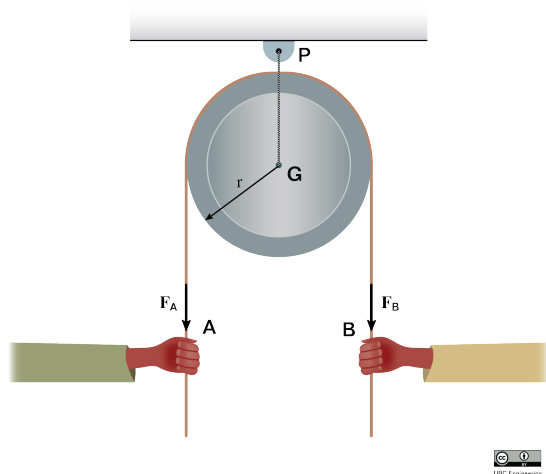


22-R-IM-TW-33



Two friends are trying to determine who is the strongest between them (and by how much). 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 $F_A = 500$ N. The pulley is measured to have a mass of 30 kg, radius 0.5 m, and radius of gyration of $k = 0.3$ m. The pulley is initially at rest when both friends start pulling on it. If after 2 seconds the pulley is moving with an angular velocity of $\vec{\omega} = -1.5\hat{k}$ rad/s, what is the force F_B ?

Solution:

$$I_G = mk^2 = (30)(0.3)^2 = 2.7 \text{ [kg} \cdot \text{m}^2]$$

$$H_{G,2} - H_{G,1} = \sum \int_0^{t_2} M d\tau$$

$$H_{G,1} = 0$$

$$H_{G,2} = I_G \vec{\omega} = (\vec{r}_{A/G} \times \vec{F}_A + \vec{r}_{B/G} \times \vec{F}_B)t_2$$

$$I_G \omega(\hat{k}) = (F_A r - F_B r)t_2(\hat{k})$$

$$\frac{I_G \omega}{rt_2} = F_A - F_B$$

$$F_B = F_A - \frac{I_G \omega}{rt_2} = 500 - \frac{(2.7)(-1.5)}{(0.5)(2)} = 504.05 \text{ [N]}$$