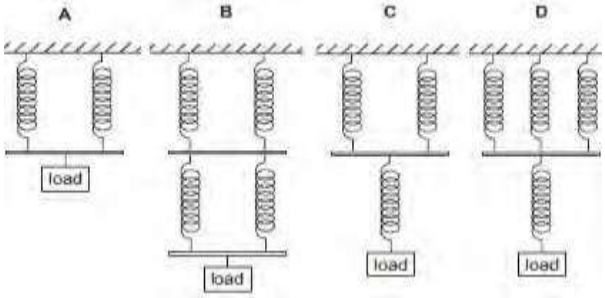
Deformation of Solids

TOPIC QUESTIONS (1)

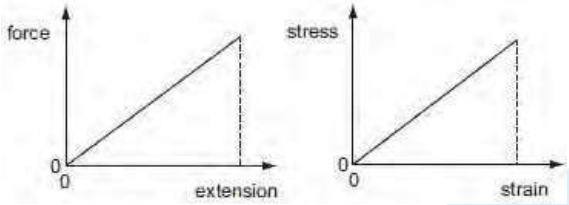
Level	AS Level
Subject	Physics
Exam Board	CIE
Paper Type	Multiple Choice

Time Allowed : 1Hour 10Min

1. A number of similar springs, each having the same spring constant, are joined in four arrangements. The same load is applied to each. Which arrangement gives the greatest extension?



2. The graphs show how force varies with extension and stress varies with strain for the loading of a metal wire.



The Young modulus for this wire is equal to
A the gradient of the force-extension graph.
B the area between the force-extension graph and the extension axis.
C the gradient of the stress-strain graph.
D the area between the stress-strain graph and the strain axis.

3. For a wire, Hooke's law is obeyed for a tension F and extension x. The Young modulus for the material of the wire is E. Which expression represents the elastic strain energy stored in the wire?

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

June 09

4. Four materials are formed into rods of the same dimensions. At room temperature, which can sustain the largest plastic deformation?

A the ductile material aluminium
B the brittle material carbon
C the brittle material glass
D the ductile material steel

5. Two steel wires P and Q have lengths l and 2l respectively, and cross-sectional areas A and *A/2* respectively. Both wires obey Hooke's law.

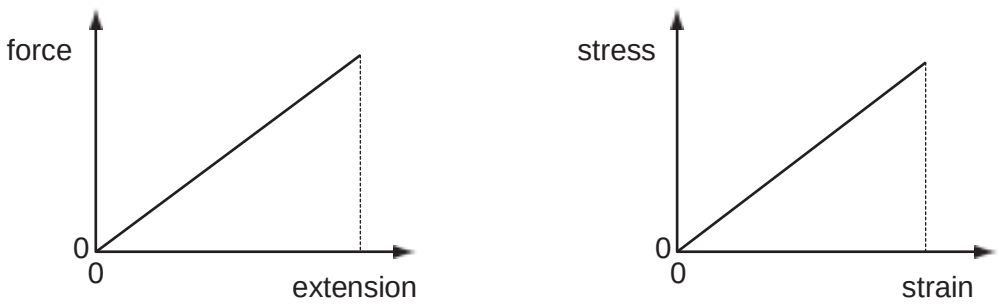
load

What is the ratio $\frac{\text{tension in P}}{\text{tension in Q}}$ when both wires are stretched to the same extension?

load load

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

6. The graphs show how force varies with extension and stress varies with strain for the loading of a metal wire.



The Young modulus for this wire is equal to

A the gradient of the force-extension graph.

B the area between the force-extension graph and the extension axis.

C the gradient of the stress-strain graph.

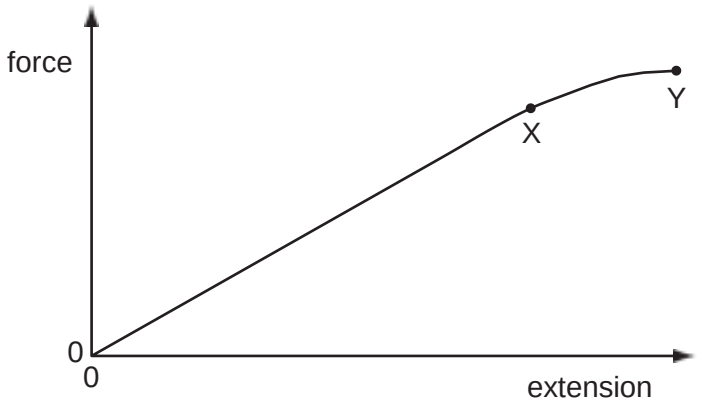
D the area between the stress-strain graph and the strain axis.

7. For a wire, Hooke's law is obeyed for a tension F and extension x. The Young modulus for thematerial of the wire is E.

Which expression represents the elastic strain energy stored in the wire?

A $\frac{1}{2}Ex$ B Ex C $\frac{1}{2}Fx$ D Fx

8. 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?

