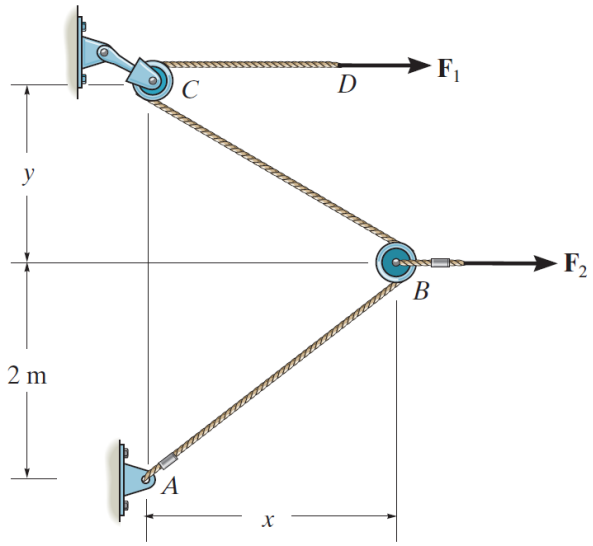
Problem 3-25

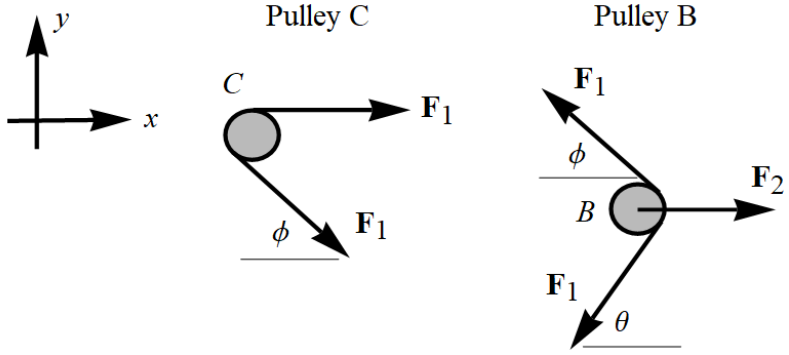
Determine the magnitude of F_1 and the distance y if $x = 1.5$ m and $F_2 = 1000$ N.



Probs. 3–24/25

Solution

Draw one free-body diagram for the pulley at C and one free-body diagram for the pulley at B, assuming that the pulleys are frictionless.



In order for the system to be in equilibrium, the sum of the forces in each direction at pulley B must be zero.

$$\sum F_x = 0: \qquad F_2 - F_1 \cos\phi - F_1 \cos\theta = 0 \tag{1}$$

$$\sum F_y = 0: \qquad F_1 \sin\phi - F_1 \sin\theta = 0 \tag{2}$$

This second equation implies that $\sin\phi = \sin\theta$, or $\phi = \theta$.

$$\tan\phi = \tan\theta \quad \rightarrow \quad \frac{y}{x} = \frac{2\text{ m}}{x} \quad \rightarrow \quad y = 2\text{ m}$$

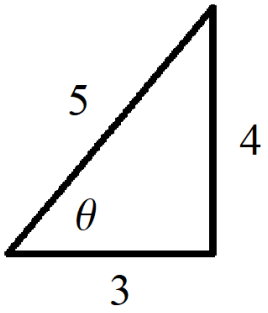
As a result, equation (1) becomes

$$F_2 - F_1 \cos\theta - F_1 \cos\theta = 0.$$

Solve for F_1.

$$F_1 = \frac{F_2}{2\cos\theta}$$

Use the fact that $\tan\theta = 2/x = 4/3$ to determine the cosine.



Therefore,

$$F_1 = \frac{F_2}{2\cos\theta} = \frac{1000\text{ N}}{2\left(\frac{3}{5}\right)} = \frac{2500}{3}\text{ N} \approx 833\text{ N}.$$