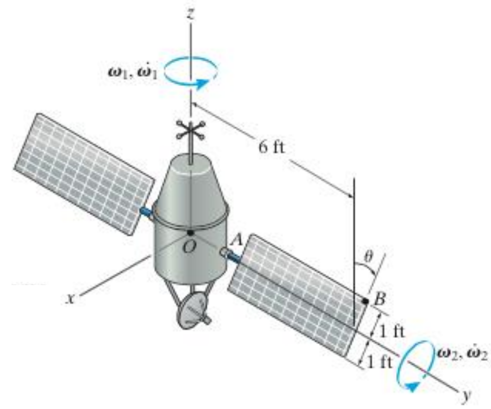
Quiz 17: Chapter 20 Due: Friday 04 Apr 25

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 17 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.

At the instant when $\theta = 90°$, the satellite's body travels in the x–direction with a velocity of $v_o = (500\frac{\text{ft}}{\text{s}})\hat{\mathbf{i}}$ and acceleration of $a_o = (50\frac{\text{ft}}{\text{s}^2})\hat{\mathbf{i}}$. Simultaneously, the satellite's body is rotating with an angular velocity of $\omega_1 = 15\frac{\text{rad}}{\text{s}}$ and angular acceleration of $\dot{\omega}_1 = \alpha_1 = 3\frac{\text{rad}}{\text{s}^2}$, and the solar panels rotate with an angular velocity of $\omega_2 = 6\frac{\text{rad}}{\text{s}}$ and angular acceleration of $\dot{\omega}_2 = \alpha_2 = 1.5\frac{\text{rad}}{\text{s}^2}$. Determine the velocity and acceleration of point B on the solar panel at this instant.



A) Determine the angular velocity $\vec{\omega}$ of the satellite:

$$\vec{\omega} = \vec{\omega}_1 + \vec{\omega}_2 = \left(15\tfrac{\text{rad}}{\text{s}}\right)\hat{\mathbf{j}} + \left(6\tfrac{\text{rad}}{\text{s}}\right)\hat{\mathbf{k}}$$

B) Determine the angular acceleration of the satellite:

$$\vec{\alpha} = \vec{\alpha}_1 + \vec{\alpha}_2 + \vec{\omega}_1 \times \vec{\omega}_2$$

$$\vec{\alpha} = \left(3\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(1.5\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{k}} + \left(15\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{j}} \times \left(6\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{k}}$$

$$\vec{\alpha} = \left(90\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left(3\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(1.5\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{k}}$$

C) Determine the vector location of point B:

$$\vec{r} = (1\text{ft})\hat{\mathbf{i}} + (6\text{ft})\hat{\mathbf{j}}$$

D) Calculate the velocity $\vec{v}_B$:

$$\vec{v}_B = \vec{v}_o + \vec{\omega} \times \vec{r}$$

$$\vec{v}_B = \left(500\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{i}} + \left[\left(15\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{j}} + \left(6\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{k}}\right] \times [(1\text{ft})\hat{\mathbf{i}} + (6\text{ft})\hat{\mathbf{j}}]$$

$$\vec{v}_B = \left(500\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{i}} + \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 0 & 15 & 6 \\ 1 & 6 & 0 \end{vmatrix} \frac{\text{ft}}{\text{s}} = \left(500\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{i}} + [(15)(0) - (6)(6)]\hat{\mathbf{i}} + [(6)(1) - (0)(0)]\hat{\mathbf{j}} + [(0)(6) - (15)(1)]\hat{\mathbf{k}}$$

$$\vec{v}_B = \left(464\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{i}} + \left(6\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{j}} - \left(15\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{k}}$$

E) Calculate the acceleration $\vec{a}_B$:

$$\vec{a}_B = \vec{a}_o + \vec{\alpha} \times \vec{r} + \vec{\omega} \times (\vec{\omega} \times \vec{r})$$

$$\vec{a}_B = \left(50\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left[\left(90\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left(3\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(1.5\frac{\text{rad}}{\text{s}^2}\right)\hat{\mathbf{k}}\right] \times [(1\text{ft})\hat{\mathbf{i}} + (6\text{ft})\hat{\mathbf{j}}] + \left[\left(15\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{j}} + \left(6\frac{\text{rad}}{\text{s}}\right)\hat{\mathbf{k}}\right] \times \left[\left(464\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{i}} + \left(6\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{j}} - \left(15\frac{\text{ft}}{\text{s}}\right)\hat{\mathbf{k}}\right]$$

$$\vec{a}_B = \left(50\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 90 & 3 & 1.5 \\ 1 & 6 & 0 \end{vmatrix} \frac{\text{ft}}{\text{s}^2} + \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 0 & 15 & 6 \\ 464 & 6 & -15 \end{vmatrix} \frac{\text{ft}}{\text{s}^2}$$

$$\vec{a}_B = \left(50\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \{[(3)(1) - (1.5)(6)]\hat{\mathbf{i}} + [(1.5)(1) - (90)(0)]\hat{\mathbf{j}} + [(90)(6) - (3)(1)]\hat{\mathbf{k}}\}$$
$$+ \{[(15)(-15) - (6)(6)]\hat{\mathbf{i}} + [(6)(464) - (0)(-15)]\hat{\mathbf{j}} + [(0)(6) - (15)(36)]\hat{\mathbf{k}}\}$$

$$\vec{a}_B = \left(50\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left[\left(-6\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left(-88.5\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(537\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{k}}\right] + \left[\left(-261\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left(2784\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(-6960\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{k}}\right]$$

$$\vec{a}_B = \left(-217\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{i}} + \left(2696\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{j}} + \left(-6423\frac{\text{ft}}{\text{s}^2}\right)\hat{\mathbf{k}}$$