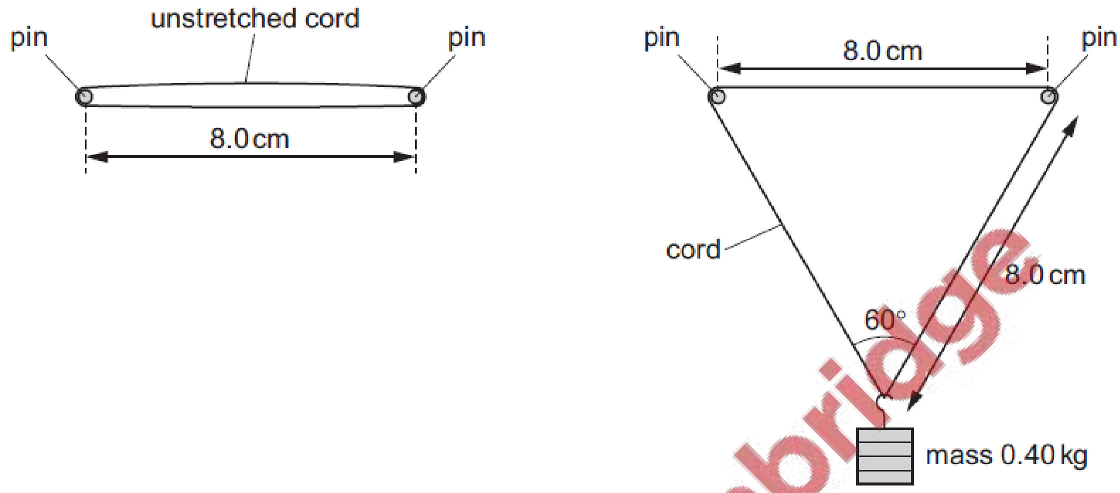
Deformation of Solid – 2023 Nov AS Physics 9702

1. Nov/2023/Paper_ 9702/11/No.18

An elastic cord of unstretched total length 16.0 cm and cross-sectional area $2.0 \times 10^{-6}\,m^2$ is held horizontally by two smooth pins a distance 8.0 cm apart.

The cord obeys Hooke's law. A load of mass 0.40 kg is suspended centrally on the cord. The angle between the two sides of the cord supporting the load is 60°.

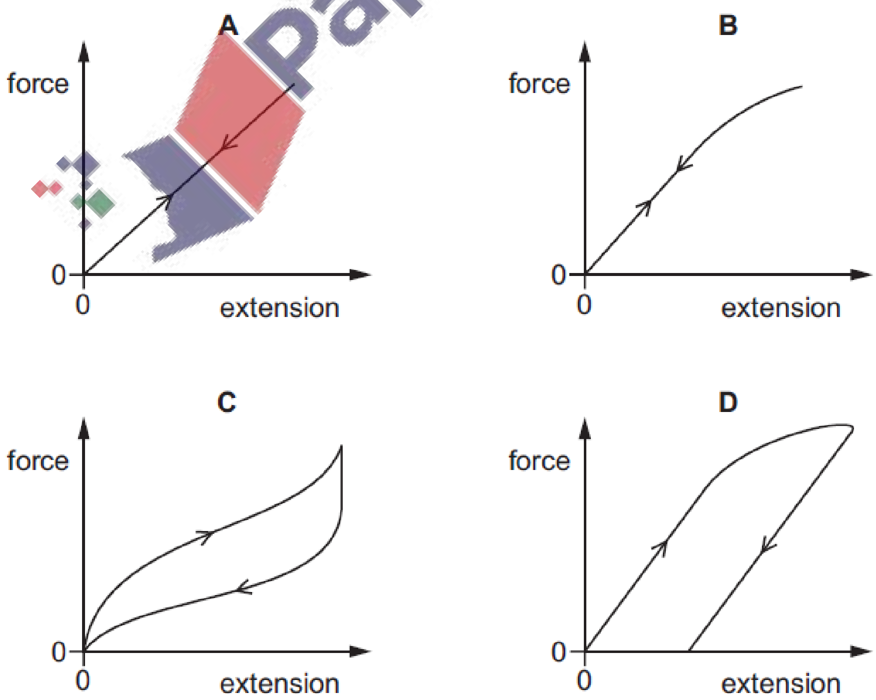


What is the Young modulus of the cord material?

