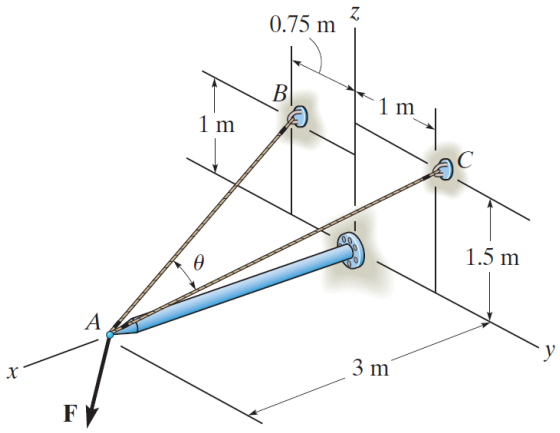
Problem 2-117

Determine the magnitudes of the projected components of the force $\mathbf{F} = [60\mathbf{i} + 12\mathbf{j} - 40\mathbf{k}]$ N along the cables AB and AC.



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Solution

Write the position vectors to the points A, B, and C.

$$\mathbf{r}_A = \langle 3, 0, 0 \rangle \text{ m}$$

$$\mathbf{r}_B = \langle 0, -0.75, 1 \rangle \text{ m}$$

$$\mathbf{r}_C = \langle 0, 1, 1.5 \rangle \text{ m}$$

The unit vector in the direction from B to A is

$$\hat{\mathbf{u}}_{BA} = \frac{\mathbf{r}_A - \mathbf{r}_B}{|\mathbf{r}_A - \mathbf{r}_B|} = \frac{\langle 3, 0.75, -1 \rangle}{\sqrt{(3)^2 + (0.75)^2 + (-1)^2}} = \frac{\langle 3, 0.75, -1 \rangle}{3.25}.$$

The unit vector in the direction from C to A is

$$\hat{\mathbf{u}}_{CA} = \frac{\mathbf{r}_A - \mathbf{r}_C}{|\mathbf{r}_A - \mathbf{r}_C|} = \frac{\langle 3, -1, -1.5 \rangle}{\sqrt{(3)^2 + (-1)^2 + (-1.5)^2}} = \frac{\langle 3, -1, -1.5 \rangle}{3.5}.$$

Take the dot product of $\mathbf{F}$ with each of these unit vectors to get the component of the force along each of the cables.

$$\mathbf{F} \cdot \hat{\mathbf{u}}_{BA} = \langle 60, 12, -40 \rangle \cdot \frac{\langle 3, 0.75, -1 \rangle}{3.25} \text{ N} = \frac{916}{13} \text{ N}$$

$$\mathbf{F} \cdot \hat{\mathbf{u}}_{CA} = \langle 60, 12, -40 \rangle \cdot \frac{\langle 3, -1, -1.5 \rangle}{3.5} \text{ N} = \frac{456}{7} \text{ N}$$

Therefore, the magnitudes of these components are

$$|\mathbf{F} \cdot \hat{\mathbf{u}}_{BA}| = \frac{916}{13} \text{ N} \approx 70.5 \text{ N}$$

$$|\mathbf{F} \cdot \hat{\mathbf{u}}_{CA}| = \frac{456}{7} \text{ N} \approx 65.1 \text{ N}.$$