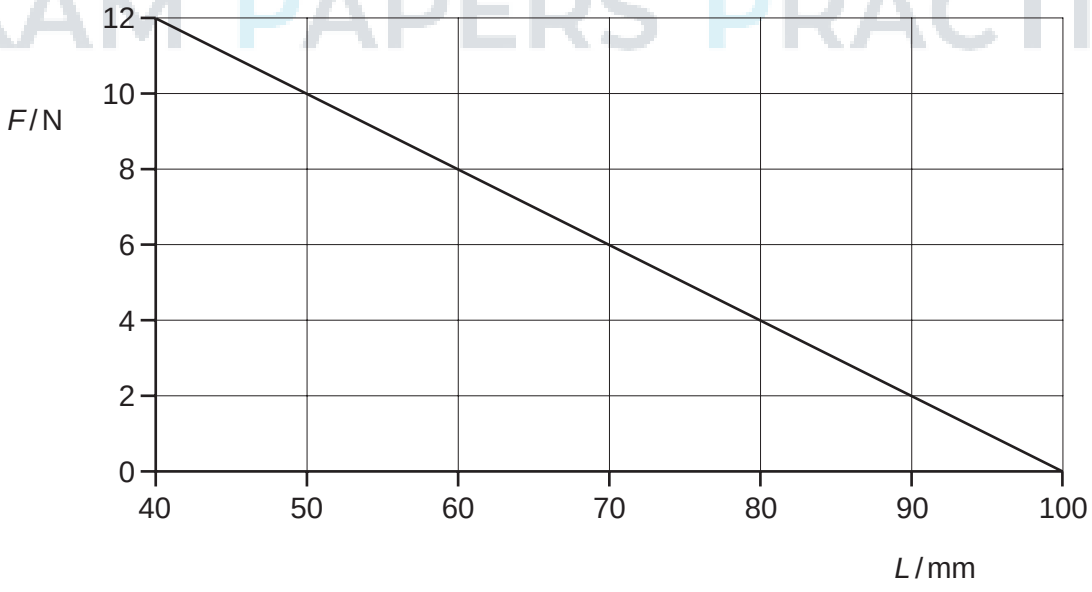
A both elastic and plastic

B elastic but not plastic

C plastic but not elastic

D not elastic and not plastic

9. A spring of original length 100 mm is compressed by a force. The graph shows the variation of the length *L* of the spring with the compressing force *F*.



What is the energy stored in the spring when the length is 70 mm?

A 0.090 J B 0.21 J C 0.27 J D 0.63 J

10. The Young modulus of steel is determined using a length of steel wire and is found to have thevalue *E*.

Another experiment is carried out using a wire of the same steel, but of twice the length and halfthe diameter.

What value is obtained for the Young modulus in the second experiment?

A $\frac{1}{4}E$ B $\frac{1}{2}E$ C E D $2E$

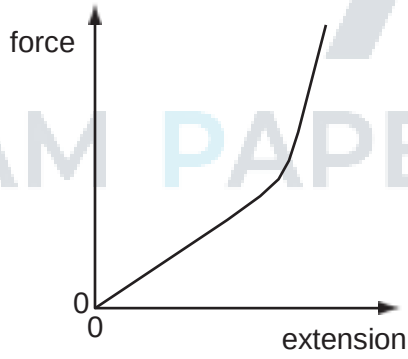
11. A spring of unextended length 40 mm is suspended from a fixed point. A load of 16 N is applied to the free end of the spring. This causes the spring to extend so that its final length is five times its original length. The spring obeys Hooke's Law.

What is the energy stored in the spring due to this extension?

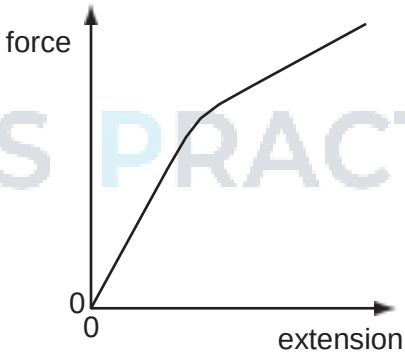
A 1.3 J B 1.6 J C 2.6 J D 3.2 J

12. Which graph represents the force-extension relationship of a rubber band that is stretched almost to its breaking point?

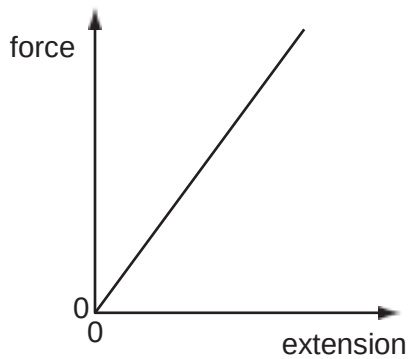
A



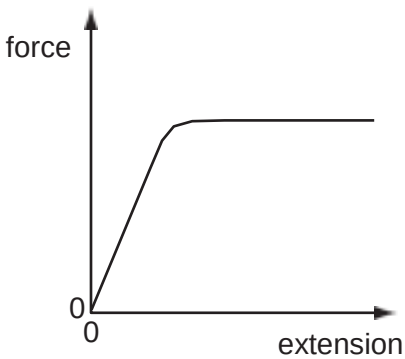
B



C



D

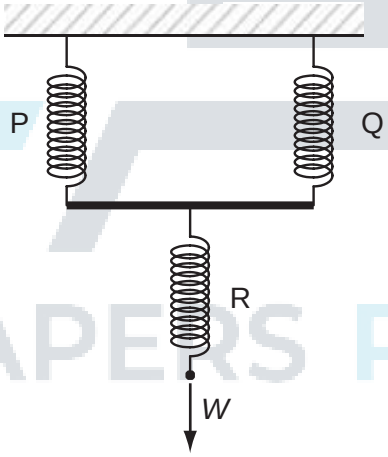


13. A spring is stretched over a range within which elastic deformation occurs. Its spring constant is $3.0\ \text{N cm}^{-1}$.

Which row, for the stated applied force, gives the correct extension and strain energy?

	force / N	extension / cm	strain energy / mJ
A	3.0	1.0	1.5
B	6.0	2.0	120
C	12.0	3.0	180
D	24.0	8.0	960

14. Three springs are arranged vertically as shown.

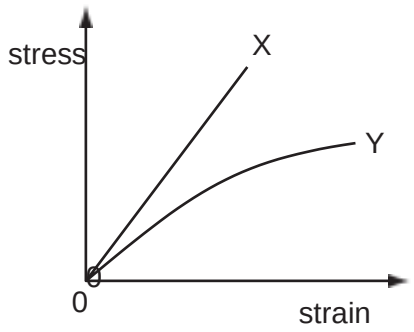


Springs P and Q are identical and have spring constant k. Spring R has spring constant $3k$.

