

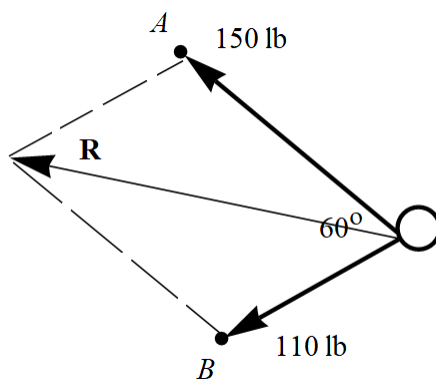
Exercise 34

Two persons pull horizontally on ropes attached to a post, the angle between the ropes being 60° . Person A pulls with a force of 150 lb, while person B pulls with a force of 110 lb.

- The resultant force is the vector sum of the two forces. Draw a figure to scale that graphically represents the three forces.
- Using trigonometry, determine formulas for the vector components of the two forces in a conveniently chosen coordinate system. Perform the algebraic addition, and find the angle the resultant force makes with A.

Solution

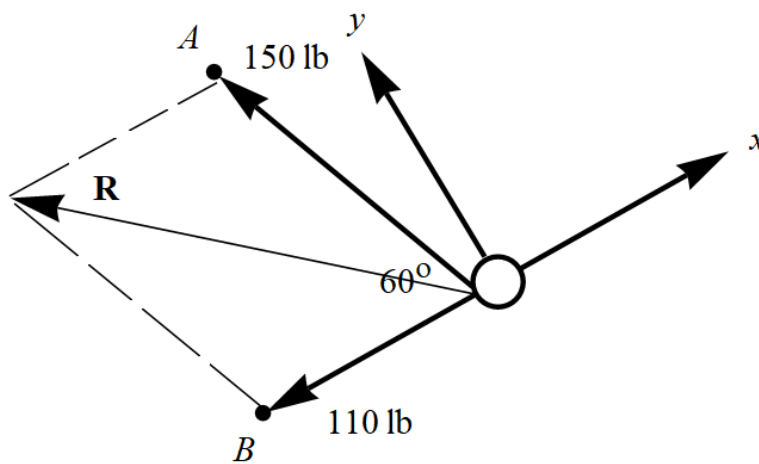
Part (a)



The vector \mathbf{R} is the resultant force and is the vector sum of the 150 lb and 110 lb forces.

Part (b)

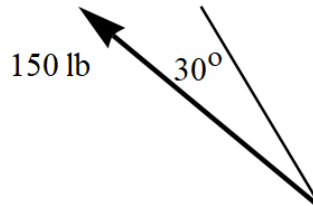
Use the xy -coordinate system shown below.



Let \mathbf{A} and \mathbf{B} be the forces due to person A and person B , respectively. Since \mathbf{B} points exclusively in the negative x -direction, it has no y -component, and a minus sign is needed in the x -component.

$$\mathbf{B} = (-110, 0)$$

Zoom in on \mathbf{A} in the figure.



The angle between \mathbf{A} and the y -axis is 30° . Determine the components of this vector.

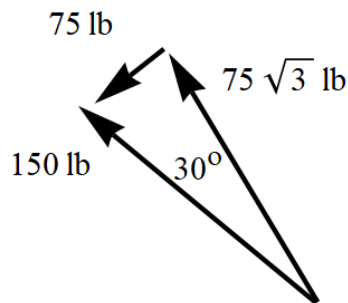
$$\cos 30^\circ = \frac{y}{150}$$

$$\sin 30^\circ = \frac{x}{150}$$

Solve for x and y .

$$y = 150 \cos 30^\circ = 75\sqrt{3} \text{ lb}$$

$$x = 150 \sin 30^\circ = 75 \text{ lb}$$



Since the 75 lb force points in the negative x -direction, a minus sign is needed. On the other hand, the $75\sqrt{3}$ lb force points in the positive y -direction, so no minus sign is needed.

$$\mathbf{A} = (-75, 75\sqrt{3}) \text{ lb}$$

Consequently, the resultant in this coordinate system is

$$\mathbf{R} = \mathbf{A} + \mathbf{B} = (-110, 0) + (-75, 75\sqrt{3}) = (-185, 75\sqrt{3}).$$

Determine the angle of \mathbf{R} from the x -axis.

$$\tan \theta = \frac{75\sqrt{3}}{-185} \rightarrow \theta = \pi - \tan^{-1} \left(\frac{75\sqrt{3}}{185} \right) \approx 144.9^\circ$$

Therefore, the angle between \mathbf{R} and \mathbf{A} is about $144.9^\circ - 30^\circ - 90^\circ = 24.9^\circ$.