Physics 113 - November 1, 2012

- Can pick up Exam 2 (and Exam 1) papers outside my office door
- Regrade requests ... under my office door, in my hand or in my B+C Mailbox by main office

  Not in box outside my office door!
- Questions / issues / suggestions ?

Last Time

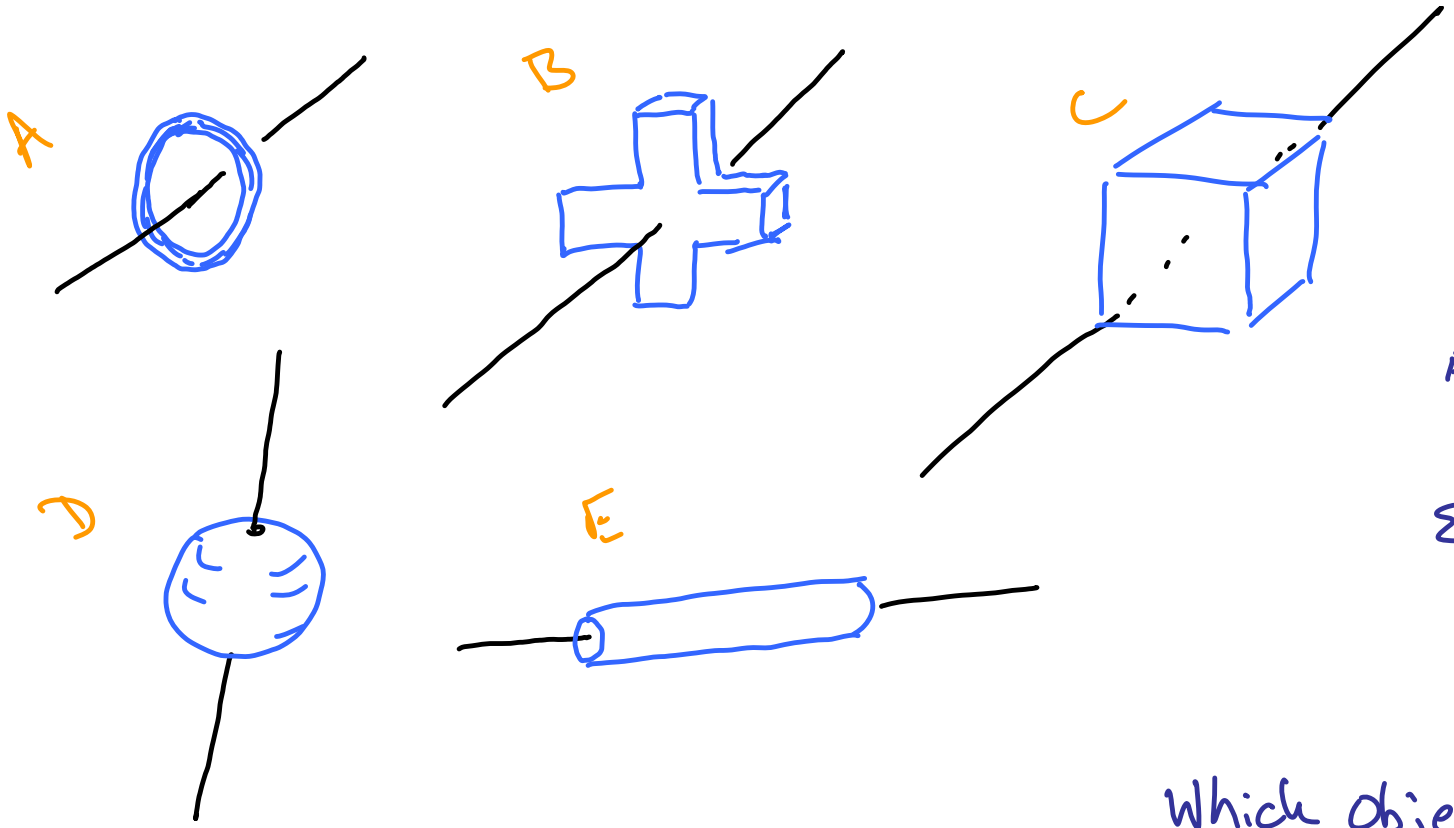
Rotational Motion

$s = r\theta$

$v = r\omega$

$a = r\alpha$

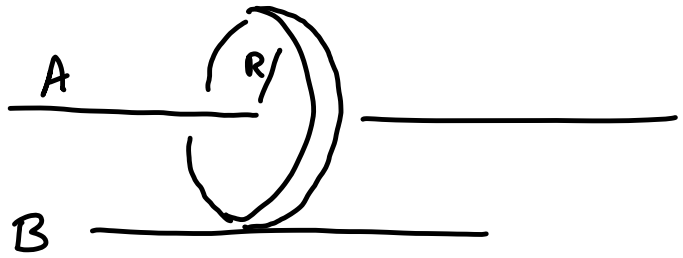
Linear	angular
general	
$x - x_0 = \int v\,dt$	$\theta - \theta_0 = \int \omega\,dt$
$v - v_0 = \int a\,dt$	$\omega - \omega_0 = \int \alpha\,dt$
constant a / constant α	
$v = v_0 + at$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2}at^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$v^2 = v_0^2 + 2a(x - x_0)$	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$
$x - x_0 = \frac{1}{2}(v + v_0)t$	$\theta - \theta_0 = \frac{(\omega + \omega_0)}{2}t$
general	
$F = ma$	$\tau = I\alpha$
$KE = \frac{1}{2}mv^2$	$KE = \frac{1}{2}I\omega^2$



All objects have the same Mass.

Each is solid and has uniform Density.

