Springs and Hooke's law

Worked solutions

GCSE science calculations

This topic online

1 The spring inside a newton meter has a spring constant of 40 N/m.
The spring is stretched by an extension of 0.15 m.
Calculate the force on the spring. (2 marks)

Force = spring constant x extension

$F = ke$

$F = 40 \times 0.15$

$F = 6\ N$

2 In a Year 10 practical, Priya measures a spring. Its original length is 0.20 m. When a load is hung on it, its length is 0.26 m.
The spring constant is 50 N/m.
Calculate the force stretching the spring. (2 marks)

Extension = stretched length - original length

$e = 0.26 - 0.20$

$e = 0.06\ m$

Force = spring constant x extension

$F = 50 \times 0.06$

$F = 3\ N$

3 A toy launcher uses a spring with a spring constant of 200 N/m. The spring is compressed by 0.05 m.
Calculate the elastic potential energy stored in the spring. (2 marks)

Elastic potential energy = 0.5 x spring constant x extension^2

$Ee = 0.5 \times 200 \times 0.05^2$

$Ee = 0.5 \times 200 \times 0.0025$

$Ee = 0.25\ J$

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4 A spring in a toy car has a spring constant of 30 N/m.

The spring is stretched by 12 cm.

Calculate the force on the spring. (2 marks)

Force = spring constant x extension

12 cm = 0.12 m

$F = 30 \times 0.12$

$F = 3.6\ N$

5 Kwame hangs a bag of masses on a spring. The spring constant is 60 N/m.

The original length of the spring is 15.0 cm. With the masses on, its length is 22.5 cm.

Calculate the force stretching the spring. (3 marks)

Extension = stretched length - original length

$e = 22.5 - 15.0$

$e = 7.5\ cm$

7.5 cm = 0.075 m

Force = spring constant x extension

$F = 60 \times 0.075$

$F = 4.5\ N$

6 The spring in a click pen has a spring constant of 80 N/m. When the pen is clicked, the spring is compressed by 25 mm.

Calculate the elastic potential energy stored in the spring. (2 marks)

Elastic potential energy = 0.5 x spring constant x extension^2

25 mm = 0.025 m

$Ee = 0.5 \times 80 \times 0.025^2$

$Ee = 0.5 \times 80 \times 0.000625$

$Ee = 0.025\ J$

7 A small parcel hangs from a hand-held luggage scale. It pulls on the spring inside with a force of 2.4 N. The extension of the spring is 0.06 m.

Calculate the spring constant of the spring. (2 marks)

Force = spring constant x extension

$2.4 = k \times 0.06$

$k = 2.4 \div 0.06$

$k = 40\ N/m$

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8 A spring has a spring constant of 120 N/m. A force of 9.0 N is applied to it. The spring does not go past its limit of proportionality.

Calculate the extension of the spring. Give your answer in centimetres. (3 marks)

Force = spring constant x extension

$9.0 = 120 \times e$

$e = 9.0 \div 120$

$e = 0.075$ m

0.075 m = 7.5 cm

$e = 7.5$ cm

9 Chloe plots a force-extension graph for a spring. The graph is a straight line through the origin. These points lie on the line:

Extension in m	0	0.02	0.04	0.06	0.08
Force in N	0	0.5	1.0	1.5	2.0

Use the gradient of the graph to calculate the spring constant of the spring. (3 marks)

Spring constant = gradient = change in force ÷ change in extension

$k = (2.0 - 0) \div (0.08 - 0)$

$k = 2.0 \div 0.08$

$k = 25$ N/m

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10 Oliver adds weights to a spring and measures the extension each time.

Force in N	0	1.0	2.0	3.0	4.0	5.0
Extension in cm	0	2.0	4.0	6.0	8.0	11.5

a. Use the results for forces up to 4.0 N to calculate the spring constant in N/m. Show your working.

b. Which force in the table shows that the spring has gone past its limit of proportionality?

(3 marks)

a)

2.0 cm = 0.020 m

Force = spring constant x extension

$1.0 = k \times 0.020$

$k = 1.0 \div 0.020$

$k = 50$ N/m

b)

Each 1.0 N adds 2.0 cm up to 4.0 N

5.0 N should give 10.0 cm but gives 11.5 cm

5.0 N

11 A spring has a spring constant of 50 N/m. A force of 4.0 N stretches it. The spring does not go past its limit of proportionality.

Calculate the elastic potential energy stored in the spring. Show your working.

(3 marks)

Force = spring constant x extension

$4.0 = 50 \times e$

$e = 4.0 \div 50$

$e = 0.08$ m

Elastic potential energy = 0.5 x spring constant x extension^2

$Ee = 0.5 \times 50 \times 0.08^2$

$Ee = 0.5 \times 50 \times 0.0064$

$Ee = 0.16$ J

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12 Amira hangs a 300 g mass on a spring. The spring constant is 35 N/m. The spring does not go past its limit of proportionality.

Gravitational field strength = 9.8 N/kg.

Calculate the elastic potential energy stored in the spring. Give your answer to 2 significant figures. Show your working.

(5 marks)

300 g = 0.3 kg

Weight = mass x gravitational field strength

$W = 0.3 \times 9.8$

$W = 2.94$ N

Force = spring constant x extension

$2.94 = 35 \times e$

$e = 2.94 \div 35$

$e = 0.084$ m

Elastic potential energy = 0.5 x spring constant x extension^2

$Ee = 0.5 \times 35 \times 0.084^2$

$Ee = 0.12348$ J

$Ee = 0.12$ J (2 s.f.)

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