Spring extension: loading and unloading

Student activity • investigation and reasoning

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The question

How does the extension of each spring depend on the applied force?

Compare two springs using measured extensions, not total lengths. Stay within a separately piloted load range for each spring.

Equipment

- Two springs, secured stand, ruler and blunt pointer
- Light hanger, small masses and padded tray
- Eye protection, booklet and graph paper

Wear eye protection and closed footwear. Clamp stands to benches and place padded trays under loads. Keep faces out of the spring line, add and remove masses gently, and use only the approved loads. Never pull a loaded spring sideways or deliberately stretch it to failure.

Course coverage: Shared Physics / Double Award: 1.22–1.24. Force–extension measurements and elastic behaviour.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection. Staff secure the stand to the bench, attach the spring securely and fix a ruler beside a blunt pointer. Place a padded tray below the hanger.

2. Read the spring's unloaded pointer position at eye level from the side. Keep your face out of the spring's line. Record this zero-load reference before attaching the hanger.

3. Add the light hanger and small masses gently, using only the five loads approved for this spring. Include the hanger in total hanging mass; record the settled position each time.

4. Remove loads in reverse order and record positions at the same masses. Return to zero load and check whether the original reading is recovered.

5. Calculate extension as loaded position minus the zero-load reading. Convert hanging mass to force using g = 9.8 N kg^{-1}, and plot force vertically against extension horizontally.

6. Repeat with the second spring. Identify any approximately linear region through the origin and compare its gradient. Stop and tell staff if a spring distorts or fails to return.

Cleanup

- Support the hanger while unloading; remove all masses before dismantling and report distorted springs.

Record your evidence

Blank spaces are for your own work

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Reference and task data

For a spring obeying Hooke's law, F = kx. Use extension x in metres for k in N m^{-1}. A force–extension graph's gradient is k only with force on the vertical axis. A proportionality limit and the onset of permanent deformation are different ideas; do not assume they are identical. No deliberate breaking or overstretching is part of this method.

Total mass / kg	Loading position / mm	Unloading position / mm	Extension / mm

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Why subtract the unloaded reading?

2. Why include the hanger mass?

3. What is the force from a total hanging mass of 0.10 kg?

4. What does a straight line through the origin show?

5. On these axes, which spring is stiffer?

6. What is evidence of permanent deformation?