21 A wire has an unstretched length of 2.00 m.

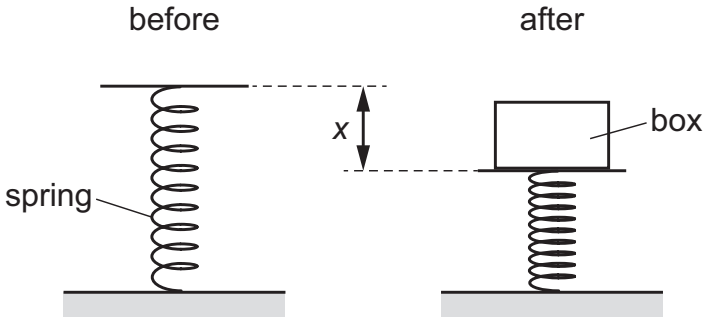
A stress of 1.6×10^5 Pa is applied to the wire, and the new length of the wire is 2.10 m.

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

21 A platform is supported by a spring. A box is placed onto the platform. The diagram shows the spring before and after the box is placed onto it.



What is the term for the quantity marked as *x*?

A compression

B load

C strain

D stress

22 A copper wire has length 1.7 m and uniform diameter 0.64 mm.

The Young modulus of copper is 1.2×10^{11} Pa.

What is the spring constant of the wire?

A 2.3×10^4 N m^{-1}

B 9.1×10^4 N m^{-1}

C 4.5×10^7 N m^{-1}

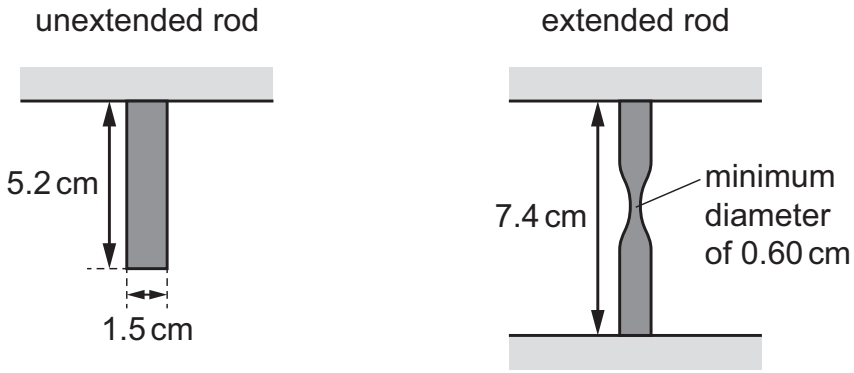
D 7.1×10^7 N m^{-1}

20 A cylindrical steel rod with negligible weight has a diameter of 1.5 cm and a length of 5.2 cm.

The rod is firmly attached at the top end.

The rod is firmly attached to a machine at the other end that applies a constant force of 363 N to the rod.

This causes the rod to extend to a length of 7.4 cm and to have a minimum diameter of 0.60 cm in the position shown.



What is the maximum stress acting on the steel rod when the length is 7.4 cm?

A 2.1×10^6 Pa **B** 3.2×10^6 Pa **C** 5.7×10^6 Pa **D** 1.3×10^7 Pa

23 Which expression gives the formula for the spring constant?

A Fx **B** $2Fx^2$ **C** $\frac{F}{x}$ **D** $\frac{F}{x^2}$

3 A wire has length L and cross-sectional area A. The wire is made from a metal that has Young modulus E and resistivity ρ.

(a) Define the Young modulus of a material.

.....

..... [1]

(b) **(i)** State an expression, in terms of some or all of L, A, E and ρ, for the resistance R_0 of the wire.

R_0 = ... [1]

(ii) Show that the spring constant k_0 of the wire is given by

$$k_0 = \frac{EA}{L}.$$

[2]

(c) The wire is stretched, within the limit of proportionality, by a tensile force F. Assume that any changes in the cross-sectional area of the wire are negligible.

(i) On Fig. 3.1, sketch the variation with F of the resistance R of the wire.

