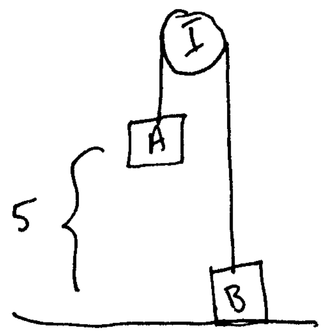
9-50

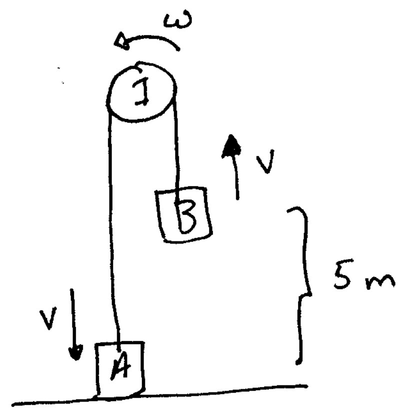


$I = 0.42\ \mathrm{kgm^2}$

$m_A = 4\ \mathrm{kg}$

$m_B = 2\ \mathrm{kg}$

$h = 5\ \mathrm{m}$



"Total Initial Energy" = "Total Final Energy"

$$m_A g h = \frac{1}{2} m_A v^2 + \frac{1}{2} m_B v^2 + \frac{1}{2} I \omega^2 + m_B g h$$

$v = R\omega$

$\omega = v/R$

$$m_A g h = \frac{1}{2} m_A v^2 + \frac{1}{2} m_B v^2 + \frac{1}{2} \frac{I}{R^2} v^2 + m_B g h$$

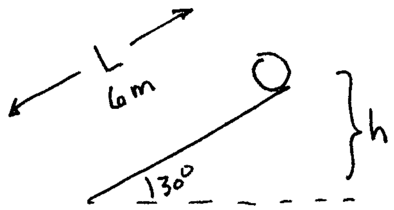
$$m_A g h = \left(\frac{1}{2} m_A + \frac{1}{2} m_B + \frac{1}{2} \frac{I}{R^2}\right) v^2 + m_B g h$$

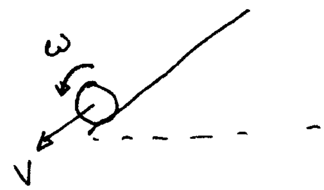
$$4(9.8)5 = \left(\frac{1}{2} 4 + \frac{1}{2} 2 + \frac{1}{2} \frac{0.42}{5^2}\right) v^2 + 2(9.8)5$$

$$196 = 3.008\, v^2 + 98$$

$$v = 5.72\ \mathrm{m/s}$$

11P





Solid cylinder
$R = 0.10$ m
$m = 12$ kg

Initial Energy = Final Energy

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$h = L\sin\theta$
$= 6\sin 30° = 3$

$I = \frac{1}{2}mR^2 = \frac{1}{2}12(0.1)^2 = 0.06 \text{ kg m}^2$

$v = R\omega$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\frac{I}{R^2}v^2$$

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

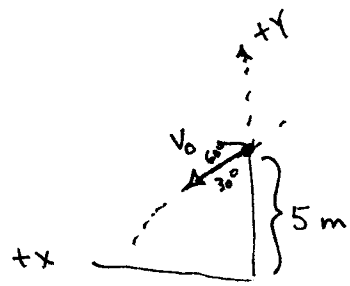
$$= \frac{1}{2}mv^2 + \frac{1}{2}\frac{\frac{1}{2}mR^2}{R^2}v^2$$

$$\cancel{m}gh = \frac{3}{4}\cancel{m}v^2$$

$$9.8(3) = \frac{3}{4}v^2$$

$$V = 6.26 \text{ m/s}$$

then $V = R\omega$
$6.26 = (0.10)\omega$
$\omega = 62.6$ rad/sec



choose +x-axis toward left

$x(t) = x_0 + V_{0x}t + \frac{1}{2}a_x t^2$
$x_0 = 0$
$V_{0x} = 6.26\cos 60° = 3.13$
$a_x = 0$

$x(t) = 3.13t$

$y(t) = y_0 + V_{0y}t + \frac{1}{2}a_y t^2$
$y_0 = 5$
$V_{0y} = -6.26\sin 60° = -5.42$
$a_y = -9.8$