What is the increase in the overall length of the arrangement when a force W is applied as shown?

A $\frac{5}{6}\frac{W}{k}$ B $\frac{4}{3}\frac{W}{k}$ C $\frac{7}{2}kW$ D $4kW$

15. The diagram shows the stress-strain graph for two wires X and Y of different materials up to their breaking points. Both wires have the same initial dimensions.



Which statement is not correct?

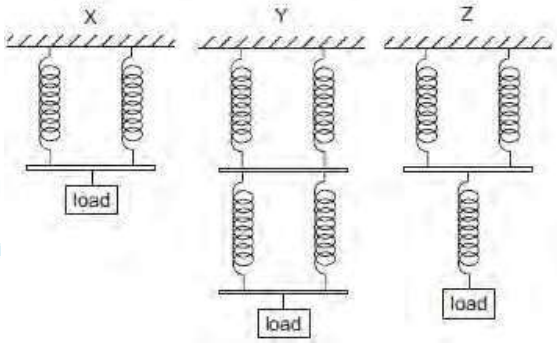
A Material X extends elastically.

B Material X extends more than material Y when loaded with the same force.

C Material X has a larger ultimate tensile stress.

D Material X is brittle.

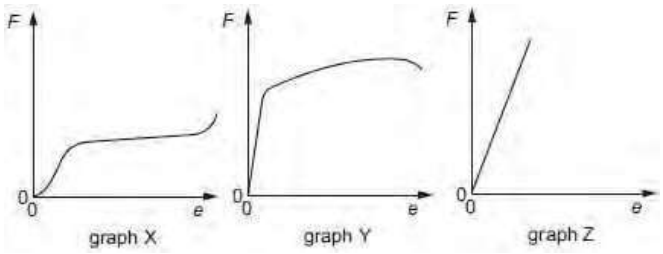
16. A number of similar springs, each having the same springconstant, are joined in three arrangements X, Y and Z. The same load is applied to each.



What is the order of increasing extension for thesearrangements?

	smallest →		largest
A	X	Y	Z
B	Z	X	Y
C	Z	Y	X
D	Y	X	Z

17. Cylindrical samples of steel, glass and rubber are each subjected to a gradually increasing tensile force F. The extensions e are measured and graphs are plotted as shownbelow.



Which row correctly relates the graphs to the materials?

	steel	glass	rubber
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Y	Z	X

18. Two steel wires P and Q have lengths l and 2l respectively, andcross-sectional areas A and A/2 respectively. Both wires obey Hooke's law.

What is the ratio $\frac{\text{tension in P}}{\text{tension in Q}}$

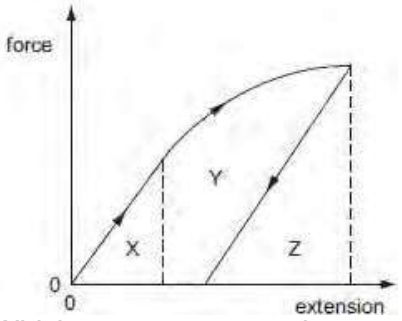
when both wires are stretched to the same extension?

A $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

19. When white sugar granules are heated, they melt. When themelt is cooled quickly, a brittle solid form of toffee is produced. How does the structure of the sugar change?

A amorphous to polymeric B crystalline to amorphous
C crystalline to polymeric D polymeric to amorphous

20. A ductile material is stretched by a tensile force to a point beyondits elastic limit. The tensile force is then reduced to zero. The graph of force against extension is shown below.



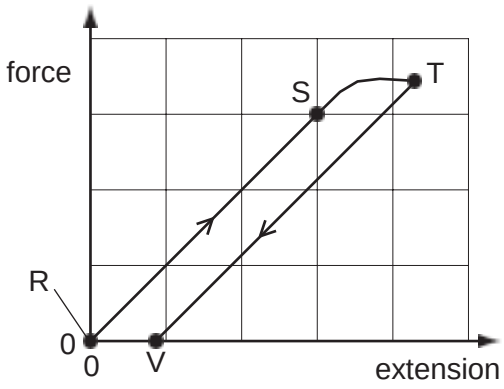
Which area represents the net work done on the sample?

A X B X + Y C Y + Z D Z

21. A long, thin metal wire is suspended from a fixed support and hangs vertically. Masses are suspended from its lower end.

The load on the lower end is increased from zero and then decreased again back to zero.

The diagram shows the force-extension graph produced.



Where on the graph would the elastic limit be found?

A anywhere between point R and point S

B beyond point S but before point T

C exactly at point S

D exactly at point T

22. The Young modulus *E* can be determined from measurements made when a wire is stretched.

Which quantities would be measured in order to determine *E*?

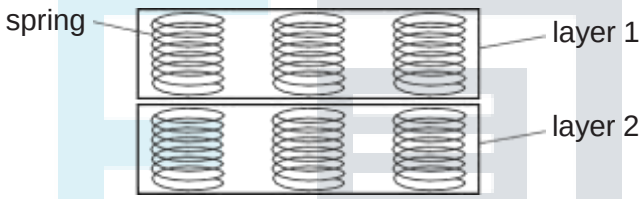
A	mass of stretching load	original length of wire	diameter of wire	extension of wire
B	mass of stretching load	new length of wire	cross-sectional area of wire	diameter of wire
C	mass of wire	original length of wire	cross-sectional area of wire	new length of wire
D	mass of wire	new length of wire	diameter of wire	extension of wire

23. The behaviour of a wire under tensile stress may be described in terms of the Young modulus E of the material of the wire and of the force per unit extension k of the wire.

For a wire of length L and cross-sectional area A, what is the relation between E and k?

A $E = \frac{A}{kL}$ B $E = \frac{kA}{L}$ C $E = \frac{kL}{A}$ D $E = \frac{L}{kA}$

24. The diagram shows the structure of part of a mattress.



The manufacturer wants to design a softer mattress (one which will compress more for the same load).

