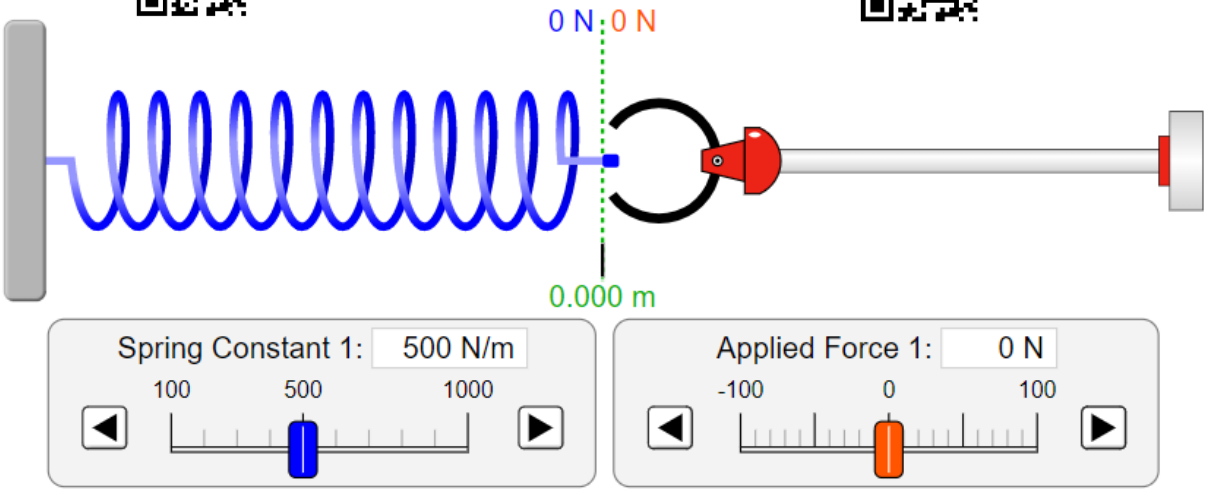
Springs & Hooke's Law – Investigation

Name: _____ Date: _____

Applet: https://bit.ly/**2VpOTnV** ***Video Overview:*** https://bit.ly/**3bu9JIr**



Purpose: To investigate and discover Hooke's Law: To describe the relationship between the force exerted on a spring and the resulting stretch. The amount of energy stored in the spring will also be determined.

Outcomes:
Student should be able to…

- Describe mathematically the relationship between the force and stretch of a spring
- Understand what is meant by spring constant and to be able to determine the spring constant.
- Determine the amount of energy stored in the stretched spring.

Procedure & Analysis:

1. Go to the applet website.
2. Watch the video explanation of the investigation and how to use the applet.
3. Complete the tables for two different spring constants (listed at the top of the table)
4. Graph both sets of data on the Force vs. Stretch graph provided. Use a scatter plot and draw a line of best fit through both lines.
5. Calculate the slope of both lines (including units)
6. Answer the discussion questions in full detail showing all work.

Data Collection:

Complete the tables using the applet.

Table 1: Spring Constant (**200 N/m**)

Force (N)	Stretch, Δx (m)
0	
10	
20	
30	
40	
50	
60	

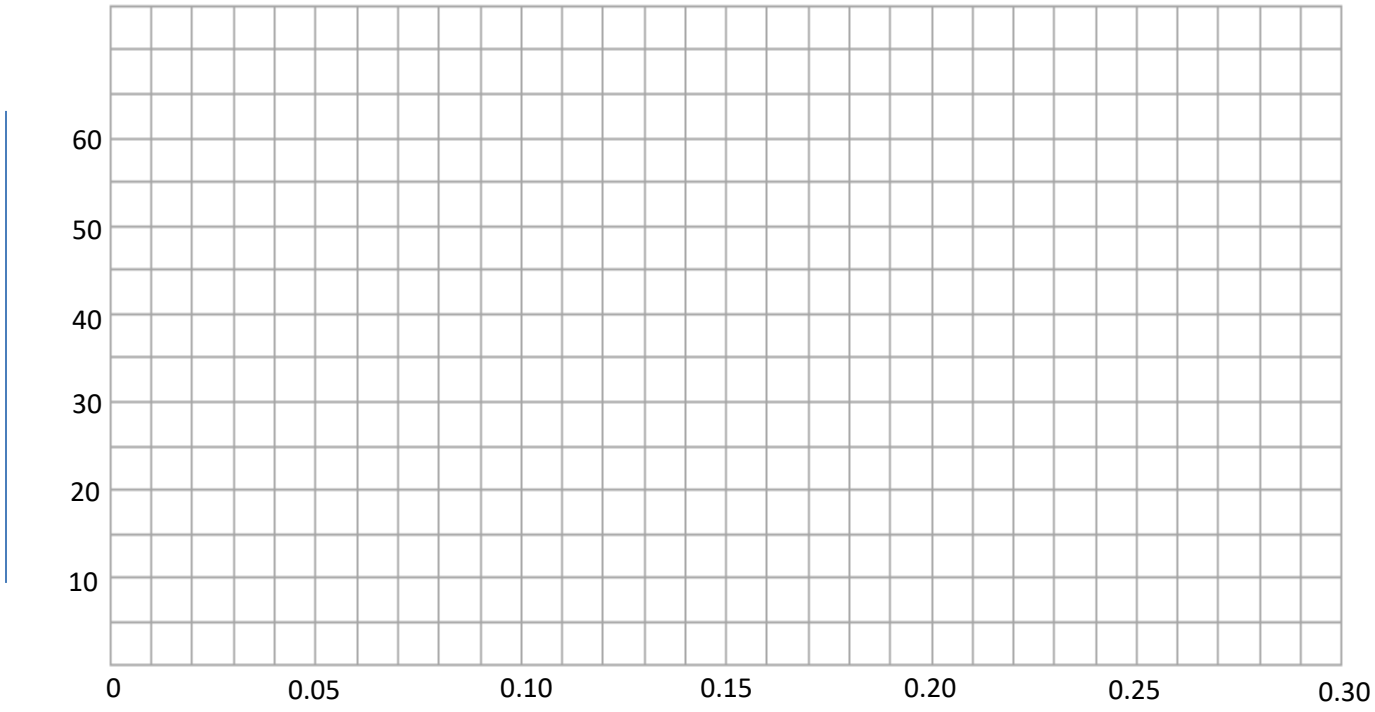
Table 2: Spring Constant (**600 N/m**)

