Spring has Sprung

Purpose: To determine the mathematical relationship between the force applied to a spring and the change in its length for two different springs.

Hypothesis:

The applied force will be (**circle one** - directly proportional, inversely proportional, proportional to the square, proportional to the square root) to the change in length (Δx) of a spring. I think this because:

How will the mathematical model and/or graph of the stiff spring differ from that of the looser spring?

Procedure notes:

You can apply force to the spring by hanging slotted weights from it or by clamping one end to a table and pulling on the spring with a spring scale or Vernier force probe connected to the computer. The Vernier probe will need to be calibrated with a known force or standard weight. The length of the spring can be measured with a ruler. Remember, however, you are graphing the **change** in length so don't forget to record the initial length of the spring. Also, do not stretch the spring out close to its limit – it ruins the spring and complicates the mathematical model.

Data:

Spring #1 – initial length (m) =

Length of spring (m)	**Change in length, Δx (m)**	**Applied force, F (N)**

Spring #2 – initial length (m) =

Length of spring (m)	**Change in length, Δx (m)**	**Applied force, F (N)**

Data Analysis/Conclusion:

Graph force, F (in N) vs change in length of spring, Δx (in m) for both springs on the same graph. Regardless of which was the dependent or independent variable, graph F on the y-axis and Δx on the x-axis. Print out your graphs and attach them to this sheet.

Mathematical models:

Spring #1:

Spring #2:

Was your hypothesis correct? Why or why not?

How do the mathematical models differ for the two springs?

The area under the curve of a force vs displacement graph from gives the elastic potential energy stored in a spring. From your mathematical models above, derive an equation for the elastic potential energy (E_{el}) stored in each spring in terms of force (F) and displacement (Δx) Energy is measured in joules (1 j = 1 Nm = 1 kgm^2/s^2).

The accepted equations for force and elastic potential energy for a spring include a term called the spring constant, k (in N/m). What do you think the spring constants are for spring #1 and spring #2? Explain.

Calibrating the force sensor if you are using a LabPro and a Computer:

1. Connect the Force Sensor to CH1 of the LabPro. Make sure your force sensor is set on ±10 N (there is a button on the top) for the loose spring and ±50 N for the stiffer spring (you may need to recalibrate when you switch to the higher setting).
2. Connect the LabPro to the computer and open "Logger Pro 3" on the computer.
3. Open Probes and Sensors>Force Sensors>Dual Range Force Sensor> and 10N Dual Range.cmbl or 50N Dual Range.cmbl depending on which spring you are testing..
4. Choose Calibrate from the Experiment menu. Select CH1: Dual Range Force. Click on the Calibrate Now button.
5. Remove all force from the sensor and hold it vertically with the hook pointed down. Enter a **0** (zero) in the Value 1 field, and after the reading shown for Reading 1 is stable, click Keep. This defines the zero force condition.
6. Hang the 200 g mass from the sensor. This applies a force of 1.96 N. Enter **1.96** in the Value 2 field, and after the reading shown for Reading 2 is stable, then click Keep.
7. Click Done to complete the calibration of the first Force Sensor.
8. You will be using the sensor in a different orientation than that in which it was calibrated. Zero the Force Sensor to account for this. Hold the sensor horizontally with no force applied, and click Zero and OK.

Calibrating the force sensor if you are using a LabQuest:

1. Connect the Force Sensor to CH1 of the LabQuest. Make sure your force sensor is set on ±10 N (there is a button on the top) for the loose spring and ±50 N for the stiffer spring (you may need to recalibrate when you switch to the higher setting).
2. Choose Calibrate ► CH:1 Force from the Sensors menu.
3. Hold the sensor attached to Channel 1 so that you can hang a weight from it but do not attach any weight now.
4. Select Calibrate Now.
5. Enter 0 as the known value for Reading 1.
6. When the voltage reading stabilizes, tap Keep.
7. Hang a 1.96 N weight (200 g) from the sensor.
8. Enter 1.96 as the known value for Reading 2 and tap Keep when the readings stabilize.
9. Select OK.
10. You will be using the sensor in a different orientation than that in which it was calibrated. Next you will zero the sensor. To do this
    a. Hold the sensor with the measurement axis horizontal and no force applied to the hook.
    b. When the reading stabilizes, choose Zero ► All Sensors from the Sensors menu. The reading for the sensor should be close to zero.