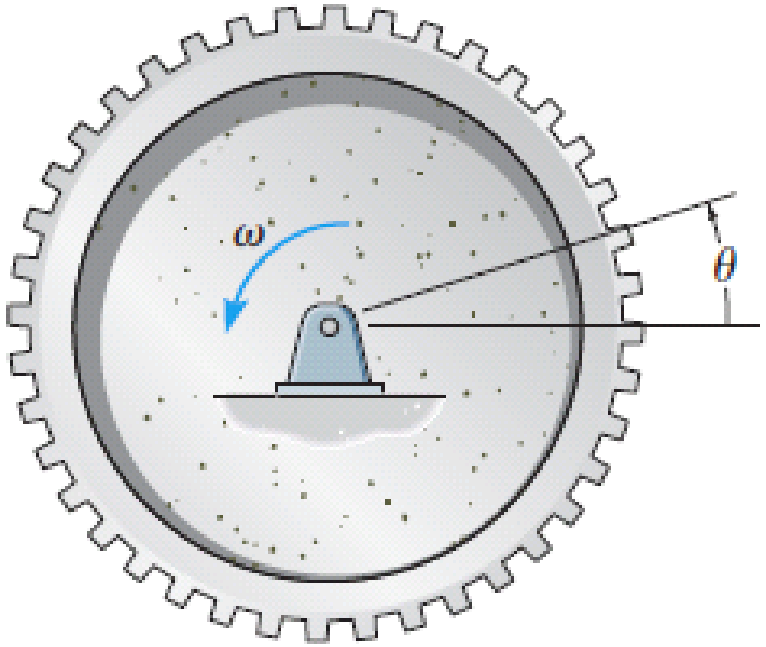
When the gear rotates 20 revolutions, it achieves an angular velocity of $\omega = 30\,\text{rad/s}$, starting from rest. Determine its constant angular acceleration and the time required.



$$\theta = (20 \text{ rev})\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right) = 40\pi \text{ rad}$$

$$\omega^2 = \omega_0^2 + 2\alpha_c(\theta - \theta_0)$$

$$(30 \text{ rad/s})^2 = 0^2 + 2\alpha_c[(40\pi \text{ rad}) - 0]$$

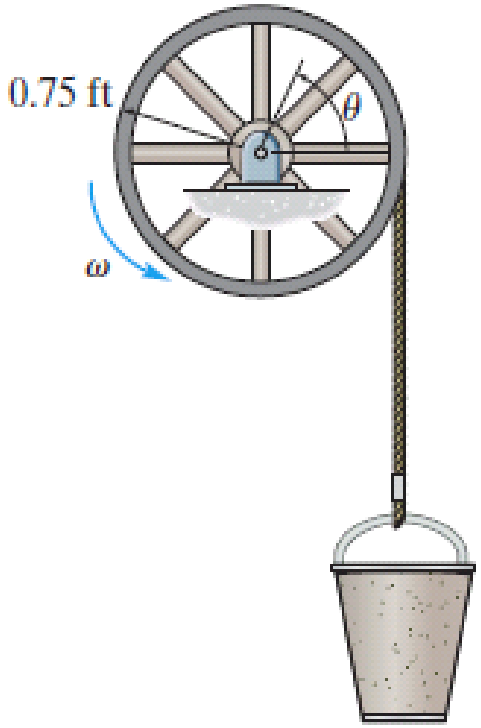
$$\alpha_c = 3.581 \text{ rad/s}^2 \qquad \textit{Ans.}$$

$$\omega = \omega_0 + \alpha_c t$$

$$30 \text{ rad/s} = 0 + (3.581 \text{ rad/s}^2)t$$

$$t = 8.38 \text{ s} \qquad \textit{Ans.}$$

The bucket is hoisted by the rope that wraps around a drum wheel. If the angular displacement of the wheel is $\theta = (0.5t^3 + 15t)$ rad, where t is in seconds, determine the velocity and acceleration of the bucket when $t = 3$ s.



