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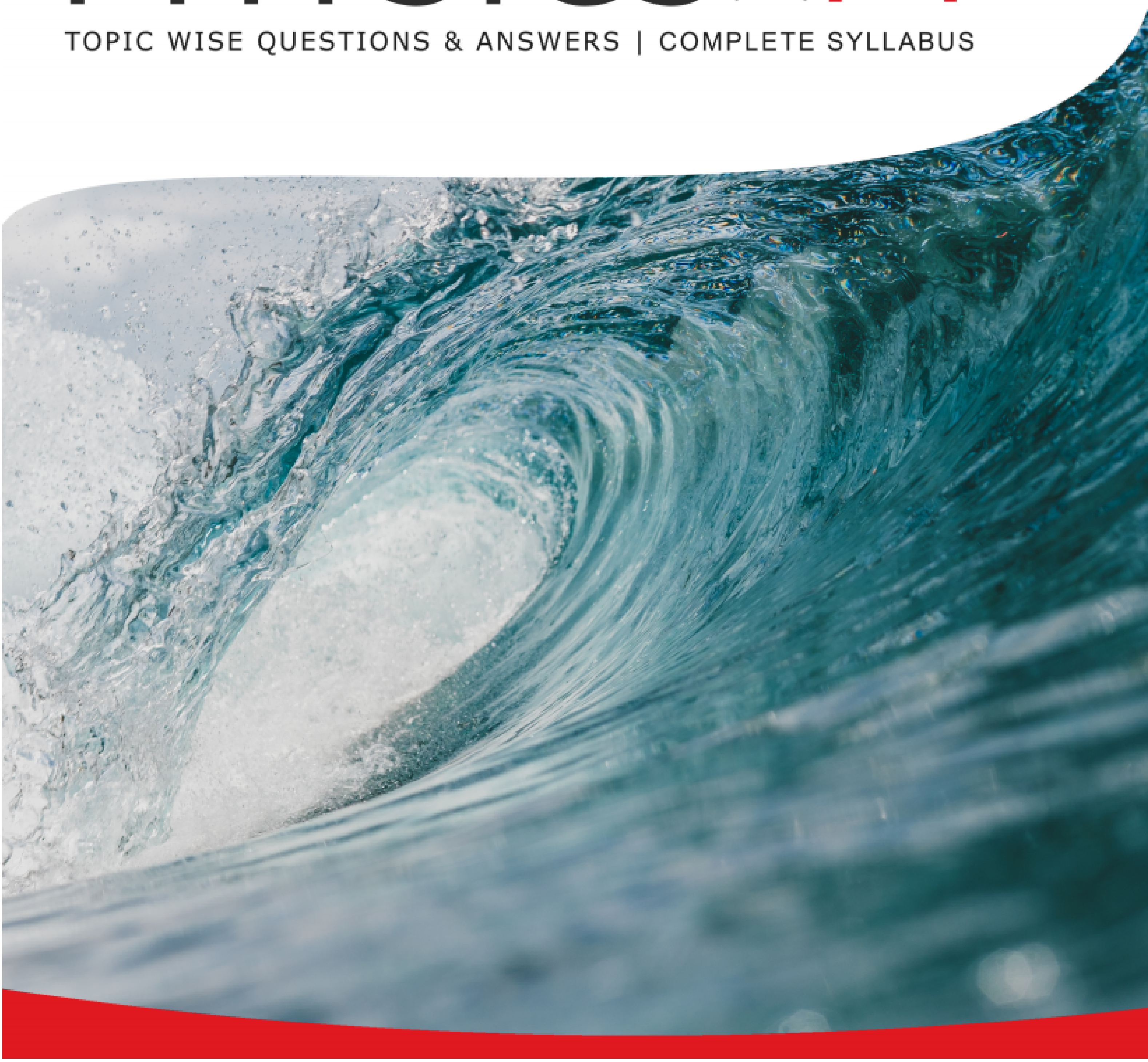
Cambridge International AS & A Level

PHYSICS (9702) P1

TOPIC WISE QUESTIONS & ANSWERS | COMPLETE SYLLABUS



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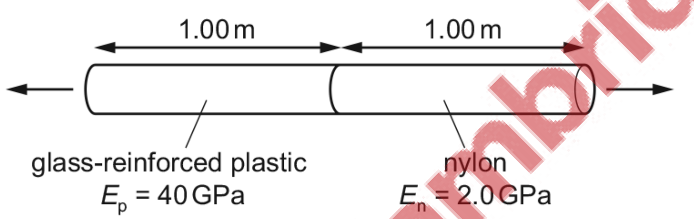
Chapter 7

Deformation of solids

7.1 Stress and strain

638. 9702_m20_qp_12 Q: 19

A composite rod is made by attaching a glass-reinforced plastic rod and a nylon rod end to end, as shown.



The rods have the same cross-sectional area and each rod is 1.00 m in length. The Young modulus E_p of the plastic is 40 GPa and the Young modulus E_n of the nylon is 2.0 GPa.

The composite rod will break when its total extension reaches 3.0 mm.

What is the greatest tensile stress that can be applied to the composite rod before it breaks?

