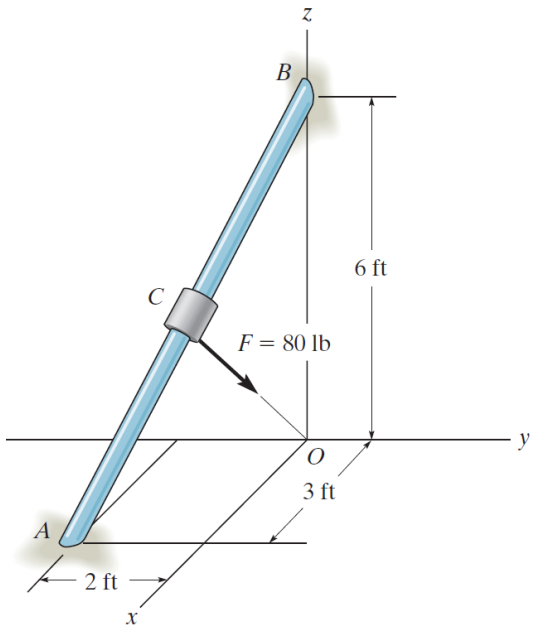
Problem 2-98

The force **F** has a magnitude of 80 lb and acts at the midpoint C of the thin rod. Express the force as a Cartesian vector.



Prob. 2–98

Solution

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

$$\mathbf{r}_O = \langle 0, 0, 0 \rangle \text{ ft}$$

$$\mathbf{r}_A = \langle 3, -2, 0 \rangle \text{ ft}$$

$$\mathbf{r}_B = \langle 0, 0, 6 \rangle \text{ ft}$$

The position vector to the midpoint C is obtained by averaging those to A and B.

$$\mathbf{r}_C = \frac{\mathbf{r}_A + \mathbf{r}_B}{2} = \langle 1.5, -1, 3 \rangle \text{ ft}$$

The position vector going from C to O is

$$\begin{aligned} \mathbf{r}_{CO} &= \mathbf{r}_O - \mathbf{r}_C \\ &= \langle -1.5, 1, -3 \rangle \text{ ft}. \end{aligned}$$

Its magnitude is

$$\begin{aligned} |\mathbf{r}_{CO}| &= \sqrt{(-1.5)^2 + (1)^2 + (-3)^2} \text{ ft} \\ &= 3.5 \text{ ft}. \end{aligned}$$

Divide $\mathbf{r}_{CO}$ by its magnitude to get a unit vector in the same direction.

$$\hat{\mathbf{u}}_{CO} = \frac{\mathbf{r}_{CO}}{|\mathbf{r}_{CO}|} = \frac{\langle -1.5, 1, -3 \rangle}{3.5}$$

The force $\mathbf{F}$ can now be written.

$$\mathbf{F} = F\hat{\mathbf{u}}_{CO} = 80\,\frac{\langle -1.5, 1, -3 \rangle}{3.5}\ \text{lb} \approx \langle -34.3, 22.9, -68.6 \rangle\ \text{lb}$$