



## Experiment Module 4

### Vectors

#### **Objective/Introduction:**

Vectors are measurements that have both size and direction. Types of vectors you will be exploring with your Sea Perch include Forces, Acceleration, Velocity, and Magnetic Fields. In this experiment you will explore how to use vectors to solve problems related to your Sea Perch.

#### **Science Content Standards**

- At the end of 8th grade, students should know that
  - That unbalanced forces acting on an object changes its speed or direction of motion, or both.
  
- At the end of 12th grade, students should know that
  - The change in motion (direction or speed) of an object is proportional to the applied force and inversely proportional to the mass.
  - Whenever one thing exerts a force on another, an equal amount of force is exerted back on it
  - Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it.

#### **Materials Needed:**

2 meters of string  
Students' shoes  
Spring Balance (optional)

#### **Procedure:**

##### ***Tug of War***

1. Have one student volunteer his or her shoes.
2. Label one of these shoes, SHOE #1 and the other SHOE #2.
3. Tie one shoe to each end of the string.
4. While holding the string, lay the string across a tabletop and allow the shoes to hang off either end of the table.
5. Let go of the string and observe what happens to the shoes.
6. Now untie SHOE #2 and pick someone else to donate a shoe with a smaller mass. Call this new shoe, SHOE #3.
7. Tie SHOE #3 shoe to the string.

Discussion: Have students predict what direction the shoes will fall when the string is released. Release the string. Have students decide if their prediction was correct? Have them discuss the results with their lab partners.

1. Now untie the SHOE #3 and have someone else contribute a shoe with a larger mass. Call this shoe, SHOE #4.
2. Tie SHOE #4 to the string.
3. Predict what direction the shoes will fall when the string is released.
4. Release the string.

## 5. Observe what happens.

Extension: Use a spring balance or other scale to measure the weight of each of the shoes. Fill out the table below.

	Weight of Shoe (N)	Weight of Shoe (N)	Prediction of which shoe will “win” the tug of war.	Total Force acting on Shoe #1 (N)
Trial 1				
Trial 2				
Trial 3				

Looking at the last column of the previous data table apply Newton’s 2<sup>nd</sup> Law to calculate the acceleration of Shoe #1.

	Total Force acting on Shoe #1 (N)	Mass of Shoe #1 (kg)	Acceleration of Shoe #1 (m/s <sup>2</sup> )
Trial 1			
Trial 2			
Trial 3			

If you know the weight of an object in Newton’s, divide this number by 9.8 m/s<sup>2</sup> to calculate the object’s mass in kg. This value of 9.8 m/s<sup>2</sup> is the acceleration due to gravity of object’s on earth.

### **Extending the Discussion to Sea Perch:**

The weight of the shoes pulling on the string is similar to the forces pulling on the Sea Perch in the water. In the vertical direction the Weight of the Sea Perch is pulling down while the Force of Buoyancy is pushing up on the Sea Perch.

1. What will physically happen to your Sea Perch if these forces are the same size?
2. What will happen to your Sea Perch if the force of the Weight is greater than the Force of Buoyancy?
3. Brainstorm with your team, is there a way to calculate the net horizontal force acting on your Sea Perch?
4. Is there a way to calculate the maximum acceleration your Sea Perch can achieve?
5. Your motors can place a net forward force on your Sea Perch. Where could you place your motors to maximize this forward force?
6. What if you need to be able to move in all directions? Would that change the placement of your motors?
7. Is there a way to reduce the drag of the water working against your Sea Perch?

### **Additional Resources**

If your school has access to a force table, or if you want to make one this lab can be extended to add more than two vectors. There are numerous force table labs online. Please visit this link for a tutorial that discusses a force table as a part of an exploration of vector addition, <http://www.physicsclassroom.com/class/vectors/u3l3a.cfm>

### **Additional Resources to Share with Students**

- If you would like to learn more about vectors, please visit the following URL:  
<http://www.physicsclassroom.com/class/vectors/u3l3a.cfm>
- For some additional information, try the following sites to engage in some interactive simulations <http://phet.colorado.edu/en/simulation/vector-addition> and <http://www.compadre.org/introphys/items/detail.cfm?ID=9403>