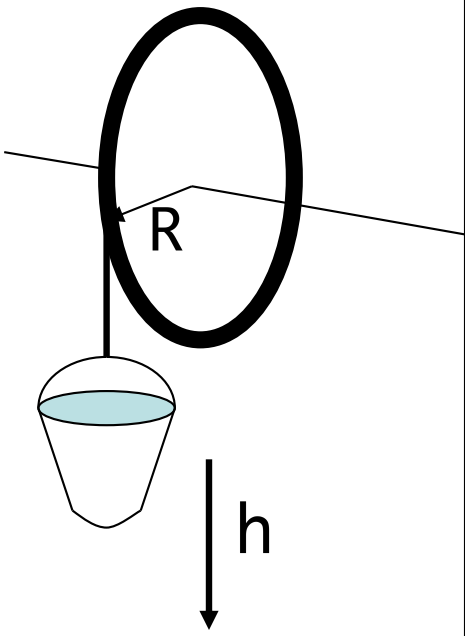
Problem 8.52

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

f.b.d.

sum of forces in "y" direction

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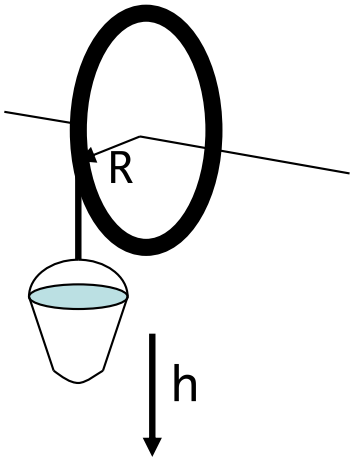


sum of torques about the axis of rotation, inserting $a=R\alpha$ and solving for T yields:

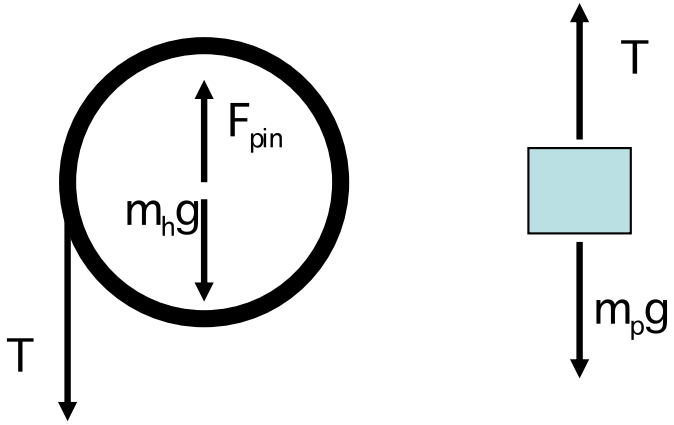
$$\sum \Gamma_{axis}:$$

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

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

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

f.b.d.



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:

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

$$\Rightarrow \quad a = \frac{m_p g}{m_p + \frac{1}{2}m_s} = \frac{(3\text{ kg})(9.8\text{ m/s}^2)}{(3\text{ kg}) + .5(5\text{ kg})}$$

$$= 5.35\text{ m/s}^2 \text{ downward, so negative . . .}$$

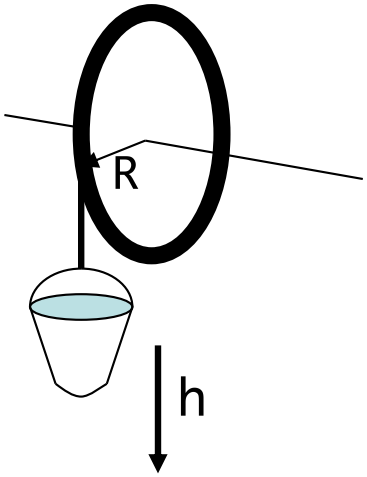
$$v_2^2 = v_1^2 + 2a(\Delta y)$$

$$= 0 + 2(-5.35\text{ m/s}^2)(-4\text{ m})$$

$$= 42.8$$

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

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.



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

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

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

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

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

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