A 2.9×10^6 Pa

B 5.7×10^6 Pa

C 2.9×10^9 Pa

D 5.7×10^9 Pa

639. 9702_s20_qp_11 Q: 16

A mass attached to the lower end of a spring bounces up and down.

At which points in the path of the mass do the gravitational potential energy of the mass (GPE), the elastic potential energy in the spring (EPE) and the kinetic energy of the mass (KE) have their highest values?

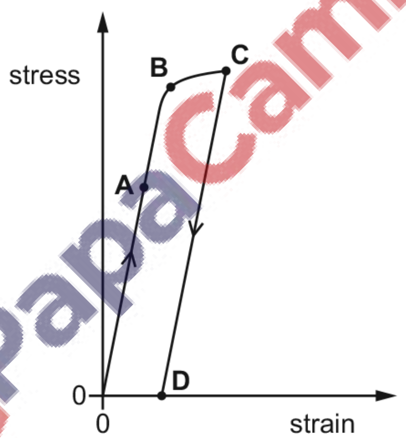
	GPE	EPE	KE
A	bottom	middle	top
B	bottom	top	middle
C	top	bottom	middle
D	top	bottom	top

640. 9702_s20_qp_11 Q: 20

A tensile force is used to extend a sample of a material. The force is then removed.

The variation with strain of the applied stress is shown on the graph.

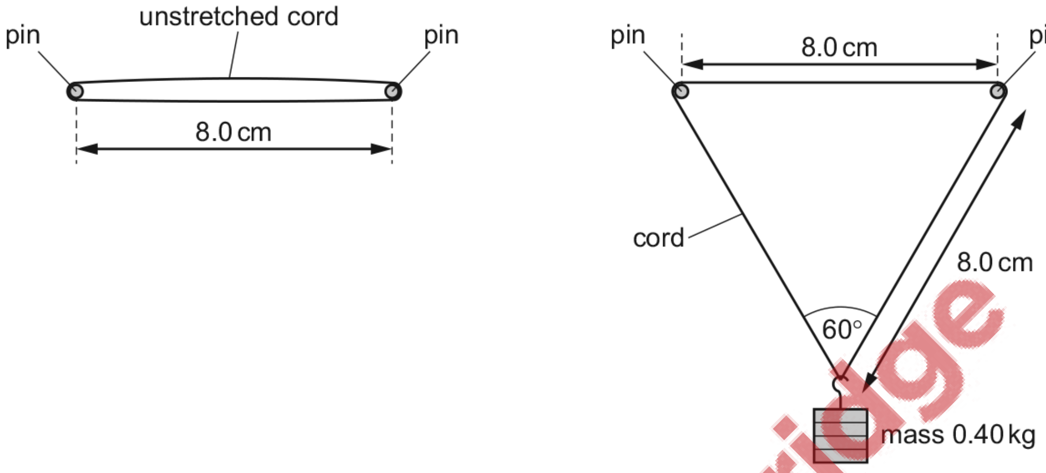
Which point on the graph could represent the elastic limit for the material?



641. 9702_s20_qp_12 Q: 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°.

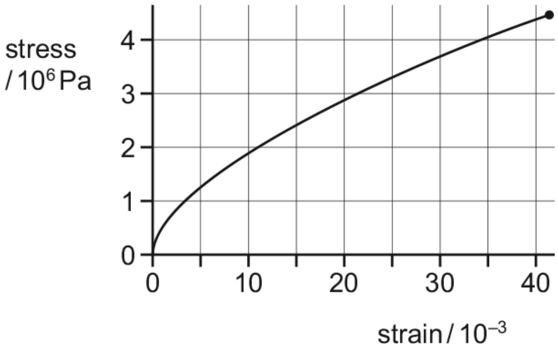


What is the Young modulus of the cord material?

