Name: ________________________________________

# LAB 4. STATIC FORCES

## Introduction

This lab consists of combining three forces to give a zero net force.

## Supplies

Force table, three pulleys, central ring with three leads, mass hangers, protractor, disk masses, graph paper

## Activity

The force table is a circle with several pulleys around the edge to support threads tied to a central ring. Weights are hung from 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 weights from the instructor.

   Mass 1: ________ Angle 1: ________ Mass 2: ________ Angle 2: ________

2. Center the ring on the removable pin at the center of the force table. Position two of the pulleys as directed and hang the directed masses, including the masses of the hangers, from their threads.

3. Determine the mass and angle that produces 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 (recommended), or by trial and error (not recommended). You may even show your work below. Write the equilibrant 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 properly equilibrates. (If it doesn't, you get one more try.)

   Instructor verification: ________

## Data Analysis

You worked with three tension vectors in this activity: the two that were assigned, and the equilibrant. Here, you will add the vectors graphically and by components.

### Cartesian components

Express the three vectors in terms of their Cartesian components, add them, and see that their sum is close to the zero vector. Convert the sum to polar notation. Show your work right here, and your results in the following table.

| **Number** | $m$ (g) | $\theta$ (degrees) | $m_x$ (g) | $m_y$ (g) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| sum | | | | |

**Graph paper**

Using graph paper, a ruler, and a protractor, represent the three tension vectors as scaled arrows and add the arrows together, head-to-tail, on the graph paper. Verify that the sum is close to the zero vector.

## Report

There is not much to this lab, so you probably can complete the report before the class is out. Each student should complete an individual lab report.

**Abstract, Purpose, Theory**

You are adding force vectors together to make a net force of zero on the central ring. You model the vector addition graphically and quantitatively using components. You also practice converting between Cartesian and polar vector representations.

There! You don't need to write anything for these sections.

**Experimental**

You did what the previous page told you, so you don't need to write anything further.

**Observations and Data**

You recorded these by filling in the blanks on the previous page.

**Analysis and Discussion**

Tabulate the Cartesian decomposition of your two assigned vectors and their equilibrant (previous page and the table on this page), and attach the graph paper on which you plotted the graphical addition of the tension vectors.

**Conclusion**

Do the force vectors empirically combine according to the mathematical rules of vector addition? Answer below in no more than three sentences.