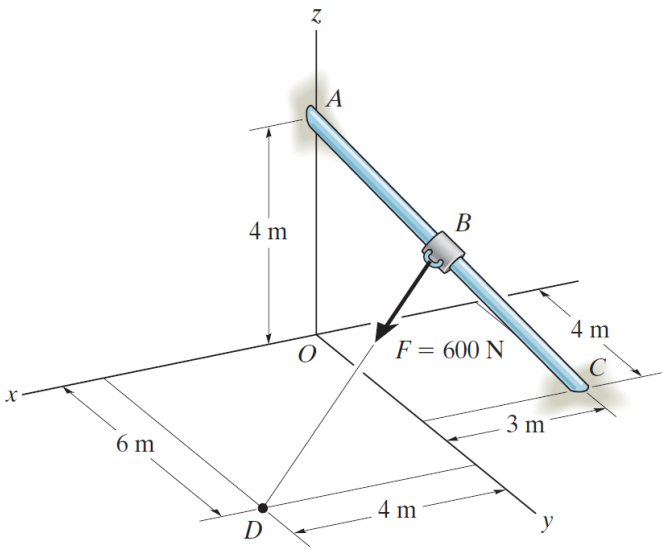
Problem 2-106

Express the force **F** in Cartesian vector form if it acts at the midpoint B of the rod.



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Solution

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

$$\mathbf{r}_A = \langle 0, 0, 4 \rangle \text{ m}$$

$$\mathbf{r}_C = \langle -3, 4, 0 \rangle \text{ m}$$

$$\mathbf{r}_D = \langle 4, 6, 0 \rangle \text{ m}$$

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

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

The position vector from B to D is

$$\begin{aligned}\mathbf{r}_{BD} &= \mathbf{r}_D - \mathbf{r}_B \\ &= \langle 5.5, 4, -2 \rangle \text{ m}.\end{aligned}$$

Its magnitude is

$$\begin{aligned}|\mathbf{r}_{BD}| &= \sqrt{(5.5)^2 + (4)^2 + (-2)^2} \text{ m} \\ &= \frac{\sqrt{201}}{2} \text{ m}.\end{aligned}$$

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

$$\hat{\mathbf{u}}_{BD} = \frac{\mathbf{r}_{BD}}{|\mathbf{r}_{BD}|} = \frac{\langle 5.5, 4, -2 \rangle}{\frac{\sqrt{201}}{2}}$$

The force **F** can now be written.

$$\mathbf{F} = F\hat{\mathbf{u}}_{BD} = 600\,\frac{\langle 5.5, 4, -2\rangle}{\frac{\sqrt{201}}{2}}\ \text{N} \approx \langle 466, 339, -169\rangle\ \text{N}$$