Phy 4A 11/18

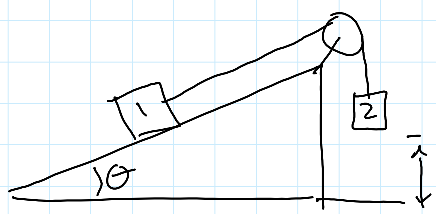
Friday, November 18, 2016 10:07 AM

Goals for the Lecture:

1) Understand how to use energy with a rolling object
2) Be able to use energy to solve problems that include rotational motion

Rotational KE

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

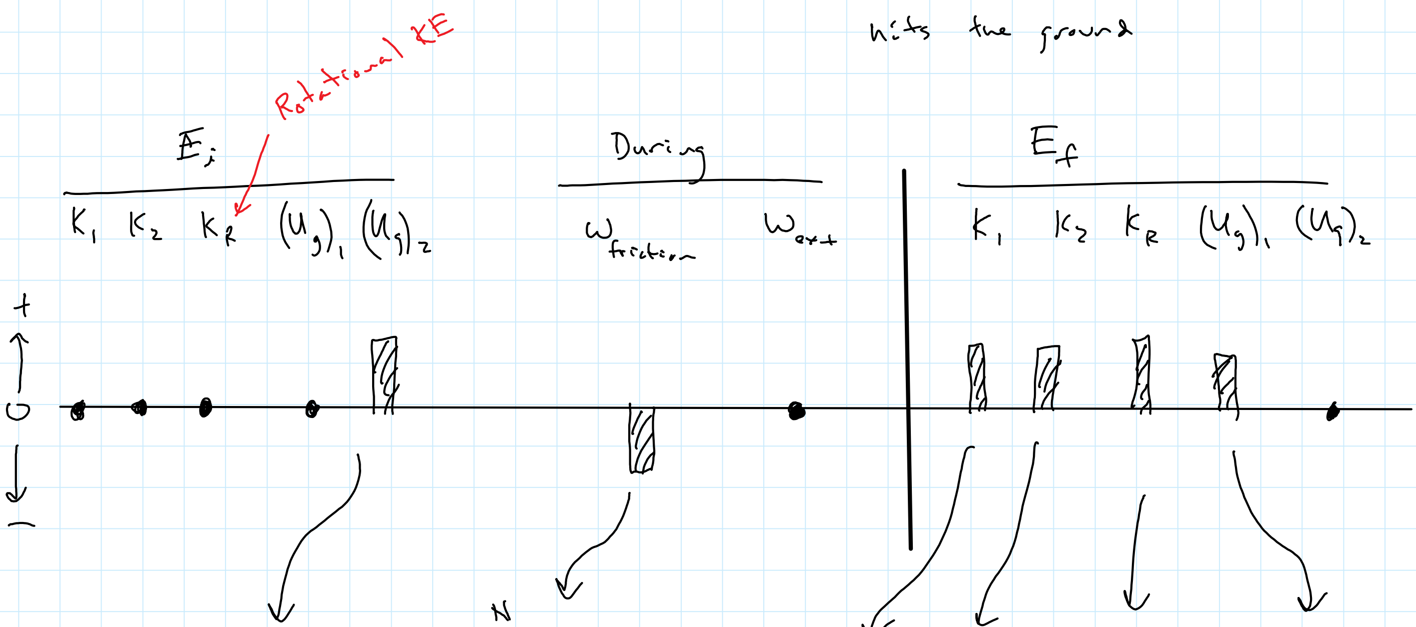


given: $m_1, m_2, m_{pulley}, R_{pulley}$

Pulley is a solid disk

$\theta, \mu_k, h, v_i = 0$

Find: v_f just before m_2 hits the ground



$$m_2 g h - \mu_k \overbrace{m_1 g \cos\theta}^{N} h = \frac{1}{2} m_1 v_f^2 + \frac{1}{2} m_2 v_f^2 + \frac{1}{2} I \omega_f^2 + m_1 g h \sin\theta$$

I for solid disk: $I = \frac{1}{2} M_p R_p^2$

ω: $v = r\omega$

$v_f = R\omega_f$

$$\omega_f = \frac{v_f}{R}$$

$$\frac{1}{2} I \omega^2 = \frac{1}{2}\left(\frac{1}{2} m_p \cancel{R^2}\right)\left(\frac{v_f^2}{\cancel{R^2}}\right)$$

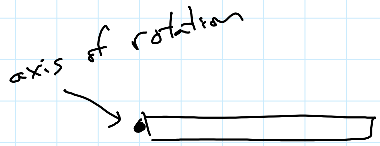
$$= \frac{1}{4} m_p v_f^2$$

Calculate I

Look it up in the book

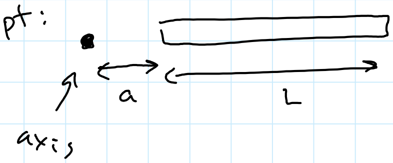
Book:

1) Uniform Rod rotating about end: $\frac{1}{3} ML^2$



2) Uniform Rod rotating about center: $\frac{1}{12} ML^2$

3) Uniform Rod rotating about some other pt: ?

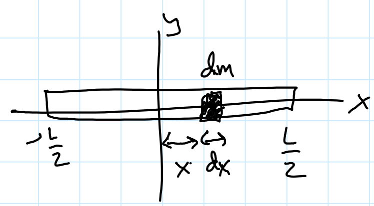


Integrate:

1) Did it last time

2) $I = \int r^2 \, dm$

r is distance from axis of rotation to dm



$r = x$

$dm = \lambda \, dx$

$$I = \int_{-\frac{L}{2}}^{+\frac{L}{2}} x^2 \lambda \, dx = \lambda \int_{-\frac{L}{2}}^{+\frac{L}{2}} x^2 \, dx = \lambda \left. \frac{x^3}{3} \right|_{-\frac{L}{2}}^{+\frac{L}{2}}$$

$$= \frac{\lambda}{3}\left[\left(\frac{L}{2}\right)^3 - \left(\frac{-L}{2}\right)^3\right]$$

$$= \frac{\lambda}{3}\left(\frac{L^3}{8} + \frac{L^3}{8}\right)$$

$$= \frac{\lambda}{3}\left(\frac{L^3}{8} + \frac{L^3}{8}\right)$$

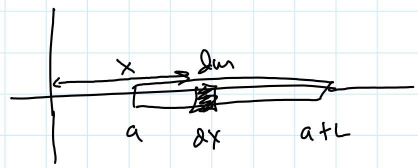
$$= \frac{\lambda}{3}\,\frac{L^3}{4} = \lambda\,\frac{L^3}{12}$$

$$= \frac{M}{L}\,\frac{L^3}{12}$$

$$= \frac{1}{12} m L^2$$

3)

$$I = \int r^2\, dm$$



$$= \int x^2 \lambda\, dx$$

$$= \lambda \int_a^{a+L} x^2\, dx$$

$r = x$

$dm = \lambda\, dx$

$$= \lambda \left.\frac{x^3}{3}\right|_a^{a+L}$$

$$= \frac{m}{3L}\left((a+L)^3 - a^3\right)$$

Parallel Axis