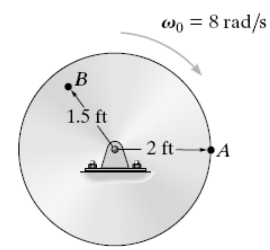
16-3

16–22. The disk is originally rotating at $\omega_0 = 8$ rad/s. If it is subjected to a constant angular acceleration of $\alpha = 6$ rad/s^2, determine the magnitudes of the velocity and the n and t components of acceleration of point B just after the wheel undergoes 2 revolutions.



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

$\omega^2 = (8)^2 + 2(6)[2(2\pi) - 0]$

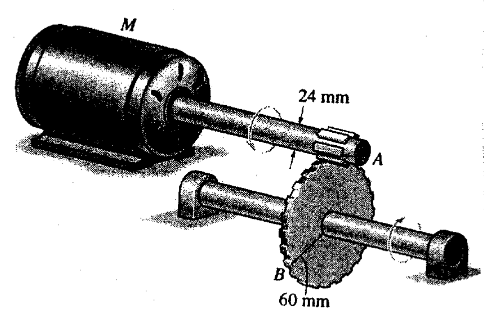
$\omega = 14.66$ rad/s

$v_B = \omega r = 14.66(1.5) = 22.0$ ft/s **Ans.**

$(a_B)_t = \alpha r = 6(1.5) = 9.00$ ft/s^2 **Ans.**

$(a_B)_n = \omega^2 r = (14.66)^2(1.5) = 322$ ft/s^2 **Ans.**

16-5. Due to an increase in power, the motor M rotates the shaft A with an angular acceleration of $\alpha = (0.06\theta^2)$ rad/s^2, where θ is in radians. If the shaft is initially turning at $\omega_0 = 50$ rad/s, determine the angular velocity of gear B after the shaft undergoes an angular displacement $\Delta\theta = 10$ rev.



$\omega\, d\omega = \alpha\, d\theta$

$\int_{50}^{\omega} \omega\, d\omega = \int_0^{2\pi(10)} 0.06\theta^2\, d\theta$

$\frac{1}{2}\omega^2\Big|_{50}^{\omega} = 0.02\theta^3\Big|_0^{2\pi(10)}$

$0.5\omega^2 - 1250 = 4961$

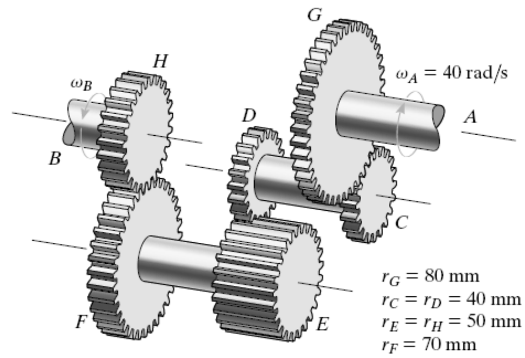
$\omega = 111.45$ rad/s

$\omega_A r_A = \omega_B r_B$

$(111.45)(12) = \omega_B(60)$

$\omega_B = 22.3$ rad/s **Ans**

•16–5. The operation of reverse gear in an automotive transmission is shown. If the engine turns shaft A at $\omega_A = 40$ rad/s, determine the angular velocity of the drive shaft, ω_B. The radius of each gear is listed in the figure.



$r_A \omega_A = r_C \omega_C$: $\quad 80(40) = 40\omega_C \quad \omega_C = \omega_D = 80$ rad/s

$\omega_E r_E = \omega_D r_D$: $\quad \omega_E(50) = 80(40) \quad \omega_E = \omega_F = 64$ rad/s

$\omega_F r_F = \omega_B r_B$: $\quad 64(70) = \omega_B(50) \quad \omega_B = 89.6$ rad/s

$\omega_B = 89.6$ rad/s **Ans.**

*Problem 16-36

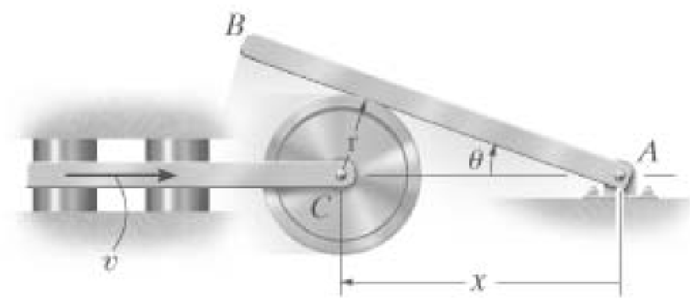
Determine the angular velocity of rod AB for the given θ. The shaft and the center of the roller C move forward at a constant rate v.

