**Connecting springs in series and parallel**

**Introduction**

In this experiment students will be using combinations of springs to contribute to their understanding of the Young modulus as the property of a material.

They are expected to be familiar with the concept of the application of a force leading to the extension of an elastic material in tension and the further concepts of stress and strain.

This activity could either lead in to teaching on the Young modulus or be used to reinforce the ideas after having been taught.

**Aim and skills covered**

* To determine relationships for combinations of springs in series and parallel
* To use these relationships to contribute to a measurement of the property of a material independent of its shape.

**Intended class time**

* 60 to 90 minutes

**Links to Specification**

**Physics A**

* 3.4.1(a) tensile and compressive deformation; extension and compression
* 3.4.1(b) Hooke's law
* 3.4.1(c) force constant *k* of a spring or wire; *F* = *kx*
* 3.4.1(d)(ii) techniques and procedures used to investigate force–extension characteristics for arrangements which may include springs, rubber bands, polythene strips.
* 3.4.2(c) stress, strain and ultimate tensile strength
* 3.4.2(d) Young modulus = tensile stress/tensile strain
* 3.4.2(f) elastic and plastic deformations of materials

**Physics B**

* 3.2a(i) simple mechanical behaviour: elastic and plastic deformation and fracture
* 3.2b(i) Make appropriate use of the terms stress, strain
* 3.2b(ii) Stress – Strain graphs
* 3.2c(ii) Make calculations and estimates involving stress, strain, Young modulus

**Practical Skills**

* 1.2.1(b) Safely and correctly use a range of practical equipment and materials
* 1.2.1(c) Follows written procedures
* 1.2.1(d) Makes and records observations
* 1.2.1(f) Present information and data in a scientific way
* 1.2.2(a) Using appropriate analogue apparatus to record length and distance and to interpolate between scale marks
* 1.2.2(b) Use of appropriate digital instruments to measure mass
* 1.2.2(c) Use methods to improve accuracy of measurements

**CPAC**

* (1) Follows written procedures
* (3) Safely uses a range of practical equipment and materials
* (4) Makes and records observations

**Mathematical skills**

* M0.1 Recognise and make use of appropriate units in calculations
* M0.2 Recognise and use expressions in standard form
* M0.3 Use ratios, fractions and percentages
* M0.4 Estimate results
* M1.1 Use an appropriate number of significant figures
* M1.2 Find arithmetic means
* M2.3 Substitute numerical values into algebraic equations using appropriate units
* M3.1 Translate information between graphical, numerical and algebraic forms
* M3.2 Plot two variables from experimental or other data
* M3.4 Determine the slope of a linear graph

**Equipment**

* spring x 6
* 100g masses on holder
* calipers or Vernier measurement system
* metre rule
* stand
* boss and clamp
* additional stand upright x2
* 1 kg mass
* safety goggles to EN166F, where the F denotes impact

**Health and Safety**

Safety goggles or spectacles (as provided by the centre) must be worn at all times.

The centre should determine the maximum load to be applied to the springs to reduce the risk of breaking.

Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.

**Notes**

* These practical activities are not controlled assessments, should not be carried out in exam conditions and can be adapted by the centre. Students can collaborate during the activities which should take place as part of the normal teaching sequence. They are intended to be formative with students acquiring and practising skills throughout the course.
* To achieve a pass in the Practical Endorsement each student is required to demonstrate competence in all the skills, apparatus and techniques listed in section 1.2 of the specification and assessed against the Ofqual Common Practical Assessment Criteria (CPAC) at the end of the course.
* The skills, apparatus and techniques can be demonstrated during any practical work undertaken during the A Level course whether an OCR practical activity or not.
* Learners are expected to take a number of readings for each reading and to tabulate data, although this is not explicitly stated in the instructions.

**Recording**

* Learners should not need to re-draft their work but rather keep all their notes as a continuing record of Practical Activity.
* Learners should have evidence of the data collected from their individual readings, as well as the combined class data, in a clear and logical format.

In addition, to support the assessment of practical work in the written examinations:

* They should plot a graphs as required
* They should carry out the estimates and calculations required