LAB 3. VECTOR ADDITION

Introduction

This lab consists of two exercises. The first one involves calculating distances and angles of displacement vectors between different locations on campus. Based upon this information, you will calculate the distance between two other points on campus. The second exercise involves combining three forces to give a zero net force.

Supplies

Displacements: protractor, long tape measure, magnetic compass, graph paper
Forces: Force table, protractor, disk masses, graph paper

Activities

Displacements

In this exercise, you become the instrument. Before you can be used to measure a distance, you must be calibrated. To do this, you will use a tape measure to calibrate your average pace size.

1. Mark off a 30-meter length on the sidewalk using the tape. Record how many paces it takes you to walk the 30-meter distance. Calculate the length of your pace in meters. You will use this calibration factor to calculate the distance in meters between various points around school.

2. Determine the heading (in degrees) from the outside entrance to the swimming pool to the nearest telephone pole. Do this by placing the magnetic compass on the stool and sighting to the destination. Once it settles, the compass needle should point north; read the heading from the line inscribed on the compass crystal.

3. Determine the distance from the entrance to the swimming pool to the nearest telephone pole by walking the distance and counting the number of paces. Convert the number of paces into meters by using the calibration factor from Step 1. These are the heading and magnitude of the vector $\vec{A}$, the displacement vector from the swimming pool entrance to the telephone pole.

   $\vec{A}$: Length: _______________ Heading: ______________

4. In the same way, determine the heading and magnitude of $\vec{B}$, the displacement vector from the telephone pole to the entrance by the dining hall.

   $\vec{B}$: Length: _______________ Heading: ______________

5. Draw vectors $\vec{A}$ and $\vec{B}$ to scale on a piece of graph paper. Begin the vector $\vec{B}$ at the head of $\vec{A}$. Draw the resultant vector $\vec{A}+\vec{B}$ (pool entrance to dining hall entrance), as length and heading. Measure the length with a ruler and the heading with a protractor.

   $\vec{A}+\vec{B}$: Length: _______________ Heading: ______________

6. Convert the heading angles to trigonometric angles. The compass headings use the convention that North is 0°, and the angles increase clockwise. So we can convert the

heading angles to the trigonometric angles by setting North as the direction of the $+x$ axis and negating all the angles (or subtracting from 360°).

$\vec{A}$: Length: ______________ Angle: _______________

$\vec{B}$: Length: ______________ Angle: _______________

7. Use these trigonometric angles to convert vectors $\vec{A}$ and $\vec{B}$ into their x- (North) and y- (West) components.

   A_x = ________ A_y = ________ B_x =________ B_y = ________

8. Find the resultant vector $\vec{A} + \vec{B}$ by adding the components of $\vec{A}$ and $\vec{B}$.

   $(A{+}B)_x$ = _________ $(A{+}B)_y$ = __________

9. Convert $\vec{A} + \vec{B}$ to magnitude (distance) and (trigonometric) direction.

   $\vec{A} + \vec{B}$: Length: ______________ Angle: _______________

10. Convert the direction of $\vec{A} + \vec{B}$ back to a compass heading.

    $\vec{A} + \vec{B}$: Length: ______________ Heading: _____________

11. Compare the distance and heading of vector $\vec{A} + \vec{B}$ found graphically and by components.

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Forces

The force table is a circle with three pulleys at the edge to support three threads tied to a central ring. Weights are hung form the threads and positioned on the circle so that the forces all cancel, centering the ring at the center of the table.

1. Obtain the angles and masses for two of your threads from the instructor.
2. Position two of the pulleys as directed and hang the directed masses from their threads. (Include the mass of the platform in the indicated masses.)
3. Determine the mass and angle that should produce the equilibrant vector that combines with the other two tensions to yield a zero net force on the ring. You may determine this any way you like: graphically, by calculation, or by trial and error. Write it here.

Equilibrant: Mass: ________________ Angle: _______________

4. Once you have determined the correct equilibrant, summon your instructor to witness that the two given vectors are correct and the equilibrant actually equilibrates. (If it doesn't, you get one more try.)