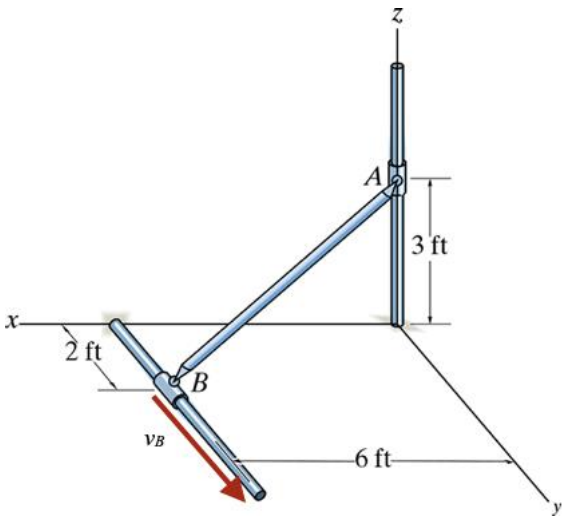
Quiz 18: Chapter 20

Due: Tuesday 08 Apr 25

Examine the solved problem below. There are four errors. Your task is to locate and identify any mistakes, then correct them and calculate the proper result. If the same error occurs more than once, only count it as a single error, even if you have to correct it in more than one instance.

Each correctly identified error is worth 4 points, and the re-calculated results are worth 4 points as well. You must save your work in pdf format and submit via the Quiz 18 Assignment in the Chapter 20 folder in the Quizzes folder of the Online Classroom in Blackboard. Please do not use any other file format than pdf.

If the rod is attached with ball-and-socket joints to smooth collars A and B at its end points, determine the vector velocity $\overrightarrow{v_A}$ at the instant shown if B is moving with speed $v_B = 5\frac{\text{ft}}{\text{s}}$ in the direction shown. Determine the angular velocity ω_{AB} of the rod if it is directed perpendicular to the axis of the rod.



A) Write the relative velocity equation:

$$\overrightarrow{v_A} = \overrightarrow{v_B} + \overrightarrow{v_{A/B}} = \left(5\tfrac{\text{ft}}{\text{s}}\right)\hat{\mathbf{j}} + \overrightarrow{\omega_{AB}} \times \overrightarrow{r_{A/B}}$$

B) Determine the direction of $\overrightarrow{v_A}$:

If B moves in the $+y$ direction, then A must move up, in the $+z$ direction

C) Rewrite the relative velocity equation:

$$(v_A)\hat{\mathbf{k}} = \left(5\tfrac{\text{ft}}{\text{s}}\right)\hat{\mathbf{j}} + (\omega_x \quad \omega_y \quad \omega_z) \times (6 \quad 2 \quad -3)\text{ft}$$

$$(0 \quad 0 \quad v_A) = \left(0 \quad 5\tfrac{\text{ft}}{\text{s}} \quad 0\right) + \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ \omega_x & \omega_y & \omega_z \\ 6 & 2 & -3 \end{vmatrix} \frac{\text{ft}}{\text{s}}$$

$$0 = 0 + [-3\omega_y + 2\omega_z]$$

$$0 = 5\tfrac{\text{ft}}{\text{s}} + [6\omega_z - 3\omega_x]$$

$$v_A = 0 + [2\omega_x + 6\omega_y]$$

D) If ω_{AB} is perpendicular to the axis of the rod, then:

$$\overrightarrow{\omega_{AB}} \cdot \overrightarrow{r_{A/B}} = 0$$

$$(\omega_x \quad \omega_y \quad \omega_z) \cdot (6 \quad 2 \quad -3) = 6\omega_x + 2\omega_y - 3\omega_z = 0$$

E) Solve the system of equations:

$$-3\omega_y + 2\omega_z = 0$$

$$3\omega_x - 6\omega_z = -5\tfrac{\text{ft}}{\text{s}}$$

$$2\omega_x + 6\omega_y = v_A$$

$$6\omega_x + 2\omega_y - 3\omega_z = 0$$

Using a solver:

$$\overrightarrow{\omega_{AB}} = (\omega_x \quad \omega_y \quad \omega_z) = (0.269 \quad 0.645 \quad 0.968)\tfrac{\text{rad}}{\text{s}}$$

$$\overrightarrow{v_A} = \left(4.41\tfrac{\text{ft}}{\text{s}}\right)\hat{\mathbf{k}}$$