Lab 8: Springs

Equipment: Computer station, Excel, Masses and Spring PhET

https://phet.colorado.edu/sims/mass-spring-lab/mass-spring-lab_en.html

In this experiment you will learn how to use the Masses and Springs PhET and take data to determine the spring constant of several different springs in the simulation.

Part 0: Getting Familiar with the PhET

Click on the link to the PhET in the equipment list, and play around with all the controls. Note that you can click on the ruler and drag it around the window. We'll use most of the controls in this lab with the exceptions of the Energy and Stopwatch functions. You will need to figure out how to measure the stretch in the spring. Describe in your lab report what happens when you change the friction slider and what happens when you change the “Softness Spring 3” slider.

Part I: Finding k

a. Open an Excel spreadsheet and label 4 columns: “Spring 1 stretch (m)”, “Spring 2 stretch (m)”, “Spring 3 stretch (m)”, and “mass (kg).”
b. Set the “Softness spring 3” slider on the third tick mark from the left edge.
c. Hang the labeled masses from each spring one at a time and record the stretch for each mass (you do not need to hang both 100g masses, they should be the same). Record your data in the spreadsheet.
d. Make three plots in Excel, one for each spring, of stretch in m vs. mass in kg. The x-axis should be stretch and the y-axis should be mass. Check the “set intercept” box so that your trend line goes through the origin, and display the equation. Copy and paste your plots with their fits into your lab report, and explain why we want to use a linear fit (you will find your prelab useful!). You should now have three plots (one for each spring).
e. Below your graphs, record the slope of each fit from the equation and explain why we wanted to use a linear fit and not some other function.
f. What is the slope of the linear fit in terms of k and g? Solve for k for each spring (you can show your calculations once and then write down k for all three springs).
g. What happens when you make spring 3 “softer”: does the spring constant increase or decrease? What about if you make it “harder”?
Part II: Finding $g$

a. Set $g = 0$ and hang a few of the weights on the springs. Describe in your lab report what happens, and explain why by including a free body diagram of one of the weights.
b. Now set the PhET to “Planet X”, and hang the 50g, 100g, and 250g weights from spring 1 and measure the stretch. Record your data in a table with two columns: Stretch (m) and mass (kg)
c. Plot your stretch vs. mass data and do a linear fit. Copy and paste your plot into your lab report, and record the slope of the line.
d. Use the slope of your linear fit to determine the value of $g$ on Planet X. Go up to the chalkboard and write what value of $g$ you found so that we can compare our results as a class.

Part III: Finding mass (experimental design)

a. Now that we know the spring constant for spring 1, we can figure out the masses of the unknown weights (colored yellow, red, and green). Pretend that you are designing an experiment to determine these masses. Write out a set of detailed instructions that a fellow Physics 20L student could follow, explaining what data to measure and what analysis steps to take in order to find the masses of each of the unlabeled weights.

Analysis/Conclusions

1. What do you think was the main source of error in the first two methods?
2. Why do we want to set all our trend lines to go through the origin of each graph?
3. How accurately were you and your group able to measure stretch in the simulation? For example, could you have been off by 1 cm, or perhaps 0.5 cm? Decide on your error in your stretch measurements.
4. How much agreement did your group’s value of $g$ on Planet X have with the rest of the class? Explain.
5. Consider the experiment you designed in Part III. Based on the measurements we can do with the PhET, what level of uncertainty would you expect your classmates to have in their results following your procedure? That is, how far off do you expect their masses to be? Explain why you expect this level of uncertainty.