

Exercise walk-through

5.3

Forces and elasticity (4.5.3, RP6)

AQA · GCSE · Physics

Exercises 2.1·2.2

2.1 A spring stretches 3.0 cm under a 6.0 N load. Calculate k in N/m. [3]

2.2 A spring of $k = 200$ N/m is compressed 5.0 cm. Calculate the elastic energy stored. [3]

Exercises 2.1·2.2

2.1 A spring stretches 3.0 cm under a 6.0 N load. Calculate k in N/m. [3]

2.1 Convert: $e = 0.030$ m (C1).

$$k = F/e = 6.0/0.030 = \mathbf{200} \text{ N/m}$$

(C1, A1)

2.2 A spring of $k = 200$ N/m is compressed 5.0 cm. Calculate the elastic energy stored. [3]

2.2 Convert: $e = 0.050$ m (C1).

$$E_e = \frac{1}{2} \times 200 \times 0.050^2 = \mathbf{0.25} \text{ J}$$

(C1, A1)

Exercise 2.3

2.3 State the difference between elastic and inelastic deformation.

[2]

3 Exam-style questions

Exercise 2.3

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3 Exam-style questions

2.3 Elastic: the object returns to its original length/shape when the load is removed;
inelastic: it does not – permanently deformed.

Exercise 3.1

3.1 A student hangs masses on a spring and measures its length.

Load in N	0	2.0	4.0	6.0	8.0	10
Length in cm	20.0	24.0	28.0	32.0	38.5	46.0

- (a) Plot-ready: state the extension at each load. [1]
- (b) Describe the shape of the force–extension graph and identify where the limit of proportionality lies. [2]
- (c) Calculate k using data from the linear section. [2]
- (d) Suggest why the graph curves at large loads. [1]

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3.1 (a) Extensions: 0, 4.0, 8.0, 12.0, 18.5, 26.0 cm. (b) A straight line through the origin up to 4.0 N load, then curving upwards; limit of proportionality at 4.0 N / 12.0 cm extension. (c) Using linear data, e.g. 4.0 N over 8.0 cm:

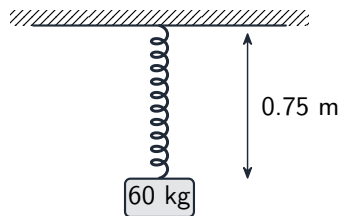
$$k = \frac{4.0 \text{ N}}{0.080 \text{ m}} = \mathbf{50 \text{ N/m}}$$

(C1 for m conversion, A1) (d) The limit of proportionality has been exceeded – the spring deforms beyond Hooke’s-law behaviour.

Exercise 3.2

3.2 A bungee cord behaves like a spring of $k = 800 \text{ N/m}$. A 60 kg person hangs at rest stretching it 0.75 m ($g = 9.8 \text{ N/kg}$).

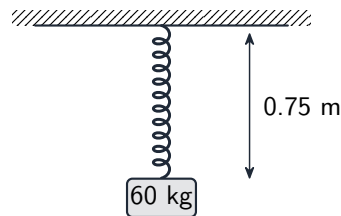
- (a) Show the cord obeys $F = ke$ at this stretch. [3]
- (b) Calculate the elastic energy stored. [2]
- (c) (Link) State where this energy came from, using energy stores. [2]



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- (b) Calculate the elastic energy stored. [2]
- (c) (Link) State where this energy came from, using energy stores. [2]



3.2 (a) Weight: $F = mg = 60 \times 9.8 = 588 \text{ N}$ (C1). Predicted force at 0.75 m: $F = ke = 800 \times 0.75 = 600 \text{ N}$ (C1); within rounding the weight equals ke ✓. (b)

$$E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 800 \times 0.75^2 = \mathbf{225 \text{ J}}$$

(C1, A1) (c) From the person's gravitational potential store (they descended stretching the cord); the cord's elastic potential store filled as they fell.

Exercise 3.3

3.3 Two springs, X ($k = 100 \text{ N/m}$) and Y ($k = 400 \text{ N/m}$), are each stretched by the same 8.0 N force.

- (a) Calculate each extension. [4]
- (b) Calculate the ratio of stored energies $E_X : E_Y$. [3]
- (c) State which spring needs more work for the same extra 1 cm of stretch, with a reason. [2]

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3.3 (a) $e_X = F/k = 8.0/100 = \mathbf{0.080 \text{ m}}$ (C1, A1); $e_Y = 8.0/400 = \mathbf{0.020 \text{ m}}$ (C1, A1). (b)

$$E_X = \frac{1}{2} \times 100 \times 0.080^2 = 0.32 \text{ J} \quad E_Y = \frac{1}{2} \times 400 \times 0.020^2 = 0.080 \text{ J}$$

(each energy C1; ratio **4 : 1** A1) (c) Spring Y: stiffer means larger k , and the work for an extra stretch Δe is approximately $F\Delta e = k\Delta e$ – Y needs four times the force at any given extension.