Which change will not have the desired effect?

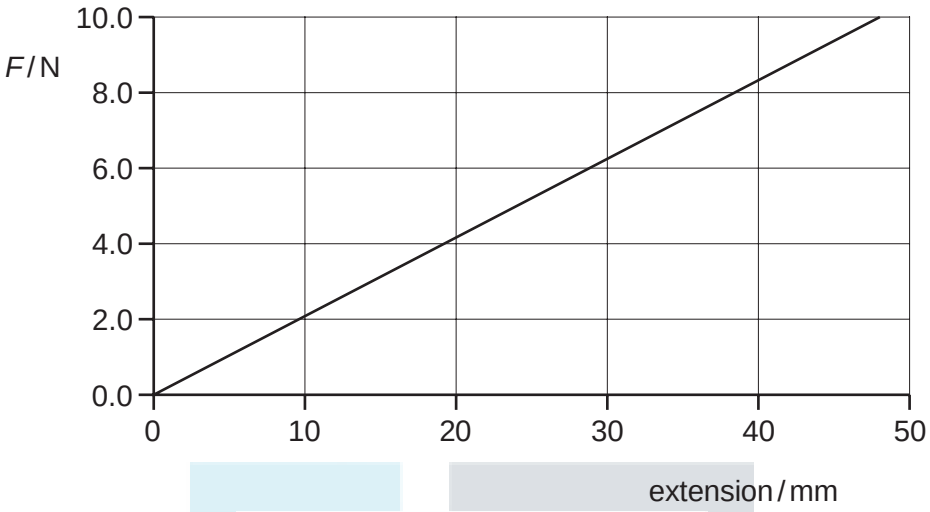
A using more layers of springs

B using more springs per unit area

C using springs with a smaller spring constant

D using springs made from wire with a smaller Young modulus

25. The graph shows how force depends on extension for a certain spring.



What is the energy stored in the spring when the extension is 30 mm?

A 0.095 J B 0.19 J C 0.25 J D 0.95 J

26. The Young modulus of the material of a wire is to be found. The Young modulus *E* is given by the equation below.

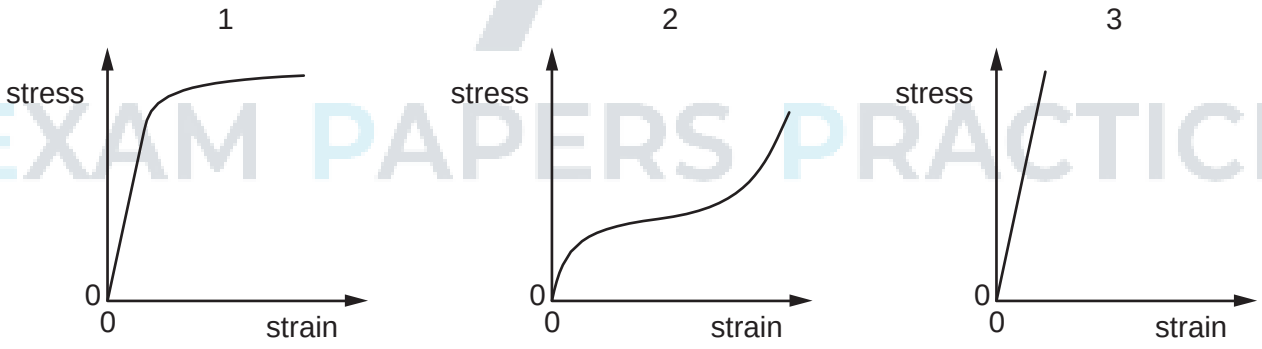
$$E = \frac{4Fl}{\pi d^2 x}$$

The wire is extended by a known force and the following measurements are made.

Which measurement has the largest effect on the uncertainty in the value of the calculated Young modulus?

	measurement	symbol	value
A	length of wire before force applied	l	2.043 ± 0.002 m
B	diameter of wire	d	0.54 ± 0.02 mm
C	force applied	F	19.62 ± 0.01 N
D	extension of wire with force applied	x	5.2 ± 0.2 mm

27. The stress-strain graphs for three different materials are shown, not drawn to the same scales.

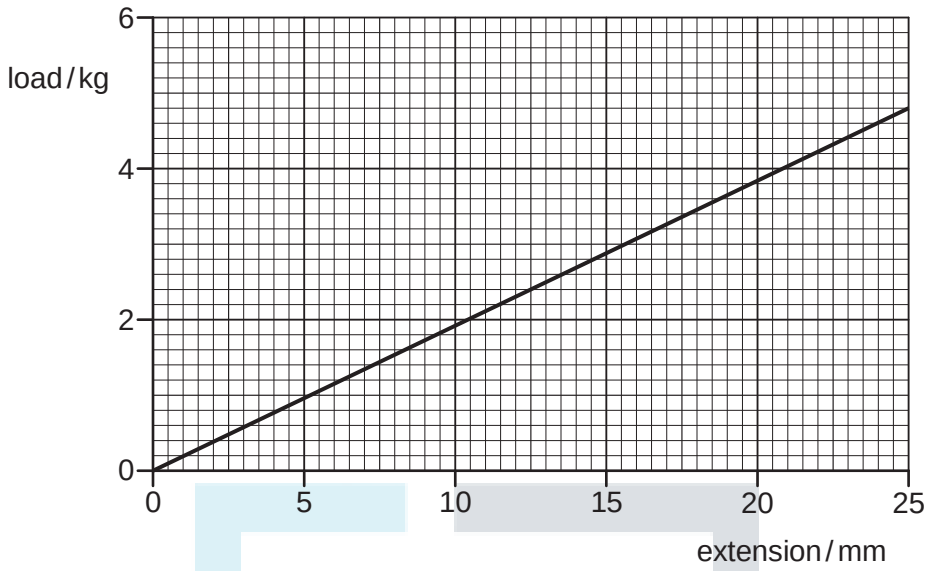


The three materials are copper, rubber and glass.

