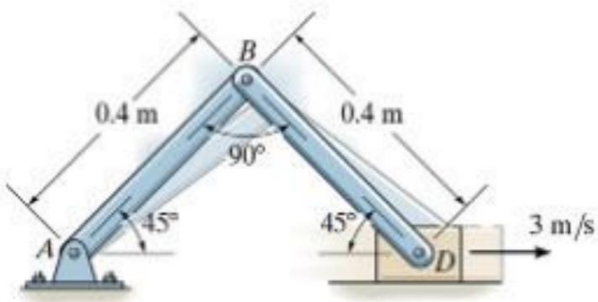
<u>Upload a copy of your completed homework to uLearn AND turn in a physical copy in class.</u>
<u>For full credit, you must show your work at how you arrived at the answer</u>

1. 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

$$V_B = V_D + \omega_{BD} \times r_{B/D}$$

$$V_B = 3\hat{i} + \underbrace{\omega_{BD}\hat{k} \times -0.4\cos45\hat{i} + 0.4\sin45\hat{j}}_{-0.282\omega_{BD}\hat{j} - 0.282\omega_{BD}\hat{i}}$$

Link AB

$$V_B = \omega_{AB} \times r_B$$

$$V_B = \omega_{AB}\hat{k} \times 0.4\cos45\hat{i} + 0.4\sin45\hat{j}$$

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

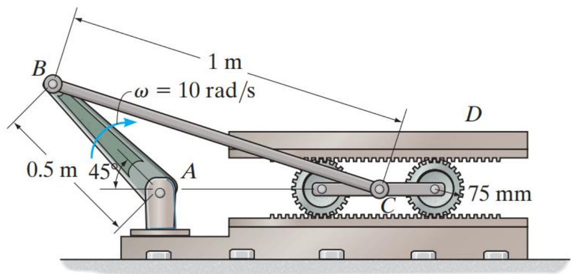
$$\hat{i}: \ 3 - 0.282\omega_{BD} = -0.282\,\omega_{AB}$$

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

$$\hat{j}: \ -0.\cancel{282}\omega_{BD} = 0.\cancel{282}\omega_{AB}$$

$$-\omega_{BD} = \omega_{AB} \leftarrow \boxed{\omega_{AB} = -5.31 \text{ rad/s} = 5.31 \text{ rad/s}}$$

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 $V_C = 2.2$ m/s



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

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

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

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

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

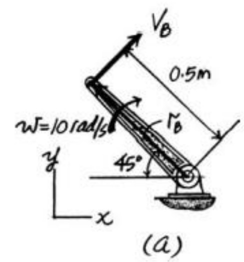
$$\mathbf{v}_B = \mathbf{v}_C + \boldsymbol{\omega}_{BC} \times \mathbf{r}_{B/C}$$
$$3.536\mathbf{i} + 3.536\mathbf{j} = v_C\,\mathbf{i} + (-\omega_{BC}\,\mathbf{k}) \times (-1\cos 20.70^\circ\,\mathbf{i} + 1\sin 20.70^\circ\,\mathbf{j})$$
$$3.536\mathbf{i} + 3.536\mathbf{j} = (v_C + 0.3536\omega_{BC})\mathbf{i}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

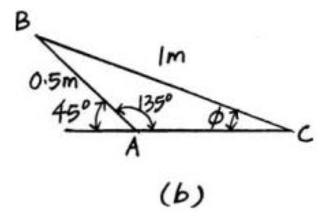
Equating the **i** and **j** components yields,

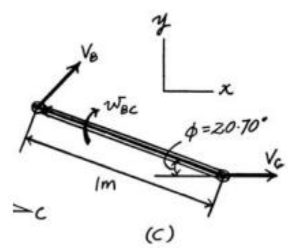
$$3.536 = v_C + 0.3536\omega_{BC}$$
$$3.536 = 0.9354\omega_{BC}$$

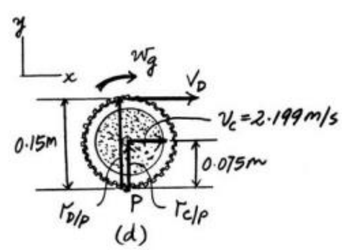
Solving,

$$\omega_{BC} = 3.780\text{ rad/s} \qquad \textbf{Ans.}$$
$$v_C = 2.199\text{ m/s} \qquad \textbf{Ans.}$$

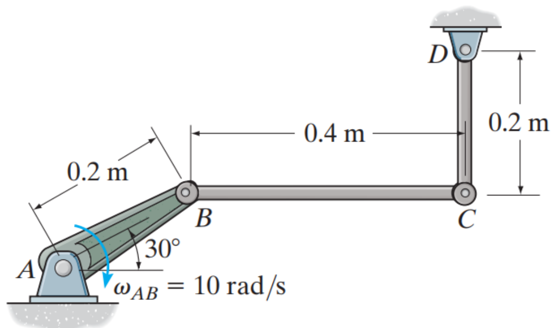








3. Using methods of instantaneous centers, determine the angular velocity of links BC and CD at the instant shown. $\omega_{BC} = 4.33\frac{rad}{s}, \omega_{CD} = 5\frac{rad}{s}$



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

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

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

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

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

$$= 4.33 \text{ rad/s} \qquad \textit{Ans.}$$

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

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

$$\omega_{CD} = 5 \text{ rad/s} \qquad \textit{Ans.}$$