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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.

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

 $\mathbf{a}_B = \boldsymbol{\alpha}_{AB} \times \mathbf{r}_{AB} - \omega_{AB}^2 \mathbf{r}_{AB}$ = 6k × (0.5 cos 45°i + 0.5 sin 45°j) - 4²(0.5 cos 45°i + 0.5 sin 45°j)

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

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,

$$v_B = \omega_{BC} r_{B/IC};$$
 $2 = \omega_{BC} \left(\frac{\sqrt{2}}{2}\right) \qquad \omega_{BC} = 2\sqrt{2} \text{ rad/s}$
 $v_C = \omega_{BC} r_{B/IC}; \qquad v_C = (2\sqrt{2})(1.3660) = 3.864 \text{ m/s} = 3.86 \text{ m/s} \leftarrow \text{ Arr}$

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

$$\mathbf{a}_{C} = \mathbf{a}_{B} + \alpha_{BC} \times \mathbf{r}_{C/B} - \omega_{BC}^{2} r_{C/B}$$
$$-a_{C}\mathbf{i} = (-5.5\sqrt{2}\mathbf{i} - 2.5\sqrt{2}\mathbf{j}) + (-\alpha_{BC}\mathbf{k}) \times (1\cos 60^{\circ}\mathbf{i} - 1\sin 60^{\circ}\mathbf{j})$$
$$- (2\sqrt{2})^{2}(1\cos 60^{\circ}\mathbf{i} - 1\sin 60^{\circ}\mathbf{j})$$

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

Equating j components,

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

Then, i component gives

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