Given:

$$v = 5 \frac{\text{m}}{\text{s}}$$

$$\theta = 30 \text{ deg}$$

$$r = 100 \text{ mm}$$



Solution:

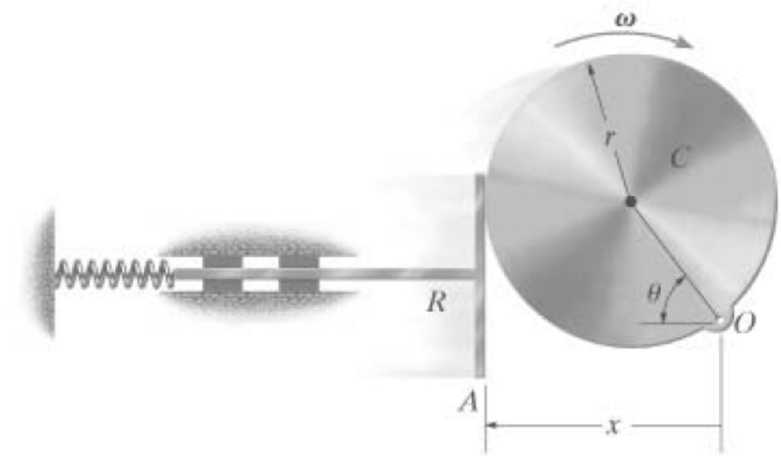
$$r = x\sin(\theta) \quad 0 = x'\sin(\theta) + x\cos(\theta)\theta' = -v\sin(\theta) + x\cos(\theta)\omega$$

$$x = \frac{r}{\sin(\theta)} \qquad \omega = \left(\frac{v}{x}\right)\tan(\theta) \qquad \omega = 14.43 \frac{\text{rad}}{\text{s}}$$

16-39

***Problem 16-40**

Determine the velocity of the rod R for any angle θ of cam C as the cam rotates with a constant angular velocity ω. The pin connection at O does not cause an interference with the motion of plate A on C.



Solution:

$$x = r + r\cos(\theta)$$

$$x' = -r\sin(\theta)\theta'$$

$$v = -r\omega\sin(\theta)$$

Problem 16-47

When the bar is at the angle θ the rod is rotating clockwise at ω and has an angular acceleration α. Determine the velocity and acceleration of the weight A at this instant. The cord is of length L.

Given:

$L = 20\ \text{ft}$

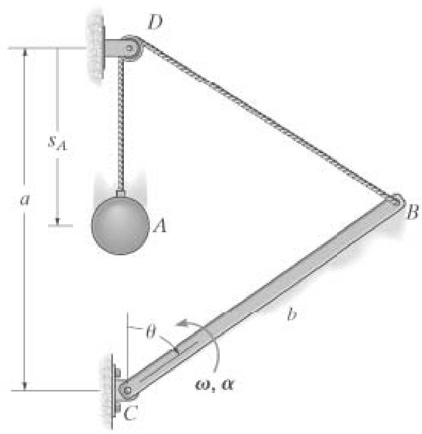
$a = 10\ \text{ft}$

$b = 10\ \text{ft}$

$\theta = 30\ \text{deg}$

$\omega = 3\ \frac{\text{rad}}{\text{s}}$

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



Solution: $\theta' = -\omega \qquad \theta'' = -\alpha$

$$s_A = L - \sqrt{a^2 + b^2 - 2ab\cos(\theta)}$$

$$v_A = \frac{-ab\sin(\theta)\theta'}{\sqrt{a^2 + b^2 - 2ab\cos(\theta)}}$$

$$a_A = \frac{-ab\sin(\theta)\theta'' - ab\cos(\theta)\,\theta'^2}{\sqrt{a^2 + b^2 - 2ab\cos(\theta)}} + \frac{(ab\sin(\theta)\theta')^2}{\sqrt{\left(a^2 + b^2 - 2ab\cos(\theta)\right)^3}}$$

$s_A = 14.82\ \text{ft}$ $\qquad v_A = 29.0\ \frac{\text{ft}}{\text{s}}$ $\qquad a_A = 59.9\ \frac{\text{ft}}{\text{s}^2}$