**Outdoor Vector Lab**

**Introduction**

A vector is a quantity which has both a magnitude and a direction. Vectors arise naturally as physical quantities. Examples of vectors are displacement, velocity, acceleration, force and electric field. For example, suppose your teacher tells you "A bag of gold is located outside the classroom. To find it, displace yourself 20 meters." This statement may provide yourself enough information to pique your interest; yet, there is not enough information included in the statement to find the bag of gold. The displacement required to find the bag of gold has not been fully described. On the other hand, suppose your teacher tells you "A bag of gold is located outside the classroom. To find it, displace yourself from the center of the classroom door 20 meters in a direction 30 degrees to the west of north." This statement now provides a complete description of the displacement vector - it lists both magnitude (20 meters) and direction (30 degrees to the west of north) relative to a reference or starting position (the center of the classroom door). Vector quantities are not fully described unless both magnitude and direction are listed. Vector quantities are often represented by scaled [vector diagrams](http://www.physicsclassroom.com/class/1DKin/U1L2c.cfm). Vector diagrams depict a vector by use of an arrow drawn to scale in a specific direction. 

Suppose we journey across the school following the sidewalks, walking 100 meters north, 275 meters east, and 200 meters north. How far have we gone? Even though we have walked 575 meters, we are only slightly over 400 meters from where we started. In order to state the situation precisely, a physicist would frame this situation in terms of vectors.

200 m

275 m

100 m

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**Procedure**

**Part A (displacement and distance vectors)**

1. Locate the piece of tape where you will begin your walk outside. This tape marks the origin.

2. Walk 10 steps forward and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (don’t forget units!)

3. Now turn 180 degrees and walk 5 steps and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (don’t forget units!)

4. Now turn 180 degrees and walk 20 steps and stop. Using the meter stick, have your partner measure the distance you walked. Write that distance here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (don’t forget units!)

5. Finally, have your partner measure how far you are from the origin. Write that

 measurement here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ This is your **measured displacement**.

6. Figure out the **distance** and **calculated** **displacement** you walked.

 Add all measurements to find the **distance**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Add all *forward* measurements and subtract all *backwards* measurements to find the

 **calculated** **displacement**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Did your **measured displacement** match your **calculated displacement**? \_\_\_\_\_\_\_\_

**Part B**

7. Find your piece of tape again, and walk 10 steps forward and measure how far you walked. Write it here: \_\_\_\_\_\_\_\_\_ (don’t forget your units!)

8. Turn 90° left, walk 15 steps and measure how far you walked. Write it here: \_\_\_\_\_\_\_

9. Turn 90° left, walk 10 steps and measure how far you walked. Write it here: \_\_\_\_\_\_\_

10. Turn 90° left, walk 20 steps and measure how far you walked. Write it here: \_\_\_\_\_\_\_

11. Have your partner measure how far you are form the origin. Write it here: \_\_\_\_\_\_\_\_

 This is your **measured** **displacement**.

12. Now figure out your **distance** and write it below. Show your work. Add up the

 measurements you wrote in numbers 7 through 10.

 Distance = \_\_\_\_\_\_\_\_\_\_

 Now figure out your **calculated displacement** and write it below. Show your work.

 Add number 7 + number 8 then subtract number 9 and number 10.

 Calculated Displacement = \_\_\_\_\_\_\_\_

 Does your **calculated displacement** match your **measured displacement**? \_\_\_\_\_\_

**Part C**

13. Find your piece of tape again, and walk 20 steps forward. Measure how far you walked and write it here: \_\_\_\_\_\_\_\_\_\_\_

14. Turn 90° right and walk 20 steps. Measure how far you walked and write it here: \_\_\_\_\_\_\_\_\_\_

15. Have your partner measure how far you are from the origin, your **measured displacement**, and write it here: \_\_\_\_\_\_ (Turn this page over and continue.)

16. Now figure out your **distance** and write it below. Show your work.

 Add number 14 and 15. Distance = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Here’s a way to figure out your **calculated displacement**. You can use Pythagoras’

 Theorem!

Does it match your measured displacement (or nearly so)?



 17. Now diagram the last walk and indicate displacement with a vector arrow. Show all your measured distances and displacements on the diagram.

18. Show with the same diagram how you used Pythagoras’ theorem to find your calculated displacement. Label the square of each leg of your triangle on the diagram.

**Part D**

19. Use your tape as the starting point – carefully measure displacement to the Physics is Fun Sign. Take careful measurements and angles measurements then construct a vector drawing (on the graph paper) and using simple vector math and the Pythagorean Theorem determine the displacement to the sign.