PHY111

Lab Assignment: 03

Hooke's Law Simulation

PART A: Online Lab Resources

Simulation Resource

We will be doing the simulation using the PhET interactive simulation project. Follow the link below for projectile simulation:

https://phet.colorado.edu/en/simulation/hookes-law

Graph Plotting Resource

You may plot graph using any of the two software, Desmos(Online) and Graph(Offline), the link for these two graph-plotting software are given below:

Desmos

Desmos is an online suite of math software tools, including the renowned Desmos Graphing Calculator and Scientific Calculator. You will be using the Graphing Calculator resource of Desmos. It is accessible from the following link: https://www.desmos.com/calculator

You may follow the given link as a tutorial for plotting in ***Desmos*** :
https://www.youtube.com/watch?v=-lIUNWVKnUY

Graph

Graph is an offline open source application used to draw mathematical graphs in a coordinate system. This application needs to be downloaded and installed in your PC, then you may use it offline at any time. You may download the application from the following link:
https://www.padowan.dk/download/

You may follow the given tutorial links for using the ***Graph*** software:

How to install graph software: https://youtu.be/e19JqLJMx3A

How to draw a curve using graph software: https://youtu.be/QBkdzU_8vVo

How to calculate the slope of a line using graph software: https://youtu.be/z4cMiUFu5j8

Lab Tutorial

The detailed instruction for the lab is written below. However, you may see this tutorial video for this experiment: https://youtu.be/_VZYAWVyGXs

PART B: Theory and Purpose

Theory

In 1678 English Physicist Robert Hooke established that most solids behave with elastic properties; even very "inelastic" materials like steel will behave elastically under large loads.

Here the elastic property indicates that a material goes back to its original shape and size when the force causing deformation is removed. The deformation is proportional to the force applied within the elastic limit.

In short he resolved that $\mathbf{F_s = -kx}$ where:

$\mathbf{F_s}$ is a "spring force" or "restoring force" (as the spring tries to return to its original or unloaded form) (Units: N)

k is the "constant of elasticity" or basically a number that describes how elastic or stretchy a material is. (units: N/m)

x is the elongation or the deformation of the spring. Basically the difference in length of the spring when stretched from its unstretched length. (Units: m)

The **negative sign** indicates that the Spring Force is in the direction opposite that of the displacement (elongation).

Purpose

- Measuring extension and force using a program.
- Recording and explaining data for springs using Hooke's law.

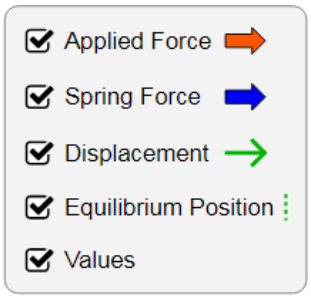
PART C: Procedure

1. Open a browser and go to: **https://phet.colorado.edu/en/simulation/hookes-law**

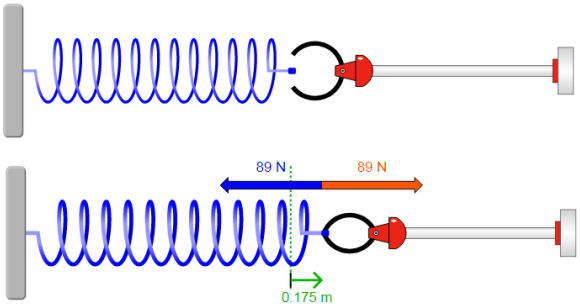
2. Click on the **"play"** button triangle and start the simulation

3. On opening the program, click on **INTRO**

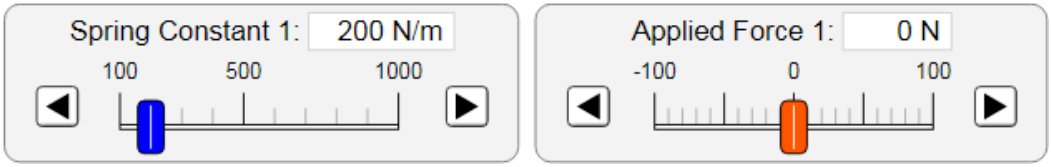
4. Check all five boxes on the right hand side (applied force, spring force, displacement, equilibrium, values).



5. Click on the red clamp so that the ring is closed.



6. Now adjust the Spring constant and applied force using the sliders or arrows in the boxes shown.



TASK 1:

1. Set **Sprint constant** to **100N/m**, vary the **Applied Force (0, 5, 10, 15, 20, 25, 30, 35, 40, 45) N** and measure the values for the **Displacement** . ***Record these values in Table-1.*** Don't forget to click on 'values' to get the measurements of displacement (extension) from equilibrium.
2. ***Plot Displacement vs Applied Force graph using recorded data from Table-1*****.** You may use any software you like. Save your graph as **ID_TASK1_LAB3** For example: 21115002_TASK1_LAB1 (Make sure you save it with your ID).

TASK 2:

1. Set **Sprint constant** to **500N/m**, vary the **Applied Force (0, 5, 10, 15, 20, 25, 30, 35, 40, 45) N** and measure the values for the **Displacement** . ***Record these values in Table-2.*** Don't forget to click on 'values' to get the measurements of displacement (extension) from equilibrium.
2. ***Plot Displacement vs Applied Force graph using recorded data from Table-2*****.** You may use any software you like. Save your graph as **ID_TASK2_LAB3** For example: 21115002_TASK1_LAB1 (Make sure you save it with your ID).

TASK 3:

1. Set **Sprint constant** to **1000N/m**, vary the **Applied Force (0, 5, 10, 15, 20, 25, 30, 35, 40, 45) N** and measure the values for the **Displacement** . ***Record these values in Table-3*****.** Don't forget to click on 'values' to get the measurements of displacement (extension) from equilibrium.
2. ***Plot Displacement vs Applied Force graph using recorded data from Table-3.*** You may use any software you like. Save your graph as **ID_TASK3_LAB3** For example: 21115002_TASK1_LAB1 (Make sure you save it with your ID).

Save the file of data table ID_TABLE_LAB3. **Submit your lab report using the Google form for your section. Attach the file of the table,3 graphs that you plotted and write the answer to each question in the google form.**

PART D: Questions

Answer the following questions using ONE sentence:

1. How is the magnitude of the applied force and the spring force, also known as the restoring force related?

2. Do the applied force and spring force act along the same direction?

3. Does a higher value of k result in a stiffer/less stretchy spring, or a less stiff/more stretchy spring?

4. How is the displacement and applied force related?

5. How does the proportionality region change in the Hooke's law graph change with respect to increase in spring constant, k?