Name ________________________ Date ________________________

AP Physics Lab Activity #3 (45 pts)

Period _____________ Mrs. Nadworny

Partners: Due Date ____________________

Vector Addition

NO Lab Write-Up Required
must be neatly written in pencil

Purpose

To study free-body diagrams, addition of vectors, and the conditions for static equilibrium.

Introduction

Forces that act on the same object at the same time are said to be *concurrent* forces. When concurrent forces act on an object and that object is *in equilibrium* (at rest or in constant velocity motion), then the forces must be balanced and yield no net force, that is, the resultant of these forces is zero. In this activity, you will analyze three concurrent forces in equilibrium, using an apparatus known as a *force table*, by two different methods – graphical and algebraic.

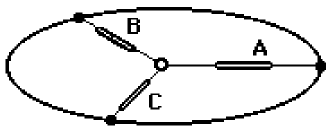
Graphical Method:
If the concurrent forces are in equilibrium, then when they are represented by vectors drawn to scale head-to-tail they will form a closed figure, in this case a triangle. Since the figure is closed, no resultant can be drawn.

Algebraic Method:
The algebraic method we will use is known as *addition by components*. Each force is represented by a vector and these vectors are broken into two perpendicular components – horizontal and vertical – in respect to a frame of reference of your choosing. The two sets of components (the three horizontal components and the three vertical components) are then analyzed independently of each other. If there is no net resultant force, then there should be no net horizontal component and no net vertical component.

Materials

- force table
- set of springs
- sharp pencil
- protractor
- ruler

Procedure



1. Set the force table flat on the lab table. Take one set of three springs connected by a central ring and notch the chain from each spring into a different groove on the rim of the force table. Try to make the arrangement asymmetric with varying forces displayed on the springs. Be sure the tension in each spring is not too small, about at least one third to one half of the full range of the scale, to reduce the effects introduced by the friction in each spring set. You now have three forces that are in equilibrium. Next, you will try to represent them as vectors drawn to scale.
2. Slide the "Graphical Method" side of your paper under the springs. Place the dot on the paper in the center of the central ring. This represents the single point at which the three concurrent forces meet. Then, put a mark on the paper underneath each of the three spring rods connected to the central ring. This will help indicate the direction of each of the three forces. Finally, write the reading on each scale on the paper next to each scale. Be as precise as the scales allow and include an appropriate estimate of your uncertainty.

3. Remove the paper from the force table without disturbing the springs.
4. With your ruler, draw three force vectors to an appropriate scale of your choosing starting at the central point and extending in the directions of the marks you made. **Be sure to state the scale**. (6)
5. Repeat steps #2-4 using the "Algebraic Method" side of the paper without disturbing the spring set-up. (6)

Data Processing

Graphical Method

1. On the "Graphical Method" side of paper, label the vectors A, B, and C, (in no particular order).
2. Redraw vector B (call it B') so that it is head-to-tail with vector A. Be sure to use the ruler and protractor to maintain the vector's magnitude and direction. (2)
3. Now, redraw vector C (call it C') so that it is head-to-tail with vector B'. Again, use the ruler and protractor to maintain the vector's magnitude and direction. You should now have the three force vectors placed head-to-tail. (2)
4. Draw, if possible, the resultant vector and label it R. Measure and record its magnitude and angle from +x axis. Show your work. (6)

Algebraic Method

1. On the "Algebraic Method" side of paper, label the vectors A, B, and C, (in no particular order).
2. Measure and label an appropriate angle at the origin for each vector.
3. Resolve each vector into horizontal and a vertical component. Draw and label each component. (3)
4. Calculate the magnitude of each component and summarize your data neatly in the provided table. Show all work. (12)
5. Calculate both the magnitude and direction of the resultant vector R with respect to the +x axis. Show all work. (4)

Conclusions (4)

1. What is the expected magnitude of the resultant in each case?

2. State one or more relevant sources of uncertainty that would explain any discrepancies between the expected resultants and your actual resultants.

3. Describe some properties of objects or systems that are *in equilibrium*.

4. Compare the values of your two resultants. [If your resultants are similar, but the components varied, note that instead.]

(2)
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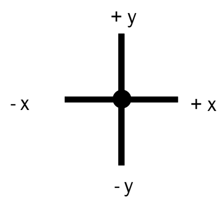
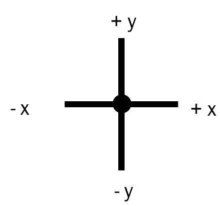
Graphical Method



Scale:

Resultant: ____________at____________

Algebraic Method



	A	B	C	ΣF
X				
Y				

Resultant: ____________at____________