VECTOR ADDITION

<u>Purpose</u>

To work with vector addition of three vectors.

<u>Apparatus</u>

Graph paper, force tables, weights, protractors.

<u>Theory</u>

Even though this experiment deals with forces, the methods can be used for any vectors. Refer to your textbook for the discussion of vector addition by resolution of vectors into components and by graphical methods. **For all parts, you are to determine the <u>vector sum of the three given forces</u>**.

For the experimental part of this lab, you determine the fourth force, F_B, acting on an object (the ring on the force table) that will balance the given three so that the net force is zero. With the net force equal to zero, the object will be in equilibrium and if initially at rest will remain at rest. F_B has the same magnitude as the sum of the first three and will be in the **opposite** direction as the sum of the first three.

Although forces should be expressed in dynes or newtons (or pounds), for this experiment you can use forces in gram-weights (gram-wt) to save work in the computations. Thus if you have a 150 gram mass hanging from one side of the force table, you can consider the force exerted by this on the center ring to be 150 gram-wt, rather than converting to dynes or newtons. In your scale drawings, be sure to convert your lengths to gram-wt, too, and label your drawing with gram-wt, rather than length units such as cm.

Procedure

Experimental Method:

Set up the given forces on the force table and determine experimentally the force necessary to balance ($F_1+F_2+F_2+F_B=0$) them. Estimate the uncertainty in your measurement, both for the magnitude and direction of F_B. Consider how much mass/angle can change by without affecting the balance and the resolution of your measurement equipment. Determine the absolute uncertainty for both the magnitude and direction, Determine the relative uncertainty for the magnitude (but not angle, here relative uncertainty is irrelevant, why?) F_B has the same magnitude but points in the opposite direction from the resultant, $R=F_1+F_2+F_3$. Use F_B to determine the magnitude and direction of R?

Theoretical Method:

For the three forces given to you, calculate the direction and magnitude of the resultant, R. First resolve each of the vectors into components, add the vectors together and then find the magnitude and direction of R. This is your "theoretical" value.

Graphical Method:

Carefully draw to scale (using a ruler and protractor) the three forces. Add them (tip to tail) and determine the direction and magnitude of R from the scale drawing. This will be your graphical value. Make a reasonable estimate of the absolute uncertainties of the magnitude and of the direction of your graphical value.

Compare Magnitudes:

Determine if the **magnitude** of the <u>resultant force</u> from each method agree by comparing the <u>relative difference</u> with the <u>relative uncertainty</u>. That is: compare the calculated value and the graphical value, the calculated value and the experimental value, and the graphical and experimental values?

Compare Angles:

Determine if the various values for the **angle** of the resultant force agree by comparing the <u>absolute difference</u> with the <u>absolute uncertainly</u>.