Deformations of solid - 2017

1. 9702/11/M/J/17/20

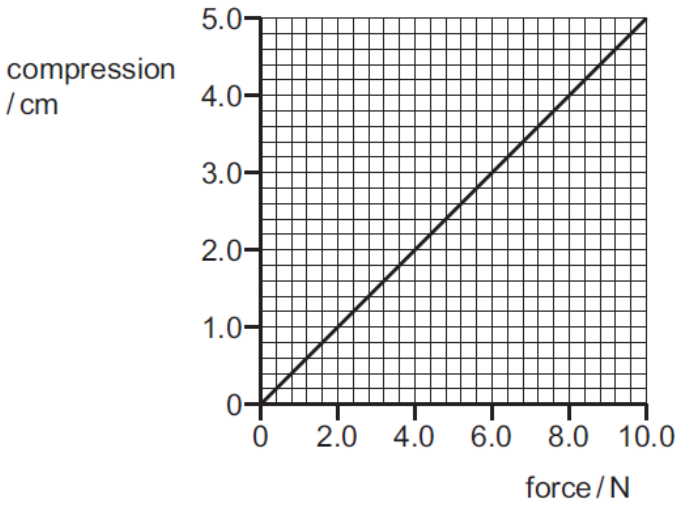
A wire of diameter d and length l hangs vertically from a fixed point. The wire is extended by hanging a mass M on its end. The Young modulus of the wire is E. The acceleration of free fall is g.

Which equation is used to determine the extension x of the wire?

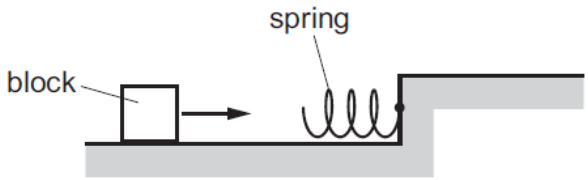
A $x = \frac{Ml}{\pi d^2 E}$ **B** $x = \frac{Mgl}{\pi d^2 E}$ **C** $x = \frac{4Mgl}{\pi dE}$ **D** $x = \frac{4Mgl}{\pi d^2 E}$

2. 9702/11/M/J/17/21

The variation of the compression of a spring with the force applied to it is shown in the graph.



A block slides along a horizontal frictionless surface towards the spring, as shown.



The block is brought to rest by the spring. When the spring reaches a compression of 4.0 cm, all of the kinetic energy of the block is transferred to the elastic potential energy of the spring.

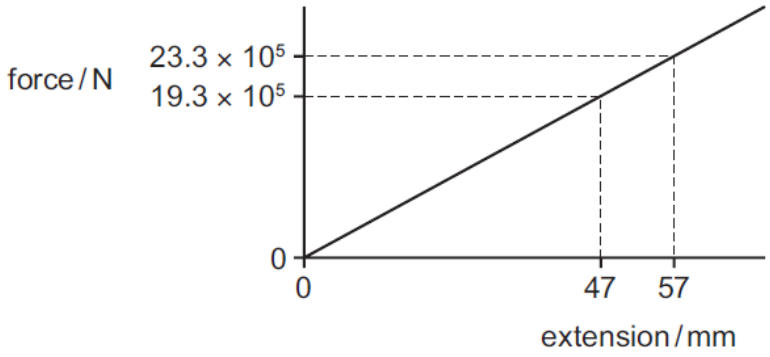
What is the kinetic energy of the block when it first makes contact with the spring?

A 0.16 J **B** 0.32 J **C** 16 J **D** 32 J

3. 9702/12/M/J/17/19

A cable on a suspension bridge supports a weight of 19.3×10^5 N. This weight causes the cable to stretch by 47 mm.

A lorry crossing the bridge then increases the force on the cable to 23.3×10^5 N. The force-extension graph for the cable is shown.



What is the **increase** in strain energy in the cable when the lorry is crossing the bridge?

A 21 kJ **B** 23 kJ **C** 45 kJ **D** 66 kJ

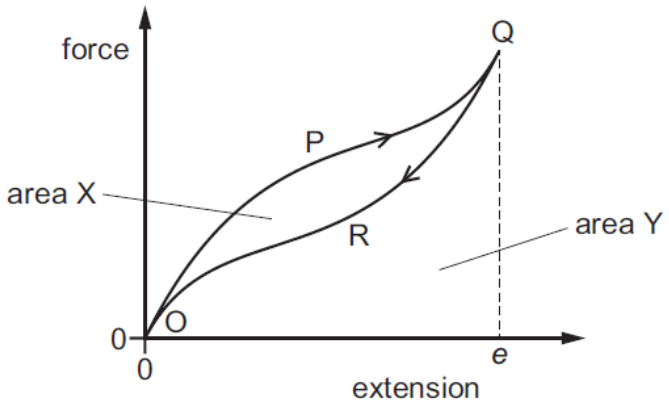
4. 9702/12/M/J/17/20

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. 9702/12/M/J/17/21

A rubber band is stretched and then relaxed to its original length. The diagram shows the force-extension graph for this process.



