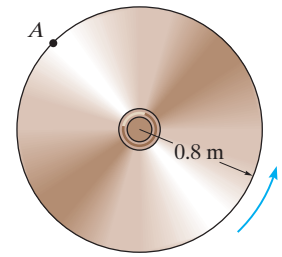


16-1.

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**

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

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

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

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

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

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

Ans.

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

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

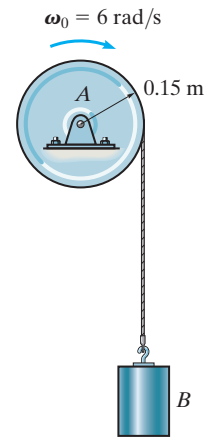
$$a_A = \sqrt{(4)^2 + (8.45)^2} = 9.35 \text{ m/s}^2$$

Ans.

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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 $t = 2 \text{ s}$.



SOLUTION

$$d\omega = \alpha dt$$

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

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

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

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

Ans.

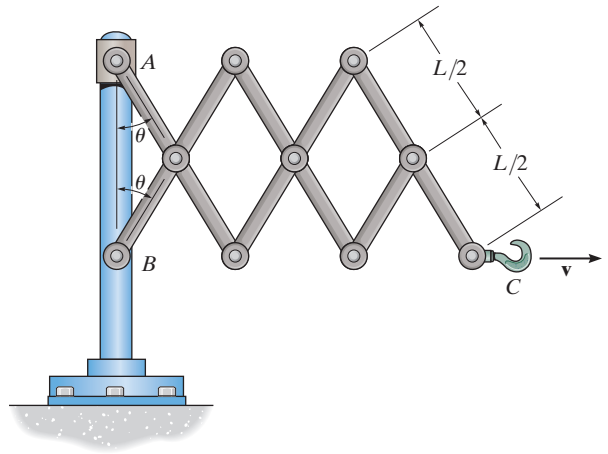
$$a_B = a_t = \alpha r = [0.6(2)^2 + 0.75](0.15) = 0.472 \text{ m/s}^2$$

Ans.

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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

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

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

$$y = L \cos \theta$$

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

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

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

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

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

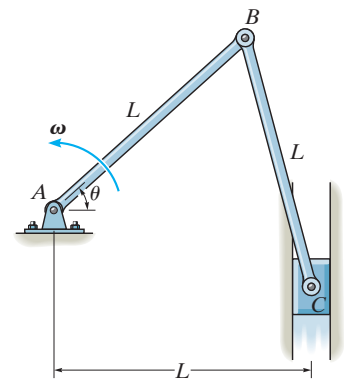
Ans.

Ans.

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16-49.

Bar AB rotates uniformly about the fixed pin A with a constant angular velocity ω . Determine the velocity and acceleration of block C , at the instant $\theta = 60^\circ$.



SOLUTION

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

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

$$\sin \theta \dot{\theta} + \sin \phi \dot{\phi} = 0 \tag{1}$$

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

When $\theta = 60^\circ, \phi = 60^\circ$,

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

$$\ddot{\theta} = 0$$

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

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

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

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

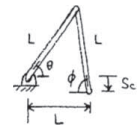
At $\theta = 60^\circ, \phi = 60^\circ$

$$s_C = 0$$

$$v_C = L(\cos 60^\circ)(-\omega) - L \cos 60^\circ(\omega) = -L\omega = L\omega \uparrow \tag{Ans.}$$

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

$$a_C = -0.577 L\omega^2 = 0.577 L\omega^2 \uparrow \tag{Ans.}$$



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