**Activity 8.2.1 Vectors and Vector Notation**

A squirrel is crossing a road when it encounters a car travelling down the road.

1. What information would you need to know to determine what happens to the squirrel if it keeps moving at a constant speed across the road and the car maintains a constant speed travelling down the road?
2. Think of how you might represent the squirrel and the car. Draw a picture of the situation.
3. In addition to the speed that the squirrel is running, what else would you need to know about the squirrel’s movement in order to determine whether the car hits it?

**Scalars and Vectors**

Numbers are referred to as *scalars* because they can be represented on a number line or scale. *Vectors* have two properties: magnitude and direction. The magnitude of a vector is a number, which is based on a scale. The direction of a vector is its angle, which is defined based on some measurement system.

There are several ways to represent a vector. One way is an arrow. The length of the arrow is the vectors magnitude (length) and when the vector is in the plane its direction can be established by an angle. Consider the vector below shown in the 2-D (two dimensional) plane.



1. The length of vector is:
2. The angle of vector , measured clockwise from the *x*-axis and shown by the dotted line, is or

We can also use compass directions (North-South-East-West) to describe directions of vectors.

Compass headings are measured clockwise from the North starting at 000 degrees.

1. Sketch a road with a car moving up the road that runs North and South. The magnitude of the vector will be the car’s speed, 50 mph. The direction is straight up the road from South toward the North. Decide a scale for the vector and draw the vector. Then add a vector for a squirrel running across the road from West to East at 25 mph. Label the vectors in the diagram. Use

For example:

[](http://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwiA07uh9-PLAhUBKiYKHRpBAr4QjRwIBw&url=http://cargocollective.com/saschaelmers/Squirrel-Icon-Design&psig=AFQjCNHB3jzj7iE2jsBSxTUt_ZEpkNgZHw&ust=1459273421161723)

1. Explain how the squirrel’s direction and the car’s direction are important to the squirrel.
2. Explain how the squirrel’s speed and the car’s speed are important to the squirrel.
3. Explain why both the speed and direction are important in this situation.
4. Draw another diagram with the squirrel running in a different direction and a different speed and explain how these would change the situation for the squirrel. Label the vectors in the diagram

For example:

[](http://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0ahUKEwiA07uh9-PLAhUBKiYKHRpBAr4QjRwIBw&url=http://cargocollective.com/saschaelmers/Squirrel-Icon-Design&psig=AFQjCNHB3jzj7iE2jsBSxTUt_ZEpkNgZHw&ust=1459273421161723)

In the previous problems, we used . It is important to remember that velocity is a vector quantity since it contains a magnitude and direction. Speed is the magnitude (length) of the velocity vector.

The examples in this activity illustrated how a vector’s direction (angle) could be measured using the positive horizontal axis as a reference and measuring degrees or radians counterclockwise in the 2-D plane.

**Velocity is a Vector**

You are paddling your canoe across the Housatonic River. The river runs directly north and south at your location and has a current of about four miles per hour. You can paddle your canoe at about six miles per hour. You are on the east side of the river and wish to travel across the river to reach a point directly on west side of the river from your starting point.

First decide on a scale that you will use for the magnitude of your velocity vectors. You will use a coordinate system with north being in the positive *y* direction.

1. Label and scale the coordinate system below and also mark corresponding compass directions on the coordinate system so you can draw the velocity vectors on the coordinate system.

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Scale:

1. Draw a vector to represent paddling the canoe from east to west. Label the vector “canoe” and make sure it has the correct magnitude and direction. What is the direction of this vector in degrees? \_\_\_\_\_\_Radians \_\_\_\_\_\_
2. Draw a vector to represent the flowing river from north to south. Label the vector “river” and make sure it has the correct magnitude and direction. What is the direction of this vector in degrees? \_\_\_\_\_\_ Radians? \_\_\_\_\_\_\_\_\_\_\_
3. If you paddle the canoe directly from east to west will you reach the opposite side of the river directly west of your starting point? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Think about how to get to a point directly across the river to on the other side. What will you need to do with your canoe so you travel directly across the river?
5. Assuming you will be paddling your canoe with the same speed, sketch a vector diagram of to show the direction you will paddle your canoe so that your resultant direction of travel is due east.

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1. The magnitude of the canoe velocity vector above is \_\_\_\_\_ mph.
2. The magnitude of the river velocity vector above is \_\_\_\_\_\_ mph.
3. The magnitude of the resultant travel velocity vector is mph
4. If the river is of a mile wide, how long will ir take to row across the river?

The following questions provide you practice and review from unit 6 converting angles from degree measure to radian measure and vice-versa.

Convert degrees to radians by multiplying by . When necessary, use your calculator.

Convert radians to degrees by multiplying by

1. 0.688 radians = \_\_\_\_\_\_\_\_ degrees
2. 3.14159 radians = \_\_\_\_\_\_\_\_\_\_\_degrees