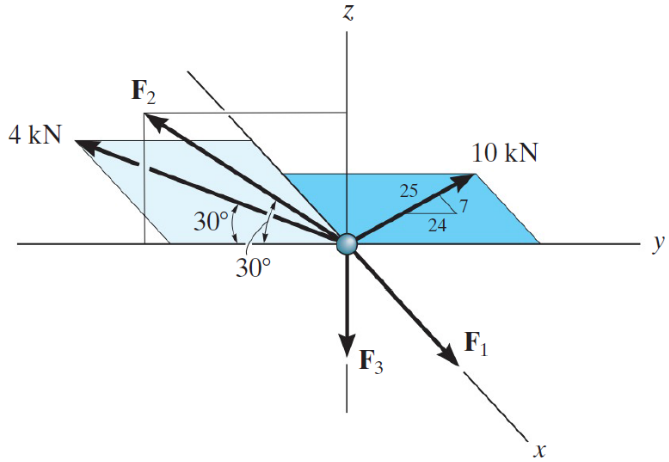
# Problem 3-44

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

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### Solution

Let $\theta$ be the angle that the 10-kN force makes with the positive $y$-axis. In order for the particle to be in equilibrium, the sum of the forces must be zero.

$$\mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + 4\langle -\sin 30^\circ, -\cos 30^\circ, 0\rangle \text{ kN} + 10\langle -\sin\theta, \cos\theta, 0\rangle \text{ kN} = \mathbf{0}$$

$$F_1\langle 1,0,0\rangle + F_2\langle 0, -\cos 30^\circ, \sin 30^\circ\rangle + F_3\langle 0,0,-1\rangle + 4\langle -\sin 30^\circ, -\cos 30^\circ, 0\rangle \text{ kN} + 10\left\langle -\frac{7}{25}, \frac{24}{25}, 0\right\rangle \text{kN} = \mathbf{0}$$

$$\left\langle F_1 - 4\sin 30^\circ - \frac{70}{25}, -F_2\cos 30^\circ - 4\cos 30^\circ + \frac{240}{25}, F_2 \sin 30^\circ - F_3\right\rangle = \langle 0,0,0\rangle$$

Match the components to get a system of equations.

$$\left.\begin{aligned} F_1 - 4\sin 30^\circ - \frac{70}{25} &= 0 \\ -F_2\cos 30^\circ - 4\cos 30^\circ + \frac{240}{25} &= 0 \\ F_2\sin 30^\circ - F_3 &= 0 \end{aligned}\right\}$$

Solving it yields

$$F_1 = \left(4\sin 30^\circ + \frac{70}{25}\right) \text{kN} = 4.80 \text{ kN}$$

$$F_2 = \frac{-4\cos 30^\circ + \frac{240}{25}}{\cos 30^\circ} \text{ kN} \approx 7.09 \text{ kN}$$

$$F_3 = F_2 \sin 30^\circ \approx 3.54 \text{ kN}.$$