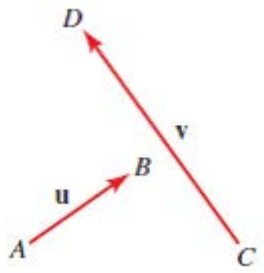
3.1 Vector Basics

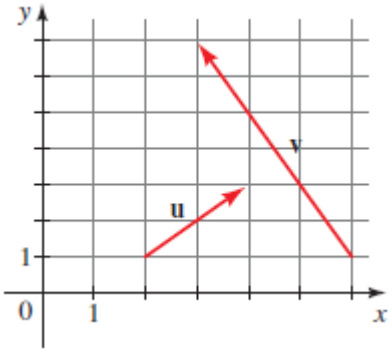
Practice Tasks

I. Concepts and Procedures

1. A vector in the plane is a line segment with an assigned direction. In the figure below, the vector *u* has initial point _____ and terminal point _____.
   Vector *v* has initial point _____ and terminal point _____.



2. A vector in a coordinate plane is expressed by using components. In the figure below, the vector *u* has initial point (_____ , _____) and terminal point (_____ , _____).
   The vector *v* has initial point (_____ , _____) and terminal point (_____ , _____).



3. Find the magnitude of vectors *u* and *v* in the graph above.

4. Identify the magnitude and direction in degrees of the following real-world examples of vectors:
   a. Harry is bicycling at 15 miles per hour for one hour due West
   b. Ron is walking 25 paces due North
   c. Hermione is pushing the handle of a lawn mower with a force of 450 newtons at an angle of 56° with the ground.
   d. A parachutist is falling straight down at 12.5 miles per hour

5. Find the horizontal and vertical components of the vector with the given magnitude and direction (θ):
   a. Magnitude $= 40$ foot-pounds; $\theta = 30°$
   b. Magnitude $= 1$ mph; $\theta = 225°$
   c. Magnitude $= 4$ newtons; $\theta = 10°$

II. Problem Solving

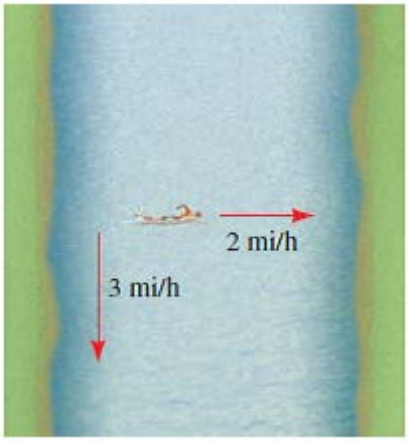
1. A soccer player kicks a soccer ball so that it leaves the ground with a velocity of 44 feet per second at an angle of 37° with the ground.
   a. Draw a diagram that that represents the path of the ball that results from the given magnitude and direction.

   b. Find the horizontal and vertical components of the velocity.

2. A man pushes a lawn mower with a force of 30 lb exerted at an angle of 30° to the ground. Find the horizontal and vertical components of the force.

3. A jet is flying in a direction N 20° E with a speed of 500 mi/h. Find the north and east components of the velocity.

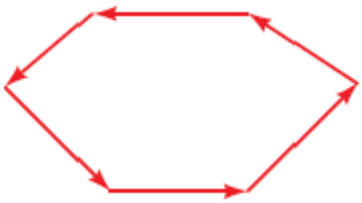
4. A river flows due south at 3 mi/h. A swimmer attempting to cross the river heads due east swimming at 2 mi/h relative to the water. Find the true velocity of the swimmer as a vector.



5. Suppose that in Exercise 4 the current is flowing at 1.2 mi/h due south. In what direction should the swimmer head in order to arrive at a landing point due east of his starting point?

III. Reasoning

1. Vectors That Form a Polygon: Suppose that n vectors can be placed head to tail in the plane so that they form a polygon. (The figure shows the case of a hexagon.) Explain why the sum of these vectors is **0.**



IV. Modeling

1. **Equivalent vectors** have the same magnitude and the same direction. On the same coordinate grid, sketch four equivalent vectors.

2. **Parallel vectors** have the same or opposite direction, but not necessarily the same magnitude. On the same coordinate grid, sketch three parallel vectors that are not *equivalent vectors*.

3. **Opposite vectors** have the same magnitude but opposite direction. On the same coordinate grid, sketch two opposite vectors.