A 5.7×10^5 Pa **B** 1.1×10^6 Pa **C** 2.3×10^6 Pa **D** 3.9×10^6 Pa

2. Nov/2023/Paper_ 9702/11/No.19

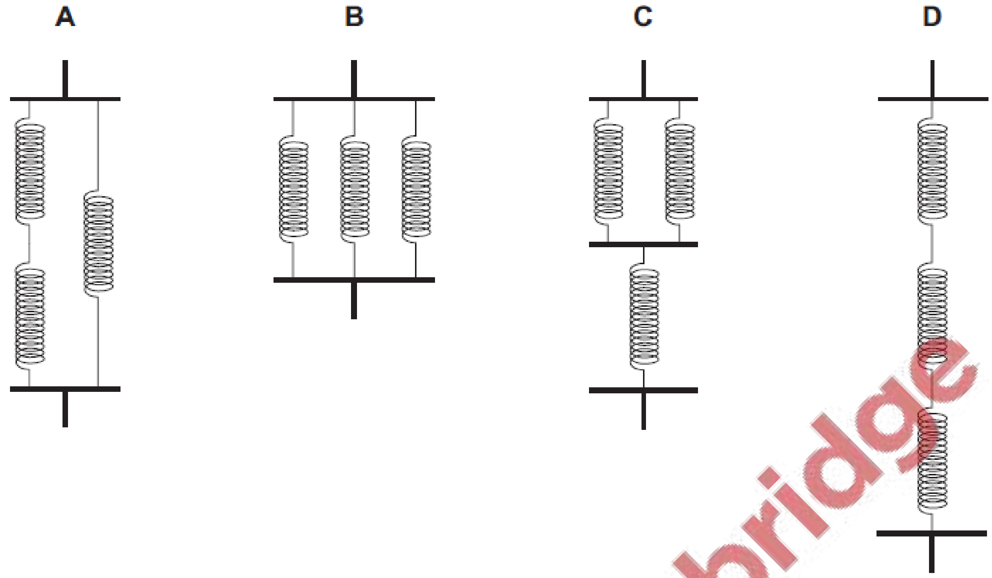
Which force–extension graph shows plastic deformation of a sample of material?



3. Nov/2023/Paper_ 9702/12/No.18

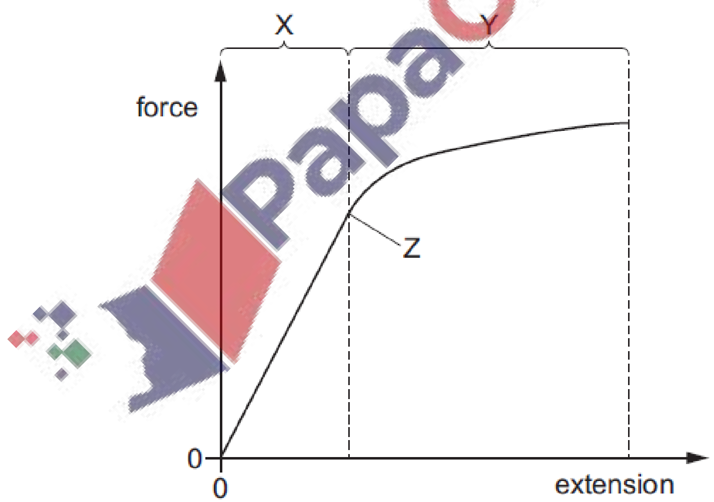
Three identical springs, each with the same spring constant, are connected together in four different arrangements, as shown.

Which arrangement has the largest combined spring constant?



4. Nov/2023/Paper_ 9702/12/No.19

The force–extension graph for a wire is shown.



Which row could identify the labels X, Y and Z?

	limit of proportionality	region of elastic deformation	region of plastic deformation
A	X	Y	Z
B	Z	Y	X
C	Y	Z	X
D	Z	X	Y

5. Nov/2023/Paper_ 9702/13/No.18

A copper wire of diameter 1.6 mm is stretched within its limit of proportionality by a tensile force of 430 N.

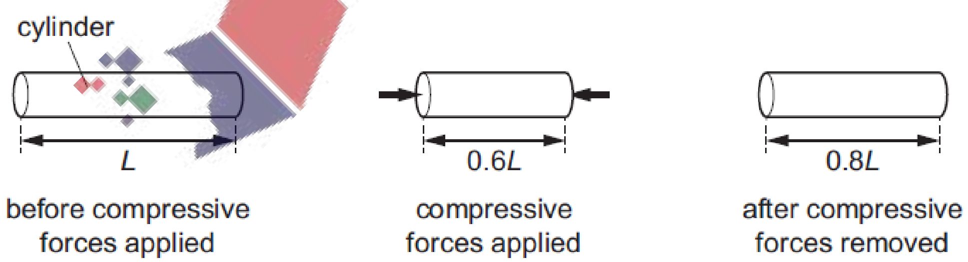
The Young modulus of copper is 130 GPa.

What is the strain in the wire?

A 4.1×10^{-4} **B** 1.3×10^{-3} **C** 1.6×10^{-3} **D** 5.2×10^{-3}

6. Nov/2023/Paper_ 9702/13/No.19

Compressive forces are applied normally to the end faces of a cylinder of initial length L. The cylinder is compressed by the forces so that its length decreases to $0.6L$. After the compressive forces are removed, the cylinder's length increases to $0.8L$.



