

PHYSICS

Reiner, Hutchison, Vourgourakis

Lab 6-1: Hooke's Law

Springs are objects which exert restoring forces: when you exert a force on them, they either stretch or compress. If they stretch, then are said to be in tension – if they compress, then they are in compression. Springs can be built for tension, compression, or both. The springs you will use in this lab are built for tension.

The relationship between the amount of force applied to/by a spring (Newton's 3rd law!) and the amount of stretch or compression in the spring is called Hooke's Law, which mathematically is stated as

$$F_{\text{spring}} = k\Delta l$$

where F is the force exerted by or on the spring, Δl is the change in length of the spring from its natural length, and "k" is called the "spring constant." The spring constant is the ratio of applied force to deformation in a spring. The stiffer a spring is, the greater the "k" value, as it would take more force to produce a given amount of stretch.

In principle, the spring constant can be calculated from a single data point, where a known force is applied and the amount of stretch is measured. Better, though, is to make a graph of applied force vs. stretch. Since $F = k\Delta l$ represents a linear relationship, the slope of the best fit line will give you the spring constant of the spring. At this station, you will hang a series of masses to determine the spring constant of a spring – different springs will give different values, depending upon their stiffness and their length. Use masses from 100 grams to 1000 grams in increments of 100 grams.

Mass (g)	F_{spring} (N)	Length (cm)	Stretch (= $l-l_0$) (cm)
0	0	$l_0 =$	0
100			
200			
300			
400			
500			
600			
700			
800			
900			
1000			

You will now plot a graph of F_{spring} vs. stretch and get a best-fit equation using your calculator, as per the instructions below:

1. Press the **STAT** button, then the **EDIT** button. This will bring up the “lists.”
2. Enter your Δl values under where it says **L1**, pressing enter after each value.
3. Enter your F_{spring} values under where it says **L2**, pressing enter after each value.
4. Make sure that your **L1** and **L2** lists match up appropriately (there should be an equal number of values in each column). Press the **GRAPH** button and see if your graph appears. If it doesn't, do the following:
 - I. Press the **STAT PLOT** button (2^{nd} function, $y=$, upper right-hand corner)
 - II. Set Plot 1 so that it reads **L1 L2** and says **On**. Adjust the **TYPE** of graph so that is a scatter plot (not a bar graph or a connect the dots). Choose the **MARK** as either the square or the plus symbol for best visibility.
 - III. Press the **GRAPH** button. If the graph “window” happens to match up with your data, then the graph will appear. If not, then press the **ZOOM** button and choose **9: ZOOMSTAT**. Your graph should now appear.
5. To obtain a best fit equation for your data, press **STAT** again, followed by **CALC**, and choose **4: LinReg (ax+b)**. The calculator will assume by default that L1 corresponds to your x values and L2 to your y values, and will give you a best-fit linear equation.

CALCULATOR GENERATED BEST-FIT EQUATION:

6. In order to get your best-fit line to appear on your graph, press **LinReg** again, but before pressing enter, press the **VARS** button (VARS is short for variables), choose **Y-VARS**, choose **FUNCTION**, and then choose **Y₁**. This stores your best-fit equation in the calculator memory under Y_1 . When you press **GRAPH**, you should now see a scatter plot of your data points, along with the best fit line.

A few brief questions to answer, using your data and/or graph and/or equation:

1. Does your data seem linear? Justify/explain.

2. Does your best fit-line go through (0,0)? Why or why not?

3. What is the value of your spring constant?
(Include appropriate units)