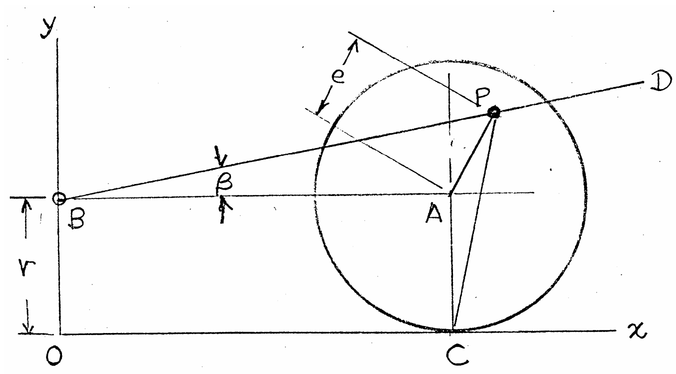
Chapter 15, Solution 151.



Coordinates.

$$x_A = (x_A)_0 + r\theta,\ y_A = r$$
$$x_B = 0,\ y_B = r$$
$$x_C = x_A,\ y_C = 0$$
$$x_P = x_A + e\sin\theta$$
$$y_P = r + e\cos\theta$$

Data: $(x_A)_0 = 24$ in.

$$r = 10 \text{ in.}$$
$$e = 7 \text{ in.}$$

Velocity analysis. $\boldsymbol{\omega}_{AC} = \omega_{AC} \circlearrowright,\ \boldsymbol{\omega}_{BD} = \omega_{BD} \circlearrowright,$

$$\mathbf{v}_P = \mathbf{v}_A + \mathbf{v}_{P/A} = [r\omega_{AC} \longrightarrow] + [e\omega_{AC} \searrow \theta]$$

$$\mathbf{v}_{P'} = [x_P\omega_{BD} \downarrow] + [(e\cos\theta)\omega_{BD} \longrightarrow]$$

$$\mathbf{v}_{P/F} = [u\cos\beta] \longrightarrow + [u\sin\beta \uparrow]$$

Use $\mathbf{v}_P = \mathbf{v}_{P'} + \mathbf{v}_{P/F}$ and resolve into components.

$$\xrightarrow{+}:\quad (r + e\cos\theta)\omega_{AC} = (e\cos\theta)\omega_{BD} + (\cos\beta)u \qquad (1)$$

$$+\downarrow:\quad (e\sin\theta)\omega_{AC} = x_P\omega_{BD} - (\sin\beta)u \qquad (2)$$

$$\theta = 30°, \qquad x_P = 24 + (10)\left(\frac{\pi}{6}\right) + 7\sin 30° = 32.736 \text{ in.}$$

$$\tan\beta = \frac{7\cos 30°}{32.736} \qquad \beta = 10.491°$$

Substituting into Eqs. (1) and (2)

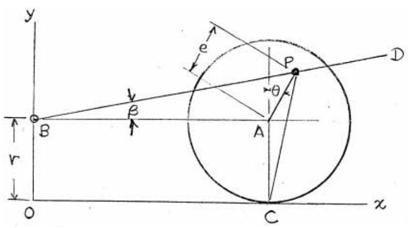
$$(10 + 7\cos 30°)(20) = (7\cos 30°)\omega_{BD} + (\cos 10.491°)u \qquad (1)$$

$$(7\sin 30°)(20) = 32.736\omega_{BD} - (\sin 10.491°)u \qquad (2)$$

Solving simultaneously, $\omega_{BD} = 3.82$ rad/s ↻ ◀

$u = 303.13$ in./s $\qquad \mathbf{v}_{P/F} = 25.3$ ft/s ∠ 10.49° ◀

Chapter 15, Solution 175.



Coordinates.

$$x_A = (x_A)_0 + r\theta, \qquad y_A = r$$

$$x_B = 0, \qquad y_B = r$$

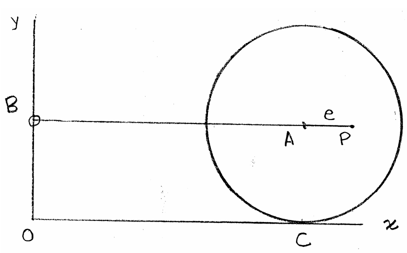
$$x_C = x_A, \qquad y_C = 0$$

$$x_P = x_A + e\sin\theta, \qquad y_P = r + e\cos\theta$$

Data: $(x_A)_0 = 24$ in.

$r = 10$ in.

