PHSX 221L **Forces as Vectors** **Name:**_____

Object: To study how simultaneous forces combine together to produce a resultant force.

Introduction: A basic concept in the study of physics is that forces can be represented theoretically by vectors. This means that when several forces act simultaneously on the same object, they combine together into one resultant force. This resultant force can be calculated theoretically using the rules of vector addition by either of the following methods:

1. By diagram (graphically): Several vectors representing concurrent forces can be added by diagramming the vectors head-to-tail using rulers and protractors to measure the magnitude and direction of each vector. The resultant vector is found by drawing an arrow from the tail of the first vector in the series to the head of the last.

2. By component (numerically): The resultant of several concurrent vectors can also be found by breaking each vector up into its x- and y-components.

$$x = r\cos\theta \qquad y = r\sin\theta \tag{1}$$

Corresponding components of the several forces are then added together separately to obtain the x- and y-components of the resultant. The magnitude r and direction θ of this resultant vector are given by:

$$r = \sqrt{x^2 + y^2} \qquad \theta = \arctan\frac{y}{x} \tag{2}$$

Procedure: Using a force table, three forces will be set up as described in the following list. A fourth force will then be determined by the student and adjusted so as to balance the resultant of the other three. This balancing force, which you will find by trial and error, is the reverse of the resultant force you are looking for.

Trial	Force A	Force B	Force C
1	150 g at 0°	130 g at 35°	150 g at 110°
2	110 g at 20°	110 g at -75°	150 g at 120°

Theoretical Results: Make a scale drawing on some graph paper.

1. What was the magnitude and direction of each resultant force obtained by diagram (graphically)?
2. What was the magnitude and direction of each resultant force obtained by the component method (numerically)?

Experimental Results:

Analysis:

1. Do your results show that forces combine together the same way that vectors do? That is, do forces really behave as vectors?
2. Calculate the percent difference between theory and experiment for the resultant of each trial.

Conclusions:

1. What is your evaluation of this experiment?
2. What are some possible sources of error?
3. What did you do to reduce your error?