Force (N)	Stretch, Δx (m)
0	
10	
20	
30	
40	
50	
60	

Analysis:

Graph both sets of data and label the axis. **Stretch on x-axis and Force on y-axis.**

1. Create it as a scatter plot and draw the line of best fit (colour code and/or label each line as well)
2. Calculate the slope of each line (include units) – compare the applet.



Discussion Questions & Analysis:

1. Describe the relationship between the force and stretch of the spring.

2. On the applet try compressing the spring (negative force) with the same values as the table. What do you notice about the COMPRESSION distance compared to the STRECTH distance?

3. The **spring constant** is the slope of the best-fit line and is given the symbol ***k***. Different springs have different *k* values. What are the values and the units of *k* from your experiments?

   Spring 1: *Spring 2:*

4. Assume you have a slinky (very small spring constant) and a car suspension spring (very large spring constant. You apply the same force to both in order to stretch them. Which would stretch more?

5. Resistance band workout bands come in different colours. There are many different brands – one brand has the following coding system. Which band would have the lowest k value and which would have the largest k value? Indicate on the chart.

Color	Resistance
Tan	XX-Light
Yellow	X-Light
Red	Light
Green	Medium
Blue	Heavy
Black	X-Heavy
Silver	XX-Heavy
Gold	XXX-Heavy

6. Using the 600 N/m spring constant from your investigation calculate / predict the amount of stretch that would get if you applied a force of 45 N. Check with the applet.

7. Using the 600 N/m spring constant from your investigation calculate / predict the amount of pushing force needed to compress the spring by 9.5 cm. Check with the applet.

8. You have a spring with a *k*=440 N/m, and you stretch it by 5.2 cm. Calculate the force applied to do this. Check with the applet.

Consolidation:

Hooke's Law

For an **ideal spring**, the force needed to stretch of compress a spring by some distance, x, scales linearly with respect to that distance. If a spring is overstretched or over-compressed it will deform and the relationship becomes non-linear and the spring is considered non-ideal.

$$F_s = -k\Delta x$$

*The negative sign simply indicates that the force the spring is opposite to the applied force (Newton's 3rd Law)

1. A spring has a spring constant of 256 N/m and is stretched 32 cm. Calculate the force acting on the spring?

2. A force of 20 N is applied to a 12.5 N/m spring. Calculate the stretch on the spring.

Energy Stored in a Spring

The **area under the curve** on the graph represents the **energy stored** in the spring at that given stretch.

1. Using the 200 N/m spring from the investigation – using the graph, shade the area from 0 to 0.20m under the line. Calculate the area of the triangle. The units will be $N \cdot m = J\ (Joules)$

Equation: The energy stored in the spring can also be determined by:

$$E_s = \frac{k\Delta x^2}{2}$$

2. Using the equation above. Calculate the energy stored in the spring where the stretch is 0.20 m and the spring constant is 200 N/m. How does this value compare to the area you calculated?

Questions:

1. A spring with a spring constant of 350 N/m is stretched 0.45 m. Determine the force of the spring and the amount of stored energy in the spring.

2. A spring is stretch 35 cm and the amount of energy stored in the spring was determined to be 160 J. Determine the spring constant of the spring.