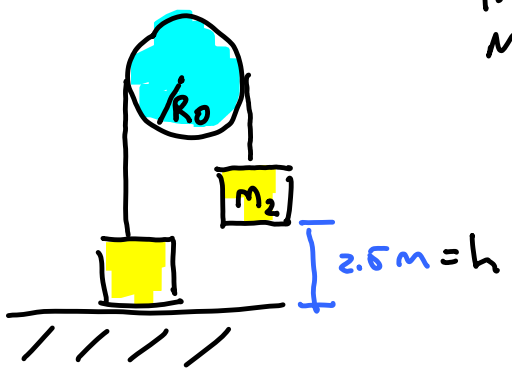
Which object has the largest Moment of inertia about the Axes shown?



$I_A = \frac{1}{2} M R^2$ $\quad r \equiv$ Dist bet Axes

Parallel axis Theorem

$$I_B = I_A + M r^2 = \frac{1}{2} M R^2 + M R^2 = \frac{3}{2} M R^2$$



$M_1 = 35.0$ kg
$M_2 = 38.0$ kg

Pulley: uniform cylinder
w/ radius $R_0 = 0.3$ m
and Mass $M = 4.8$ kg

Init M_1 on ground M_2 at rest 2.5 m above grnd

Assume rope massless and does not slip

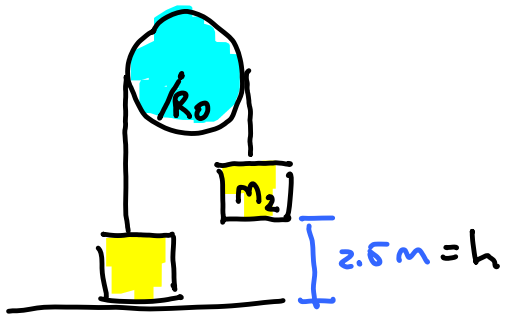
System released → what is speed of M_2 just before it hits the ground?

Two ways to solve this problem
- Energy conservation
- Newton's Laws

Energy Conservation

$E_{START} = E_{end}$

↑v ↓v



$$m_2 g h = m_1 g h + \tfrac{1}{2} m_1 v_1^2 + \tfrac{1}{2} m_2 v_2^2 + \tfrac{1}{2} I \omega^2$$

$$v_1 = v_2 = v = R_0 \omega$$

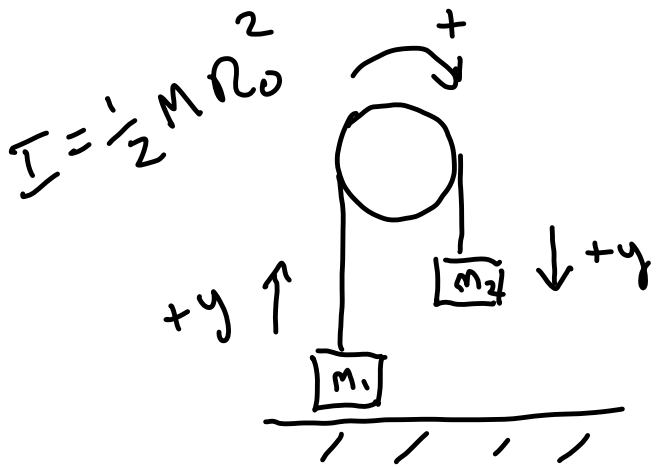
$$I = \tfrac{1}{2} M R_0^2$$

$$m_2 g h = m_1 g h + \tfrac{1}{2}(m_1 + m_2) v^2 + \tfrac{1}{2}\left(\tfrac{1}{2} M R_0^2\right)\frac{v^2}{R_0^2}$$

