Physics S
Restoring Force versus Stretch Distance for Solids.

In class, we use the assumption that for an elastic solid, the restoring force is proportional to the amount we have stretched it. In this lab you are going to explore this assumption more fully. You will use a computer interfaced force probe and ultrasonic range finder to construct force-distance graphs, and then you will use these graphs to see what is going on when a solid is distorted.

What to do:
1. You will need a computer with Mac motion on it, a ULI, a force probe, an ultrasonic motion detector, a meter stick, a piece of cardboard, a rubber band, a coil spring, a piece of elastic, a C clamp, and a positive attitude toward Physics.
2. Start up the Mac motion program on the computer. Get it to measure distances and forces. Remember that the motion detectors cannot measure distances less than 50 cm.
3. Hook the piece of cardboard to the force probe so the motion detector can "see" the position of the force probe. Adjust the force probe so that it is measuring forces in the range of the forces you will be measuring when you are stretching the materials in this lab. (How you do this may vary from lab station to lab station)
4. Arrange the motion detector, C clamp and force probe so that you can measure the force of stretch at the same time that you measure distance. Hook a rubber band to the force probe, and make a graph of Force v distance, stretching the rubber band until you feel it stretch taught. (Don't break it yet) Check to see that your force probe reads force for the entire distance. Adjust its sensitivity if it doesn't.
5. Make as many Force v Distance graphs as you want, but print out only the graphs that best support your answers to these questions: (If you need an actual data graph to answer the question) Include no graph to which you have not specifically referred.
A. What would a force - distance graph look like for an ideal spring where $|F| = |Kx|$? Draw an accurate graph of this function.

B. The formula $F = Kx$ has a zero y-intercept. (For zero stretch, the force is zero) Do real coil springs always have a zero y-intercept? Why or why not - come up with a hypothesis and sketch out an experiment to check it.

C. To what extent do the materials in this lab follow the relation $F = Kx$? Bring in an elastic solid of your own and make a Force versus Stretch distance graph. (i.e. not a rubber band or a spring - anything that stretches) (Refer to A., and specifically refer to specific parts of actual data graphs you have made to support your answers)

D. An ideal spring will give you the same Force v distance graph whether you are stretching it or letting it return to its original position. Is this true for the elastics we are using in this lab?

E. Stretch a rubber band to its full extent, and let it return to its original position. (This is a hysteresis graph) Print out a Force-Distance graph of this with a background grid. Using the idea that the area under the curve is energy, compare the work done to the spring to the work the spring does on the world. (If the latter is the larger, notify me immediately and stand back - the spring is about to explode). Where does the missing energy go? Come up with a theory, and design an experiment to account for the missing energy. What would a Force-Distance hysteresis graph look like for Flubber?