Hooke's Law (Graphing)

Purpose

To measure the force constant of a spring using the static stretch of the spring. The force constant is also called the *spring constant*.

Introduction and Theory

When a spring is deformed (extended or compressed) from its relaxed position, it opposes the deformation with a force. The force is called a restoring force because it is opposite in direction to the deformation and tries to restore the spring to the relaxed position. If the magnitude of the restoring force F is proportional to the extension or the compression Δx, then the spring is said to obey Hooke's law:

$$F = k\,\Delta x$$

where k is the force constant or the spring constant. A real spring obeys this law only for a limited range of deformation.

If an object is suspended vertically from a spring, then, at the equilibrium, the weight of the object is equal to the restoring force, F, in magnitude. Therefore, the slope of the weight vs. the extension will give an experimental value for the spring constant.

Writing a Lab Report

Your report should always contain 5 parts: Purpose, Apparatus, Data, Calculations and Conclusions. Some labs, like this one, also contain a Discussions section. Refer to "Introductory Materials for 1114/1118 Labs" and "Sample Lab Report" for details. The front page should look like:

Your name
Partner's name(s)
Physics 1118 Section #
Desk #
Date

Hooke's Law (Graphing)

Purpose: (Write the purpose of the lab here. Keep it in mind as you work.)

Apparatus: (Follow the instructions on the next page.)

Apparatus

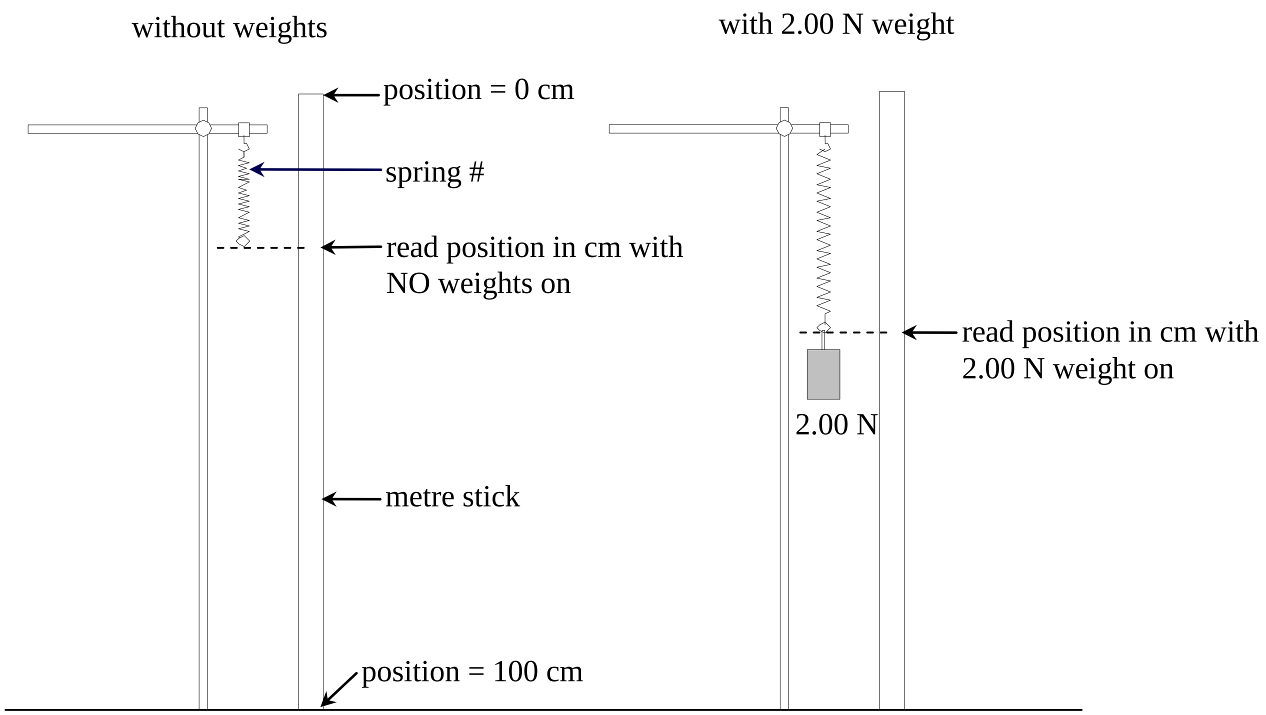

Figure 1

Draw a labelled diagram of the apparatus, showing any identifying numbers (the spring, in this case). List any other apparatus that is not shown on the diagram, with any identifying numbers. See Figure 1.

Data

Measure and record the positions of the bottom end of the spring hook by hanging different weights. For $F = 0.00\text{N}$, we hang no weight. Then hang more weight on the hook to decide the maximum weight you can put on (The maximum should not be more than 15.00N). Between 0.00N and maximum weight, choose 6 values of weight F for data collection. Decide the uncertainties for "Positions" based on how precise you can locate the end of the spring hook. Then find the extensions of the spring under each weight. No uncertainty is needed for the extensions.

Table 1: Extension of the spring under different weights

Weight F (N)	Position x (cm)	Extension Δx (cm)
0.00 ±	±	
±	±	
±	±	
±	±	
±	±	
±	±	
±	±	

Don't take the apparatus down until you have finished calculating the percentage discrepancy.

Calculations

On mm graph paper, plot a graph of the weight F as a function of the extension Δx: F is on the y-axis. Make sure that your graph has a title, axis labels with units, axis scales, data points, the best fit line, two points marked on the line for calculating slopes, and the slope calculation. Do not use original data points for the slope calculation. The slope should have units and 5 non-zero digits, with the last sig. fig underlined. Refer to "Graphing: Basic" for detailed graphing requirements.

In the calculation section of your report, explicitly refer to your graph by its title to help direct your readers. Then present the spring constant (slope) value obtained from the graph. Convert the spring constant to N/m if you have not done so.

Find and record the reference spring constant for your spring from the 1118 Reference Values table on the wall. Calculate the percentage discrepancy between your value and the reference value:

$$\text{Percentage discrepancy} = \frac{|\text{your value} - \text{reference value}|}{\text{reference value}} \times 100\%$$

Conclusions

Before writing the conclusions, think about the following questions: what were you trying to find today? Have you found it? What is it? How many significant digits does it have? Is it correct?

State your result in a full sentence, in N/m, with the correct number of significant digits, and compare it to the reference value. For example: "We measured the spring constant of spring #17 to be 21.5 N/m, which is about 0.9% higher than the reference value 21.3 N/m."

The percentage discrepancy gives you an idea of how close your value is to the reference value, so it does not need to (and should not) be very precise. An integer percentage or one sig. fig. is enough. As we do more labs in this course, you will see that we have different expectations on the percentage discrepancies. For this lab, we have a high expectation: less than 3%. If your value is too far away from the reference value, you should check your data, graph, or calculations.

Discussion

Does your best fit line pass through the origin, as Hooke's law says? If not, explain why not. (When answering this question, consider whether Hooke's law applies near the origin. You can hang a small weight under the spring to test this.)