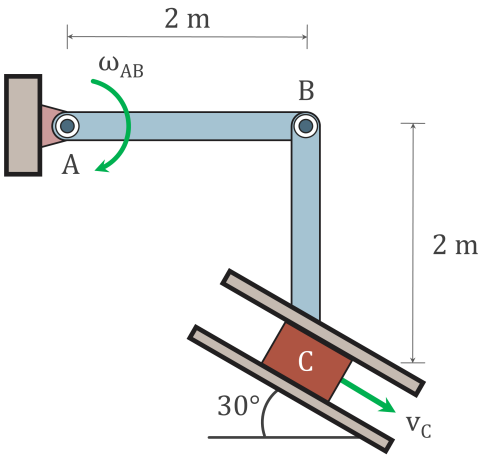
Sliding Block



A slider block moves inside a tilted cylinder with a velocity of $v_C = 8$ m/s. Determine the angular velocity of the link AB, if the length of AB and BC is 2 m.

Using known expressions:

$$\boldsymbol{v_B} = \boldsymbol{v_A} + \boldsymbol{\omega_{AB}} \times \boldsymbol{r_{B/A}} \tag{1}$$

$$\boldsymbol{v_C} = \boldsymbol{v_B} + \boldsymbol{\omega_{BC}} \times \boldsymbol{r_{C/B}} \tag{2}$$

Given:
Velocity of point C: $v_C = 8$ m/s
Length AB: $L_{AB} = 2$ m
Length BC: $L_{BC} = 2$ m
Angle: $\theta = 30°$

From the image can be seen that v_A is zero, since A is a fixed point. From this Equation 1 becomes.

$$\boldsymbol{v_B} = 0 + \boldsymbol{\omega_{AB}} \times \boldsymbol{r_{B/A}} \quad \Rightarrow \quad \boldsymbol{v_B} = \begin{pmatrix} 0 \\ 0 \\ -\omega_{AB} \end{pmatrix} \times \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} \quad \Rightarrow \quad \boldsymbol{v_B} = \begin{pmatrix} 0 \\ -2 \\ 0 \end{pmatrix} \omega_{AB} \tag{3}$$

Inserting this in Equation 2 results in.

$$\boldsymbol{v_C} = \boldsymbol{v_B} + \boldsymbol{\omega_{BC}} \times \boldsymbol{r_{C/B}} \quad \Rightarrow \quad \boldsymbol{v_C} = \begin{pmatrix} 0 \\ -2 \\ 0 \end{pmatrix} \omega_{AB} + \begin{pmatrix} 0 \\ 0 \\ \omega_{BC} \end{pmatrix} \times \begin{pmatrix} 0 \\ -2 \\ 0 \end{pmatrix} \tag{4}$$

$$\boldsymbol{v_C} = \begin{pmatrix} 2 \cdot \omega_{BC} \\ -2 \cdot \omega_{AB} \\ 0 \end{pmatrix} \tag{5}$$

We can decompose the given velocity of point C under the angle θ in the x-and y-direction as follows.

$$\boldsymbol{v_C} = \begin{pmatrix} v_C \cdot \cos\theta \\ -v_C \cdot \sin\theta \\ 0 \end{pmatrix} \tag{6}$$

From Equation 5 and 6 ω_{AB} can be solved.

$$\begin{pmatrix} 2 \cdot \omega_{BC} \\ -2 \cdot \omega_{AB} \\ 0 \end{pmatrix} = \begin{pmatrix} v_C \cdot \cos\theta \\ -v_C \cdot \sin\theta \\ 0 \end{pmatrix} \quad \Rightarrow \quad -2 \cdot \omega_{AB} = -v_C \cdot \sin\theta \tag{7}$$

$$\omega_{AB} = \frac{-v_C \cdot \sin\theta}{-2} \quad \Rightarrow \quad \omega_{AB} = \frac{8 \cdot \sin 30}{2} = 2 \text{ rad/s}$$