Relative Velocity and Vector Addition

Name_____

Procedure: Open up the following link. Press "Begin".

http://www.thephysicsaviary.com/Physics/Programs/Labs/RiverCrossingLab/index.html

A screen similar to that shown below should come up.

There are 4 inputs to this simulation. Waterway Size sets the width of the waterway. Boat Speed (V_B) is the speed of the boat relative to the water. River Speed (V_R) is the velocity of the water relative to the shore. Launch Angle (q) is the direction the boat relative to the water measured counter-clockwise from the +X axis.

There is one output from this simulation: the time to cross the river, t.

1. First we need to determine the width of the river, y. Set the Waterway Size to "River". Set V_B to 6 m/s, q to 90°, and V_R to 0 m/s. Click "Play". The simulation will output the time to cross, t. Use that and V_B to determine the width of the river. Show all of your work below.
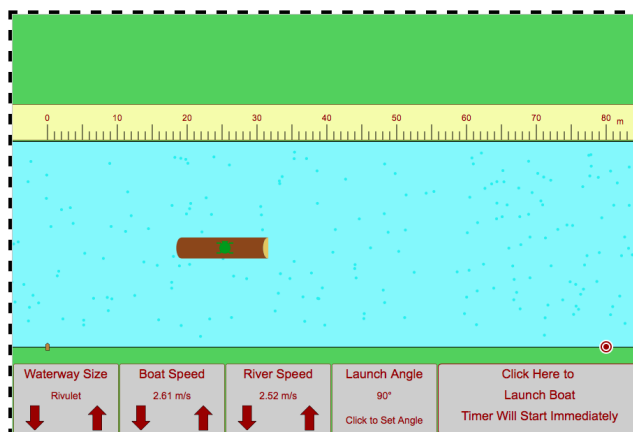
2. Predict the effect that the River Speed will have on the time to cross and the distance traveled. Will setting the River Speed to the maximum value increase, decrease, or not change the time to cross? Will setting the River Speed to the maximum value increase, decrease, or not change the distance traveled? **AFTER** you have made your predictions, change the River Speed to 6 m/s, keep the Boat speed and direction the same, and click Play to check your predictions. What is the effect of River Speed on time to cross? What is the effect of River Speed on distance traveled?

3. As you found out, the River Speed does not affect the time to cross the river. The time depends only on the component of the Boat's velocity relative to the shore in the Y direction and the width of the river. The River Speed does affect the Distance traveled. This is because it will change how far the boat goes in the X direction. We will now use vector addition to predict the time to cross, the distance traveled, and the boat speed relative to shore with these inputs: Boat Speed = 6 m/s, q = 60°, and River Speed = 3 m/s. We need to know the velocity of the boat relative to the shore, V_S. This is the vector sum of the velocity of the boat relative to the water, V_B, and the velocity of the water relative to the shore, V_R. This means that $\mathbf{V_S = V_B + V_R}$. To add 2 vectors we need the x and y components of each. Determine the x and y components of these 2 vectors and write them in the table below. Show all of your work for each part.

The x component of the vector sum, V_{Sx} is the sum of the x components of V_B and V_R. The y component of the vector sum, V_{Sy} is the sum of the y components of V_B and V_R. Determine the x and y components of V_S and write them in the table.

The time to cross is only affected by the y distance (width of river from #1) and the y velocity of the boat relative to the shore, V_{Sy}. Calculate the time to cross, t, and enter it in the table.

The distance traveled up or down the shore, x, is only affected by the time to cross and the x velocity of the boat relative to the shore, V_{Sx}. Calculate x and write it in the table above.

R is the total distance traveled and can be determined from y and x and the Pythagorean theorem. Calculate R and write it in the table.

$|V_S|$ is the boat speed relative to the shore. It is the magnitude of V_S that can be determined from the x and y components of V_S and the Pythagorean theorem. Determine $|V_S|$ and write it in the table. Run the simulation and check all of your predictions. Correct your work if necessary.

V_{Bx}	V_{By}	V_{Rx}	V_{Ry}	V_{Sx}	V_{Sy}	t	x	R	$|V_S|$

4. Complete the table below for these inputs: Boat Speed = 6 m/s, q = 135°, and River Speed = 3 m/s. Show all of your work below. Run the simulation and correct if necessary.

V_{Bx}	V_{By}	V_{Rx}	V_{Ry}	V_{Sx}	V_{Sy}	t	x	R	$|V_S|$

5. Do these three problems *individually*. When you've finished, show all three end screens to your teacher.

http://www.thephysicsaviary.com/Physics/APPrograms/RiverCrossingProblem/index.html
http://www.thephysicsaviary.com/Physics/APPrograms/RiverCrossing2Problem/index.html
http://www.thephysicsaviary.com/Physics/APPrograms/RiverCrossing3Problem/index.html