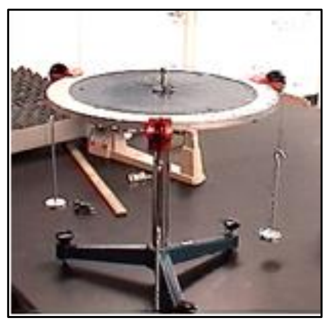
COMPOSITION AND RESOLUTION OF VECTORS

OBJECT: The purpose of this lab is to practice adding vectors. You will be adding vectors graphically, trigonometrically, and also experimentally by suspending masses that represent the magnitude of a force vector, at various angles from the center of a circular table.

APPARATUS: A ruler and protractor for graphical vector addition, a calculator for trigonometric vector addition, and a circular table with a central ring and center pin, set of slotted weights, four pulleys and four weight hangers for experimental vector addition.

THEORY: Newton's first law states that if there is no net force acting on an object, then the object has no acceleration, and thus remains in 'equilibrium'. For this lab, we will be studying a special case of equilibrium, *static* equilibrium, where an object has no acceleration, but also no velocity (as measured in the lab's frame of reference). On the circular table, if the center ring is not moving or resting on the center pin, then the ring is in static equilibrium and the total vector sum of forces acting on the center ring is zero. The sum of forces on the ring can be made zero by placing a single vector equal in magnitude, but opposite in direction to the sum of all of the other forces pulling on the ring. This initial sum of all of the forces pulling on the ring is called the *resultant force* and the equal and opposite force to the resultant force is called the *equilibrant*. You will be experimentally verifying that the sum of the *resultant* and *equilibrant* force vectors is zero.

PROCEDURE: A number of pulleys (one is needed per vector) are attached on the circular table. Strings are tied at one end to the ring, pass over the pulleys, and are then attached to weight hangers at the other end. Note that the proper conversion of hanging mass to force is through multiplication with a gravitational acceleration vector, but because the gravitational acceleration is the same for all of the masses in this lab, the value of the hanging mass can be used as a substitute for the magnitude of the force. Carefully follow the procedures below for each set.



SET I

1. Set one pulley at 0° and hang a mass of 200 g from the pulley. Set another pulley at 90° and hang a mass of 300 g from that pulley. Remember that the weight hangers themselves constitute a portion of the mass.
2. Next, try to balance the two hanging masses by setting a third pulley with some hanging mass somewhere on the table. The three hanging masses are balanced (in static equilibrium) when the center ring is not moving or touching the center pin. When you have the masses balanced, write down the corresponding hanging mass and angle below:

    Mass:___________________

    Angle:___________________

3. On a sheet of paper, draw a vector diagram for the two original vectors (at 0° and 90°) and find the resultant sum of the two vectors *both* graphically *and* trigonometrically.
4. Use the resultant vector calculated in step 3 to determine the equilibrant vector, and set this on the table using the pulley and mass from step 2. Verify the two vectors and their equilibrant sum to have zero net force. **By how much did your Mass and Angle from step 2 change? Write some comments or observations below.**

SET II

4. Set a mass of 200 g at 0°. Set a mass of 400 g at 120°.
5. Draw the vector diagram on a piece of paper and find the resultant force either graphically *or* trigonometrically. Set the equilibrant determined from your resultant vector on the table and verify the static equilibrium condition.

SET III

6. Leaving the two vectors as above (Set II), hang another mass of 300 g at 150°. Find the resultant force on paper by the trigonometric *and* graphical methods. Verify the resultant force on the force table by setting all the vectors and their equilibrant.

OBSERVATIONS:

SET I

	Pulley 1	**Pulley 2**	**Resultant**	**Equilibrant**
Magnitude	200 g	300 g		
Direction	0°	90°		

SET II

	Pulley 1	**Pulley 2**	**Resultant**	**Equilibrant**
Magnitude	200 g	400 g		
Direction	0°	120°		

SET III

	Pulley 1	**Pulley 2**	**Pulley 3**	**Resultant**	**Equilibrant**
Magnitude	200 g	400 g	300 g		
Direction	0°	120°	150°		
***x* - component**					
***y* - component**					

QUESTIONS:

1. If the weight of the weight hangers was the same, can we then neglect their weight in the calculations?

2. If the ring at the center had weighed considerably more, what would have been the resulting effect on the system (experimentally)?

3. What could be reasons for the discrepancy between the calculated resultant and the experimental (measured) equilibrant?

4. Could all the pulleys, including equilibrant be placed in one quadrant? Could they be placed in two adjacent quadrants? Explain.

5. What is the difference between the mass and the weight of an object?

6. Name **four** physical quantities (i.e. force) that are vectors, and four that are scalars.