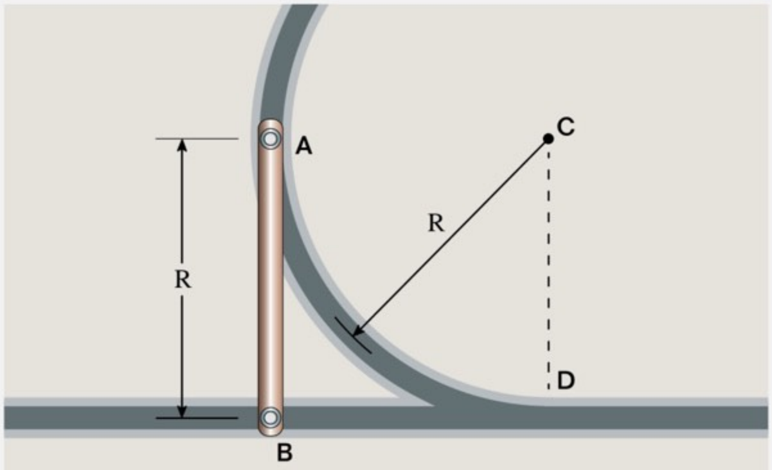
22-R-KM-TW-5



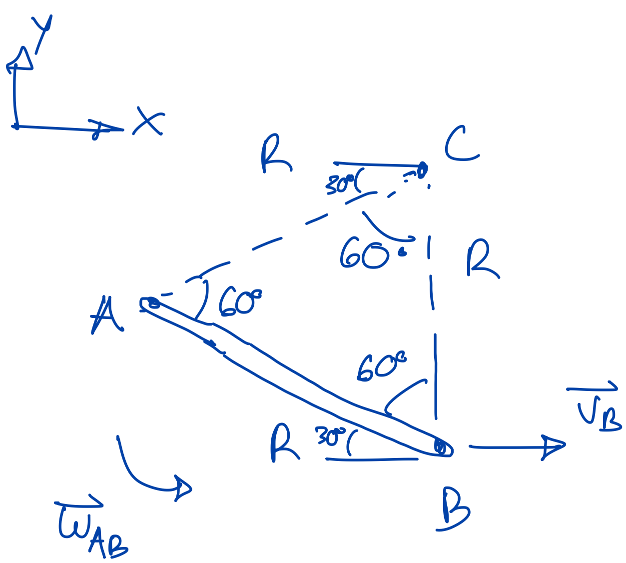
A rod is moving along a circular sliding track with a radius $R = 8\ m$. The point B is moving at a constant velocity of $1\ m/s$ to the right (positive $\hat{i}$ direction). At the instant that point B is at the point D, what is the velocity of point A?

Solve using the method of instantaneous center of zero velocity.

$\vec{r}_{CA}$ [ ] Equation Editor $\hat{i}$ + [ ] Equation Editor $\hat{j}\ m/s$

$\vec{\omega}_C =$ [ ] Equation Editor $\hat{k}\ rad/s$

$\vec{v}_A =$ [ ] Equation Editor $\hat{i}$ + [ ] Equation Editor $\hat{j}\ m/s$



$\vec{v}_B = 1\ m/s\ \hat{i}$

IC is C

$\vec{r}_{B/IC} = -R\hat{j}$ $\quad \vec{\omega}_{AB} = \omega_{AB}\hat{k}$

$\vec{v}_B = \vec{\omega}_{AB} \times \vec{r}_{B/IC}$

$= \omega_{AB}\hat{k} \times -R\hat{j}$

$1\ m/s\ \hat{i} = \omega_{AB} R\, \hat{i}$

$\Rightarrow \omega_{AB} = \frac{1}{R}\ rad/s = \frac{1}{8}\ rad/s$

$$\vec{V}_A = \vec{V}_B + \vec{\omega}_{AB} \times \vec{r}_{A/B} \qquad \vec{r}_{A/B} = R(-\cos 30\,\hat{i} + \sin 30\,\hat{j})$$

$$= 1\,\hat{i} + \frac{1}{8}\hat{k} \times R(-\cos 30\,\hat{i} + \sin 30\,\hat{j})$$

$$= 1\,\hat{i} - \frac{1}{\cancel{8}}\cancel{R}\cos 30\,\hat{j} - \frac{1}{8}\cancel{R}\sin 30\,\hat{i}$$

$$= 1\,\hat{i} - \cos 30\,\hat{j} - \sin 30\,\hat{i}$$

$$= (1 - \sin 30)\,\hat{i} - \cos 30\,\hat{j} = (1 - 0.5)\,\hat{i} - \frac{\sqrt{3}}{2}\hat{j}$$

$$= 0.5\,\hat{i} - \frac{\sqrt{3}}{2}\hat{j}$$

OR

$$\vec{V}_A = \vec{\omega}_{AB} \times \vec{r}_{A/IC} \qquad \vec{r}_{A/IC} = R(-\cos 30\,\hat{i} - \sin 30\,\hat{j})$$

$$= \frac{1}{\cancel{R}}\hat{k} \times \cancel{R}(-\cos 30\,\hat{i} - \sin 30\,\hat{j})$$

$$= -\cos 30\,\hat{j} + \sin 30\,\hat{i}$$

$$= -\frac{\sqrt{3}}{2}\hat{j} + 0.5\,\hat{i} \qquad \text{(same)}$$