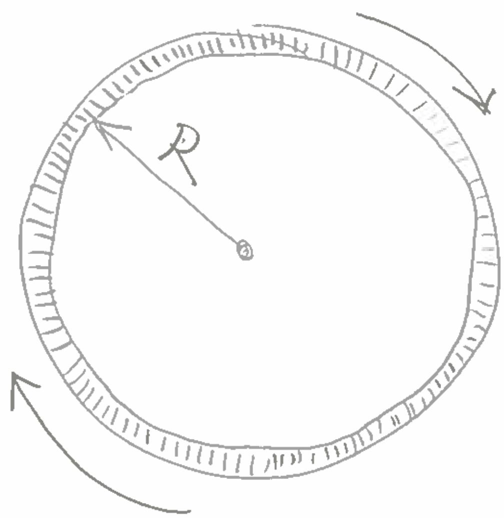


Cosmonaut Vassily encounters an alien artifact in space: a big hoop of

radius $R = 7.7\ m$

mass $M = 596\ kg$

The object spins slowly at $\omega = 0.17\ \frac{rad}{s}$.

The moment of inertia is

$$I = MR^2 = (596\ kg)(7.7\ m)^2 = 35,337\ kg \cdot m^2$$

The kinetic energy of rotation is

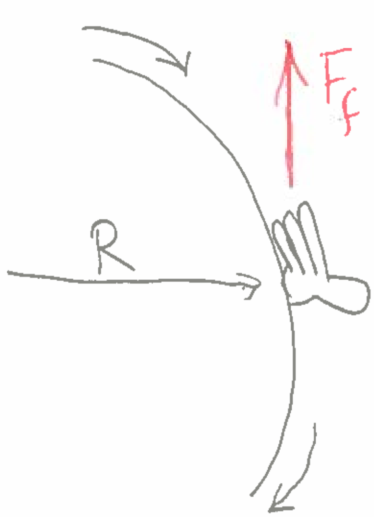
$$KE = \frac{1}{2} I \omega^2 = \frac{1}{2}(35,337\ kg \cdot m^2)\left(0.17\ \frac{rad}{s}\right)^2$$

$$= 511\ J$$

Vassily presses his glove against the hoop, exerting a normal force $F_N = 48\ N$, with coeff of kinetic friction $\mu_K = 0.25$.

The friction force on the hoop is

$$F_f = F_N \cdot \mu_K = 12\ N$$



The torque around the center of the hoop due to this force is

$$\tau = |R||F_f| \sin 90°$$

$$= 92.4\ N \cdot m \quad \text{out of page}$$

Due to this torque, the hoop's angular velocity starts to change. The magnitude of the angular acceleration is

$$|\alpha| = \frac{|\tau|}{I} = \frac{92.4 \text{ N}\cdot\text{m}}{35,337 \text{ kg}\cdot\text{m}^2} = 0.00262 \frac{\text{rad}}{\text{s}^2}$$

If Vassily continues to exert this torque, the wheel will eventually come to a halt.

$$\omega_f = \omega_i + \alpha t$$

$$0 \frac{\text{rad}}{\text{s}} = 0.17 \frac{\text{rad}}{\text{s}} + \left(-0.00262 \frac{\text{rad}}{\text{s}^2}\right) t$$

$$\Rightarrow t = \frac{-0.17 \frac{\text{rad}}{\text{s}}}{0.00262 \frac{\text{rad}}{\text{s}^2}} = \underline{65.0 \text{ s}}$$