Which materials are represented by the graphs?

	1	2	3
A	copper	glass	rubber
B	copper	rubber	glass
C	glass	copper	rubber
D	glass	rubber	copper

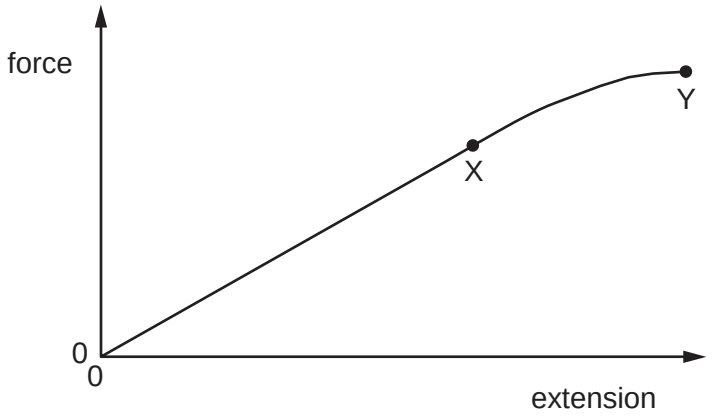
28. The graph is a load-extension graph for a wire undergoing elastic deformation.



How much work is done on the wire to increase the extension from 10 mm to 20 mm?

A 0.028 J B 0.184 J C 0.28 J D 0.37 J

29. A sample of metal is subjected to a force which increases to a maximum value and thendecreases 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?

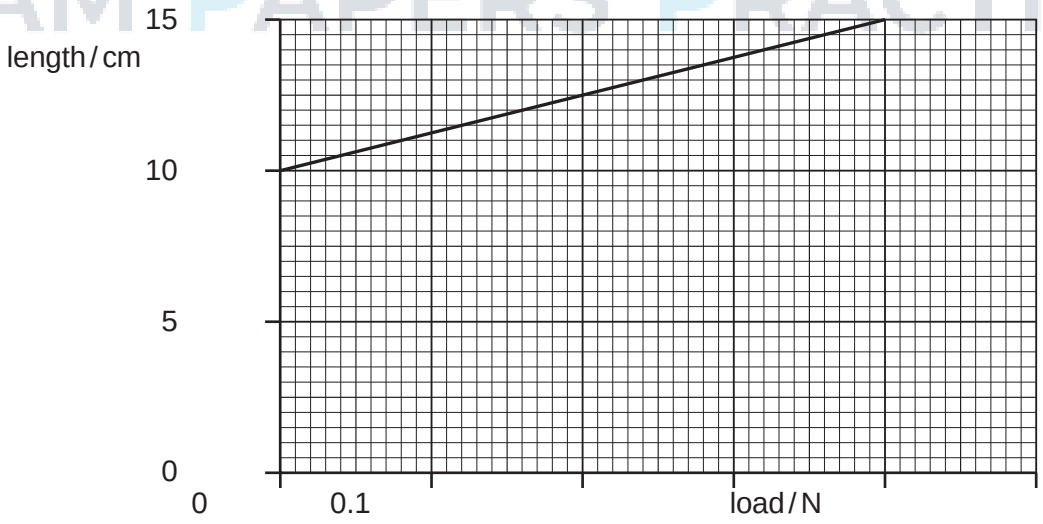
A both elastic and plastic

B not elastic and not plastic

C plastic but not elastic

D elastic but not plastic

30. The graph shows the length of a spring as it is stretched by an increasing load.



What is the spring constant?

A $8.0\,N\,m^{-1}$ B $2.7\,N\,m^{-1}$ C $0.13\,N\,m^{-1}$ D $0.080\,N\,m^{-1}$

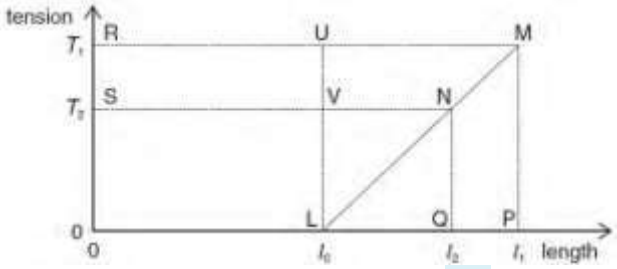
31. Which of the following correctly defines the terms *stress*, *strain* and *Young modulus*?

	stress	strain	Young modulus
A	(force) x (area)	(extension) x (original length)	(stress) / (strain)
B	(force) x (area)	(extension) / (original length)	(stress) x (strain)
C	(force) / (area)	(extension) / (original length)	(stress) / (strain)
D	(force) / (area)	(extension) x (original length)	(stress) x (strain)

32. A wire is stretched by 8 mm when a load of 60 N is applied. What will be the extension of a wire of the same material having four times the cross-sectional area and twice the original length, when the same load is applied?

A 2 mm **B** 4 mm **C** 8 mm **D** 16 mm

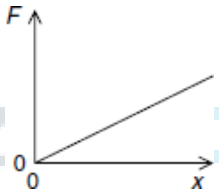
33. The tension in a spring of natural length l_0 is first increased from zero to T_1, causing the length to increase to l_1. The tension is then reduced to T_2, causing the length to decrease to l_2 (as shown).



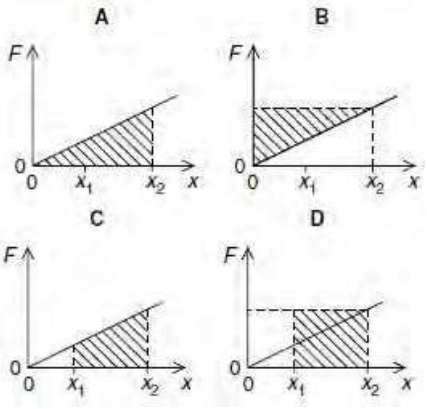
Which area of the graph represents the work done by the spring during this reduction in length?

