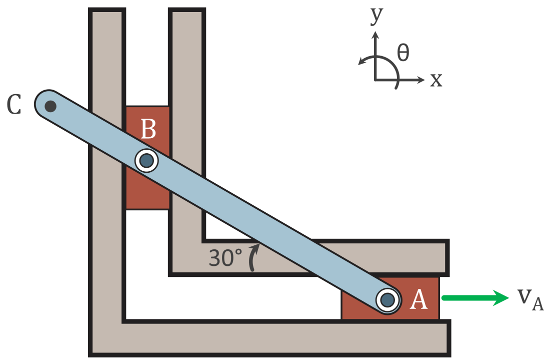
# Linked Bodies




**Determine the speed of point** C**. With** $L_{AC} = 1$ m **and** $L_{BC} = 0.25$ m**.**
**Note:** $\omega = 8$ rad/s**,** $v_A = 3$ m/s**, and** $v_B$ **=**$-\frac{1}{3}\sqrt{3}$ m/s**.**

*Using known expressions*:

$$\boldsymbol{v_{C/A}} = \boldsymbol{v_A} + \boldsymbol{\omega} \times \boldsymbol{r_{C/A}} \tag{1}$$

$$\boldsymbol{v_{C/B}} = \boldsymbol{v_B} + \boldsymbol{\omega} \times \boldsymbol{r_{C/B}} \tag{2}$$

$$|v_C| = \sqrt{{v_{C,x}}^2 + {v_{C,y}}^2 + {v_{C,z}}^2} \tag{3}$$

*Given*:
Distance between A and C: $L_{AC} = 1$ m
Distance between A and B: $L_{AB} = 0.75$ m
Angle of the blue bar: $\theta = 30°$
Velocity of C: $v_C = 3$ m/s
Velocity of B: $v_B = -3\sqrt{3}$ m/s
Angular velocity: $\omega = 8$ rad/s

There are two ways to solve this problem, either use Equation 1 or 2. Here we will show both solutions, we start with the method using $v_A$ and $r_{C/A}$ of Equation 1.

Inserting results in:

$$\boldsymbol{v_{C/A}} = \boldsymbol{v_A} + \boldsymbol{\omega} \times \boldsymbol{r_{C/A}} \quad \Rightarrow \quad \boldsymbol{v_{C/A}} = \begin{pmatrix} v_A \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ \omega \end{pmatrix} \times \begin{pmatrix} -\cos 30 \\ \sin 30 \\ 0 \end{pmatrix} L_{AC} = \tag{4}$$

$$\begin{pmatrix} v_A \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -\sin 30 \\ -\cos 30 \\ 0 \end{pmatrix} L_{AC} \cdot \omega = \begin{pmatrix} 3 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -\frac{1}{2} \\ -\frac{1}{2}\sqrt{3} \\ 0 \end{pmatrix} \cdot 8 = \begin{pmatrix} -1 \\ -4\sqrt{3} \\ 0 \end{pmatrix}$$

Inserting this in Equation 3 gives the speed of point C.

$$|v_C| = \sqrt{{v_{C,x}}^2 + {v_{C,y}}^2 + {v_{C,z}}^2} \quad \Rightarrow \quad |v_C| = \sqrt{(-1)^2 + (-4\sqrt{3})^2} = 7 \text{ m/s} \tag{5}$$

For method two we insert $v_B$ and $L_{BC}$ in Equation 2.

$$\boldsymbol{v_{C/B}} = \boldsymbol{v_B} + \boldsymbol{\omega} \times \boldsymbol{r_{C/B}} \quad \Rightarrow \quad \boldsymbol{v_{C/B}} = \begin{pmatrix} 0 \\ v_B \\ 0 \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ \omega \end{pmatrix} \times \begin{pmatrix} -\cos 30 \\ \sin 30 \\ 0 \end{pmatrix} L_{BC} = \tag{6}$$

$$\begin{pmatrix} 0 \\ v_B \\ 0 \end{pmatrix} + \begin{pmatrix} -\sin 30 \\ -\cos 30 \\ 0 \end{pmatrix} L_{BC} \cdot \omega = \begin{pmatrix} 0 \\ -3\sqrt{3} \\ 0 \end{pmatrix} + \begin{pmatrix} -\frac{1}{2} \\ -\frac{1}{2}\sqrt{3} \\ 0 \end{pmatrix} \frac{1}{4} \cdot 8 = \begin{pmatrix} -1 \\ -4\sqrt{3} \\ 0 \end{pmatrix}$$

Inserting this in Equation 3 gives the speed of point C.

$$|v_C| = \sqrt{{v_{C,x}}^2 + {v_{C,y}}^2 + {v_{C,z}}^2} \quad \Rightarrow \quad |v_C| = \sqrt{(-1)^2 + (-4\sqrt{3})^2} = 7 \text{ m/s} \tag{7}$$