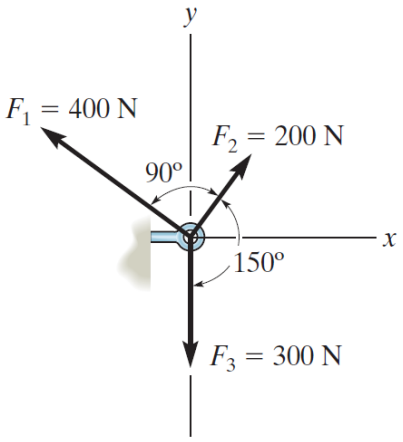
Problem 2-22

Determine the magnitude and direction of the resultant force, $\mathbf{F}_R$ measured counterclockwise from the positive x axis. Solve the problem by first finding the resultant $\mathbf{F}' = \mathbf{F}_2 + \mathbf{F}_3$ and then forming $\mathbf{F}_R = \mathbf{F}' + \mathbf{F}_1$.



Probs. 2–21/22

Solution

Write each of the forces in component form.

$$\mathbf{F}_1 = 400\langle -\cos 30°, \sin 30° \rangle \text{ N}$$

$$\mathbf{F}_2 = 200\langle \cos 60°, \sin 60° \rangle \text{ N}$$

$$\mathbf{F}_3 = 300\langle 0, -1 \rangle \text{ N}$$

Add the second and third forces to get $\mathbf{F}'$.

$$\begin{aligned}\mathbf{F}' &= \mathbf{F}_2 + \mathbf{F}_3 \\ &= \langle 200\cos 60°, 200\sin 60° - 300 \rangle \text{ N}\end{aligned}$$

Finally, add $\mathbf{F}' + \mathbf{F}_1$ to get $\mathbf{F}_R$.

$$\begin{aligned}\mathbf{F}_R &= \mathbf{F}' + \mathbf{F}_1 \\ &= \langle 200\cos 60° - 400\cos 30°, 200\sin 60° - 300 + 400\sin 30° \rangle \text{ N} \\ &\approx \langle -246, 73.2 \rangle \text{ N}\end{aligned}$$

Its magnitude is

$$\begin{aligned}|\mathbf{F}_R| &= \sqrt{(200\cos 60° - 400\cos 30°)^2 + (200\sin 60° - 300 + 400\sin 30°)^2} \\ &\approx 257 \text{ N},\end{aligned}$$

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

$$\tan\phi = \frac{200\sin 60° - 300 + 400\sin 30°}{200\cos 60° - 400\cos 30°} \quad \rightarrow \quad \phi \approx 180° + \tan^{-1}\left(\frac{73.2}{-246}\right) \approx 163°.$$