What describes the deformation of the cylinder when its length was $0.6L$?

A both elastic and plastic

B elastic only

C plastic only

D neither elastic nor plastic

7. Nov/2023/Paper_ 9702/21/No.2(c)

A hot-air balloon floats just above the ground. The balloon is stationary and is held in place by a vertical rope, as shown in Fig. 2.1.

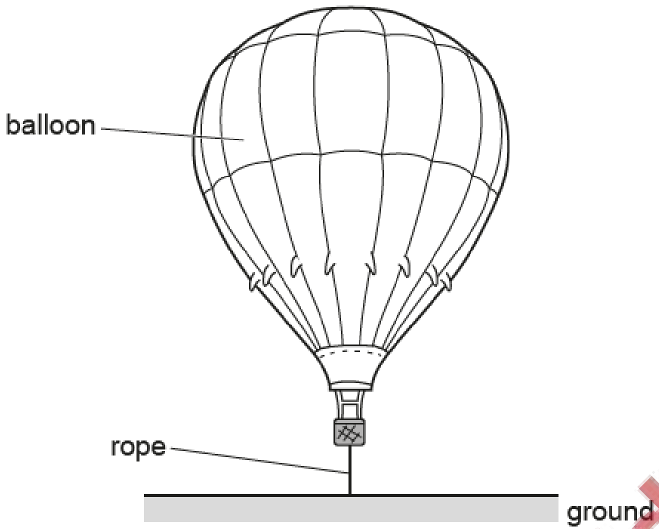


Fig. 2.1

The balloon has a weight W of 3.39×10^4 N. The tension T in the rope is 4.00×10^2 N.
Upthrust U acts on the balloon.
The density of the surrounding air is $1.23\,kg\,m^{-3}$.

(c) Before the balloon is released, the rope holding the balloon has a strain of 2.4×10^{-5}. The rope has an unstretched length of 2.5 m. The rope obeys Hooke's law.

(i) Show that the extension of the rope is 6.0×10^{-5} m.

[1]

(ii) Calculate the elastic potential energy E_P of the rope.

E_P = ... J [2]

(iii) The rope holding the balloon is replaced with a new one of the same original length and cross-sectional area. The tension is unchanged and the new rope also obeys Hooke's law.

The new rope is made from a material of a lower Young modulus.

State and explain the effect of the lower Young modulus on the elastic potential energy of the rope.

....

....

.... [2]

8. Nov/2023/Paper_ 9702/22/No.3

A vertical rod is fixed to the horizontal surface of a table, as shown in Fig. 3.1.

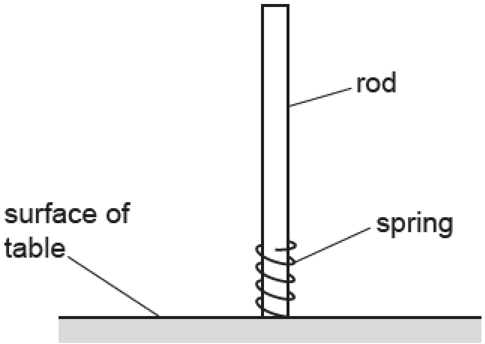


Fig. 3.1 (not to scale)

A spring of mass 7.5 g is able to slide along the full length of the rod.

The spring is first pushed against the surface of the table so that it has an initial compression of 2.1 cm. The spring is then suddenly released so that it leaves the surface of the table with a kinetic energy of 0.048 J and then moves up the rod.

Assume that the spring obeys Hooke's law and that the initial elastic potential energy of the compressed spring is equal to the kinetic energy of the spring as it leaves the surface of the table. Air resistance is negligible.

(a) By using the initial elastic potential energy of the compressed spring, calculate its spring constant.

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

(b) Calculate the speed of the spring as it leaves the surface of the table.

speed = ... $m\,s^{-1}$ [2]

(c) The spring rises to its maximum height up the rod from the surface of the table. This causes the gravitational potential energy of the spring to increase by 0.039 J.

(i) Calculate, for this movement of the spring, the increase in height of the spring after leaving the surface of the table.

increase in height = ... m [2]

(ii) Calculate the average frictional force exerted by the rod on the spring as it rises.

average frictional force = ... N [2]

(d) The rod is replaced by another rod that exerts negligible frictional force on the moving spring. The initial compression *x* of the spring is now varied in order to vary the maximum increase in height Δh of the spring after leaving the surface of the table. Assume that the spring obeys Hooke's law for all compressions.

On Fig. 3.2, sketch a graph to show the variation with *x* of Δh. Numerical values are not required.

