Introduction and Background:

In the next unit, we will tackle the next kind of vector, force. A force has a magnitude, measured in Newtons (N), and a direction in which it acts. In this lab, we will use spring scales to measure the magnitude of some forces, and rely on old-fashioned trigonometry to find the directions.

For this lab, you need not worry about a spiffy write up, the proof of your work will be in the analysis that you turn in with this as a cover sheet. The procedure is already written for you, and the data sheet will be collected from your entire group. Don’t try to answer the questions on this sheet.

Procedure: (Read carefully before starting)

1. In groups of no more than four, gather around a table and tape a piece of large paper to the center of the table. Get one of the groups of strings, tied together at one end, and a corresponding number of spring scales. You may need to “zero” the spring scale out before using it.
2. We next construct an x-y axial grid on the paper (2-D Cartesian plane with labels). Make it so the origin is in the center of the paper. The knot of the strings is always to remain at the reference point (origin) of this coordinate system.
3. Try attaching the spring scales, each to the end of separate strings, and pulling in unison, always keeping the knot at the origin. Since you have three magnitudes and three angles for each of the forces, you must have three different vectors (3 different size forces pulling 3 different ways).
4. Have the non-pulling member of the group make marks on the paper to show the angles of the various scales, and write down the magnitude of the force for each scale. Remember that the magnitude of a vector is just the length of the arrow you draw to represent it, and its direction is the angle with respect to the coordinate system.
5. You should have at least two different sets of vectors (two times through this procedure) completed before you start any of the analysis. Use two separate large sheets of paper.

Analysis: (All work must be shown for credit)

1. Mark on your papers lines that will represent each of your vectors, being sure to draw their lengths proportional to the magnitude of the force (you must invent a scale like 1 cm = 1 N, first).
2. Prior to making any calculations, answer the following question. If each set of vectors (the string tensions) were rigged up so that there was no change in the center of the system (the knot), what do you think the situation is with the forces? (i.e., what is the “overall” force?) What do you think that this means the resultant vector should “look” like, specifically?
3. Each member should copy down the information, and make a sketch of the patterns for their own analysis section. Without your own copy, you will receive no credit.
4. Find the angles between each vector and the x-axis, by way of first drawing in each vector’s x- and y-components. Do not use a protractor; use trigonometry.
5. Find the resultant of all three tension vectors by adding their components (add all the x-components separately and all the y-components separately, then find the overall resultant). Do this for each trial.
6. Find the same resultant by using the “Tip-to-Tail” method of adding the three vectors. Does this give you the same result? Which is more accurate, and why? Do this for each trial.
7. From your best trial, pick any two of the three vectors. Add these two separately, and discuss how their resultant compares to the third tension vector that you “left out” of the calculation. Does this verify your predictions in #2 further, or give you more insight into the nature of vector addition?
8. How could the group’s measuring and recording techniques be improved/adapted?