$y(t) = 5 - 5.42t + \frac{1}{2}(-9.8)t^2$

on ground when $y = 0$

$0 = 5 - 5.42t - 4.9t^2$

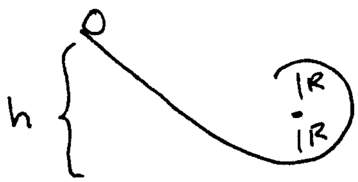
$4.9t^2 + 5.42t - 5 = 0$

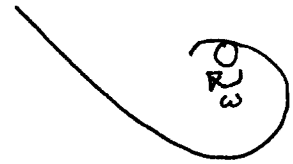
$$t = \frac{-5.42 \pm \sqrt{(5.42)^2 - 4(4.9)(-5)}}{2(4.9)}$$

$$t = \frac{-5.42 \pm 11.29}{9.8} = \cancel{-1.71}, 0.599$$

$x = 3.13(0.599)$
$= 1.87$ m

12P





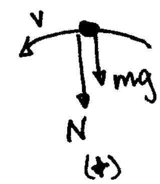
Solid ball

$I = \frac{2}{5} m r^2$

Total Initial Energy = Total Final Energy

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2 + mg\,2R$$

$v = r\omega$



$$m a_{radial} = \sum F$$

$$m \frac{v^2}{R} = N + mg$$

the smallest speed occurs when $N \to 0$

$v^2 = gR$

$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} \frac{I}{r^2} v^2 + mg\,2R$$

$$= \frac{1}{2}\left(m + \frac{I}{r^2}\right) v^2 + mg\,2R$$

$$mgh = \frac{1}{2}\left(m + \frac{I}{r^2}\right) gR + mg\,2R$$

$I = \frac{2}{5} m r^2$

$$mgh = \frac{1}{2}\left(m + \frac{2/5\, m r^2}{r^2}\right) gR + mg\,2R$$

$$mgh = \frac{1}{2} m\left(1 + \frac{2}{5}\right) gR + mg\,2R$$

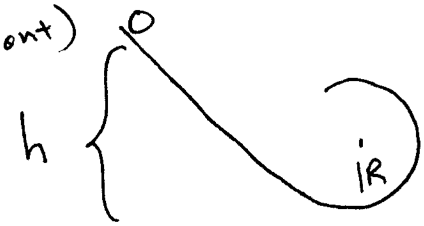
$$mgh = \frac{1}{2} m \frac{7}{5} g R + mg\,2R$$

$$h = \frac{7}{10} R + 2R$$

$$h = \frac{27}{10} R$$

(cont)

12P (cont)



Total Initial Energy = Total Final Energy

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgR$$

$$v = r\omega$$

$$= \frac{1}{2}mv^2 + \frac{1}{2}\frac{I}{r^2}v^2 + mgR$$

solid ball $I = \frac{2}{5}mr^2$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\frac{2/5\,mr^2}{r^2}v^2 + mgR$$