Fig. 3.1

[1]

(ii) On Fig. 3.2, sketch the variation with F of the spring constant k of the wire.

Fig. 3.2

[1]

(d) Copper has a resistivity of $1.8 \times 10^{-8}\,\Omega\,\text{m}$ and a Young modulus of $1.3 \times 10^{11}\,\text{Pa}$.

A copper wire of diameter 1.6 mm has a resistance of $0.034\,\Omega$.

(i) Show that the length of the wire is 3.8 m.

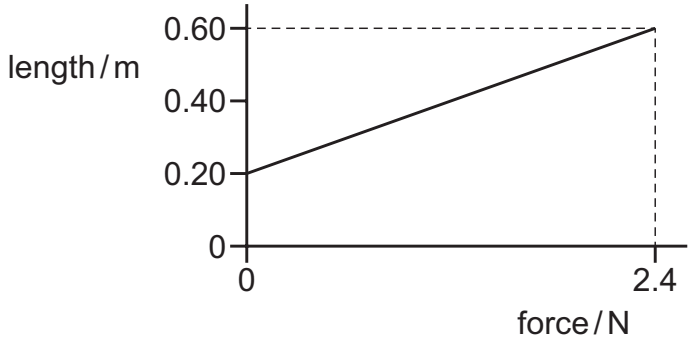
[1]

(ii) Use the equation in **(b)(ii)** to determine the spring constant of the wire.

spring constant = ... N m^{-1} [2]

[Total: 9]

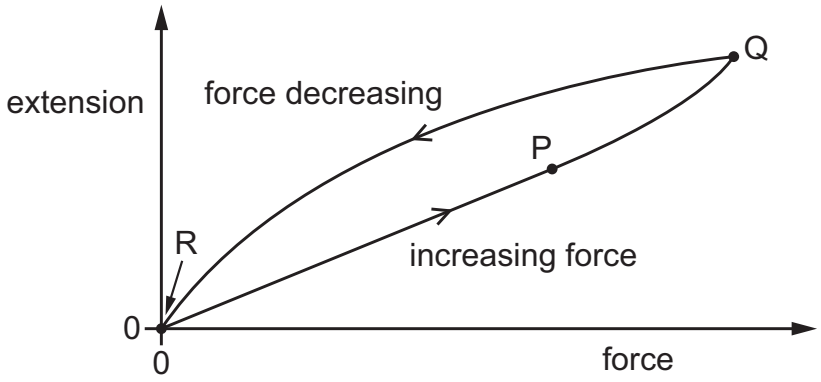
21 A student investigates a spring. The variation of the length of the spring with the force applied to the spring is shown.



What is the spring constant of the spring?

A $0.17\,\text{N m}^{-1}$ **B** $0.25\,\text{N m}^{-1}$ **C** $4.0\,\text{N m}^{-1}$ **D** $6.0\,\text{N m}^{-1}$

22 The graph shows the variation with force of the extension of a wire.



The force is gradually increased to a maximum at Q and then gradually decreased to zero at R.

Which statement is correct?

A Along the line PQ, the wire obeys Hooke's law.

B Along the line RP, the spring constant is equal to $\frac{\text{extension}}{\text{force}}$.

C The wire has elastic deformation at point Q.

D The work done in stretching the wire to P is equal to (force × extension) at point P.

23 A uniform metal wire of length L and diameter d has spring constant k.

What is the Young modulus of the metal?

A $\frac{\pi d^2}{4kL}$ **B** $\frac{\pi d^2}{kL}$ **C** $\frac{kL}{\pi d^2}$ **D** $\frac{4kL}{\pi d^2}$

21 A student has a copper wire and a steel wire with equal lengths and cross-sectional areas.

The student hangs identical loads on the two wires.

The extensions of the two wires are different.

The student calculates the stress, strain and Young modulus of each wire.

Which row identifies with a tick (✓) the calculated values that are equal for both wires?

	stress	strain	Young modulus
A	✓		
B		✓	
C		✓	✓
D	✓		✓