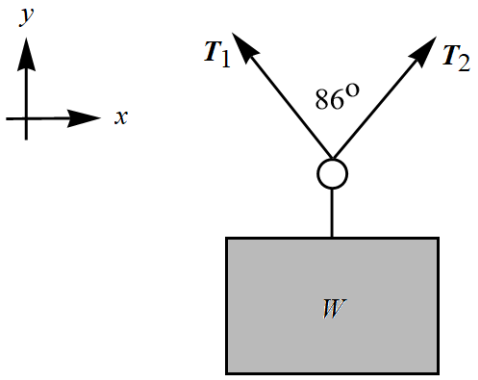
Problem 1.38

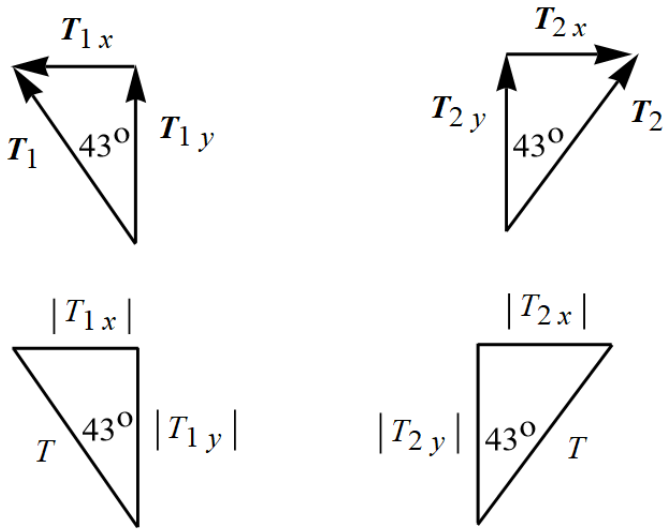
Two ropes in a vertical plane exert equal-magnitude forces on a hanging weight but pull with an angle of 86.0° between them. What pull does each one exert if their resultant pull is 372 N directly upward?

Solution

A schematic of the hanging weight is shown below.



Decompose these tension vectors into components along the x- and y-axes. Because the resultant points directly upward and the tensions are equal, the angles from the vertical are 43°.



The corresponding triangles with the magnitudes are drawn as well. Use trigonometry to determine the vertical components.

$$\cos 43^\circ = \frac{|T_{1y}|}{T} \quad \rightarrow \quad |T_{1y}| = T\cos 43^\circ \qquad\qquad \cos 43^\circ = \frac{|T_{2y}|}{T} \quad \rightarrow \quad |T_{2y}| = T\cos 43^\circ$$

Because $\mathbf{T}_{1y}$ and $\mathbf{T}_{2y}$ point in the positive y-direction, no minus signs are needed.

$$T_{1y} = T\cos 43^\circ$$
$$T_{2y} = T\cos 43^\circ$$

The sum of these vertical components must add to 372 N.

$$T_{1y} + T_{2y} = 372 \text{ N}$$

$$T\cos 43^\circ + T\cos 43^\circ = 372 \text{ N}$$

Solve for T.

$$2T\cos 43^\circ = 372 \text{ N}$$

$$T = \frac{186 \text{ N}}{\cos 43^\circ} \approx 254 \text{ N}$$

Each rope exerts a pull of roughly 254 newtons.