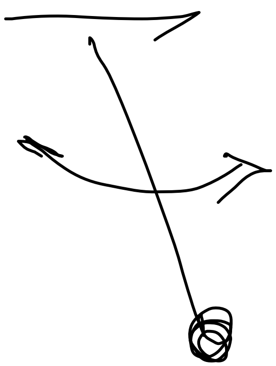
$$P_{rot} = I \omega$$

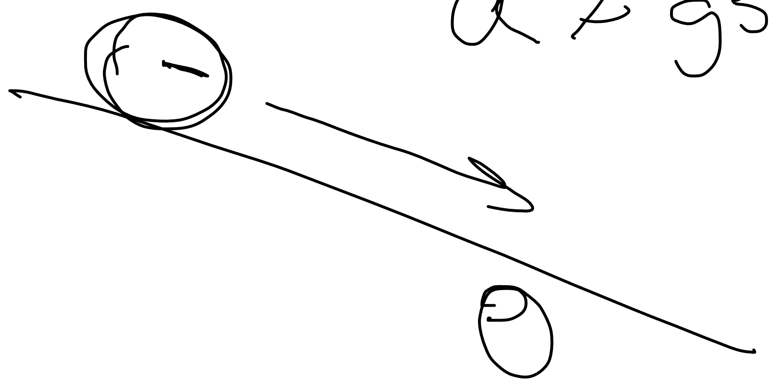
$$P = mv$$



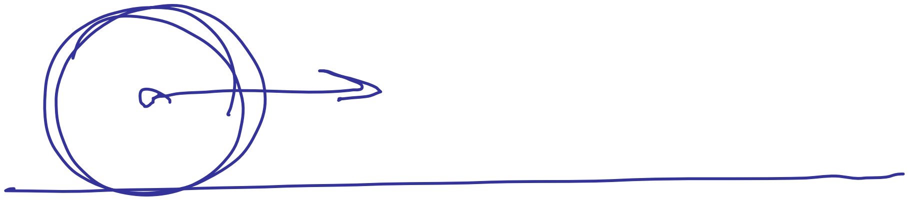
$$a = g \sin\theta$$

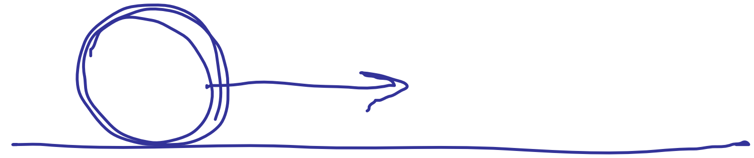
$$a \neq g \sin\theta$$

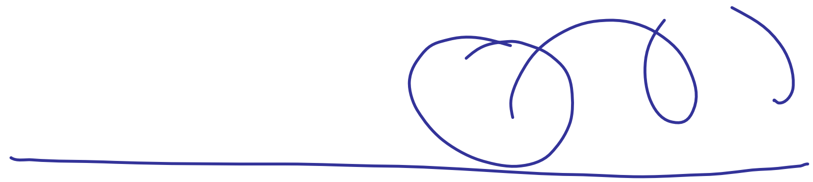


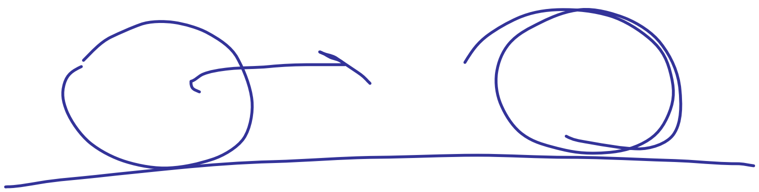


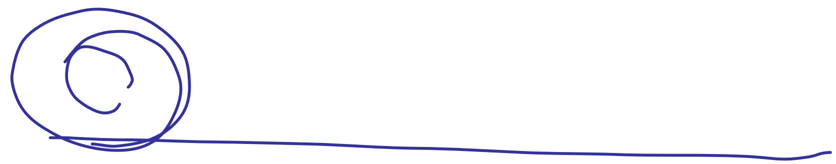
Rolling motion



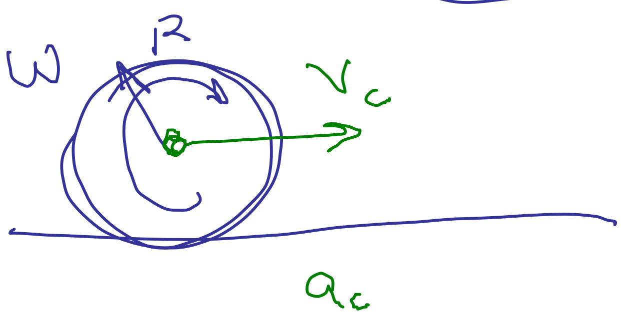






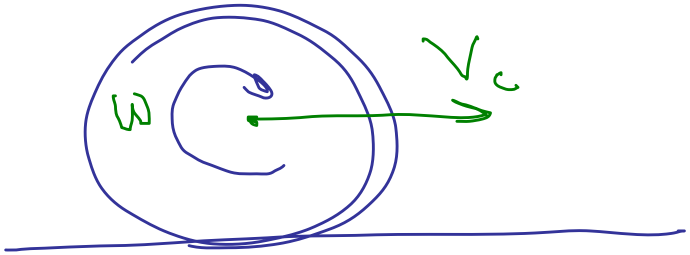


Rolling w/o slipping. → ω, v_c

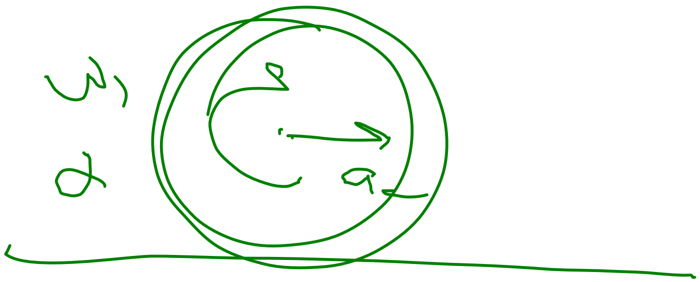


$$\boxed{v_c = \omega r}$$

$s = \theta r \qquad v = r\omega$



$$v_c = \omega r$$



$$a_c = \alpha r$$