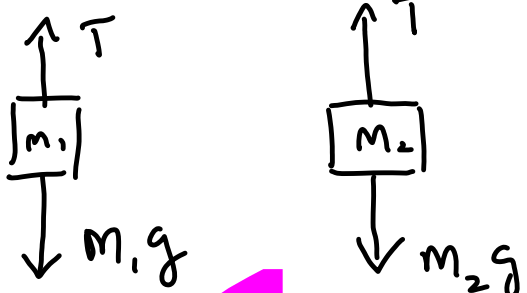
Solve for v

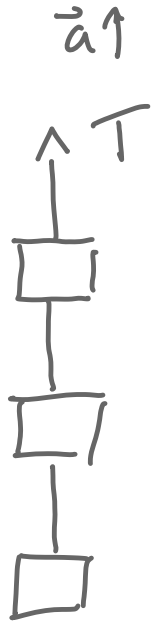
$$v = \pm \sqrt{\frac{(m_1 - m_2) g h}{\frac{m}{4} + \frac{m_2}{2} + \frac{m_1}{2}}} = \pm 1.4 \text{ m/s}$$

(1.4 m/s)



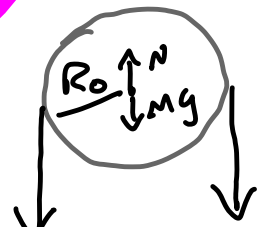
FBD's





$\Sigma F_y = m_1 a = T - m_1 g$

$\Sigma F_y = m_2 a = m_2 g - T'$



$\Sigma \tau = I\alpha$

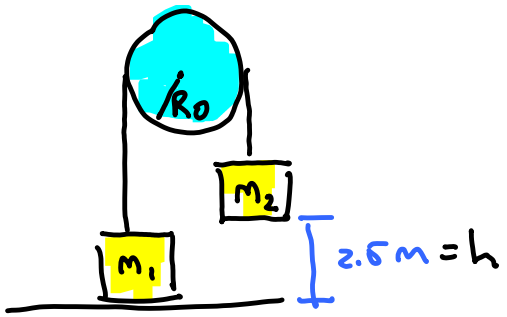
$= I\alpha = R_0 T' - R_0 T$

$\frac{1}{2} m R_0^2 \frac{a}{R_0}$

$\frac{1}{2} m R_0 a = R_0 T' - R_0 T$

$$a = \frac{(m_2 - m_1)\,g}{\frac{1}{2}m + m_1 + m_2}$$

const a



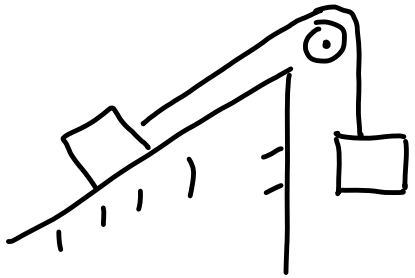
$$a = 0.4\ m/s^2$$

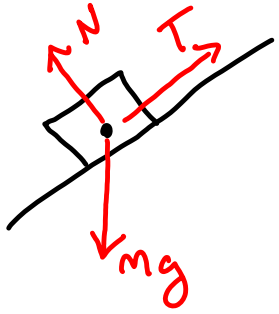
$$V_2^2 = \cancel{V_{o2}^2}^{0} + 2ah$$

$$V_2^2 = 2(.4)(2.5) = 2$$

$$V_2 = 1.4\ m/s$$

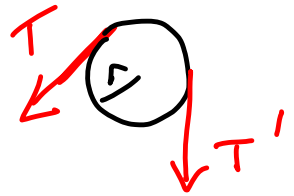
pulley has mass $I \neq 0$





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

as usual



$\Sigma \tau = I\alpha$

$I\alpha = rT' - rT$

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

as usual

$I_{cylinder} = \frac{1}{2}mr^2$

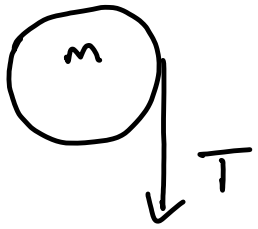
Find correct expression for a of M

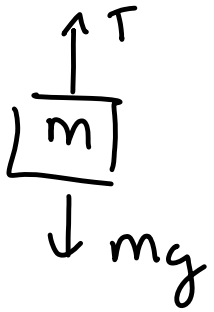
A ① g

B ② $\left(\frac{M-m}{M+m}\right)g$

C ③ $\left(\frac{1}{2}mr^2+M\right)g$

D ④ $\left(\frac{2M}{2M+m}\right)g$





$I = \frac{1}{2} m r^2$

$\tau = I\alpha$

$\alpha = \frac{a}{r}$

$I = \frac{1}{2} m r^2$

Tr

$Tr = \frac{1}{2} m r^2 \frac{a}{r}$

$T = \frac{1}{2} ma$

$Mg - T = Ma$

$Mg - \frac{1}{2} ma = Ma$

$a = \frac{2Mg}{2M + m}$