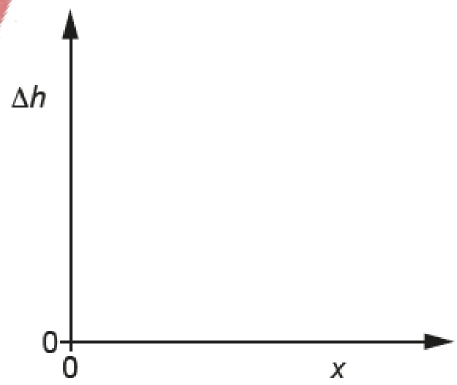


Fig. 3.2

[2]

[Total: 10]

9. Nov/2023/Paper_ 9702/23/No.4

Fig. 4.1 shows the variation with extension *x* of the tensile force *F* for two wires, G and H, made from the same material.

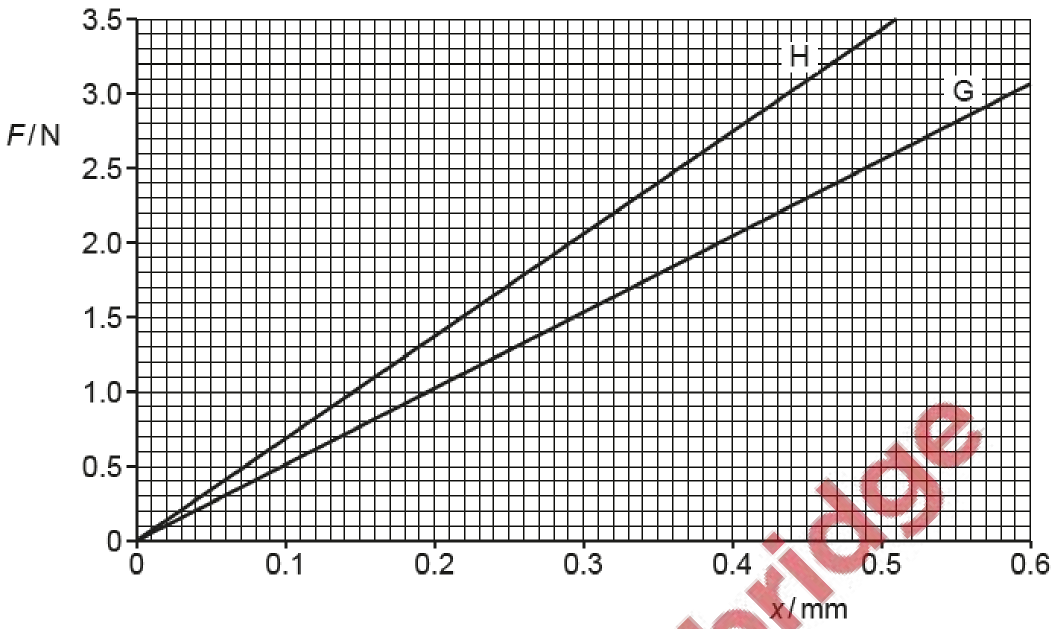


Fig. 4.1

The elastic limit has not been exceeded for G or H.

(a) For the lines in Fig. 4.1:

(i) state what is represented by the gradient

.... [1]

(ii) explain why the area under the line represents the elastic potential energy of the wire.

....

....

....

.... [2]

(b) Wires G and H are joined together end-to-end to form a composite wire of negligible weight. The composite wire hangs vertically from a fixed support.

A block of weight of 2.0 N is attached to the end of the wire, as shown in Fig. 4.2.

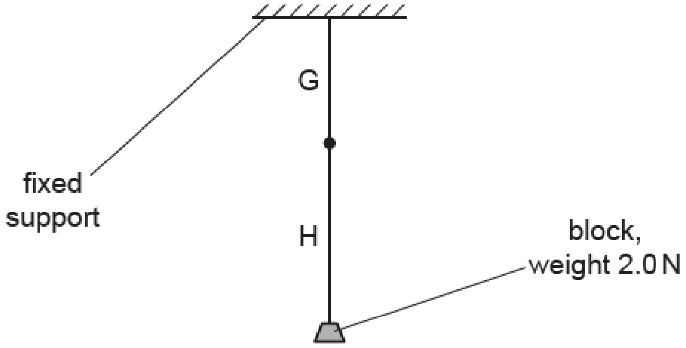


Fig. 4.2

(i) Use Fig. 4.1 to determine:

- the extension x_G of wire G

x_G = ... mm

- the extension x_H of wire H.

x_H = ... mm [1]

(ii) Calculate the total elastic potential energy E_P of the composite wire due to the weight of the block.

E_P = ... J [2]

(iii) The original length of wire G is L and the original length of wire H is $1.5L$.

Calculate the ratio

$$\frac{\text{cross-sectional area of wire G}}{\text{cross-sectional area of wire H}}.$$

ratio = ... [3]

[Total: 9]