A MLP **B** MNQP **C** MNSR **D** MPLU

34. The variation of the extension x of a spring with applied force F is shown.



Which shaded area represents the work done when the extension is increased from x_1 to x_2?



35. Two springs P and Q both obey Hooke's law. They have spring constants $2k$ and k respectively. The springs are stretched, separately, by a force that is gradually increased from zero up to a certain maximum value, the same for each spring. The work done in stretching spring P is W_P, and the work done in stretching spring Q is W_Q.

How is W_P related to W_Q?

A $W_P = \frac{1}{4}W_Q$ **B** $W_P = \frac{1}{2}W_Q$ **C** $W_P = 2W_Q$ **D** $W_P = 4W_Q$

36. At room temperature, the density of liquid mercury is five times greater than the density of solid aluminium.

What is the reason for this?

a. Aluminium atoms are spaced widely apart.

b. Aluminium atoms move more freely than mercury atoms.

C Atoms in a liquid take up less space than atoms in a solid.

D Mercury atoms have greater mass than aluminium atoms.

37. When white sugar granules are heated, they melt. When the melt is cooled quickly, a brittle solid form of toffee is produced.

How does the structure of the sugar change?

A amorphous to polymeric

B crystalline to amorphous

C crystalline to polymeric

D polymeric to amorphous

38. Which property of a metal wire depends on its Young modulus?

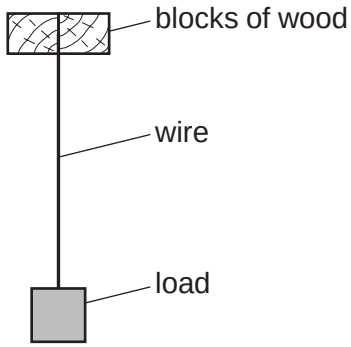
A ductility

B elastic limit

C spring constant

D ultimate tensile stress

39. The diagram shows a wire of diameter *D* and length *L* that is firmly clamped at one end betweentwo blocks of wood. A load is applied to the wire which causes it to extend by an amount *x*.



By how much would a wire of the same material, but of diameter 2*D* and length 3*L*, extend when the same load is applied?

A $\frac{2}{3}x$ B $\frac{3}{4}x$ C $\frac{4}{3}x$ D $\frac{3}{2}x$

40. What is represented by the gradient of a graph of force (vertical axis) against extension (horizontal axis)?

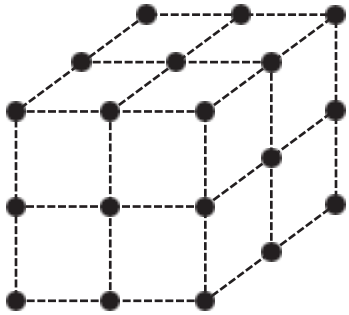
A elastic limit

B spring constant

C stress

D Young modulus

41. The diagram shows the arrangement of atoms in a particular crystal.



Each atom is at the corner of a cube.

The mass of each atom is 3.5×10^{-25} kg. The density of the crystal is 9.2×10^{3} kg m^{-3}.

What is the shortest distance between the centres of two adjacent atoms?

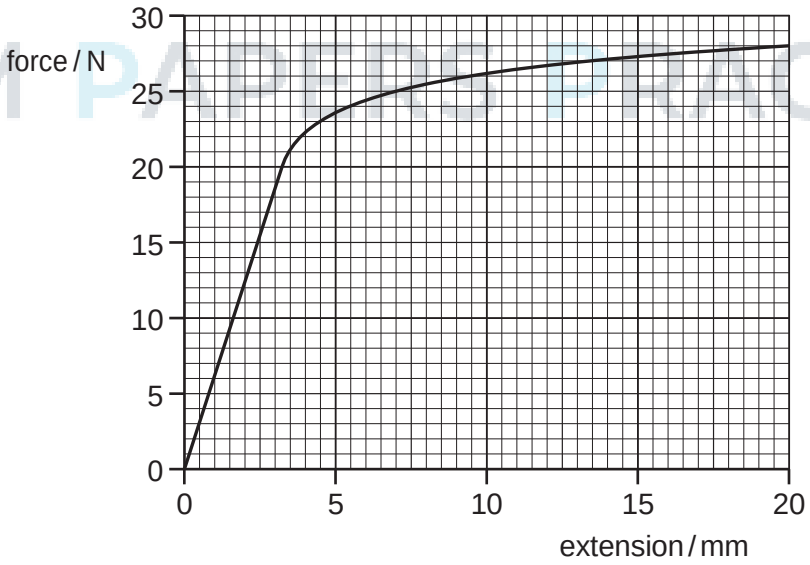
A 3.8×10^{-29} m

B 6.2×10^{-15} m

C 3.4×10^{-10} m

D 3.0×10^{-9} m

42. The graph is a force-extension graph for a wire that is being stretched.



How much work needs to be done by the tensile force, to two significant figures, to cause an extension of 7.0 mm?

A 0.088 J B 0.12 J C 0.53 J D 120 J

43. A wire stretches 8 mm under a load of 60 N.

A second wire of the same material, with half the diameter and a quarter of the original length of the first wire, is stretched by the same load.

Assuming that Hooke's law is obeyed, what is the extension of this wire?

