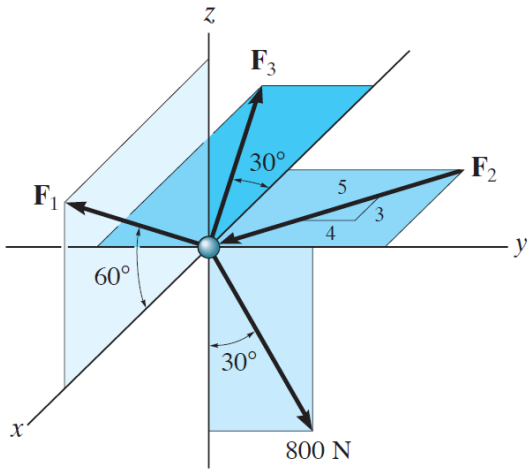
Problem R3-6

Determine the magnitudes of $\mathbf{F}_1$, $\mathbf{F}_2$, and $\mathbf{F}_3$ for equilibrium of the particle.



Prob. R3–6

Solution

Begin by writing each of the force vectors in component form. Let θ be the angle that $\mathbf{F}_2$ makes with the y-axis.

$$\mathbf{F}_1 = F_1 \langle \cos 60°, 0, \sin 60° \rangle$$

$$\mathbf{F}_2 = F_2 \langle \sin\theta, -\cos\theta, 0 \rangle = F_2 \left\langle \frac{3}{5}, -\frac{4}{5}, 0 \right\rangle$$

$$\mathbf{F}_3 = F_3 \langle -\cos 30°, -\sin 30°, 0 \rangle$$

$$\mathbf{F} = 800 \langle 0, \sin 30°, -\cos 30° \rangle \text{ N}$$

In order for the particle to be in equilibrium, the sum of the forces must be zero.

$$\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \mathbf{F} = \mathbf{0}$$

$$F_1 \langle \cos 60°, 0, \sin 60° \rangle + F_2 \left\langle \frac{3}{5}, -\frac{4}{5}, 0 \right\rangle + F_3 \langle -\cos 30°, -\sin 30°, 0 \rangle + 800 \langle 0, \sin 30°, -\cos 30° \rangle \text{ N} = \mathbf{0}$$

$$\left\langle F_1 \cos 60° + \frac{3}{5}F_2 - F_3 \cos 30°,\ -\frac{4}{5}F_2 - F_3 \sin 30° + 800 \sin 30°,\ F_1 \sin 60° - 800 \cos 30° \right\rangle = \langle 0, 0, 0 \rangle$$

Match the components to get a system of equations and then solve it.

$$\left.\begin{aligned} F_1 \cos 60° + \frac{3}{5}F_2 - F_3 \cos 30° &= 0 \\ -\frac{4}{5}F_2 - F_3 \sin 30° + 800 \sin 30° &= 0 \\ F_1 \sin 60° - 800 \cos 30° &= 0 \end{aligned}\right\} \quad \Rightarrow \quad \left\{\begin{aligned} F_1 &= 800 \text{ N} \\ F_2 &\approx 147 \text{ N} \\ F_3 &\approx 564 \text{ N} \end{aligned}\right.$$