d) The acceleration is in the same direction as the total force. A unit vector in the direction of the total force is found by taking the total force and dividing by its magnitude:
\[
\frac{1}{F_{\text{total}}} \vec{F}_{\text{total}} = \frac{1}{614 \text{ N}} \left( (565 \text{ N})\hat{i} + (241 \text{ N})\hat{j} \right) = 0.920\hat{i} + 0.393\hat{j}.
\]

5.10

a) Choose \(\hat{i}\) to point in the direction of travel of the incoming ball and let \(t = 0\) s be the time that the ball hits the player’s head. Then
\[
v_{x0} = 15.0 \text{ m/s}, \quad \text{and} \quad v_x = -18.0 \text{ m/s} \quad \text{when} \ t = 0.100 \text{ s}.
\]
Therefore, since the acceleration is constant over this 0.100 s interval,
\[
-18.0 \text{ m/s} = 15.0 \text{ m/s} + a_x(0.100 \text{ s}) \implies a_x = -330 \text{ m/s}^2.
\]
The magnitude of the acceleration is the absolute value of this single acceleration component.
\[
a = 330 \text{ m/s}^2.
\]
b) The magnitude of the total force on the ball is
\[
F_{\text{total}} = ma = (0.430 \text{ kg})(330 \text{ m/s}^2) = 142 \text{ N}.
\]

5.11 Let \(\vec{F}_2\) be the other force. Since its magnitude is 5.0 N and since it is directed 240° counterclockwise from the \(x\) axis,
\[
\vec{F}_2 = (5.0 \text{ N}) \cos 240^\circ \hat{i} + (5.0 \text{ N}) \sin 240^\circ \hat{j} = (-2.5 \text{ N})\hat{i} + (-4.3 \text{ N})\hat{j}.
\]
The total force on the mass is
\[
\vec{F}_{\text{total}} = \vec{F}_1 + \vec{F}_2 = (-3.0 \text{ N})\hat{i} + (6.5 \text{ N})\hat{j} + (-2.5 \text{ N})\hat{i} + (-4.3 \text{ N})\hat{j} = (-5.5 \text{ N})\hat{i} + 2.2 \text{ N}\hat{j}.
\]
Newton’s second law states that
\[
\vec{F}_{\text{total}} = m\vec{a} \implies (-5.5 \text{ N})\hat{i} + (2.2 \text{ N})\hat{j} = (4.0 \text{ kg})\vec{a} \implies \vec{a} = \frac{1}{4.0 \text{ kg}} \left((-5.5 \text{ N})\hat{i} + (2.2 \text{ N})\hat{j}\right) = (-1.4 \text{ m/s}^2)\hat{i} + (0.6 \text{ m/s}^2)\hat{j}.
\]
The magnitude of the acceleration is
\[
a = \sqrt{(-1.4 \text{ m/s}^2)^2 + (0.6 \text{ m/s}^2)^2} = 1.5 \text{ m/s}^2.
\]
To find its direction, we find the angle \(\phi\) that it makes with \(\hat{i}\) by computing the scalar product of \(\vec{a}\) with \(\hat{i}\).
\[
a \cdot 1 \cdot \cos \phi = \vec{a} \cdot \hat{i} = \left((-1.4 \text{ m/s}^2)\hat{i} + (0.6 \text{ m/s}^2)\hat{j}\right) \cdot \hat{i} = -1.4 \text{ m/s}^2
\]
\[
\implies \cos \phi = \frac{-1.4 \text{ m/s}^2}{1.5 \text{ m/s}^2} = -0.93
\]
\[
\implies \phi = 158^\circ.
\]
Only two significant figures are justified, so \(\phi = 1.6 \times 10^2\) degrees.
Since the \(\hat{j}\) component of \(\vec{a}\) is positive, we know that this is the \textit{counter}clockwise angle from \(\hat{i}\) to \(\vec{a}\). The acceleration is shown in the sketch below.