As the force is increased, the curve follows the path OPQ to extension *e*. As the force is reduced, the curve follows the path QRO to return to zero extension.

The area labelled X is between the curves OPQ and QRO. The area labelled Y is bounded by the curve QRO and the horizontal axis.

Which statement about the process is correct?

A Area X is the energy which heats the band as it is stretched to extension *e*.

B (Area X + area Y) is the minimum energy required to stretch the band to extension *e*.

C Area X is the elastic potential energy stored in the band when it is stretched to extension *e*.

D (Area Y – area X) is the net work done on the band during the process.

6. 9702/13/M/J/17/18

Two wires with the same Young modulus E and cross-sectional area A, but different lengths L, are subject to different tensile forces F. The extension e of each wire is the same.

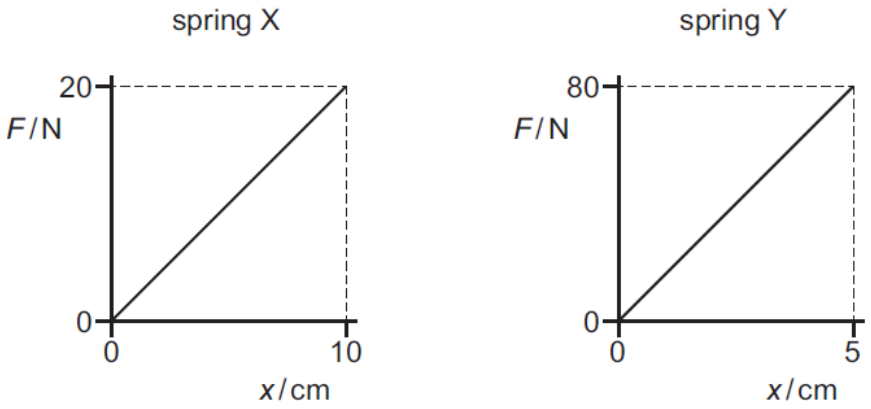
The column headings in the table show four different quantities.

Which quantities have the same value and which quantities have different values for the two wires?

	$\frac{FL}{e}$	$\frac{Ae}{L}$	$\frac{E}{FL}$
A	different	different	same
B	different	same	same
C	same	different	different
D	same	different	same

7. 9702/13/M/J/17/19

Two springs X and Y stretch elastically. The graphs show the variation with extension x of the force F applied to each spring.



Which statement is correct?

A When each spring is given the same extension, the energy stored in Y is 4 times the energy stored in X.

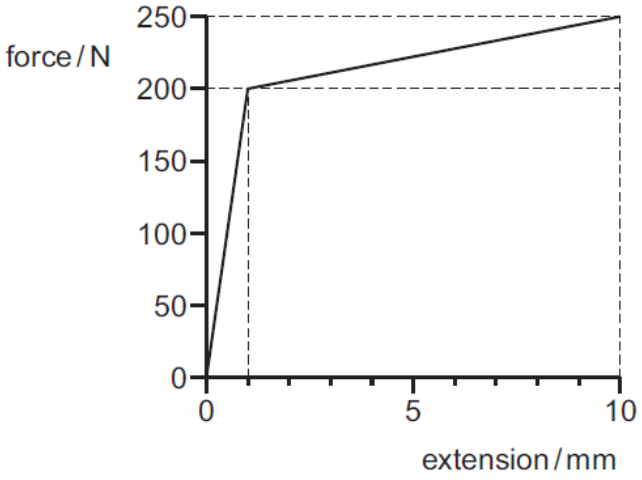
B When each spring is given the same extension, the energy stored in Y is 8 times the energy stored in X.

C When the same force is applied to each spring, the energy stored in Y is 4 times the energy stored in X.

D When the same force is applied to each spring, the energy stored in Y is 8 times the energy stored in X.

8. 9702/13/M/J/17/20

The diagram shows the force-extension graph for a steel wire, up to its breaking point.



What is the best estimate of the work done to break the wire?

A 2.1 J **B** 2.3 J **C** 2.4 J **D** 2.5 J

9. 9702/11/O/N/17/20

A spring is loaded with weights. When the weights are removed, the spring returns to its original length.

The spring is then loaded with heavier weights. When the weights are removed, the spring is longer than it was originally.

Which types of deformation are shown by this experiment?

