

Chapter 15, Solution 43.

In units of mm/s,

$$\mathbf{v}_{B/A} = \boldsymbol{\omega} \times \mathbf{r}_{B/A} = \boldsymbol{\omega} \times (125\mathbf{i} + 75\mathbf{j}) = -75\boldsymbol{\omega}\mathbf{i} + 125\boldsymbol{\omega}\mathbf{j}$$

$$\mathbf{v}_{C/A} = \boldsymbol{\omega} \times \mathbf{r}_{C/A} = \boldsymbol{\omega} \times (50\mathbf{i} + 150\mathbf{j}) = -150\boldsymbol{\omega}\mathbf{i} + 50\boldsymbol{\omega}\mathbf{j}$$

$$\mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A}$$

$$(v_B)_x \mathbf{i} - 75\mathbf{j} = 100\mathbf{i} + (v_A)_y \mathbf{j} - 75\boldsymbol{\omega}\mathbf{i} + 125\boldsymbol{\omega}\mathbf{j}$$

Components.

$$\mathbf{i}: (v_B)_x = 100 - 75\boldsymbol{\omega} \quad (1)$$

$$\mathbf{j}: -75 = (v_A)_y + 125\boldsymbol{\omega} \quad (2)$$

$$\mathbf{v}_C = \mathbf{v}_A + \mathbf{v}_{C/A}$$

$$400\mathbf{i} + (v_C)_y \mathbf{j} = 100\mathbf{i} + (v_A)_y \mathbf{j} - 150\boldsymbol{\omega}\mathbf{i} + 50\boldsymbol{\omega}\mathbf{j}$$

Components.

$$\mathbf{i}: 400 = 100 - 150\boldsymbol{\omega} \quad (3)$$

$$\mathbf{j}: (v_C)_y = (v_A)_y + 125\boldsymbol{\omega} \quad (4)$$

(a) From (3),

$$\boldsymbol{\omega} = -2 \text{ rad/s}$$

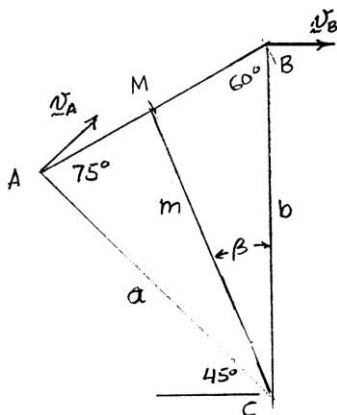
$$\boldsymbol{\omega} = -(2 \text{ rad/s})\mathbf{k} \blacktriangleleft$$

(b) From (2),

$$(v_A)_y = -75 - 125\boldsymbol{\omega} = -75 - 125(-2) = 175 \text{ mm/s}$$

$$\mathbf{v}_A = (100.0 \text{ mm/s})\mathbf{i} + (175.0 \text{ mm/s})\mathbf{j} \blacktriangleleft$$

Chapter 15, Solution 87.



$$\mathbf{v}_A = v_A \angle 45^\circ, \quad \mathbf{v}_B = 7.5 \text{ ft/s} \rightarrow$$

Locate the instantaneous center (point C) of rod AB by noting that velocity directions at points A and B are known. Draw AC perpendicular to \mathbf{v}_A and BC perpendicular to \mathbf{v}_B .

Let $l = AB = 24 \text{ in.} = 2 \text{ ft}$

Law of sines for triangle ABC .

$$\frac{b}{\sin 75^\circ} = \frac{a}{\sin 60^\circ} = \frac{l}{\sin 45^\circ} = 2.8284 \text{ ft}$$

$$a = 2.4495 \text{ ft}, \quad b = 2.73205 \text{ ft}$$

$$\omega = \frac{v_B}{b} = \frac{7.5}{2.73205} = 2.7452 \text{ rad/s}$$

(a) $v_A = a\omega = (2.4495)(2.7452) = 6.724 \text{ ft/s}$

$$\mathbf{v}_A = 6.72 \text{ ft/s} \angle 45.0^\circ \blacktriangleleft$$

(b) $\omega = 2.75 \text{ rad/s} \blacktriangleleft$

(c) Let M be the midpoint of AB .

Law of cosines for triangle CMB .

$$\begin{aligned} m^2 &= b^2 + \left(\frac{l}{2}\right)^2 - 2b\frac{l}{2}\cos 60^\circ \\ &= (2.73205)^2 + (1)^2 - (2)(2.73205)(1)\cos 60^\circ \\ m &= 2.3942 \text{ ft} \end{aligned}$$

Law of sines.

$$\frac{\sin \beta}{\frac{l}{2}} = \frac{\sin 60^\circ}{m}, \quad \sin \beta = \frac{1 \sin 60^\circ}{2.3942}, \quad \beta = 21.2^\circ$$

$$v_M = m\omega = (2.3942)(2.7452) = 6.573 \text{ ft/s},$$

$$\mathbf{v}_M = 6.57 \text{ ft/s} \angle 21.2^\circ \blacktriangleleft$$