9. **REASONING** Let due east be chosen as the positive direction. Then, when both forces point due east, Newton's second law gives

\[
\frac{F_A + F_B}{\Sigma F} = ma_i
\]  

where \( a_i = 0.50 \text{ m/s}^2 \). When \( F_A \) points due east and \( F_B \) points due west, Newton's second law gives

\[
\frac{F_A - F_B}{\Sigma F} = ma_2
\]  

where \( a_2 = 0.40 \text{ m/s}^2 \). These two equations can be used to find the magnitude of each force.

**SOLUTION**

a. Adding Equations 1 and 2 gives

\[
F_A = m(a_i + a_2) = \frac{(8.0 \text{ kg})(0.50 \text{ m/s}^2 + 0.40 \text{ m/s}^2)}{2} = 3.6 \text{ N}
\]

b. Subtracting Equation 2 from Equation 1 gives

\[
F_B = m(a_i - a_2) = \frac{(8.0 \text{ kg})(0.50 \text{ m/s}^2 - 0.40 \text{ m/s}^2)}{2} = 0.40 \text{ N}
\]

17. **REASONING** We first determine the acceleration of the boat. Then, using Newton's second law, we can find the net force \( \Sigma F \) that acts on the boat. Since two of the three forces are known, we can solve for the unknown force \( F_W \) once the net force \( \Sigma F \) is known.

**SOLUTION** Let the direction due east be the positive \( x \) direction and the direction due north be the positive \( y \) direction. The \( x \) and \( y \) components of the initial velocity of the boat are then

\[
v_{0x} = (2.00 \text{ m/s}) \cos 15.0^\circ = 1.93 \text{ m/s}
\]

\[
v_{0y} = (2.00 \text{ m/s}) \sin 15.0^\circ = 0.518 \text{ m/s}
\]
Thirty seconds later, the x and y velocity components of the boat are
\[ \begin{align*}
  v_x &= (4.00 \text{ m/s}) \cos 35.0^\circ = 3.28 \text{ m/s} \\
  v_y &= (4.00 \text{ m/s}) \sin 35.0^\circ = 2.29 \text{ m/s}
\end{align*} \]

Therefore, according to Equations 3.3a and 3.3b, the x and y components of the acceleration of the boat are
\[ \begin{align*}
  a_x &= \frac{v_x - v_{0x}}{t} = \frac{3.28 \text{ m/s} - 1.93 \text{ m/s}}{30.0 \text{ s}} = 4.50 \times 10^{-2} \text{ m/s}^2 \\
  a_y &= \frac{v_y - v_{0y}}{t} = \frac{2.29 \text{ m/s} - 0.518 \text{ m/s}}{30.0 \text{ s}} = 5.91 \times 10^{-2} \text{ m/s}^2
\end{align*} \]

Thus, the x and y components of the net force that act on the boat are
\[ \begin{align*}
  \sum F_x &= ma_x = (325 \text{ kg}) (4.50 \times 10^{-2} \text{ m/s}^2) = 14.6 \text{ N} \\
  \sum F_y &= ma_y = (325 \text{ kg}) (5.91 \times 10^{-2} \text{ m/s}^2) = 19.2 \text{ N}
\end{align*} \]

The following table gives the x and y components of the net force \( \sum F \) and the two known forces that act on the boat. The fourth row of that table gives the components of the unknown force \( F_W \).

<table>
<thead>
<tr>
<th>Force</th>
<th>x-Component</th>
<th>y-Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \sum F )</td>
<td>14.6 N</td>
<td>19.2 N</td>
</tr>
<tr>
<td>( F_1 )</td>
<td>( (31.0 \text{ N}) \cos 15.0^\circ = 29.9 \text{ N} )</td>
<td>( (31.0 \text{ N}) \sin 15.0^\circ = 8.02 \text{ N} )</td>
</tr>
<tr>
<td>( F_2 )</td>
<td>( -(23.0 \text{ N}) \cos 15.0^\circ = -22.2 \text{ N} )</td>
<td>( -(23.0 \text{ N}) \sin 15.0^\circ = -5.95 \text{ N} )</td>
</tr>
</tbody>
</table>

\[ \begin{align*}
  F_W &= \sum F - F_1 - F_2 \\
       &= 14.6 \text{ N} - 29.9 \text{ N} + 22.2 \text{ N} = 6.9 \text{ N} \\
       &= 19.2 \text{ N} - 8.02 \text{ N} + 5.95 \text{ N} = 17.1 \text{ N}
\end{align*} \]

The magnitude of \( F_W \) is given by the Pythagorean theorem as
\[ F_W = \sqrt{(6.9 \text{ N})^2 + (17.1 \text{ N})^2} = 18.4 \text{ N} \]
The angle \( \theta \) that \( \mathbf{F}_W \) makes with the \( x \) axis is

\[
\theta = \tan^{-1}\left(\frac{17.1 \text{ N}}{6.9 \text{ N}}\right) = 68^\circ
\]

Therefore, the direction of \( \mathbf{F}_W \) is \( 68^\circ \), north of east.

---

29. **REASONING AND SOLUTION** There are two forces that act on the balloon; they are, the combined weight of the balloon and its load, \( Mg \), and the upward buoyant force \( F_B \). If we take upward as the positive direction, then, initially when the balloon is motionless, Newton's second law gives \( F_B - Mg = 0 \). If an amount of mass \( m \) is dropped overboard so that the balloon has an upward acceleration, Newton's second law for this situation is

\[
F_B - (M - m)g = (M - m)a
\]

But \( F_B = mg \), so that

\[
Mg - (M - m)g = mg = (M - m)a
\]

Solving for the mass \( m \) that should be dropped overboard, we obtain

\[
m = \frac{Ma}{g + a} = \frac{(310 \text{ kg})(0.15 \text{ m/s}^2)}{9.80 \text{ m/s}^2 + 0.15 \text{ m/s}^2} = 4.7 \text{ kg}
\]

---

69. **REASONING** The speed of the skateboarder at the bottom of the ramp can be found by solving Equation 2.9 \( v^2 = v_0^2 + 2ax \) where \( x \) is the distance that the skater moves down the ramp) for \( v \). The figure at the right shows the free-body diagram for the skateboarder. The net force \( \Sigma F \), which accelerates the skateboarder down the ramp, is the component of the weight that is parallel to the incline: \( \Sigma F = mg \sin \theta \). Therefore, we know from Newton's second law that the acceleration of the skateboarder down the ramp is

\[
a = \frac{\Sigma F}{m} = \frac{mg \sin \theta}{m} = g \sin \theta
\]

**SOLUTION** Thus, the speed of the skateboarder at the bottom of the ramp is

\[
v = \sqrt{v_0^2 + 2ax} = \sqrt{v_0^2 + 2gx \sin \theta} = \sqrt{(2.6 \text{ m/s})^2 + 2(9.80 \text{ m/s}^2)(6.0 \text{ m}) \sin 18^\circ} = 6.6 \text{ m/s}
\]