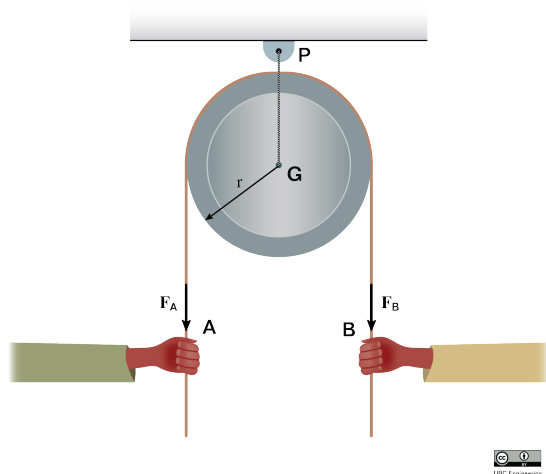


22-R-IM-TW-33



Two friends are trying to determine who is the strongest between them. They decide to settle the argument by each pulling down on a rope looped around a pulley with a constant force as shown. Friend *A* measures their force to be $F_A = 450$ N. The pulley is measured to have a mass of 50 kg, radius 0.3 m, and radius of gyration of $k = 0.15$ m. The pulley is initially at rest when both friends start pulling on it. If after 10 seconds the pulley is moving with an angular velocity of $\vec{\omega} = 2.5\hat{k}$ rad/s, what is the force F_B ?

Solution:

$$\begin{aligned}
 I_G &= mk^2 = (50)(0.15)^2 = 1.125 \text{ [kg} \cdot \text{m}^2] \\
 \Delta H_G &= \sum \int_0^{\Delta t} M dt \\
 I_G \vec{\omega} &= (\vec{r}_{A/G} \times \vec{F}_A + \vec{r}_{B/G} \times \vec{F}_B) \Delta t \\
 I_G \omega(\hat{k}) &= (F_A r - F_B r) \Delta t(\hat{k}) \\
 \frac{I_G \omega}{r \Delta t} &= F_A - F_B \\
 F_B &= F_A - \frac{I_G \omega}{r \Delta t} = 450 - \frac{(1.125)(2.5)}{(0.3)(10)} = 449.06 \text{ [N]}
 \end{aligned}$$