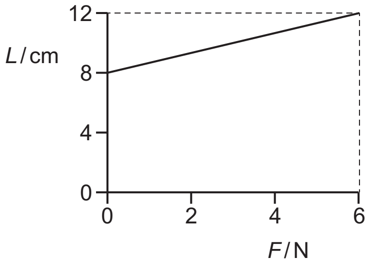
20 A spring is fixed at one end. The length L of the spring is increased by applying a tensile force F to the other end.

The graph shows the variation of L with F.



What is the elastic potential energy of the spring when F is 6.0 N?

A 0.12 J **B** 0.24 J **C** 0.36 J **D** 0.60 J

21 A wire has an unstretched length of 2.00 m.

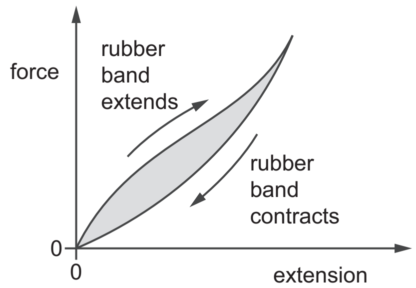
A stress of 1.6×10^5 Pa is applied to the wire, and the new length of the wire is 2.10 m.

The wire obeys Hooke's law.

What is the Young modulus of the wire?

A 8.0×10^3 Pa **B** 7.8×10^4 Pa **C** 1.5×10^5 Pa **D** 3.2×10^6 Pa

23 The diagram shows a force–extension graph for a rubber band as the band is extended and then the stretching force is decreased to zero.



What can be deduced from the graph?

A The rubber band does **not** return to its original length when the force is decreased to zero.

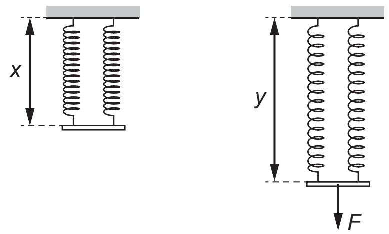
B The rubber band obeys Hooke's law for the extensions shown.

C The rubber band remains elastic for the extensions shown.

D The shaded area represents the work done in extending the rubber band.

22 Two identical springs have the same spring constant k. The springs are connected in parallel. The length of the unstretched springs is x.

A force F is applied to the spring combination. The length of the springs is now y.



Both springs are deformed within their limits of proportionality.

Which expression gives the elastic potential energy stored in **one** of the springs?

A $\frac{1}{4}F(y-x)$ **B** $\frac{1}{2}F(y-x)$ **C** $\frac{1}{4}k(y-x)^2$ **D** $k(y-x)^2$

1 On a bench, a steel ball of radius r is used to compress a spring by a distance x. The ball is held at rest in this position, as shown in Fig. 1.1.

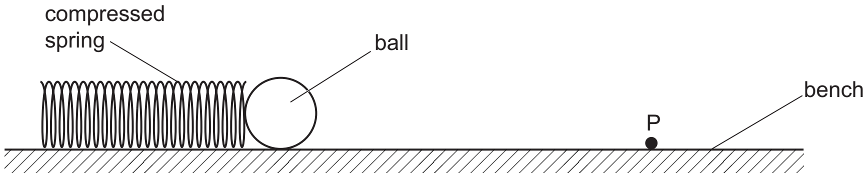


Fig. 1.1

The ball is released and rolls along the bench. At a fixed point P, the ball has speed v. The speed of the ball at P is determined using **one** light gate connected to a timer.

Several steel balls of different radii are available.

It is suggested that v is related to r by the relationship

$$v^2 = \frac{Ykx^2}{r^n \rho}$$

where k is the spring constant of the spring, ρ is the density of the steel, and Y and n are constants.

Plan a laboratory experiment to test the relationship between v and r.

Draw a diagram showing the arrangement of your equipment.

Explain how the results could be used to determine values for Y and n.

In your plan you should include:

- the procedure to be followed
- the measurements to be taken
- the control of variables
- the analysis of the data
- any safety precautions to be taken.

Diagram

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[15]

20 What are the units of stress, strain and the Young modulus?

	stress	strain	Young modulus
A	newton	metre	pascal
B	newton	no unit	newton
C	pascal	metre	newton
D	pascal	no unit	pascal

5 **(a)** Define the Young modulus.

....

.... [1]

(b) A wire of unstretched length 0.81 m is made of a metal with Young modulus 95 GPa. The wire obeys Hooke's law and has a constant cross-sectional area. Fig. 5.1 shows the force–extension graph for the wire.

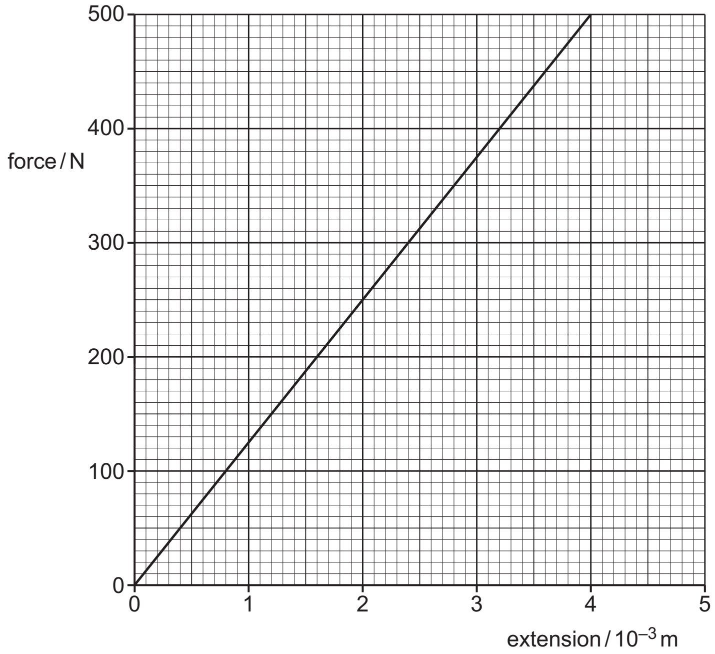

Fig. 5.1

(i) Determine the cross-sectional area of the wire.

area = ... m^2 [3]

(ii) The extension of the wire is initially 2.0×10^{-3} m.

Determine the work done to increase the extension of the wire to 3.0×10^{-3} m.

work done = ... J [3]

[Total: 7]

4 **(a)** Define the Young modulus of a material.

....

.... [1]

(b) A metal wire P that obeys Hooke's law is stretched within its limit of proportionality.

(i) On Fig. 4.1, sketch the variation of tensile force F in the wire with its extension x.

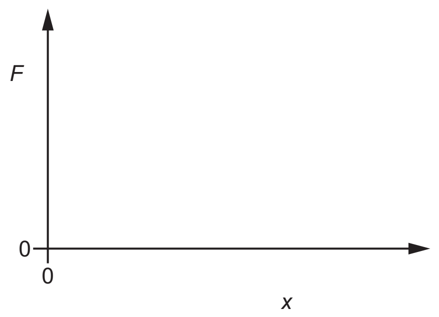

Fig. 4.1

[1]

(ii) State the name of the quantity represented by the gradient of the line in Fig. 4.1.

.... [1]

(iii) State the name of the quantity represented by the area under the line in Fig. 4.1.

.... [1]

(c) Another wire Q is made from a metal that has twice the Young modulus of the metal of wire P in **(b)**. Wire Q has the same volume as wire P but has double the cross-sectional area of wire P.

The two wires are extended by equal tensile forces within their limits of proportionality.

State and explain how the extension of wire Q compares with the extension of wire P.

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.... [3]

[Total: 7]