3 One-dimensional vector addition: The result of adding two vectors is the sum (two vectors have same directions) or difference (two vectors have opposite directions) of the two lengths and the direction of the longer one.

\[
\text{5 m E.} \quad \text{5 m E.} \\
\text{10 m E.} \\
\text{5 m E.} \quad \text{5 m W.}
\]

**Question 3**

a. If John walks 10 m to the right, 6 m to the left, 2 m to the right, and then 9 m to the left. What is (a) the total distance, and (b) the total displacement of John after all these movements.

b. If a boat moves toward east at 25 km/hr relative to the river, while the speed of the river current is 5 km/hr to the west, what is the actual speed of the boat from an observer on the river bank?

4 Two-dimensional vector addition: The result of adding two vectors, called the resultant, is the diagonal of the parallelogram described by the two vectors. When the two vectors are perpendicular to each other, the resultant is the diagonal of the rectangle.

a. 3-step (parallelogram) vector addition:

\[
\begin{array}{c}
\text{1} \\
\text{\sqrt{3}} \\
\text{\sqrt{3}} \\
\end{array} \quad \Rightarrow \quad
\begin{array}{c}
\text{1} \\
\text{\sqrt{3}} \\
\text{\sqrt{3}} \\
\end{array} \quad \Rightarrow \quad
\begin{array}{c}
\text{1} \\
\text{\sqrt{3}} \\
\text{\sqrt{3}} \\
\end{array} + \begin{array}{c}
\text{2} \\
\text{\sqrt{3}} \\
\text{\sqrt{3}} \\
\end{array}
\]

i) Draw two vectors with their tail touching.
ii) Draw a parallel projection of each vector with dashed lines to form a parallelogram.
iii) Draw the diagonal from the point where the two tails are touching.

b. Head-tail method for vector addition:

\[
\begin{array}{c}
\bullet \\
\bullet \\
\bullet \\
\end{array} \quad \Rightarrow \quad
\begin{array}{c}
\bullet \\
\bullet \\
\bullet \\
\end{array} \quad \Rightarrow \quad
\begin{array}{c}
\bullet \\
\bullet \\
\bullet \\
\end{array}
\]

i) Choose a scale and indicate it on paper.
ii) Select a starting point and draw the first vector to scale in the indicated direction. Label the magnitude and direction of the scale on the diagram.
iii) Starting from the head of the first vector, draw the second vector to scale in the indicated direction. Label the magnitude and direction of the vector on the diagram.
iv) Repeat steps (iii) for all vectors which are to be added. (The order is not important!)
v) Draw the resultant from the tail of the first vector to the head of the last vector.
vii) Using a ruler, measure the length of the resultant and determine its magnitude by converting to real units using the scale.
vi) Measure the direction of the resultant using the counterclockwise convention.