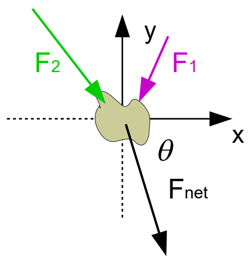
Chapter 5 Problem 72 †



Given

$m = 125\ kg$
$\vec{F}_1 = \{-2.40\hat{\imath} - 6.10\hat{\jmath}\}\ N$
$\vec{F}_2 = \{8.50\hat{\imath} - 9.70\hat{\jmath}\}\ N$

Solution

a) Find the net force.

The net force is just the sum of the two force vectors.

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2$$

$$\vec{F}_{net} = \{-2.40\hat{\imath} - 6.10\hat{\jmath}\}\ N + \{8.50\hat{\imath} - 9.70\hat{\jmath}\}\ N$$

Simplifying gives

$$\vec{F}_{net} = \{6.10\hat{\imath} - 15.80\hat{\jmath}\}\ N$$

b) What are the magnitude and direction of the net force.

Using the Pythagorean theorem, the magnitude of the force is

$$F_{net} = \sqrt{(6.10\ N)^2 + (-15.80\ N)^2} = 16.9\ N$$

The x-component is positive and the y-component is negative. Therefore, the force is in the fourth quadrant. Calculating the angle gives

$$\theta = \tan^{-1}\frac{-15.80\ N}{6.10\ N} = -68.9°$$

The angle is 69° clockwise from the positive x-axis.

c) If the mass is $m = 125\ kg$, what is the acceleration.

By Newton's 2nd law

$$\vec{F}_{net} = m\vec{a}$$

Solving for acceleration gives

$$\vec{a} = \frac{\vec{F}_{net}}{m}$$

†Problem from University Physics by Ling, Sanny and Moebs (OpenStax)

$$\vec{a} = \frac{\{6.10\hat{\imath} - 15.80\hat{\jmath}\}\ N}{125\ kg}$$

$$\vec{a} = \{0.0488\hat{\imath} - 0.1264\hat{\jmath}\}\ m/s^2$$

d) What are the magnitude and direction of the acceleration.

We could calculate the magnitude and angle by the method from part (b), but there is an easier way. Since we already have the magnitude of the force, we can just divide the answer for part (b) by the mass.

$$a = \frac{F_{net}}{m} = \frac{16.9\ N}{125\ kg}$$

$$a = 0.135\ m/s^2$$

Since we are dividing by a positive scalar, the angle will be the same as the net force. Therefore,

$$\theta = -68.9^\circ$$