$$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 + mgR$$

$\frac{5}{10}$ $\frac{2}{1}$

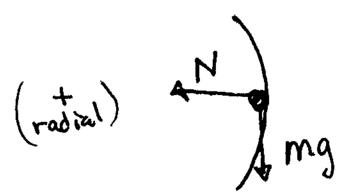
$$mgh = \frac{7}{10}mv^2 + mgR$$

Told $h = 6R$

$$\cancel{m}g6R = \frac{7}{10}\cancel{m}v^2 + \cancel{m}gR$$

$$5gR = \frac{7}{10}v^2$$

$$v^2 = \frac{50}{7}gR$$



we only need to consider the radial motion here

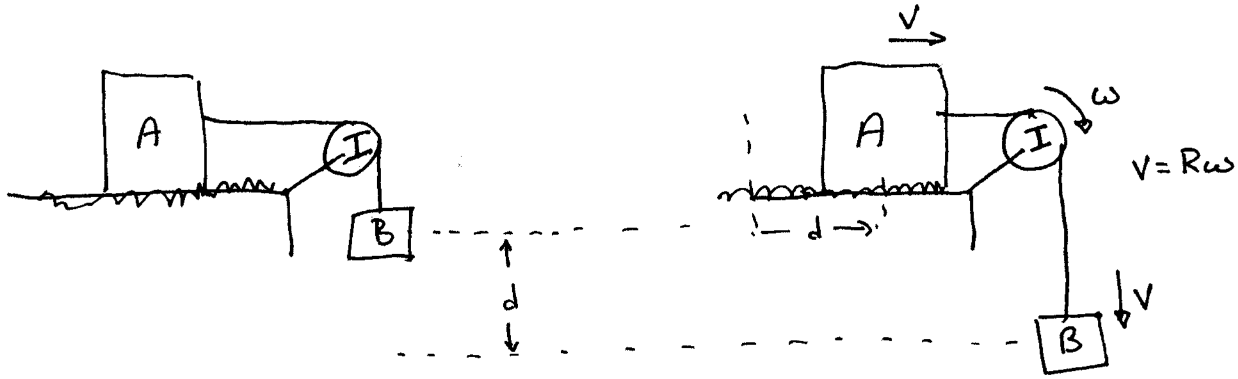
$$m a_{rad} = \sum F_{rad}.$$

$$m\frac{v^2}{R} = N$$

$$m\frac{50/7\,gR}{R} = N$$

$$N = \frac{50}{7}mg$$

9-49



"Total Init Energy" − Lost to friction = "Total Final Energy"

$$\text{"}0\text{"} - fd = \frac{1}{2}m_A v^2 + \frac{1}{2}I\omega^2 + \frac{1}{2}m_B v^2 + mg(-d)$$

the mass dropped below what we called zero grav pot'l energy

$$-\mu N d =$$

$$-\mu m_A g d = \frac{1}{2}m_A v^2 + \frac{1}{2}\frac{I}{R^2}v^2 + \frac{1}{2}m_B v^2 + mg(-d)$$

$$-\mu m_A g d = \left(\frac{1}{2}m_A + \frac{1}{2}\frac{I}{R^2} + \frac{1}{2}m_B\right)v^2 - mgd$$

Here we did not mention the grav potential energy of block A & pulley because it didn't change before & after

66P

call this zero grav pot'l energy

$v = R\omega_{sphere}$ $\quad$ $v = r\omega_{pulley}$

"Tot Init Energy" $=$ "Total Final Energy"

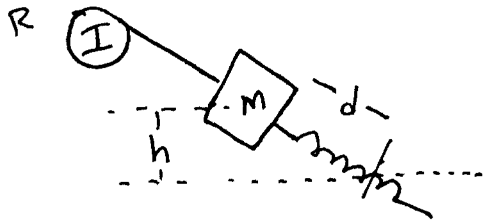
$$0 = \frac{1}{2} I_{sph}\, \omega_{sph}^2 + \frac{1}{2} I_{pulley}\, \omega_{pulley}^2 + \frac{1}{2} m v^2 + mg(-h)$$

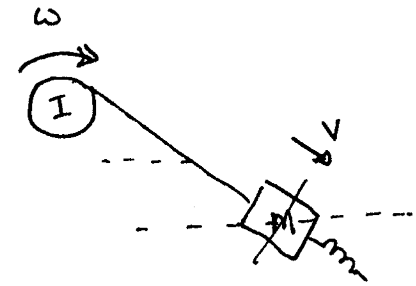
$$0 = \frac{1}{2} \frac{I_{sph}}{R^2} v^2 + \frac{1}{2} \frac{I_{pulley}}{r} v^2 + \frac{1}{2} m v^2 + mg(-h)$$

$$0 = \left[\frac{1}{2} \frac{I_{sph}}{R^2} + \frac{1}{2} \frac{I_{pulley}}{r} + \frac{1}{2} m\right] v^2 - mgh$$

Here we didn't mention the gravational pot'l energy of the sphere & pulley because it didn't change before & after.

51.





Measure zero in gravitational potential from the equilibrium position of the spring

"Tot Init Energy" = "Tot Final Energy"

$$mgh + \frac{1}{2}kd^2 = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$$

Make the subsitutions: $h = d\sin\theta$ $\quad V = R\omega$

$$mgd\sin\theta + \frac{1}{2}kd^2 = \frac{1}{2}I\omega^2 + \frac{1}{2}mR^2\omega^2$$