A both elastic and plastic deformation

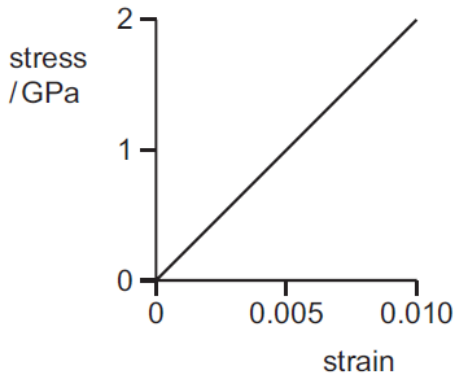
B elastic deformation only

C neither elastic nor plastic deformation

D plastic deformation only

10. 9702/11/O/N/17/21

The stress-strain graph for a metal is shown.

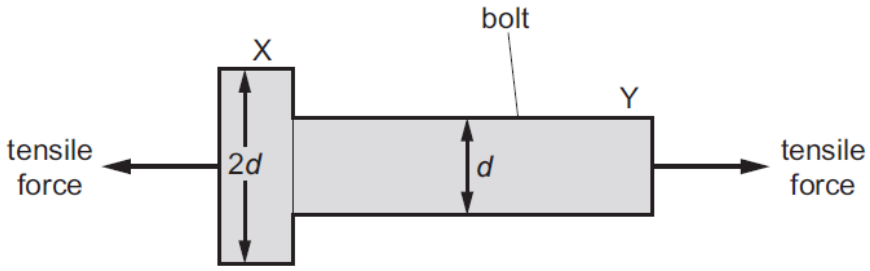


What is the strain energy per unit volume of a rod made from this metal when the strain of the rod is 0.010?

A $10\,kJ\,m^{-3}$ **B** $100\,kJ\,m^{-3}$ **C** $1.0\,MJ\,m^{-3}$ **D** $10\,MJ\,m^{-3}$

11. 9702/12/O/N/17/20

A bolt is subjected to a tensile force, as shown.



The bolt has a circular cross-section. At end X the diameter is $2d$. At end Y the diameter is d.

What is the ratio $\frac{\text{stress at Y}}{\text{stress at X}}$?

A 0.25 **B** 0.50 **C** 2.0 **D** 4.0

12. 9702/12/O/N/17/21

A rectangular block of steel supporting a very large component of a bridge has a height of 15 cm and a cross-section of 20 cm × 12 cm. It is designed to compress 1 mm when under maximum, evenly distributed, load.

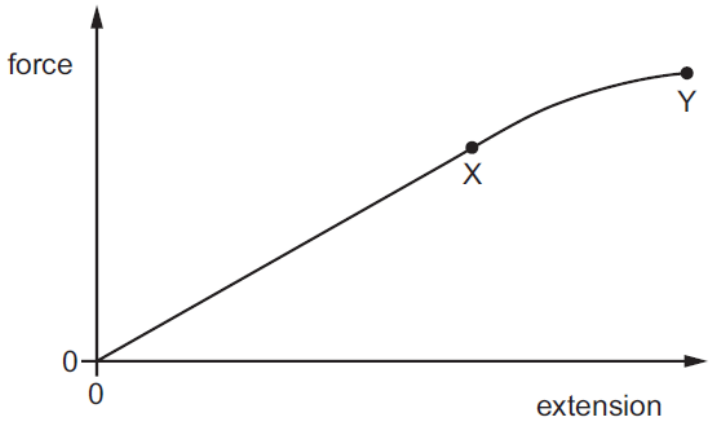
The Young modulus of steel is $2.0 \times 10^{11}\,\text{N m}^{-2}$.

What is the maximum load it can support?

A 32 MN **B** 56 GN **C** 720 GN **D** 32 TN

13. 9702/13/O/N/17/20

A sample of metal is subjected to a force which increases to a maximum value and then decreases back to zero. A force-extension graph for the sample is shown.



When the sample contracts, it follows the same force-extension curve as when it was being stretched.

What is the behaviour of the metal between X and Y?

A both elastic and plastic

B not elastic and not plastic

C plastic but not elastic

D elastic but not plastic

14. 9702/13/O/N/17/21

A load is hung from the end of a metal wire. The load is increased and the wire stretches elastically. The table shows the length of the wire for different loads.

load / kN	length / mm
0	500.0
1.0	502.0
2.0	504.0
3.0	506.0
4.0	508.0

When the load is 4.0 kN, what is the strain energy stored in the wire?

A 16 J **B** 32 J **C** 1.0 kJ **D** 2.0 kJ

15. 9702/12/F/M /17/20

Two wires X and Y are made of different metals. The Young modulus of wire X is twice that of wire Y. The diameter of wire X is half that of wire Y.

The wires are extended with the same strain and obey Hooke's law.

What is the ratio $\frac{\text{tension in wire X}}{\text{tension in wire Y}}$?

A $\frac{1}{8}$ **B** $\frac{1}{2}$ **C** 1 **D** 8

16. 9702/12/F/M /17/21

A weight of 120 kN is placed on top of a metal column. The length of the column is compressed by 0.25 mm. The column obeys Hooke's law when compressed.

How much energy is stored in the compressed column?

A 15 J **B** 30 J **C** 15 kJ **D** 30 kJ