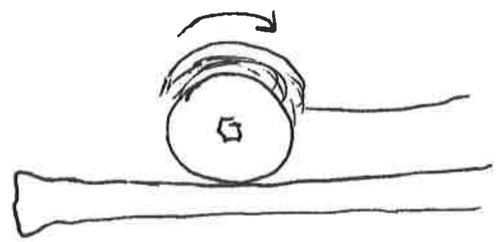
Name: Key

*10.3 *Dynamics

Practice - 10.2 Kinematics of Rotation

1. A spinning fishing reel has an initial angular velocity is $\omega_0 = 220$ rad/s. If the fisherman applies a brake to the spinning reel, achieving an angular acceleration of -300 rad/s^2, how long does it take the reel to come to a stop?



$\omega_0 = 220 \frac{rad}{s}$

$\alpha = -300 \frac{rad}{s^2}$

$t = ?$

$\omega_f = 0$

$\overset{0}{\cancel{\omega_f}} = \omega_0 + \alpha t$

$t = \frac{-\omega_0}{\alpha} = \frac{-220 \frac{rad}{s}}{-300 \frac{rad}{s^2}} = \boxed{0.733\,s}$

2. Large freight trains accelerate very slowly. Suppose one such train accelerates from rest, giving its 0.350-m-radius wheels an angular acceleration of 0.250 rad/s^2.

A. After the wheels have made 200 revolutions (assume no slippage), how far has the train moved down the track?

$\omega_0 = 0$

$r = 0.350 m$

$\alpha = 0.250 \frac{rad}{s^2}$

$\theta = 200 rev \times \frac{2\pi rad}{rev}$

$s = \theta r = (400\pi\, rad)(0.350\, m) = \boxed{440\, m}$

B. After the wheels have made 200 revolutions (assume no slippage), what are the final angular velocity of the wheels and the linear velocity of the train?

$\omega_f^2 = \overset{0}{\cancel{\omega_0^2}} + 2\alpha\theta$

$\omega_f = \sqrt{2\alpha\theta} = \sqrt{2\left(0.250 \frac{rad}{s^2}\right)(400\pi\, rad)}$

$= \boxed{25.1 \frac{rad}{s}}$

$25.07 \frac{rad}{s}$

$v = \omega r = \left(25.07 \frac{rad}{s}\right)(0.350 m) = \boxed{8.77 \frac{m}{s}}$

Name: Key

Practice – ~~10.2~~ 10.3 Dynamics of Rotational Motion: Rotational Inertia (cont'd)
Kinematics

3. Calculate the rotational inertia of a solid sphere of mass M = 5.0 kg and a radius of R = 0.25 m.

$$I = \frac{2}{5}MR^2 = \frac{2}{5}(5.0\,kg)(0.25\,m)^2 = \boxed{0.13\ kg\,m^2}$$

$0.125\ kg\,m^2$

4. Calculate the rotational inertia of a solid cylinder of mass M = 2.0 kg and a radius of R = 0.075 m about its central axis.

$$I = \frac{1}{2}MR^2 = \frac{1}{2}(2.0\,kg)(0.075\,m)^2 = \boxed{5.6\times10^{-3}\ kg\,m^2}$$

5. Suppose you exert a force of 180 N tangential to a 0.280-m-radius 75.0-kg grindstone (a solid disk).

A. What torque is exerted?

$$\tau = rF = (0.280\,m)(180\,N) = \boxed{50.4\ N\cdot m}$$

$50.40\ N\cdot m$

B. What is the angular acceleration assuming negligible opposing friction?

$$\tau = I\alpha \Rightarrow \alpha = \frac{\tau}{I} = \frac{\tau}{\frac{1}{2}MR^2} = \frac{50.40\,N\cdot m}{\frac{1}{2}(75.0\,kg)(0.280\,m)^2} = \boxed{17.1\ \frac{rad}{s^2}}$$

$17.14\ \frac{rad}{s^2}$

C. What is the angular acceleration if there is an opposing frictional force of 20.0 N exerted 1.50 cm from the axis?

$$\alpha = \frac{\tau_{NET}}{I} = \frac{50.40 - (1.50\times10^{-2}\,m)(20.0\,N)}{\frac{1}{2}(75.0\,kg)(0.280\,m)^2} = \boxed{17.0\ \frac{rad}{s^2}}$$

$17.04\ \frac{rad}{s^2}$