Practice Problems with Angular Acceleration - Answers

6. In each revolution, the wheel moves forward a distance equal to its circumference, πd.

$$\Delta x = N_{\text{rev}}(\pi d) \quad \rightarrow \quad N = \frac{\Delta x}{\pi d} = \frac{8000\text{ m}}{\pi(0.68\text{ m})} = \boxed{3.7\times10^{3}\text{ rev}}$$

7. (*a*)

$$\omega = \left(\frac{2500\text{ rev}}{1\text{ min}}\right)\left(\frac{2\pi\text{ rad}}{1\text{ rev}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right) = 261.8\text{ rad/sec} \approx \boxed{2.6\times10^{2}\text{ rad/sec}}$$

(*b*)

$$v = \omega r = (261.8\text{ rad/sec})(0.175\text{ m}) = \boxed{46\text{ m/s}}$$

$$a_{\text{R}} = \omega^2 r = (261.8\text{ rad/sec})^2(0.175\text{ m}) = \boxed{1.2\times10^{4}\text{ m/s}^2}$$

16. (*a*) For constant angular acceleration:

$$\alpha = \frac{\omega-\omega_o}{t} = \frac{1200\text{ rev/min} - 4500\text{ rev/min}}{2.5\text{ s}} = \frac{-3300\text{ rev/min}}{2.5\text{s}}\left(\frac{2\pi\text{ rad}}{1\text{ rev}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right)$$

$$= \boxed{-1.4\times10^{2}\text{ rad/s}^2}$$

(*b*) For the angular displacement, given constant angular acceleration:

$$\theta = \tfrac{1}{2}(\omega_o+\omega)t = \tfrac{1}{2}(4500\text{ rev/min} + 1200\text{ rev/min})(2.5\text{ s})\left(\frac{1\text{ min}}{60\text{ s}}\right) = \boxed{1.2\times10^{2}\text{rev}}$$

17. (*a*) The angular acceleration can be found from $\theta = \omega_o t + \tfrac{1}{2}\alpha t^2$ with $\omega_o = 0$.

$$\alpha = \frac{2\theta}{t^2} = \frac{2(20\text{ rev})}{(1.0\text{ min})^2} = \boxed{4.0\times10^{1}\text{ rev/min}^2}$$

(*b*) The final angular speed can be found from $\theta = \tfrac{1}{2}(\omega_o+\omega)t$, with $\omega_o = 0$.

$$\omega = \frac{2\theta}{t} - \omega_o = \frac{2(20\text{ rev})}{1.0\text{ min}} = \boxed{4.0\times10^{1}\text{ rpm}}$$

18. Use Eq. 8-9d combined with Eq. 8-2a.

$$\bar{\omega} = \frac{\omega+\omega_0}{2} = \frac{240\text{ rpm} + 360\text{ rpm}}{2} = 300\text{ rpm}$$

$$\theta = \bar{\omega}t = \left(300\frac{\text{rev}}{\text{min}}\right)\left(\frac{1\text{ min}}{60\text{ sec}}\right)(6.5\text{ s}) = 32.5\text{ rev}$$

Each revolution corresponds to a circumference of travel distance.

$$32.5\text{ rev}\left[\frac{\pi(0.33\text{ m})}{1\text{ rev}}\right] = \boxed{34\text{ m}}$$

19. (*a*) The angular acceleration can be found from $\omega^2 = \omega_o^2 + 2\alpha\theta$.

$$\alpha = \frac{\omega^2-\omega_o^2}{2\theta} = \frac{0-(850\text{ rev/min})^2}{2(1500\text{ rev})} = \left(-241\frac{\text{rev}}{\text{min}^2}\right)\left(\frac{2\pi\text{ rad}}{1\text{ rev}}\right)\left(\frac{1\text{ min}}{60\text{ s}}\right)^2 = \boxed{-0.42\frac{\text{rad}}{\text{s}^2}}$$

(*b*) The time to come to a stop can be found from $\theta = \tfrac{1}{2}(\omega_o+\omega)t$.

$$t = \frac{2\theta}{\omega_o+\omega} = \frac{2(1500\text{ rev})}{850\text{ rev/min}}\left(\frac{60\text{ s}}{1\text{ min}}\right) = \boxed{210\text{ s}}$$