Investigation of the force-extension graph for a spring

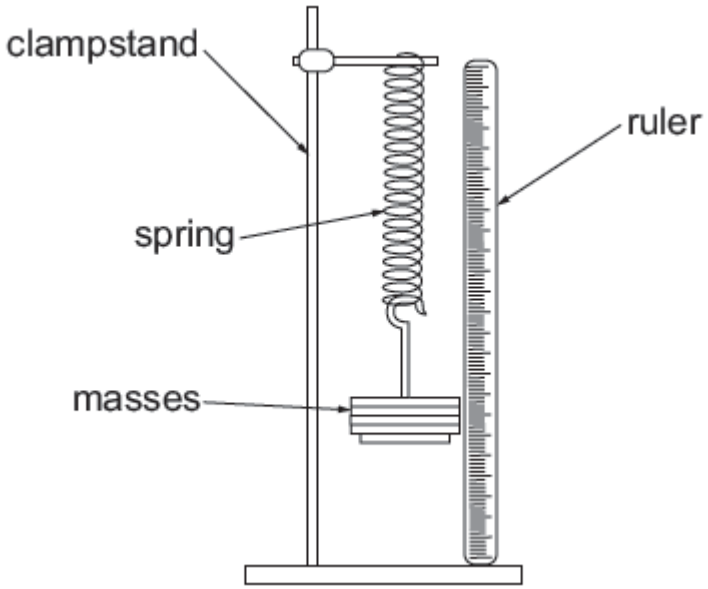
Introduction

When a force is applied to a spring its length increases. The extension of the spring is found by subtracting the original length of the spring from its length with the force applied. Hooke's Law states that the extension is directly proportional to the force applied provided that the elastic limit is not exceeded. You will investigate if the spring obeys Hooke's law.

Apparatus

spring
100 g mass hanger
6 × 100 g masses
clamp stand, boss and clamp
metre ruler ± 1 mm

Diagram of Apparatus



Method

1. Record the original length of the spring.
2. Suspend the spring from the clamp and attach the 100 g mass hanger.
3. Record the new length of the spring.
4. Add a further 100 g to the spring and record the new length.
5. Repeat steps 2-3 until a total mass of 700 g has been added.
6. Repeat steps 1-5 once more.

Analysis

1. Calculate the mean length for each mass added.
2. Calculate the extension for each mass added.
3. Plot a graph of force (y-axis) against extension (x-axis). (100 g = 1 N)
4. Determine whether the spring obeys Hooke's law or not.

Risk Assessment

Hazard	Risk	Control measure
Apparatus toppling / falling from the bench	Risk of injury (e.g. to foot) from heavy, falling apparatus	Ensure suitable orientation of the clamp stand to reduce danger of toppling Do not pull the masses down further with your hand Do not exceed the maximum load of 700 g (7 N)

Teacher / Technician Notes

Students may be asked to measure the length of the spring itself and not the loops at each end. Including one, or indeed, both loops, will make no difference to their final values for extension. However, students must be consistent in making the same measurement throughout the investigation.

Students should be encouraged to measure and record each result to the nearest 0.1 cm (1 mm). If the result is 9 cm they should write 9.0 in their table.

Students should be asked to *gently* place the masses onto the spring and to ensure that the spring is stationary each time when measuring its new length.

Students should load the spring up to a limit of 700 g. This will ensure that the elastic limit is not exceeded and the springs are not over-stretched. The teacher could demonstrate the effect of further increasing the force applied.

A graph should then be plotted of force (y-axis) against extension (x-axis). The line of best fit expected is a straight line through the origin. This proves that the spring obeys Hooke's Law.

Students should design their own table, but a suggested table format is shown below.

Mass (g)	Force (N)	Length (cm)		Mean length (cm)	Extension (cm)
		1	2		

Working scientifically skills covered

2. Experimental skills and strategies
Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.

3. Analysis and evaluation
Translate data from one form to another.

Carry out and representing mathematical analysis.

Present reasoned explanations including relating data to hypotheses.

4. Scientific vocabulary, quantities, units, symbols and nomenclature
Interconvert units

Use an appropriate number of significant figures in calculation.