H.P.2C.1 Use a free-body diagram to represent the normal, tension (or elastic), applied, and frictional forces on an object.

H.P.2C.4 Analyze and interpret data on force and displacement to determine the spring (or elastic) constant of an elastic material (Hooke’s Law, F=-kx), including constructing an appropriate graph in order to draw a line-of-best-fit whose calculated slope will yield the spring constant, k.

Purpose: To investigate Hooke’s law and determine the spring constants of elastic springs.

Apparatus: Springs, mass set, mass hanger (small), pendulum clamp, lab stand, and meter stick.

Theory: Think about stretching a spring. The more stretching force you apply, the more stretch you get. Robert Hooke (1635-1703), a British physicist, discovered this empirical relationship between the stretching force (F) and the stretch (x), known as Hooke's law.

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| hooke | The stretching force is provided by the added mass.  Stretching Force = (Added Mass) X Gravity.  When you collect data make sure that you reach the maximum stretch appropriate for the spring.  Hooke’s law is verified when there is a linear relationship between the Stretching Force & Stretch. Spring constant is the slope of the Stretching Force VS. Stretch graph. |

Procedure: Attach the mass hanger to a spring and hang the spring from the pendulum clamp. Attach the meter stick so that the 0-cm is at the indicator of the spring. Add an appropriate mass and measure the stretch. Repeat this for other masses and then for other springs.

Data Analysis:  
Enter your data [stretch (cm) and stretching mass (g)] in a spread sheet program. Create two more columns, and calculate Stretch (m) and Stretching Force (N). Plot Stretching Force *versus* Stretch and determine the slope, which is the average spring constant. Display the plots for all the springs in the same graph.

Attach your hard copies of the data table and graph and then attach your conclusion page.   
  
Include the following in your conclusion:

1. Begin your conclusion by re-stating the purpose in an appropriate form.
2. For each spring, state whether Hooke's law is verified or not.
3. List the average values of the spring constants you determined from the plots.
4. List the sources for errors and suggestions for improvements.

<https://tap.iop.org/mechanics/materials/227/page_46508.html>

Extended Activity

1. Stiffness *k* obviously depends upon the actual material; it also depends on the dimensions of the sample. Thicker samples stretch less per newton than thinner ones. Imagine two identical samples in parallel – twice the cross-sectional area *A* implies half the extension for given load, as each sample supports half the load, so *k* for the system as a whole is doubled.
2. What about two identical samples in series? Both are subjected to the same load, thus each stretches the by the same amount, so the total stretch is doubled, so the stiffness for the system as a whole is halved.
3. Check the above conclusions in a demonstration using (identical) springs in parallel and in series.