Team Physics 312 Name: ___________________________
Mini-lab 4C
Date: ___________ Table/Team: _________________________

Linear Elasticity of Materials

You are already familiar with Hooke's Law for a spring, $F = - k \Delta x$, where Δx measures the stretch of the spring from its relaxed state. Let's first quickly review this experimentally, as we'll be using springs in the upcoming labs on simple harmonic motion, and it's important to understand the distinction between the position x and the extension Δx.

Hang the *small end* (can you think of why the small end?) of the spring from the support and measure the Δx extension of the spring in some reasonable manner. Consider the relaxed state to be when the mass holder alone is on the cord, and use this as the zero of your force. The mass holder may stretch the spring a little bit, but this can still be taken as $\Delta x = 0$ providing the plot in a linear relationship and we consider the force to be the weight added to the holder.

Data Table 1: Now add the following masses and measure the length of the spring.

Mass added to holder (grams)	Length of spring (cm)
0	
5	
10	
15	
30	
60	
80	
100	
150	
200	
250	
300 (Don't exceed this for the spring!)	

(Substitute other masses here if you can't arrange the ones shown, just don't exceed 300 grams).

Compute and plot the added force (not including the mass hanger) in [N] versus the stretch Δx in [cm]. Properly plan out and label the graph, and attach one copy to one copy of this report per group that you will hand in. Identify the part of the graph that most closely obeys Hooke's Law, if not all of it, and indicate this on the graph.

How well does it agree with Hooke's Law? (Estimate your uncertainties and draw error bars on the graph) If there is a linear part of the graph, determine its slope and find k. If only part of the graph is linear, use that part to find the slope.

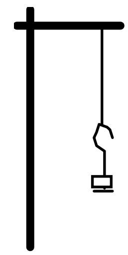
Show your calculations below, and be sure to include units in your final answer. Also make sure you have 1 significant figure on your error (possibly two if it starts with a "1"), and make sure your digit placement on the error matches that of the value.

k value calculations:

Is the graph you obtained a proportionality?

Now you will measure the behavior of something else to show that other materials besides springs also display this sort of linear behavior.

Take a length of physics cord and stretch it by various forces. The force will again be the weight of the applied masses. Use a meter stick to measure the length, but take care to do this as accurately as possible as we want a nice graph to characterize this material.



Hang the cord from a support and come up with some way of measuring the length of the cord. One way might be to tape a small paper triangle to the end to mark the position on a meter stick, but students have come up with many other ingenious methods. Consider the relaxed state to be when the mass holder alone is on the cord, and use this as the zero of your force (It's probably safe to ignore the very small extension the holder causes and take this to be the zero point).

Use masses ranging up to roughly 500 or 600 grams, and fill in the table on the next page. This weight per cross sectional area is no where close to the yield strength, so the uppermost part of a typical stress-strain curve, where the material starts to permanently deform or break, will not be seen, but there are some features to be aware of if the measurements are done accurately. **Be careful that the rubber part of the cord does not slip within the nylon sheath, as this will cause a sudden discontinuity in your data.** This might happen if the cord is loosely held at one of the ends.

Compute and plot the added force (not including the mass hanger) in [N] versus the stretch in [cm]. Properly plan out and label the graph, and attach one copy to one copy of this report per group that you will hand in.

Identify the part(s) of the graph that most closely obeys Hooke's Law, if any. Indicate this on the graph. If there is a linear part of the graph, determine its slope and find k. If only part of the graph is linear, you will have to use just that part. How well does it agree with Hooke's Law? (Estimate your uncertainties for k and draw error bars on the graph).

k values(s):

Data Table 2: Add the masses and carefully measure the extension of the cord. (Pick some convenient mass intervals here, ranging up to 600g).

Mass added to holder (grams)	Δx Extension (cm)
0	
600 (max)	

Puzzler for this lab: If you’ve done this carefully, you’ll notice that your plot is different than the simple plot obtained for the spring. Discuss this with your lab partners and try to come up with a plausible explanation of what might be going on here, and write it in the space below;

(For those of you who will grow up to be engineers, this is the sort of thing to be very careful of.)

What would be the danger here if you design a structure using these cords and decide to take just 2 or 3 data points, as some non-science students might do?

On the back of this page, write a quick abstract of this lab report. This is good practice for technical writing and all your lab partners should be involved in deciding how to state the basic numerical results and any insights in as concise a manner as possible. Pretend that it’s like one of those classified ads where you get charged for every word you use.

ABSTRACT:

Submit your one good copy of your graphs and one good copy of this report per group at the end of class.

If you finish early:

Q1: Does it matter what length of material you choose? (Compare your plot with one from a nearby group. Chances are they used a different length of cord. Do the graphs look the same? Should they?

Q2: Try starting from a large force and going back down to a small force. Are the plots still the same? (Any lack of retraceability in a plot due to direction is known as hysteresis).