$e = 7$ in.



$$\theta = 90^\circ \qquad x_P = 24 + (10)\left(\frac{\pi}{2}\right) + (7) = 46.708 \text{ in.}, \qquad \beta = 0$$

Velocity analysis.

$$\boldsymbol{\omega}_{AC} = 20 \text{ rad/s} \circlearrowright, \qquad \boldsymbol{\omega}_{BD} = \omega_{BD} \circlearrowright$$

$$\mathbf{v}_P = \mathbf{v}_A + \mathbf{v}_{P/A}$$

$$= [r\omega_{AC} \longrightarrow] + [e\omega_{AC} \downarrow]$$

$$= [(10)(20) \longrightarrow] + [(7)(20) \downarrow]$$

$$= [200 \text{ in./s} \longrightarrow] + [140 \text{ in./s} \downarrow]$$

$$\mathbf{v}_{P'} = [x_p\omega_{BD} \downarrow] = [46.708\omega_{BD} \downarrow], \qquad \mathbf{v}_{P/F} = u \longrightarrow$$

Use $\mathbf{v}_P = \mathbf{v}_{P'} + \mathbf{v}_{P/F}$ and resolve into components.

$\xrightarrow{+}$: $200 = u \qquad u = 200$ in./s.

$+\downarrow$: $140 = 46.708\omega_{BD} \qquad \omega_{BD} = 2.9973$ rad/s $\circlearrowright$

Acceleration analysis. $\boldsymbol{\alpha}_{AC} = 0, \qquad \boldsymbol{\alpha}_{BD} = \alpha_{BD} \circlearrowright$

$$\mathbf{a}_A = 0, \qquad \mathbf{a}_{P/A} = r\omega_{AB}^2 = (7)(20)^2 = 2800 \text{ in./s}^2 \longleftarrow$$

$$\mathbf{a}_P = \mathbf{a}_A + \mathbf{a}_{P/A} = 2800 \text{ in./s}^2 \longleftarrow$$

$$\mathbf{a}_{P'} = [x_P\alpha_{BD} \downarrow] + [x_P\omega_{BD}^2 \longleftarrow] = [46.708\alpha_{BD} \downarrow] + [(46.708)(2.9973)^2 \longleftarrow]$$

$$= [46.708\alpha_{BD} \downarrow] + [419.616 \text{ in./s}^2 \longleftarrow]$$

$$\mathbf{a}_{P/F} = \dot{u} \longrightarrow$$

Coriolis acceleration $2\omega_{BD}u = (2)(2.9973)(200) = 1198.92 \text{ in./s}^2 \downarrow$

Use $\mathbf{a}_P = \mathbf{a}_{P'} + \mathbf{a}_{P/F} + 2\omega_B u \downarrow$ and resolve into components.

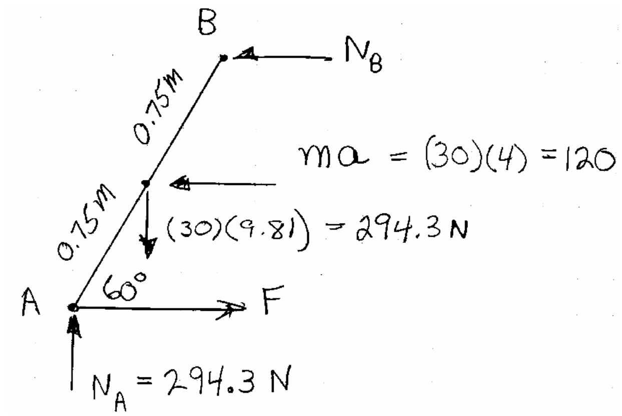
$\xrightarrow{+}$: $-2800 = -419.616 + \dot{u}$, $\dot{u} = -2380.4 \text{ in./s}^2$,

$+\downarrow$: $0 = 46.708\alpha_{BD} + 1198.92$ $\boldsymbol{\alpha}_{BD} = -25.7 \text{ rad/s}^2$

(*a*) $\boldsymbol{\alpha}_{BD} = 25.7 \text{ rad/s}^2 \circlearrowleft$ ◀

(*b*) $\mathbf{a}_{P/F} = 2380 \text{ in./s}^2 \longleftarrow$ $\mathbf{a}_{P/F} = 198.4 \text{ ft/s}^2 \longleftarrow$ ◀

Chapter 16, Solution 1.



$$+\circlearrowleft \ \Sigma M_A = N_B(1.5 \text{ m})\sin 60° - (294.3 \text{ N})(0.75 \text{ m})(\cos 60°)$$

$$= (30 \text{ kg})(4 \text{ m/s}^2)(\sin 60°)(0.75 \text{ m})$$

$$N_B = 144.96 \text{ N}$$

$$\overset{+}{\longleftarrow} \ \Sigma F_x = N_B - F = 30 \text{ kg}\left(4 \text{ m/s}^2\right)$$

$$F = 24.96 \text{ N}$$

(*a*) $$R_A = \sqrt{N_A^2 + F^2} = 295.36 \text{ N}$$

or $\mathbf{R}_A = 295$ N ∠ 85.2° ◀

$$\alpha = \tan^{-1}\frac{294.3}{24.96} = 85.2°$$

and $B = 145.0$ N ⟵ ◀

(*b*) $$\mu = \frac{F}{N_A} = \frac{24.96}{294.3} = 0.08481$$

or $\mu = 0.0848$ ◀