Answer on Question #52299-Physics-Other

1. During this time the angular speed of the wheel increases from 0 to 12 rad/s. The applied force is then removed, and the wheel comes to rest in 75 s.

a. What is the moment of inertia of the wheel?

b. What is the magnitude of the frictional torque?

c. How many revolutions does the wheel make?

Solution

a. Angular acceleration

$$\alpha = \frac{\omega_2 - \omega_1}{t_1} = \frac{(12-0)\frac{\text{rad}}{\text{s}}}{6s} = 2\frac{rad}{s^2}.$$

$$\text{torque} = I \cdot \alpha \rightarrow I = \frac{\text{torque}}{\alpha} = \frac{36\ \text{N} \cdot \text{m}}{2\frac{rad}{s^2}} = 18\ kg \cdot m^2.$$

b. The wheel comes to rest only due to the frictional torque $\tau_{friction}$

$$\tau_{friction} = I\alpha'.$$

Angular deceleration

$$\alpha' = \frac{\omega_2 - \omega_3}{t_2} = \frac{(12-0)\frac{\text{rad}}{\text{s}}}{75s} = 0.16\frac{rad}{s^2}.$$

$$\tau_{friction} = 18\ kg \cdot m^2 \cdot 0.16\frac{rad}{s^2} = 2.88\ N \cdot m.$$

c. In time 6s

$$\theta_1 = \frac{1}{2}\alpha t_1^2 = 0.5 \cdot 2 \cdot 6^2 = 36\ radians.$$

From average angular velocity formula

$$\theta_2 = \bar{\omega} t_2 = \frac{(12-0)\frac{\text{rad}}{\text{s}}}{2} \cdot 75s = 450\ radians.$$

Total angle traversed

$$\theta = \theta_1 + \theta_2 = 36 + 450 = 486\ radians.$$

Number of revolutions

$$N = \frac{486}{2\pi}\ revolutions = 77.3\ revolutions.$$

Answer: a. $18\ kg \cdot m^2$; b. $2.88\ N \cdot m$; c. $77.3\ revolutions$.