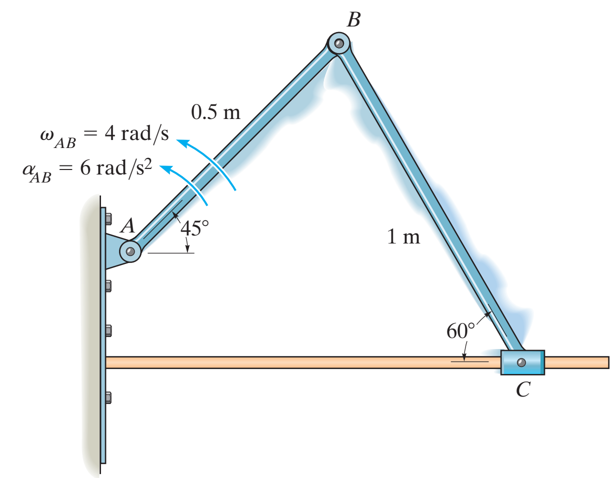
16–103.

Bar AB has the angular motions shown. Determine the velocity and acceleration of the slider block C at this instant.



SOLUTION

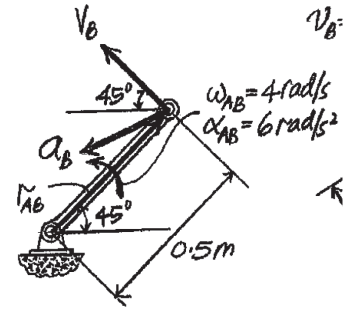
Rotation About A Fixed Axis. For link AB, refer to Fig. a.

$$v_B = \omega_{AB} r_{AB} = 4(0.5) = 2.00 \text{ m/s } 45^\circ$$

$$\mathbf{a}_B = \boldsymbol{\alpha}_{AB} \times \mathbf{r}_{AB} - \omega_{AB}^2 \mathbf{r}_{AB}$$

$$= 6\mathbf{k} \times (0.5 \cos 45^\circ \mathbf{i} + 0.5 \sin 45^\circ \mathbf{j}) - 4^2(0.5 \cos 45^\circ \mathbf{i} + 0.5 \sin 45^\circ \mathbf{j})$$

$$= \{-5.5\sqrt{2}\mathbf{i} - 2.5\sqrt{2}\mathbf{j}\} \text{ m/s}^2$$



(a)

General Plane Motion. The IC of link BC can be located using $\mathbf{v}_B$ and $\mathbf{v}_C$ as shown in Fig. b. From the geometry of this figure,

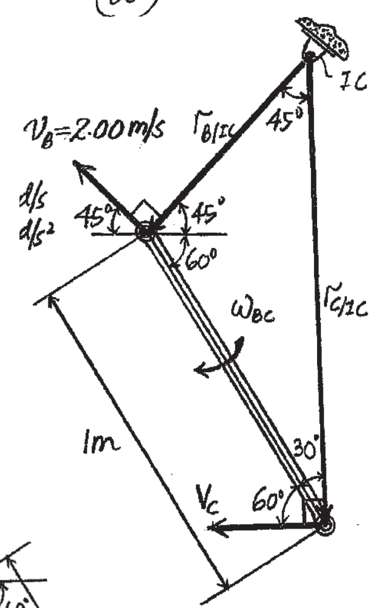
$$\frac{r_{B/IC}}{\sin 30^\circ} = \frac{1}{\sin 45^\circ}; \qquad r_{B/IC} = \frac{\sqrt{2}}{2} \text{ m}$$

$$\frac{r_{C/IC}}{\sin 105^\circ} = \frac{1}{\sin 45^\circ}; \qquad r_{C/IC} = 1.3660 \text{ m}$$

Then the kinematics gives,

$$v_B = \omega_{BC}\, r_{B/IC}; \qquad 2 = \omega_{BC}\left(\frac{\sqrt{2}}{2}\right) \qquad \omega_{BC} = 2\sqrt{2} \text{ rad/s}$$

$$v_C = \omega_{BC} r_{B/IC}; \qquad v_C = \left(2\sqrt{2}\right)(1.3660) = 3.864 \text{ m/s} = 3.86 \text{ m/s} \leftarrow \qquad \textbf{Ans.}$$



(b)

Applying the relative acceleration equation by referring to Fig. c,

$$\mathbf{a}_C = \mathbf{a}_B + \boldsymbol{\alpha}_{BC} \times \mathbf{r}_{C/B} - \omega_{BC}^2\, \mathbf{r}_{C/B}$$

$$-a_C\mathbf{i} = \left(-5.5\sqrt{2}\mathbf{i} - 2.5\sqrt{2}\mathbf{j}\right) + (-\alpha_{BC}\mathbf{k}) \times (1 \cos 60^\circ \mathbf{i} - 1 \sin 60^\circ \mathbf{j})$$

$$- \left(2\sqrt{2}\right)^2(1 \cos 60^\circ \mathbf{i} - 1 \sin 60^\circ \mathbf{j})$$

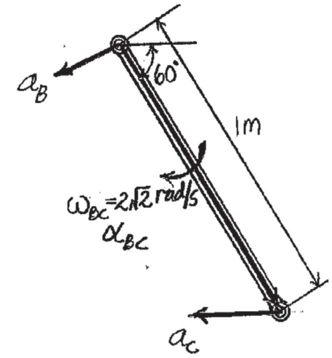
$$-a_C\mathbf{i} = \left(-\frac{\sqrt{3}}{2}\alpha_{BC} - 11.7782\right)\mathbf{i} + (3.3927 - 0.5\alpha_{BC})\mathbf{j}$$

Equating $\mathbf{j}$ components,

$$0 = 3.3927 - 0.5\alpha_{BC}; \qquad \alpha_{BC} = 6.7853 \text{ rad/s}^2$$

Then, $\mathbf{i}$ component gives

$$-a_C = -\frac{\sqrt{3}}{2}(6.7853) - 11.7782; \qquad a_C = 17.65 \text{ m/s}^2 = 17.7 \text{ m/s}^2 \leftarrow \qquad \textbf{Ans.}$$



(c)

Ans:
$v_C = 3.86 \text{ m/s} \leftarrow$
$a_C = 17.7 \text{ m/s}^2 \leftarrow$