VECTOR TREASURE HUNT

KEY CONCEPT

Vectors are used to represent many physical quantities such as displacements, velocities, and forces. This activity investigates the properties of vectors, especially the addition of vectors. The resultant displacement of an object moving through space does not depend on the order in which vectors are added.

SKILLS . . . . . . observing, analyzing
TIME . . . . . . 30 – 45 minutes
AUDIENCE . . . . . . students in grades 5 – 12
MISSOURI GRADE LEVEL EXPECTATIONS . . .

Strand 7.1B: Grades 5-8 a, e; Grades 9-11 a.
Strand 7.1C: Grades 5-11 a.
Vectors are an implicit concept underlying several GLEs that are much more effectively understood with this precursor concept. These include:

Strand 2.1A: Grade 7 a, b.
Strand 2.1B: Grades 9-11 a.
Strand 2.2 A: 9-11 a.
Strand 2.2 D: Grade 4 a-c; Grade 5 a; Grade 7 a-c; Grades 9-11 e.

SAFETY: No special safety precautions required.

CONTENT FOCUS

Vectors are used to represent the magnitude and direction of many scientific quantities including displacements, velocities and forces. Understanding vectors is important because when two or more of these quantities combine together they do not add algebraically, as pure numbers do. For example, two equal forces can act on an object to produce no net force, double the force, or anything in between, depending on the directions in which they are applied. Vectors have special properties, which will be investigated here.

Vectors are quantities that represent physical measurements having both magnitude (size) and direction. They may be represented by an arrow whose length is proportional to the size of the quantity and that points in the direction of the quantity.

Vectors may be added head-to-tail to find the net (or total) vector quantity. This net vector quantity is called the resultant.

Equivalent vectors are vectors that have the same magnitude and direction. Their location may be anywhere in space. Example: The vector representing cars in Kansas City traveling at 60 mph north are equivalent to those of any cars in St. Louis traveling at 60 mph north.

A vector may be moved anywhere in space without changing its magnitude or direction. This allows you to add vectors head-to-tail in any order without changing the resultant vector.

Name: _____

Date: _____ Section: _____

Vector Treasure Hunt

Purpose: To see what affect the order in which vectors are added affects the outcome; to gain skill in visualizing and manipulating vector quantities.

Equipment and Supplies (per group of 2 students):

9-12 popsicle sticks of 3 lengths (short, medium, long) that are labeled with compass directions (N, S, E or W) or various angles (ex.: 45° N of W).
brown paper bag
masking tape

Discussion:

As part of the settlement of your grandmother's estate you receive an old trunk and its contents, among which you find a letter from your grandmother. In it your grandmother thanks you for being such a wonderful grandchild and talks at length about the good times she has shared with you. At the end she reminds you that she never really trusted banks, so much of the money she saved before going to the retirement home she stashed in a weatherproof strong box and buried on the farm. She tells you how she carefully recorded the location of the strong box, starting from an obvious location in the back field (the Old Oak Tree), pacing out distances in various directions and recording them. She then transferred these measurements to wooden sticks, so they would last a long time, and shuffled them, just in case someone who was not in the family got hold of them. You now have these sticks in your possession. Unfortunately, a letter she mentions, giving the order in which you are to follow the directions on the sticks, is nowhere to be found! Is the treasure lost for good?

In this activity you will follow several different sets of directions to the treasure. A brown bag contains the popsicle sticks of different lengths and different directions. To begin, place two lengths of masking tape about 5 cm long near the middle of your table so that they form a "+". Where they cross is your starting point, the Old Oak Tree. See if it is possible to determine the location of the treasure from your vector directions.

Procedure:

Have your partner reach into the bag and give you a stick at random. Place the stick with the tail of the arrow on your starting point and turn it until it points in the direction specified on the stick. Have your partner give you another stick. Add this to the first one by placing its tail at the head of the first stick and pointing in the specified direction. Repeat this until you have used all the popsicle sticks. Mark your ending point with a piece of masking tape. Then, measure the distance and the direction from your starting point to the end (the treasure!). The directed distance from the Old Oak Tree to the treasure is called the **displacement**.

1st Displacement = _____

Pick up all the sticks and return them to the bag. Shake them up, and this time you pull out one stick at a time and let your partner place them in order as before. Again, measure the displacement.

2nd Displacement = _____

Analysis & Discussion:

1. How do your two displacements compare?_____

   _____

   _____

2. How does the order of the sticks affect the displacement?_____

   _____

   _____

3. Can you find grandma's treasure? Explain. _____

   _____

   _____

Conclusion:

_____

_____

_____