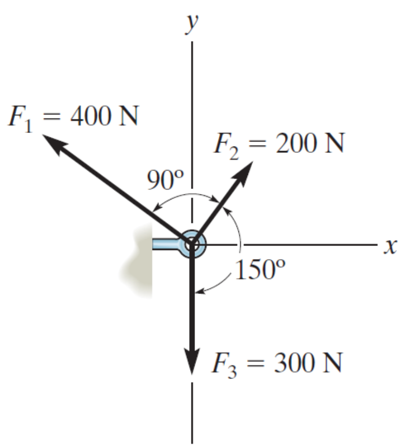
Problem 2-21

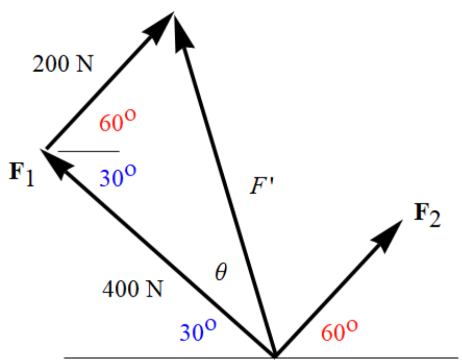
Determine the magnitude and direction of the resultant force, $\mathbf{F}_R$ measured counterclockwise from the positive x axis. Solve the problem by first finding the resultant $\mathbf{F}' = \mathbf{F}_1 + \mathbf{F}_2$ and then forming $\mathbf{F}_R = \mathbf{F}' + \mathbf{F}_3$.



Probs. 2–21/22

Solution

Draw the triangle that $\mathbf{F}_1$ and $\mathbf{F}_2$ and their resultant $\mathbf{F}'$ make.



Use the law of cosines (the Pythagorean theorem) to determine the magnitude of $\mathbf{F}'$.

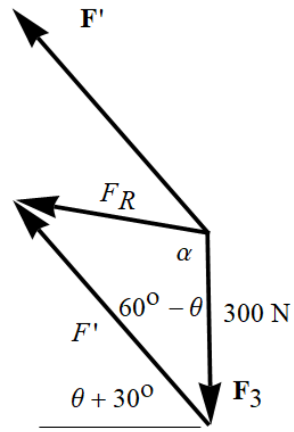
$$F'^2 = 200^2 + 400^2 - 2(200)(400)\cos(30^\circ + 60^\circ)$$

$$\begin{aligned} F' &= \sqrt{200^2 + 400^2} \text{ N} \\ &= 200\sqrt{5} \text{ N} \\ &\approx 447 \text{ N} \end{aligned}$$

As this is a right triangle, use trigonometry to determine θ.

$$\tan\theta = \frac{200 \text{ N}}{400 \text{ N}} \quad \rightarrow \quad \theta \approx 26.6^\circ$$

Draw the triangle that $\mathbf{F}'$ and $\mathbf{F}_3$ and their resultant $\mathbf{F}_R$ make.



Use the law of cosines to determine the magnitude of $\mathbf{F}_R$.

$$F_R^2 = 300^2 + F'^2 - 2(300)(F')\cos(60^\circ - \theta)$$

$$F_R = \sqrt{300^2 + F'^2 - 2(300)(F')\cos(60^\circ - \theta)}\ \text{N}$$

$$\approx 257\ \text{N}$$

Use the law of cosines again to determine α, the clockwise angle from the negative y-axis.

$$F'^2 = F_R^2 + 300^2 - 2(300)F_R\cos\alpha \quad \rightarrow \quad \cos\alpha = \frac{F_R^2 + 300^2 - F'^2}{2(300)F_R} \quad \rightarrow \quad \alpha \approx 107^\circ$$

Therefore, the counterclockwise angle of $\mathbf{F}_R$ from the positive x-axis is

$$\phi = 270^\circ - \alpha \approx 163^\circ.$$