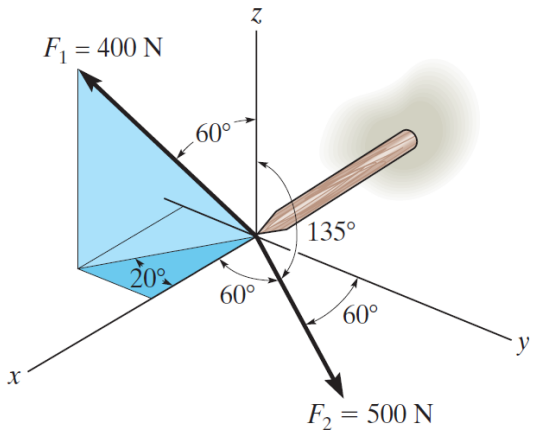
Problem 2-77

Determine the magnitude and coordinate direction angles of the resultant force, and sketch this vector on the coordinate system.



Prob. 2–77

Solution

Write each of the forces in component form.

$$\mathbf{F}_1 = 400\,\langle \sin 60^\circ \cos 20^\circ, -\sin 60^\circ \sin 20^\circ, \cos 60^\circ \rangle \text{ N}$$

$$\mathbf{F}_2 = 500\,\langle \cos 60^\circ, \cos 60^\circ, \cos 135^\circ \rangle \text{ N}$$

Add them together to get the resultant force.

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}_1 + \mathbf{F}_2 \\ &= \langle 400 \sin 60^\circ \cos 20^\circ + 500 \cos 60^\circ, -400 \sin 60^\circ \sin 20^\circ + 500 \cos 60^\circ, 400 \cos 60^\circ + 500 \cos 135^\circ \rangle \text{ N} \\ &\approx \langle 576, 132, -154 \rangle \text{ N}\end{aligned}$$

Its magnitude is

$$\begin{aligned}|\mathbf{F}_R| &\approx \sqrt{(576)^2 + (132)^2 + (-154)^2} \text{ N} \\ &\approx 610.\text{ N}.\end{aligned}$$

Divide the resultant force by its magnitude to get a unit vector in the same direction.

$$\frac{\mathbf{F}_R}{|\mathbf{F}_R|} \approx \frac{\langle 576, 132, -154 \rangle \text{ N}}{610.\text{ N}}$$

The direction angles for the resultant force can now be found.

$$\begin{cases} \cos\alpha \approx \dfrac{576}{610} \\ \cos\beta \approx \dfrac{132}{610} \\ \cos\gamma \approx -\dfrac{154}{610} \end{cases} \quad \rightarrow \quad \begin{cases} \alpha \approx 19.4^\circ \\ \beta \approx 77.5^\circ \\ \gamma \approx 105^\circ \end{cases}$$

Below is an illustration of the resultant force and its direction angles.