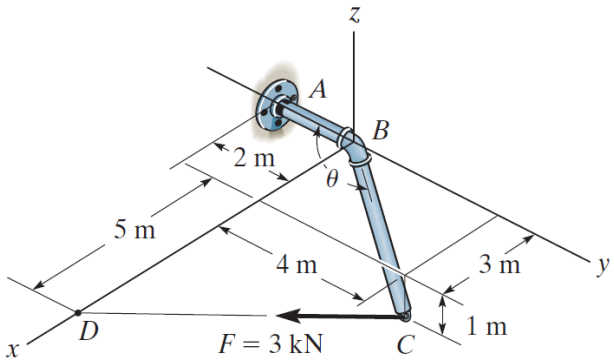
Problem 2-129

Determine the magnitude of the projected component of the 3 kN force acting along the axis BC of the pipe.



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Solution

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

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

$$\mathbf{r}_C = \langle 3, 4, -1 \rangle \text{ m}$$

$$\mathbf{r}_D = \langle 8, 0, 0 \rangle \text{ m}$$

The unit vector going from C to D is

$$\hat{\mathbf{u}}_{CD} = \frac{\mathbf{r}_D - \mathbf{r}_C}{|\mathbf{r}_D - \mathbf{r}_C|} = \frac{\langle 5, -4, 1 \rangle}{\sqrt{(5)^2 + (-4)^2 + (1)^2}},$$

and the unit vector going from C to B is

$$\hat{\mathbf{u}}_{CB} = \frac{\mathbf{r}_B - \mathbf{r}_C}{|\mathbf{r}_B - \mathbf{r}_C|} = \frac{\langle -3, -4, 1 \rangle}{\sqrt{(-3)^2 + (-4)^2 + (1)^2}}.$$

The force is then

$$\mathbf{F} = F\hat{\mathbf{u}}_{CD} = 3000 \frac{\langle 5, -4, 1 \rangle}{\sqrt{(5)^2 + (-4)^2 + (1)^2}} \text{ N}.$$

Take the dot product of this force with $\hat{\mathbf{u}}_{CB}$ to find the component of the force along axis BC.

$$\mathbf{F} \cdot \hat{\mathbf{u}}_{CB} = 3000 \frac{\langle 5, -4, 1 \rangle}{\sqrt{(5)^2 + (-4)^2 + (1)^2}} \cdot \frac{\langle -3, -4, 1 \rangle}{\sqrt{(-3)^2 + (-4)^2 + (1)^2}} \text{ N} = 1000\sqrt{\frac{3}{91}} \text{ N}$$

Therefore, the magnitude of the component along axis BC is

$$|\mathbf{F} \cdot \hat{\mathbf{u}}_{CB}| = 1000\sqrt{\frac{3}{91}} \text{ N} \approx 182 \text{ N}.$$