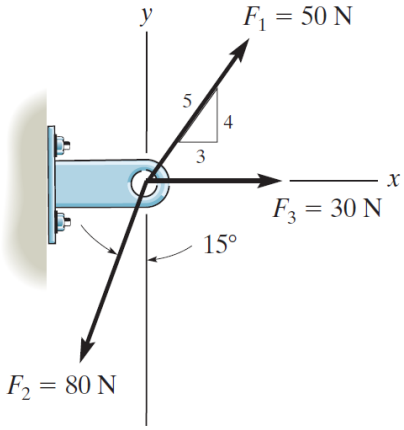
Problem 2-38

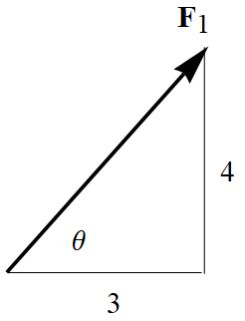
Express each of the three forces acting on the support in Cartesian vector form and determine the magnitude of the resultant force and its direction, measured clockwise from positive x axis.



Prob. 2–38

Solution

Begin by finding the angle θ that $\mathbf{F}_1$ makes with the x-axis.



$$\tan\theta = \frac{4}{3} \quad \rightarrow \quad \theta = \tan^{-1}\left(\frac{4}{3}\right) \approx 53.1^\circ$$

Write each of the forces in component form.

$$\mathbf{F}_1 = 50\,\langle \cos\theta, \sin\theta \rangle \text{ N} = 50\left\langle \frac{3}{5}, \frac{4}{5} \right\rangle \text{ N} = \langle 30, 40 \rangle \text{ N}$$

$$\mathbf{F}_2 = 80\,\langle -\sin 15^\circ, -\cos 15^\circ \rangle \text{ N} \approx \langle -20.7, -77.3 \rangle \text{ N}$$

$$\mathbf{F}_3 = 30\,\langle 1, 0 \rangle \text{ N}$$

Add them together to get the resultant force.

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 \\ &= \langle 30 - 80\sin 15^\circ + 30, 40 - 80\cos 15^\circ \rangle \text{ N} \\ &= \langle 60 - 80\sin 15^\circ, 40 - 80\cos 15^\circ \rangle \text{ N} \\ &\approx \langle 39.3, -37.3 \rangle \text{ N}\end{aligned}$$

Its magnitude is

$$|\mathbf{F}_R| = \sqrt{(60 - 80\sin 15^\circ)^2 + (40 - 80\cos 15^\circ)^2} \approx 54.2 \text{ N},$$

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

$$\tan\phi = \frac{40 - 80\cos 15^\circ}{60 - 80\sin 15^\circ} \quad \rightarrow \quad \phi \approx -43.5^\circ.$$

Therefore, the angle of the resultant force clockwise from the positive x-axis is 43.5°.