$$\omega = \frac{d\theta}{dt} = (1.5t^2 + 15)\ \text{rad/s}$$

$$\alpha = \frac{d\omega}{dt} = (3t)\ \text{rad/s}^2$$

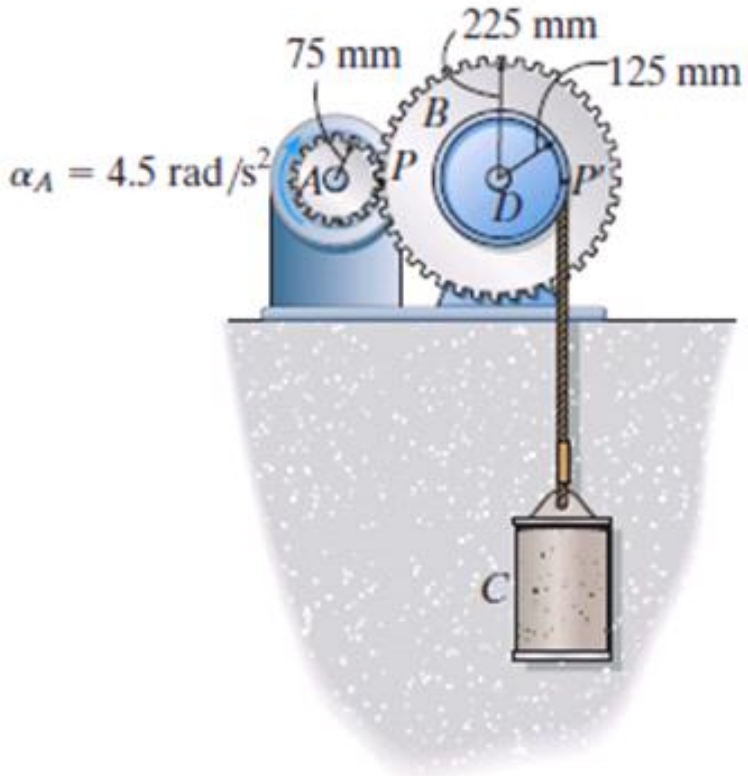
$$\omega = [1.5(3^2) + 15]\ \text{rad/s} = 28.5\ \text{rad/s}$$

$$\alpha = 3(3)\ \text{rad/s}^2 = 9\ \text{rad/s}^2$$

$$v = \omega r = (28.5\ \text{rad/s})(0.75\ \text{ft}) = 21.4\ \text{ft/s} \qquad \textit{Ans.}$$

$$a = \alpha r = (9\ \text{rad/s}^2)(0.75\ \text{ft}) = 6.75\ \text{ft/s}^2 \qquad \textit{Ans.}$$

For a short period of time, the motor turns gear A with a constant angular acceleration of $\alpha_A = 4.5\ \text{rad/s}^2$, starting from rest. Determine the velocity of the cylinder and the distance it travels in three seconds. The cord is wrapped around pulley D which is rigidly attached to gear B.



$$\alpha_B = \alpha_A \left(\frac{r_A}{r_B} \right)$$

$$= (4.5 \text{ rad/s}^2)\left(\frac{0.075 \text{ m}}{0.225 \text{ m}} \right) = 1.5 \text{ rad/s}^2$$

$$\omega_B = (\omega_B)_0 + \alpha_B t$$

$$\omega_B = 0 + (1.5 \text{ rad/s}^2)(3 \text{ s}) = 4.5 \text{ rad/s}$$

$$\theta_B = (\theta_B)_0 + (\omega_B)_0 t + \tfrac{1}{2} \alpha_B t^2$$

$$\theta_B = 0 + 0 + \tfrac{1}{2} (1.5 \text{ rad/s}^2)(3 \text{ s})^2$$

$$\theta_B = 6.75 \text{ rad}$$

$$v_C = \omega_B r_D = (4.5 \text{ rad/s})(0.125 \text{ m})$$

$$= 0.5625 \text{ m/s} \qquad \textit{Ans.}$$

$$s_C = \theta_B r_D = (6.75 \text{ rad})(0.125 \text{ m}) = 0.84375 \text{ m}$$

$$= 844 \text{ mm} \qquad \textit{Ans.}$$