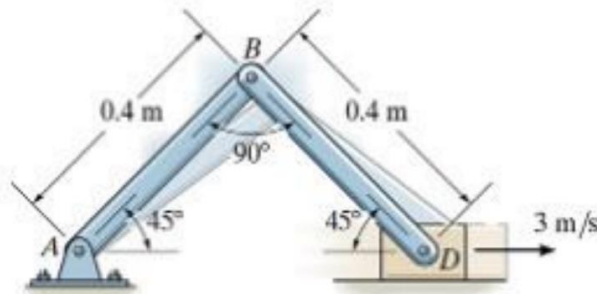


Upload a copy of your completed homework to uLearn AND turn in a physical copy in class.
For full credit, you must show your work at how you arrived at the answer

- In class we did the following example using methods of instantaneous centers. Show that you will get the same solution if you use the relative velocity (vector) approach.



Link BD

$$\mathbf{V}_B = \mathbf{V}_D + \omega_{BD} \times \mathbf{r}_{B/D}$$

$$\mathbf{V}_B = 3\hat{i} + \omega_{BD} \hat{k} \times 0.4\cos 45^\circ \hat{i} + 0.4\sin 45^\circ \hat{j}$$

$$-0.282\omega_{BD}\hat{j} - 0.282\omega_{BD}\hat{i}$$

Link AB

$$\mathbf{V}_B = \omega_{AB} \times \mathbf{r}_B$$

$$\mathbf{V}_B = \omega_{AB} \hat{k} \times 0.4\cos 45^\circ \hat{i} + 0.4\sin 45^\circ \hat{j}$$

$$3\hat{i} - 0.282\omega_{BD}\hat{j} - 0.282\omega_{BD}\hat{i} = 0.282\omega_{AB}\hat{j} - 0.282\omega_{AB}\hat{i}$$

$$\hat{i}: 3 - 0.282\omega_{BD} = -0.282\omega_{AB}$$

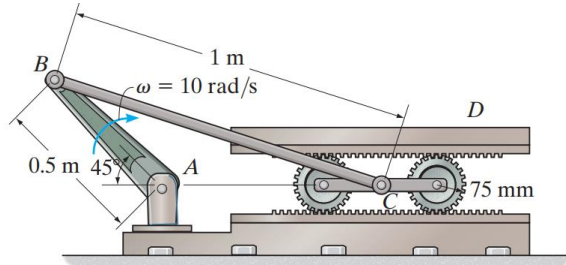
$$3 - 0.282\omega_{BD} = -0.282(-\omega_{BD}) \Rightarrow \omega_{BD} = 5.31 \text{ rad/s } \uparrow$$

$$\hat{j}: -0.282\omega_{BD} = 0.282\omega_{AB}$$

$$-\omega_{BD} = \omega_{AB}$$

$$\omega_{AB} = -5.31 \text{ rad/s} = 5.31 \text{ rad/s } \downarrow$$

2. The mechanism below is driven by link AB. If this rotates clockwise at 10 rad/s determine the velocity of point C at the instant shown. Use vector methods. Hint: Use law of sines to determine the angle that link BD makes with the horizontal. Ans $V_C = 2.2 \text{ m/s}$



Rotation About a Fixed Axis: Referring to Fig. a,

$$\begin{aligned} \mathbf{v}_B &= \boldsymbol{\omega} \times \mathbf{r}_B \\ &= (-10\mathbf{k}) \times (-0.5\cos 45^\circ \mathbf{i} + 0.5\sin 45^\circ \mathbf{j}) \\ &= [3.536\mathbf{i} + 3.536\mathbf{j}] \text{ m} \end{aligned}$$

General Plane Motion: Applying the law of sines to the geometry shown in Fig. b,

$$\frac{\sin \phi}{0.5} = \frac{\sin 135^\circ}{1} \quad \phi = 20.70^\circ$$

Applying the relative velocity equation to the kinematic diagram of link BC shown in Fig. c,

$$\begin{aligned} \mathbf{v}_B &= \mathbf{v}_C + \boldsymbol{\omega}_{BC} \times \mathbf{r}_{B/C} \\ 3.536\mathbf{i} + 3.536\mathbf{j} &= v_C \mathbf{i} + (-\omega_{BC} \mathbf{k}) \times (-1\cos 20.70^\circ \mathbf{i} + 1\sin 20.70^\circ \mathbf{j}) \\ 3.536\mathbf{i} + 3.536\mathbf{j} &= (v_C + 0.3536\omega_{BC})\mathbf{i} + 0.9354\omega_{BC} \mathbf{j} \end{aligned}$$

