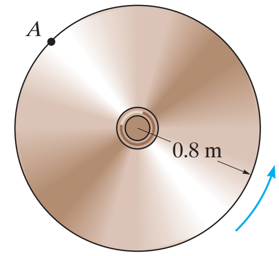
16–1.

The angular velocity of the disk is defined by $\omega = (5t^2 + 2)$ rad/s, where t is in seconds. Determine the magnitudes of the velocity and acceleration of point A on the disk when $t = 0.5$ s.



SOLUTION

$$\omega = (5\,t^2 + 2)\ \text{rad/s}$$

$$\alpha = \frac{d\omega}{dt} = 10\,t$$

$$t = 0.5\ \text{s}$$

$$\omega = 3.25\ \text{rad/s}$$

$$\alpha = 5\ \text{rad/s}^2$$

$$v_A = \omega r = 3.25(0.8) = 2.60\ \text{m/s}$$ **Ans.**

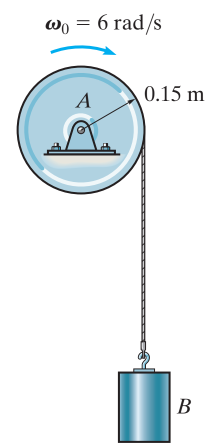
$$a_z = \alpha r = 5(0.8) = 4\ \text{m/s}^2$$

$$a_n = \omega^2 r = (3.25)^2(0.8) = 8.45\ \text{m/s}^2$$

$$a_A = \sqrt{(4)^2 + (8.45)^2} = 9.35\ \text{m/s}^2$$ **Ans.**

16–21.

A motor gives disk A an angular acceleration of $\alpha_A = (0.6t^2 + 0.75)\ \text{rad/s}^2$, where t is in seconds. If the initial angular velocity of the disk is $\omega_0 = 6\ \text{rad/s}$, determine the magnitudes of the velocity and acceleration of block B when $t = 2$ s.



SOLUTION

$$d\omega = \alpha\, dt$$

$$\int_6^{\omega} d\omega = \int_0^2 (0.6\,t^2 + 0.75)\, dt$$

$$\omega - 6 = (0.2\,t^3 + 0.75\,t)\Big|_0^2$$

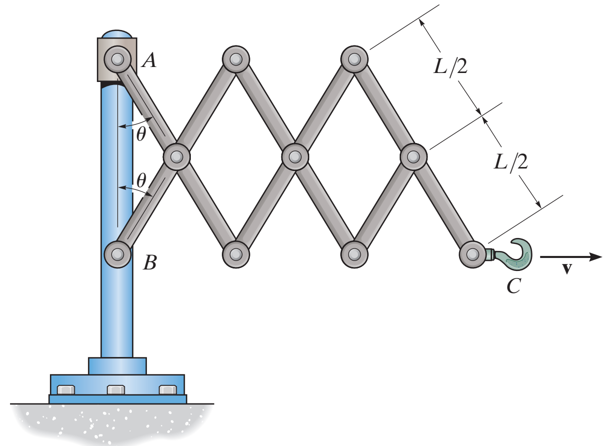
$$\omega = 9.10\ \text{rad/s}$$

$$v_B = \omega r = 9.10(0.15) = 1.37\ \text{m/s}$$ **Ans.**

$$a_B = a_t = \alpha r = [0.6(2)^2 + 0.75](0.15) = 0.472\ \text{m/s}^2$$ **Ans.**

16–42.

The mechanism shown is known as a Nuremberg scissors. If the hook at C moves with a constant velocity of $\mathbf{v}$, determine the velocity and acceleration of collar A as a function of θ. The collar slides freely along the vertical guide.



SOLUTION

$$x = 3L \sin\theta$$

$$v = \dot{x} = 3L\cos\theta\,\dot{\theta}$$

$$y = L\cos\theta$$

$$\dot{y} = -L\sin\theta\,\dot{\theta}$$

$$\frac{\dot{y}}{v} = -\frac{L\sin\theta\,\dot{\theta}}{3L\cos\theta\,\dot{\theta}}$$

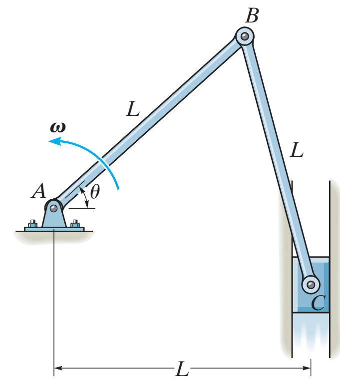
$$\dot{y} = (v\tan\theta)/3 \downarrow$$ **Ans.**

$$\ddot{y} = \frac{v}{3}(\sec^2\theta\,\dot{\theta}) = \frac{v}{3}\left(\frac{1}{\cos^2\theta}\right)\left(\frac{v}{3L\cos\theta}\right)$$

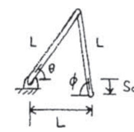
$$\ddot{y} = \frac{v^2}{9L\cos^3\theta}\downarrow$$ **Ans.**

16–49.

Bar AB rotates uniformly about the fixed pin A with a constant angular velocity $\boldsymbol{\omega}$. Determine the velocity and acceleration of block C, at the instant $\theta = 60°$.



SOLUTION



$$L\cos\theta + L\cos\phi = L$$

$$\cos\theta + \cos\phi = 1$$

$$\sin\theta\,\dot{\theta}] + \sin\phi\,\dot{\phi} = 0 \qquad \textbf{(1)}$$

$$\cos\theta(\dot{\theta})^2 + \sin\theta\ddot{\theta} + \sin\phi\ddot{\phi} + \cos\phi\ (\dot{\phi})^2 = 0 \qquad \textbf{(2)}$$

When $\theta = 60°, \phi = 60°$,

thus, $\dot{\theta} = -\dot{\phi} = \omega$ (from Eq. (1))

$\ddot{\theta} = 0$

$\ddot{\phi} = -1.155\omega^2$ (from Eq.(2))

Also, $s_C = L\sin\phi - L\sin\theta$

$$v_C = L\cos\phi\,\dot{\phi} - L\cos\theta\,\dot{\theta}$$

$$a_C = -L\sin\phi\,(\dot{\phi})^2 + L\cos\phi\,(\ddot{\phi}) - L\cos\theta(\ddot{\theta}) + L\sin\theta(\dot{\theta})^2$$

At $\theta = 60°, \phi = 60°$

$$s_C = 0$$

$$v_C = L(\cos 60°)(-\omega) - L\cos 60°(\omega) = -L\omega = L\omega\uparrow \qquad \textbf{Ans.}$$

$$a_C = -L\sin 60°(-\omega)^2 + L\cos 60°(-1.155\omega^2) + 0 + L\sin 60°(\omega)^2$$

$$a_C = -0.577\,L\omega^2 = 0.577\,L\omega^2\uparrow \qquad \textbf{Ans.}$$