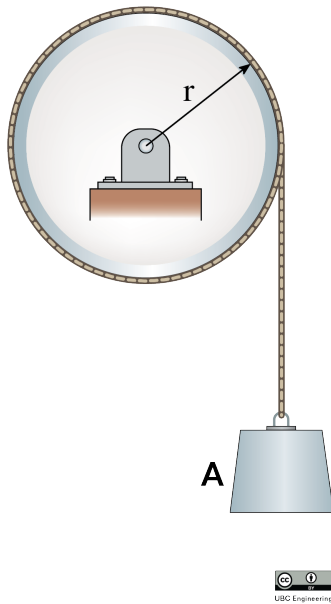
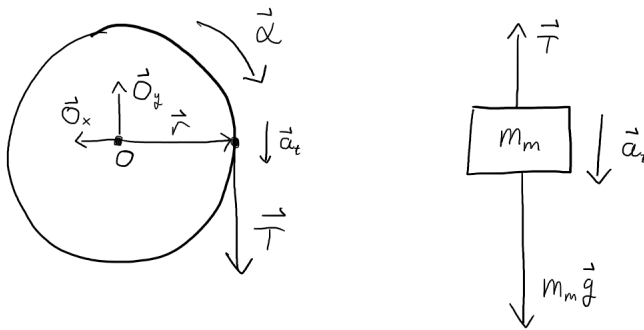


22-R-KIN-TW-14



A wheel of mass 30 kg and radius 1 m is initially at rest when an unknown mass is attached to a rope connected to the wheel. The mass causes the wheel to complete one full revolution in 1.5 s starting from when it was attached. Find the value of this unknown mass. (Use $g = 9.81 \text{ m/s}^2$ and treat the wheel as a thin cylinder)

Solution:



$$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$2\pi = \frac{1}{2}\alpha t^2$$

$$\alpha = \frac{4\pi}{t^2} = \frac{4\pi}{(1.5)^2} = 5.59 \text{ rad/s}^2$$

$$(F_y)_{\text{mass}} : T - m_m g = -m_m a_y$$

$$(M_O)_{\text{wheel}} : \vec{r} \times \vec{T} = I_O \vec{\alpha}$$

$$I_O = \frac{1}{2} m_{\text{wheel}} r^2 = (0.5)(30)(1)^2 = 15 \text{ kg} \cdot \text{m}^2$$

$$\vec{a}_y = \vec{\alpha} \times \vec{r}$$

$$m_m g - T = m_m \alpha r$$

$$T = m_m (g - \alpha r)$$

$$r m_m (g - \alpha r) = I_O \alpha$$

$$m_m = \frac{I_O \alpha}{r(g - \alpha r)} = \frac{(15)(5.59)}{(1)(9.81 - (5.59)(1))} = 19.83 \text{ kg}$$