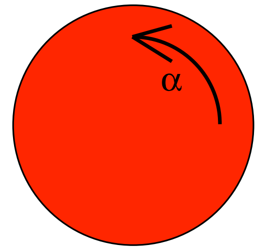
Problem 10.38



This is one of those sneaky problems that requires you to use rotational kinematics but makes you use some other approach (in this case, Newton's Laws) to determine things like the angular acceleration (this, when the whole idea is to get practice using N.S.L. in the first place). In any case, following along with all that:

The rotational version of N.S.L. has the same look as the translational version except now you are summing torques, using moments of inertias (instead of mass terms) and using *angular acceleration*. With that in mind:

$$\underline{\sum \Gamma :}$$

$$\Gamma_1 = I\alpha$$

$$\Rightarrow \quad \alpha = \frac{\Gamma_1}{I_{disk}}$$

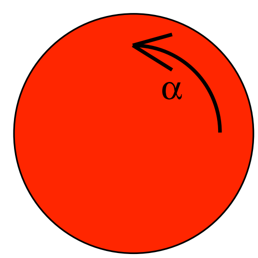
$$= \frac{\Gamma_1}{\left(\frac{1}{2}mR^2\right)}$$

$$= \frac{(.600\ \text{N}\bullet\text{m})}{\left(\frac{1}{2}(2.00\ \text{kg})(7.00\text{x}10^{-2}\ \text{m})^2\right)}$$

$$= 122\ \text{rad/s}^2$$

1.)

a.) How long does it take to reach 1200 rpm?



Using the appropriate rotational kinematic relationship, we can write:

$$\omega_2 = \cancel{\omega_1}^{\,0} + \alpha\,(\Delta t)$$

$$\left[\left(1.20\text{x}10^3\ \frac{\cancel{\text{rev}}}{\cancel{\text{min}}}\right)\left(2\pi\ \frac{\text{rad}}{\cancel{\text{rev}}}\right)\left(\frac{1\ \cancel{\text{min}}}{69\ \text{s}}\right)\right] = \left(122\ \frac{\text{rad}}{\text{sec}^2}\right)\Delta t$$

$$\Rightarrow \quad \Delta t = 1.03\ \text{s}$$

b.) Through how many revolutions does it turn during this period of time?

Again, with the rotational kinematic relationship:

$$(\theta_2 - \theta_1) = \omega_1(\Delta t) + \frac{1}{2}\alpha(\Delta t)^2$$

$$\Rightarrow \quad \Delta\theta = \frac{1}{2}(122\ \text{rad/s}^2)(1.03\ \text{s})^2$$

$$= 64.7\ \text{rad}$$

$$\Rightarrow \quad \Delta\theta = (64.7\ \cancel{\text{rad}})\left(\frac{1\ \text{rev}}{2\pi\ \cancel{\text{rad}}}\right) = 10.3\ \text{rev}$$

2.)