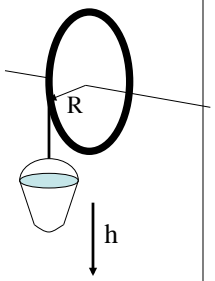
Problem 8.52

A 3 kg pail is attached to a rope wound around a 5 kg, .6 meter radius spool. The pail is released and falls 4 meters.



On the calendar, you were asked to determine the pail's acceleration first. That's a N.S.L. problem:

sum of torques about the axis of rotation

sum of forces in "y" direction

f.b.d.

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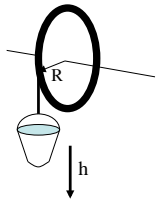


sum of torques about the axis of rotation, inserting $a=R\alpha$ and solving for T yields:

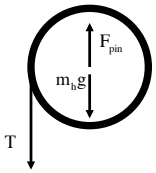
$$\sum \Gamma_{axis}:$$

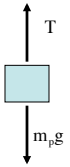
$$TR = I_{axis}\alpha$$

$$TR = \left(\frac{1}{2}m_{spool}R^2\right)\left(\frac{a}{R}\right)$$

f.b.d.s

$$\Rightarrow \quad T = \frac{1}{2}m_s a$$





sum of forces in "y" direction

$$\sum F_y:$$

$$T - m_p g = -m_p a$$

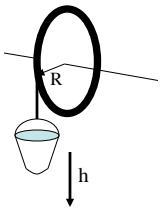
$$\Rightarrow \quad T = m_p g - m_p a$$

combining:

$$m_p g - m_p a = \frac{1}{2}m_s a$$

$$\Rightarrow \quad a = \frac{m_p g}{m_p + \frac{1}{2}m_s}$$

Again, a 3 kg pail is attached to a rope wound around a 5 kg, .6 meter radius spool. The pail is released and falls 4 meters. The actual problem wants conservation of energy to determine the velocity of the pail after the fall.



$$\sum KE_1 + \sum U_1 + \sum W_{ext} = \sum KE_2 + \sum U_2$$

$$0 + (m_p gh) + 0 = \left(\frac{1}{2}m_p v^2 + \frac{1}{2}I_{spool}\omega^2\right) + 0$$

$$\Rightarrow \quad (m_p gh) = \frac{1}{2}m_p v^2 + \frac{1}{2}\left(\frac{1}{2}m_s R^2\right)\left(\frac{v}{R}\right)^2$$

$$\Rightarrow \quad v = \sqrt{\frac{2m_p gh}{m_p + \frac{1}{2}m_s}}$$

$$\Rightarrow \quad v = \sqrt{\frac{2(3\text{ kg})(9.8\text{ m/s}^2)(4\text{ m})}{(3\text{ kg}) + \frac{1}{2}(5\text{ kg})}}$$

$$\Rightarrow \quad v = 6.54\text{ m/s}$$