A 1 mm B 4 mm C 8 mm D 16 mm

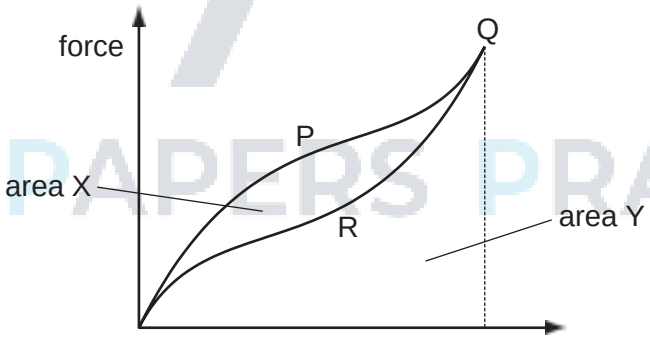
44. The Young modulus of steel is determined using a length of steel wire and is found to have thevalue *E*.

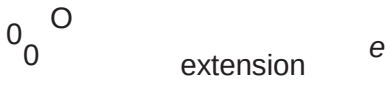
Another experiment is carried out using a wire of the same steel, but of half the length and half the diameter.

What value is obtained for the Young modulus in the second experiment?

A $\frac{1}{2}E$ B E C $2E$ D $4E$

45. A rubber band is stretched and then relaxed to its original length. The diagram shows theforce-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 thecurve 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 *e*.

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

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

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

46. Descriptions of three different types of material are listed.

a. a polycrystalline material made up of large numbers of small crystals

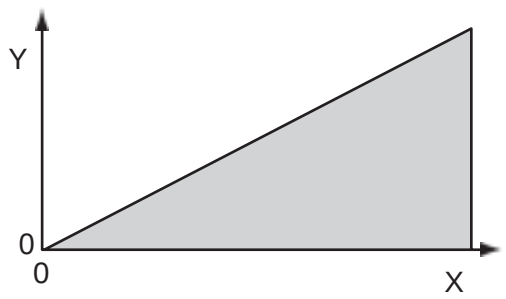
b. an amorphous material with little or no ordered arrangement of molecules

c. a polymeric material consisting of long chains of molecules

Which row correctly matches the descriptions to nylon, copper and glass?

	1	2	3
A	copper	copper	nylon
B	copper	copper	glass
C	glass	glass	copper
D	nylon	copper	glass

47. The graph shown was plotted in an experiment on a metal wire.

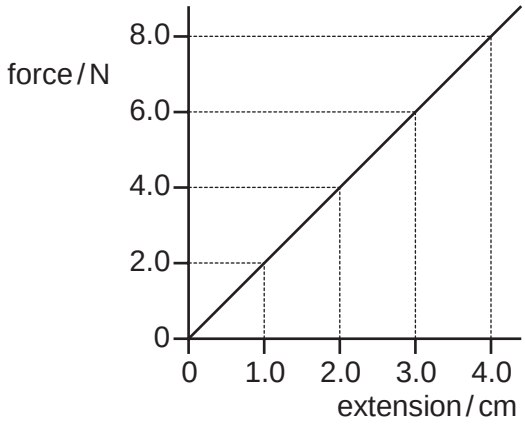


The shaded area represents the total strain energy stored in stretching the wire.

How should the axes be labelled?

	Y	X
A	force	extension
B	mass	extension
C	strain	energy
D	stress	strain

48. The variation with applied force of the extension of a spring is shown in the graph.



When there is no force applied to the spring, it has a length of 1.0 cm.

What is the increase in the strain energy stored in the spring when its length is increased from 2.0 cm to 3.0 cm?

A 0.020 J B 0.030 J C 0.040 J D 0.050 J

49. To determine the Young modulus of a wire, several measurements are taken.

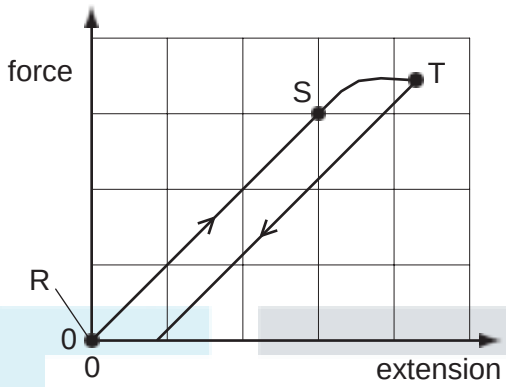
In which row can the measurement not be taken directly with the stated apparatus?

	measurement	apparatus
A	area of cross-section of wire	micrometer screw gauge
B	extension of wire	vernier scale
C	mass of load applied to wire	electronic balance
D	original length of wire	metre rule

50. A long, thin metal wire is suspended from a fixed support and hangs vertically. Masses are suspended from its lower end.

The load on the lower end is increased from zero and then decreased again back to zero.

The diagram shows the force-extension graph produced.



Where on the graph would the elastic limit be found?

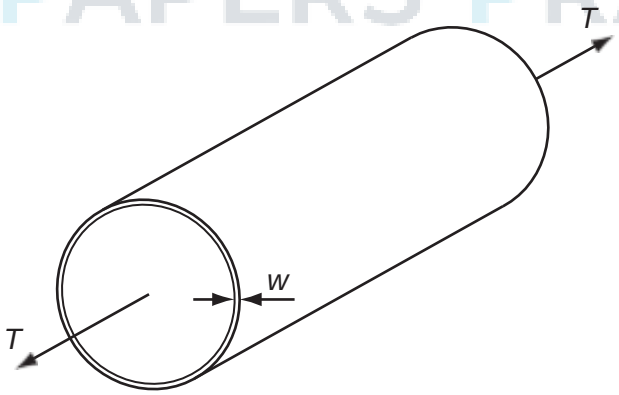
A anywhere between point R and point S

B just beyond point S

C exactly at point S

D exactly at point T

51. The diagram represents a steel tube with wall thickness *w* which is small in comparison with the diameter of the tube.



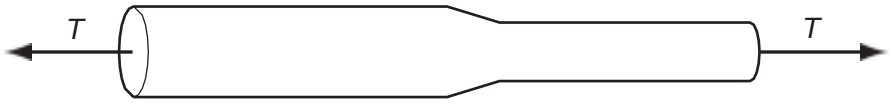
The tube is under tension, caused by a force *T*, parallel to the axis of the tube. To reduce the stress in the material of the tube, it is proposed to thicken the wall.

