1. Connect one end of a helical spring to a rigid object. Stretch the spring by pulling the other end with a spring scale. Measure the force needed to *double* the length of the spring. Do *not* stretch it to more than 2.5 times its original length. Record the names, uncertainties, and units of all three measurements.

2. Stretch the same spring with two scales, one pulling on each end. *First zero in the scales.* Stretch it until the first scale indicates the *same* reading that was used in #1. The amount of force used to stretch a spring (as measured by *either* scale) is called the **tension** of the spring.
   a. How does the spring length in #2 compare with the length of the stretched spring in #1? ______
   b. Is it possible to change the spring's length without changing its tension? _____ -Does 2a agree? ___

3. Stretch your spring to several different lengths. (Again, please do not over-stretch the spring.) Measure the tension at each length. Make a *data table* and a *graph* to describe the relation. (The title of the graph should be **spring tension vs length.)** Set up the table intelligently to avoid needless repetition.
   a. Column headings in a data table must have NAMES, such as **"Length"** or **"Tension".**
   b. Column headings in a data table must also have UNITS, such as "meters" or "newtons". Remember to put the units in parentheses after the name, as on page 5. Don't forget the preposition!
   c. All measured quantities must be in range form **OR** must have uncertainty estimates as on pages 1, 2, & 4. If all the values in a column have the same uncertainty then put it at the bottom of the column.

4. **Laboratory Lesson One:** If you make the graph for #3 on real graph paper while the series of measurements is in progress then you can notice mistakes immediately and correct them right away.
   a. Do you prefer to be unaware of mistakes until it is *too late* to correct them? ____ If so, explain why.
   b. Should you wait until you have finished collecting data before you begin plotting points? ____
   c. Does 4b contradict 4a? ___ Where have you saved a copy of Lab Lesson One? ____

5. Your first goal is to discover whether the graph is a straight line or a curve, by using real graph paper.
   a. Should you begin your series of measurements with the greatest and smallest possible values of the controlled variable? _____ (yes or no) -Does this answer contradict #4? ___
   b. What *third* value should you choose for the controlled variable to make sure that the first goal will be reached even if you run out of time? ____________ (greatest, smallest, intermediate)

6. In evaluating student graphs I always look for the following items, which were explained on page 5:
   a. At the top of the graph there must be a ***title***. (See #3.) The first noun in the title is the name of the ***dependent*** variable. Next is the abbreviation "vs.", meaning "versus", or "against". Last is the name of the ***controlled*** variable, which is the one that you personally adjust.
   b. Each axis of the graph must be labelled with a name *AND* units. The name of the ***dependent variable*** always goes on the *vertical* axis of the graph. The name of the ___________ variable should be copied from the title onto the *horizontal* axis. (Copy the word from 6a.)
   c. According to 6b, the ____________al axis of the graph in #3 should be labelled **"Spring Tension (in newtons)".** The ___________al axis should be labelled **"Length (in _______)"**.
   d. Do the column headings in your data table agree with those labels? ___ -If not, please explain.

7. If the pattern on your graph appears to be linear, draw two reasonable straight lines, as on page 5. Use those lines to calculate the smallest and greatest likely values of the slope in *decimal form*, *with units***.** To calculate the slope of a graph you divide the height of a triangle by its width. #1 on RS I says that whenever you divide two numbers with units you must also _______ their units.
   For example, **(100 mi.) ÷ (2 hr.) = 50 _____ per _____.**
   a. The big right triangle that I drew on the steeper line on my graph has a height of ______ ____. Its width is ______ ____. Therefore GLV of the slope of my graph is _______ _____.
   b. The big right triangle that I drew on the *other* line on my graph has a height of ______ ____. Its width is ______ ____, so the SLV of the slope is _______ _____.
   c. The slope of the graph is therefore between ______ and ______ ____s per ____.

* 8. The spring's **"amount of stretch"** is the difference between its stretched length and its unstretched length. What would a graph of **Tension vs Amount of Stretch** look like for your spring? Give a *short* but *complete* description of that graph *without* plotting any points. The slope which you give will be *meaningless* if you omit its units and will be *misleading* if you fail to give its range or uncertainty.

* 9. Write your conclusion as a simple, clear sentence. Use the phrase, "proportional to" as in 7b on RS I, and use the variable names given in #8. To avoid confusing cause with effect, use 4c on page 5. This conclusion is recorded in #___ on RS I, and is known as "_________'s equation".