Name: Key

Practice - 10.1 Angular Acceleration

1. At its peak, a tornado is 60.0 m in diameter and carries 500 km/h winds. What is its angular velocity in revolutions per second?

$$v = \omega r \Rightarrow \omega = \frac{v}{r} = \frac{500\frac{km}{h}\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,h}{3600\,s}\right)}{30.0\,m} = 4.630\frac{rad}{s}$$

$$= 4.630\frac{rad}{s}\left(\frac{1\,rev}{2\pi\,rad}\right) = \boxed{0.737\frac{rev}{s}}$$

2. An ultracentrifuge accelerates from rest to 100,000 rpm in 2.00 min.

A. What is its angular acceleration in rad/s^2?

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{100{,}000 - 0}{2.00\,min} = 50{,}000\frac{rev}{min^2}\left(\frac{2\pi\,rad}{1\,rev}\right)\left(\frac{1\,min}{60\,s}\right)^2$$

$$= \boxed{87.3\frac{rad}{s^2}} \quad 87.27\frac{rad}{s^2}$$

B. What is the tangential acceleration of a point 9.50 cm from the axis of rotation?

$$a_t = \alpha r = \left(87.27\frac{rad}{s^2}\right)\left(9.50\times10^{-2}\,m\right) = \boxed{8.29\frac{m}{s^2}}$$

C. What is the radial acceleration in m/s^2 and multiples of g of this point at full rpm?

$$a_r = a_c = \frac{v^2}{r} = \frac{(\omega r)^2}{r} = \omega^2 r$$

$$= \left(100{,}000\frac{rev}{min}\left(\frac{2\pi\,rad}{1\,rev}\right)\left(\frac{1\,min}{60\,s}\right)\right)^2\left(9.50\times10^{-2}\,m\right) = \boxed{1.04\times10^{7}\frac{m}{s^2}}$$

$1.042\times10^{7}\frac{m}{s^2}$

$$\frac{1.042\times10^{7}\frac{m}{s^2}}{9.80\frac{m}{s^2}} = \boxed{1.06\times10^{6}\ gs}$$

3. A drum rotates around its central axis at an angular velocity of 12.60 rad/s. If the drum then slows at a constant rate of 4.20 rad/s^2,

A. How much time does it take to come to a stop?

[Note: $\omega_f = \omega_0 + \alpha t$]

$\omega_0 = 12.60\,\frac{rad}{s}$

$\alpha = -4.20\,\frac{rad}{s^2}$

$\omega_f = 0$

$$t = \frac{\omega_f - \omega_0}{\alpha} = \frac{0 - 12.60\,\frac{rad}{s}}{-4.20\,\frac{rad}{s^2}} = \boxed{3.00\,s}$$

B. Through what angle does it rotate before coming to a stop?

[Note: $\theta_f - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$]

$$\theta_f - \theta_0 = \left(12.60\,\frac{rad}{s}\right)(3.00\,s) + \frac{1}{2}\left(-4.20\,\frac{rad}{s^2}\right)(3.00\,s)^2$$

$$= \boxed{18.9\,rad}$$

4. Starting from rest, a disk rotates about its central axis with constant angular acceleration. In 5.0 s, it rotates 25 rad. During that time, what is the magnitude of the angular acceleration? [Note: $\theta_f - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$]

$\omega_0 = 0$

$t = 5.0\,s$

$\theta_f - \theta_0 = 25\,rad$

$$\theta_f - \theta_0 = \cancel{\omega_0 t}^{\,0} + \frac{1}{2}\alpha t^2$$

$$\Rightarrow \alpha = \frac{2(\theta_f - \theta_0)}{t^2}$$

$$= \frac{2\,(25\,rad)}{(5.0\,s)^2} = \boxed{2.0\,\frac{rad}{s^2}}$$