Equating the \mathbf{i} and \mathbf{j} components yields,

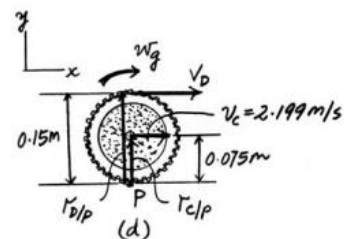
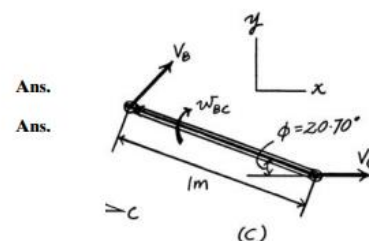
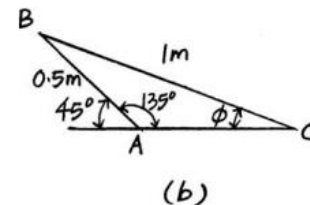
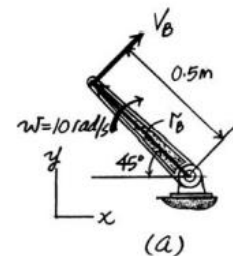
$$3.536 = v_C + 0.3536\omega_{BC}$$

$$3.536 = 0.9354\omega_{BC}$$

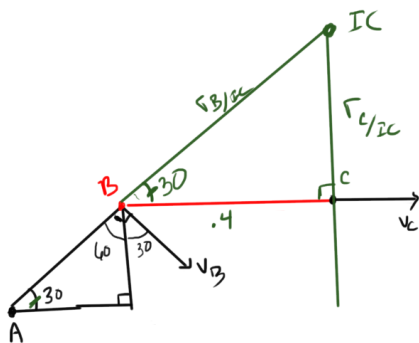
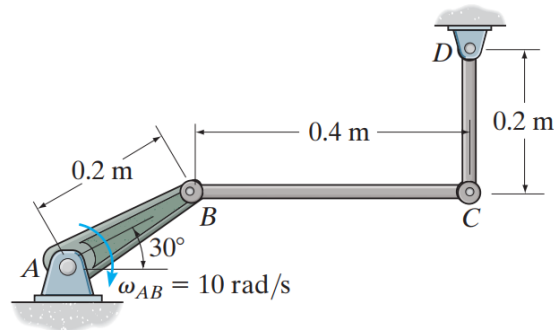
Solving,

$$\omega_{BC} = 3.780 \text{ rad/s}$$

$$v_C = 2.199 \text{ m/s}$$



3. Using methods of instantaneous centers, determine the angular velocity of links BC and CD at the instant shown. $\omega_{BC} = 4.33 \frac{\text{rad}}{\text{s}}$, $\omega_{CD} = 5 \frac{\text{rad}}{\text{s}}$



*Can use law of sines or SOHCAHTOA because it is a right triangle to get the lengths

F16-18. $v_B = \omega_{AB} r_{B/A} = 10(0.2) = 2 \text{ m/s}$

$$v_C = \omega_{CD} r_{C/D} = \omega_{CD}(0.2) \rightarrow$$

$$r_{B/IC} = \frac{0.4}{\cos 30^\circ} = 0.4619 \text{ m}$$

$$r_{C/IC} = 0.4 \tan 30^\circ = 0.2309 \text{ m}$$

$$\omega_{BC} = \frac{v_B}{r_{B/IC}} = \frac{2}{0.4619} = 4.330 \text{ rad/s}$$

$$= 4.33 \text{ rad/s}$$

Ans.

$$v_C = \omega_{BC} r_{C/IC}$$

$$\omega_{CD}(0.2) = 4.330(0.2309)$$

$$\omega_{CD} = 5 \text{ rad/s}$$

Ans.