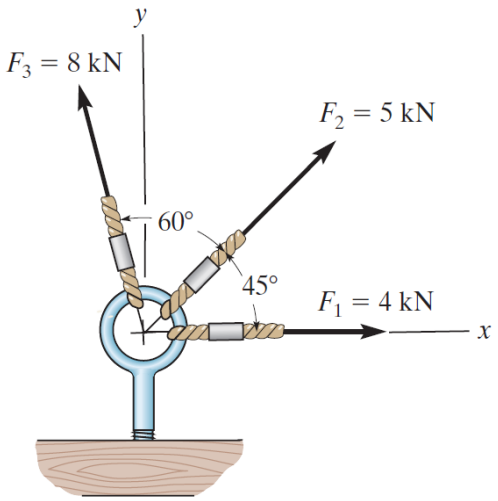
Problem 2-41

Determine the magnitude of the resultant force and its direction, measured counterclockwise from the positive x axis.



Solution

Write each of the forces in component form.

$$\mathbf{F}_1 = 4000\,\langle 1, 0\rangle \text{ N}$$

$$\mathbf{F}_2 = 5000\,\langle \cos 45^\circ, \sin 45^\circ\rangle \text{ N}$$

$$\mathbf{F}_3 = 8000\,\langle \cos 105^\circ, \sin 105^\circ\rangle \text{ N}$$

Add them together to get the resultant force.

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 \\ &= \langle 4000 + 5000\cos 45^\circ + 8000\cos 105^\circ, 5000\sin 45^\circ + 8000\sin 105^\circ\rangle \text{ N} \\ &\approx \langle 5465, 11\,263\rangle \text{ N}\end{aligned}$$

Its magnitude is

$$\begin{aligned}|\mathbf{F}_R| &= \sqrt{(4000 + 5000\cos 45^\circ + 8000\cos 105^\circ)^2 + (5000\sin 45^\circ + 8000\sin 105^\circ)^2} \text{ N} \\ &\approx 1.25 \times 10^4 \text{ N},\end{aligned}$$

and the direction it points in counterclockwise from the positive x-axis is

$$\tan\phi = \frac{5000\sin 45^\circ + 8000\sin 105^\circ}{4000 + 5000\cos 45^\circ + 8000\cos 105^\circ} \quad \rightarrow \quad \phi \approx 64.1^\circ.$$