

## PHYS 101 Experiment 1. Relative Velocity: Boat Crossing a River

### Preliminary work:

Study “Example 3.14 Flying in a Crosswind” and “Example 3.15 Correcting for a Crosswind” of the textbook. In this experiment, instead of an airplane flying in a crosswind, we consider a boat crossing a river with a current.

### Online Experiment Link:

<https://ophysics.com/>

### Procedure:

1. Open the website given under the “Online Experiment Link”. From the top menu choose the menu item “Kinematics”, and from the appearing drop-down menu choose the experiment “Relative Velocity: Boat Crossing a River”.
2. Read the description given at the bottom of the page.

### PART A

3. Set the “Velocity of the river relative to earth” parameter to  $1\text{ m/s}$  and the “Velocity of the Boat Relative to River” parameter to  $4\text{ (m/s)}$ . Run the simulation multiple times by varying the “Aim Direction” parameter and noting the value of the time taken to cross to the other side of the river, and complete the table below.

<i>Aim Direction</i>	$-50^\circ$	$-40^\circ$	$-30$	$-20^\circ$	$-10^\circ$	0	$10^\circ$	$20^\circ$
<i>Time(s)</i>								

4. Study the above data and answer the first question “What direction should the boat be aimed to get to the other side of the river in the least amount of time?”.

5. Repeat steps 3 and 4 two more times with “Velocity of the Boat Relative to River” parameter set as  $4\text{ (m/s)}$ , and values of the “Velocity of the river relative to earth” parameter set to  $3\text{ m/s}$ , and  $5\text{ m/s}$ . Comment on the result.

### PART B

6. Set the “Velocity of the river relative to earth” parameter to  $1\text{ m/s}$ , and the “Velocity of the Boat Relative to River” parameter to  $4\text{ m/s}$ . Run the simulation multiple times, and by varying the “Aim Direction” parameter, try to get the boat to the point directly across the river (the small red dot). Note the value of the “Aim Direction” parameter for which the boat crosses to the point

directly across the river (the small red dot). Repeat this procedure for different values of the “Velocity of the river relative to earth” parameter and complete the table below.

$v_{re}(m/s)$	1	2	3	4	5
<i>Aim Direction</i>					

7. Study the table above and try to find a mathematical relation between the “Aim Direction”, “Velocity of the river relative to earth”, and the “Velocity of the Boat Relative to River” parameters.

### PART C

8. Set “Velocity of the Boat Relative to River” parameter to  $4\text{ m/s}$ , and the “Velocity of the river relative to earth” parameter to  $1\text{ m/s}$ . Aim the boat directly across the river (i.e., “Aim Direction” = 0), and run the simulation noting the time it takes for the boat to cross to the other side. Repeat the procedure by varying the “Velocity of the river relative to earth” parameter to answer question 3 of the simulation.

9. Write a properly formatted report of your results, convert it into a PDF file and upload it to MOODLE. Deadline for submission is Monday, 13 July 2020 at 07:59 (am). Late submissions will result in deduction of 10 points for each day late.