**Forces 2**

**Hooke’s Law using Computer Simulation**

In this activity the learning objectives are:

* Measuring extension and force using a program
* Recording and explaining data for springs using Hooke’s law
* Recording and explaining data for springs connected in ‘parallel’ arrangements

Extra Challenge:

* **Describe** and **explain** the relationship between elastic energy stored and extension in a spring. OR set up an investigation of your own

The website you need for this is Phet Simulations (University of Colorado)

<https://phet.colorado.edu/en/simulations/category/physics/motion>

On opening the program, click on INTRO

**EXPT 1 Using one spring of force constant 200N/m**

Use the program to record data in your table below- you will need to click on ‘values’ to take measurements of displacement (extension) from equilibrium.

Independent Variable:

Dependent Variable:

Control Variable:

|  |  |
| --- | --- |
| **Force Applied (N)** | **Extension (m)** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

1. Describe the pattern in your results. How is the force applied related to the extension? Give examples from the data you have taken

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1. Sketch the arrangement of the spring as shown on the screen.

Show the direction of the applied force on the spring AND the spring force on your diagram. Use colour to tell them apart.

Diagram:

**EXPT 2 Using two springs of force constant 200N/m in parallel (side by side)**

On the main menu go to SYSTEMS.

Vary the applied force and record the extension or displacement from equilibrium.

NOTE: Use the **same** force values you used in Experiment 1.

3. From the results, for the same force, the extension produced by the parallel arrangement is \_\_\_\_\_\_\_\_\_\_\_ than for the single spring system.

|  |  |
| --- | --- |
| **Force Applied (N)** | **Extension (m)** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

4 Explain the main difference in the extension produced by this ‘spring system’ compared to the system in Expt 1.

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**EXPT 3 Elastic PE stored in a Spring**

On the main menu go to ENERGY

You should find a single spring system with a k value (force/spring constant) of 100N/m

Click on ‘Energy plot’ and ‘Values’. Enter data into the Displacement box to apply forces. Record the force applied and Energy below

|  |  |  |
| --- | --- | --- |
| **Displacement/Extension (m)** | **Force Applied (N)** | **Elastic PE (J)** |
| 0.1 |  |  |
| 0.2 |  |  |
| 0.3 |  |  |
| 0.4 |  |  |
| 0.5 |  |  |
| 0.6 |  |  |

5 Plot a graph of Elastic Potential Energy (y axis) v extension (x-axis) on graph paper.

Allow a scale on your x axis up to 0.7m

Draw a line of best fit and use it to predict a value for the Elastic PE stored at 0.7m extension, write your value below:

Value from curve of Elastic PE = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ when extension is 0.7m

Input an extension of 0.7m into the simulation and check/record value here:\_\_\_\_\_\_\_

6 Try to find a relationship between the Elastic PE and the extension. What happens to the PE as the extension doubles, for example, in the data you’ve recorded?

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**Extra Challenge Menu**

**Option 1**

The relationship from Experiment 3 is: Elastic PE is proportional to the extension squared. **Or, Elastic PE α x2**

Using the idea that

Elastic PE stored = WD = average force x extension AND Hooke’s law, try to prove the mathematical relationship between Elastic PE and extension.

**Option 2**

Use the Simulation to investigate the effect that **changing the value of the Force constant k** for the spring has on its **extension.**

**Start by identifying…..**

Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Control variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain why you have selected the control variable.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Draw up a table of results below (with a ruler!) and explain the results.