QUIZ#9- CHAPTER 10
DATE: 14/11/19

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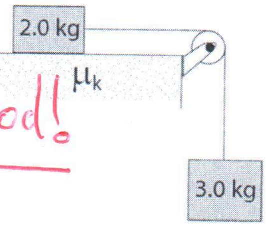
The two masses m_1= 2.0 kg and m_2 = 3.0 kg are released from rest. Consider the pulley as a disk of mass M = 2.0 kg and radius R = 20 cm. Calculate **the speed** the 3.0-kg mass after it has fallen 1.0 m.

$\mu_k = 0.4$



System = $m_1 + m_2 +$ pulley

use energy method!

$$\Rightarrow \Delta K + \Delta U_g = W_f$$

$$\left(\frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2 + \frac{1}{2} I \omega^2 - 0\right) + m_2 g (0 - d) = - f_k d$$

$$\omega = \frac{v}{R} \qquad f_k = \mu_k m_1 g \qquad I = \frac{1}{2} M R^2$$

$$\Rightarrow \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2 + \frac{1}{2} \frac{I}{R^2} v^2 - m_2 g d = - \mu_k m_1 g d$$

$$\frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2 + \frac{1}{4} M v^2 = (m_2 - \mu_k m_1) g d$$

$$v^2 = \frac{4 (m_2 - \mu_k m_1) g d}{2(m_1 + m_2) + M}$$

$$v = \sqrt{\frac{4 (m_2 - \mu_k m_1) g d}{2(m_1 + m_2) + M}}$$

$$= \sqrt{\frac{86.24}{12}} = \boxed{2.68 \text{ m/s}}$$

If you use Newton's laws it is long!

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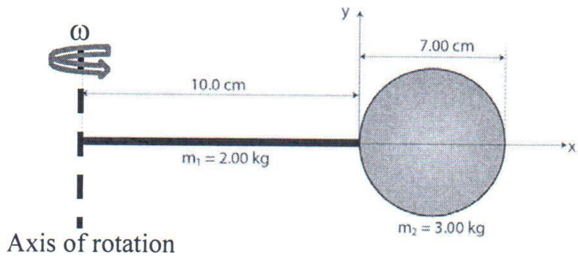
The figure shows a uniform thin rod, with mass $m_1 = 2.00$ kg and length L = 10.0 cm, attached to a uniform solid sphere, of mass $m_2 = 3.00$ kg and diameter 7.00 cm. The system is rotating about the y axis with angular speed of 200 rev/min.

(a) Calculate the rotational inertia of the system about the y-axis.



$$I_{system} = I_{rod} + I_{sphere}$$

$$I_{rod} = I_{cm} + mh^2$$

$$= \frac{1}{12} m_1 L^2 + m_1 \left(\frac{L}{2}\right)^2 = \frac{1}{3} m L^2 = 6.67 \times 10^{-3} \text{ Kg.m}^2$$

$$I_{sphere} = I_{cm} + mh^2 = \frac{2}{5} m_2 R^2 + m_2 (L+R)^2 = 0.00147 + 0.055$$

$$= 0.0565 \text{ Kg.m}^2$$

$$\boxed{I_{system} = 0.06314 \text{ Kg.m}^2}$$

(b) Calculate the kinetic energy of the system.

$$K = \frac{1}{2} I \omega^2 = \frac{1}{2} (0.06314) \left(200 \times \frac{2\pi}{60}\right)^2$$

$$\boxed{K = 13.85 \text{ J}}$$

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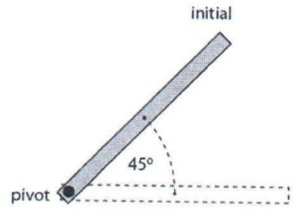
A thin rod of mass 0.50 kg and length 2.5 m is pivoted at one end and can rotate in a vertical plane about a frictionless pivot. It is released from rest when the rod makes an angle of 45° above the horizontal.

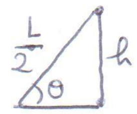
(a) Calculate the angular speed of the rod as it passes through the horizontal position.



$$\Delta K + \Delta U_g = 0$$

$$\left(\frac{1}{2} I_{new}\omega^2 - 0\right) + mg(0 - h) = 0$$

$$I_{new} = I_{cm} + mh^2 = \frac{1}{12}mL^2 + m\left(\frac{L}{2}\right)^2 = \frac{1}{3}mL^2$$



$$\frac{1}{6} m L^2 \omega^2 = mgh = g\frac{L}{2}\sin\theta$$

$$\omega = \sqrt{\frac{3g\sin\theta}{L}} = \sqrt{8.31} = \boxed{2.88 \text{ rad/s}} \qquad h = \frac{L}{2}\sin\theta$$

(b) Calculate the linear speed of the center of mass of the rod.

$$v = \omega r = \omega\frac{L}{2} = \boxed{3.6 \text{ m/s}}$$

(c) Calculate the angular acceleration of the rod if the time taken from initial to final position is 2.0 s.

$$\omega = \omega_0 + \alpha t \quad (\omega_0 = 0)$$

$$\alpha = \frac{\omega}{t} = \frac{2.88}{2} = \boxed{1.44 \text{ rad/s}^2}$$