The tube diameter and the tension being constant, which wall thickness gives half the stress?

A $\frac{w}{2}$ B $\sqrt{2}\,w$ C $2w$ D $4w$

52. A steel bar of circular cross-section is under tension *T*, as shown.

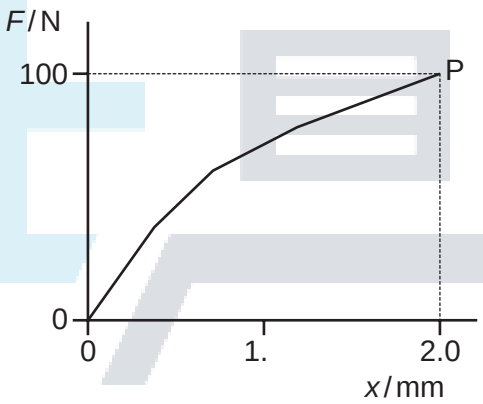
The diameter of the wide portion is double the diameter of the narrow portion.



What is the value of $\frac{\text{stress in the wide portion}}{\text{stress in the narrow portion}}$?

A 0.25 B 0.50 C 2.0 D 4.0

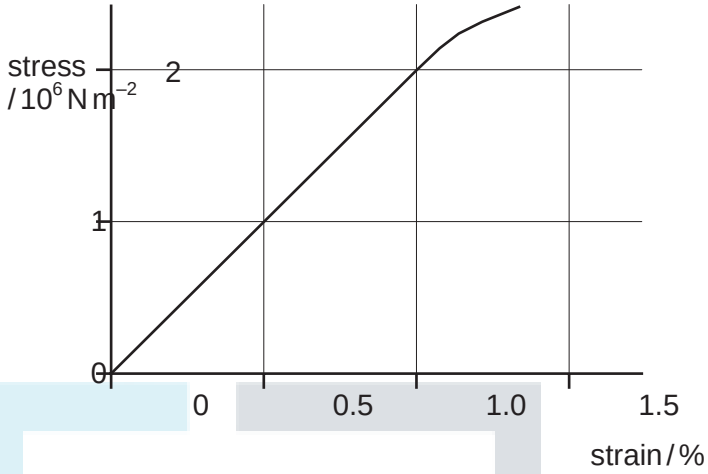
53. The graph shows the non-linear force-extension curve for a wire made from a new composite material.



What could be the value of the strain energy stored in the wire when it is stretched elastically to point P?

A 0.09 J B 0.10 J C 0.11 J D 0.20 J

54. The diagram shows the stress-strain graph for bone.



What is the Young modulus of bone?

A 1×10^6 N m^{-2}

B 2×10^6 N m^{-2}

C 1×10^8 N m^{-2}

D 2×10^8 N m^{-2}

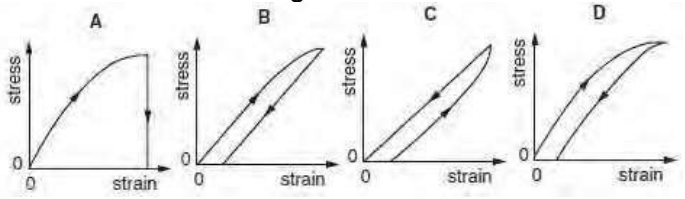
55. A steel wire is stretched in an experiment to determine the Young modulus for steel.The uncertainties in the measurements are given below.

measurement	uncertainty
load on wire	±2%
length of wire	±0.2%
diameter of wire	±1.5%
extension	±1%

What is the percentage uncertainty in the Young modulus?

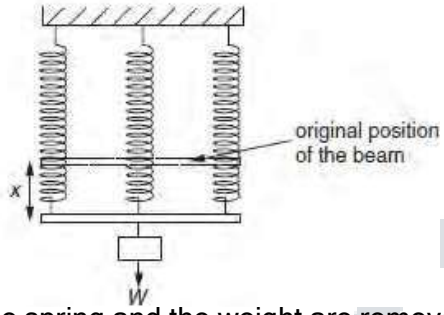
A 1.3% B 1.8% C 4.7% D 6.2%

56. A suspended copper wire is gradually loaded until it is stretchedjust beyond the elastic limit, and it is then gradually unloaded.
Which graph (with arrows indicating the sequence) best illustratesthe variation of the tensile stress with longitudinal strain?



57. What is the ultimate tensile stress of a material? **A** the stress at which the material becomes ductile **B** the stress at which the material breaks
C the stress at which the material deforms plastically
D the stress at which the material reaches its elastic limit

58. A beam, the weight of which may be neglected, is supported by three identical springs. When a weight *W* is hung from the middle ofthe beam, the extension of each spring is *x*.

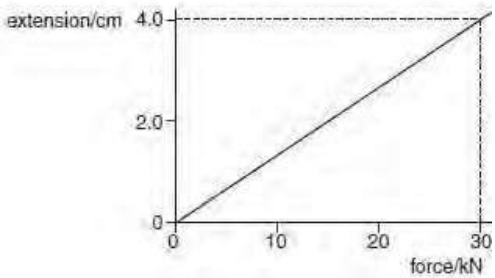


The middle spring and the weight are removed.
What is the extension when a weight of 2*W* is hung from the middleof the beam?
A 3x/2 B 4x/3 C 2*x* D 3*x*

59. What is the Young modulus of a metal?

A extension / force **B** force / extension
C strain / stress **D** stress / strain

60. The graph shows how the extension of a spring varies with theforce used to stretch it.



What is the strain energy stored in the spring when the extension is 4.0 cm?
A 60 J **B** 120 J **C** 600 J **D** 1200 J