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

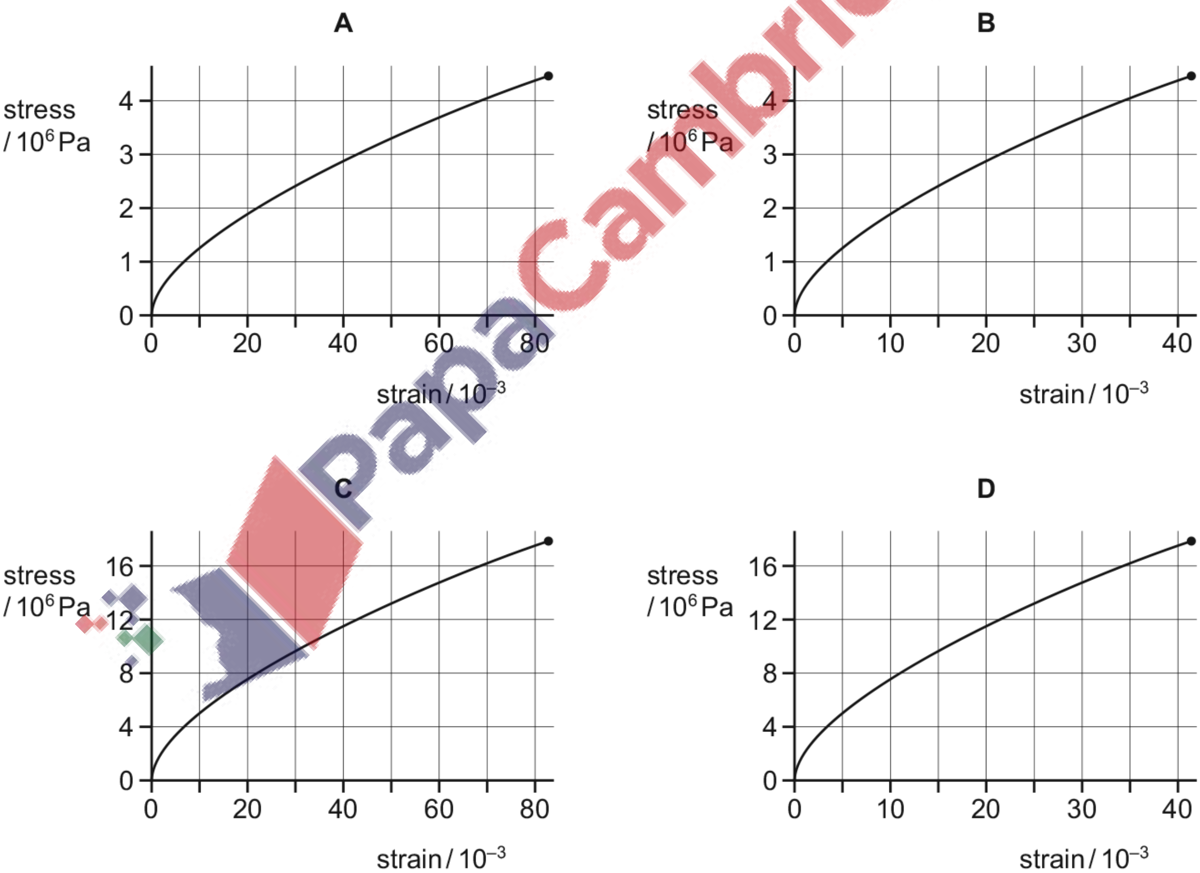
642. 9702_s20_qp_12 Q: 19

A student is investigating the mechanical properties of a metal. He applies different loads to a long thin wire up to its breaking point, and measures the extension of the wire for each load. He then plots a graph of stress against strain.



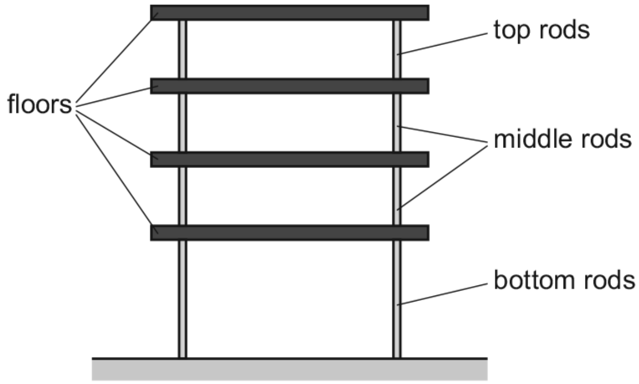
The student repeats the experiment with a wire made from the same metal, with twice the original length and half the diameter.

Which graph is obtained?



643. 9702_s20_qp_13 Q: 20

The diagram shows a simplified model of a building with four identical heavy floors.



The spacing of the bottom floor from the ground is twice that of the spacing between the floors. Between each floor are equal numbers of vertical steel supporting rods of negligible mass compared with the floors. The rods are of different diameters so that the stress in each rod is the same.

What is the ratio $\dfrac{\text{diameter of bottom rods}}{\text{diameter of top rods}}$?

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

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644. 9702_m19_qp_12 Q: 19

A metal wire, fixed at one end, has length *l* and cross-sectional area *A*. The wire extends a distance *e* when mass *m* is hung from the other end of the wire.

What is an expression for the Young Modulus *E* of the metal?

A $E = \dfrac{ml}{Ae}$ **B** $E = \dfrac{mgl}{Ae}$ **C** $E = \dfrac{me}{Al}$ **D** $E = \dfrac{mge}{Al}$

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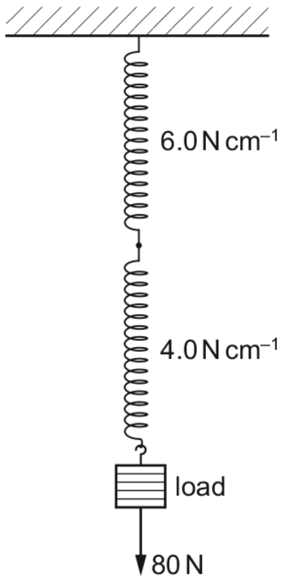
645. 9702_m19_qp_12 Q: 20

A spring has a spring constant of 6.0 N cm $^{-1}$. It is joined to another spring whose spring constant is 4.0 N cm^{-1}. A load of 80 N is suspended from this composite spring.



What is the extension of this composite spring?

A 8.0 cm **B** 16 cm **C** 17 cm **D** 33 cm

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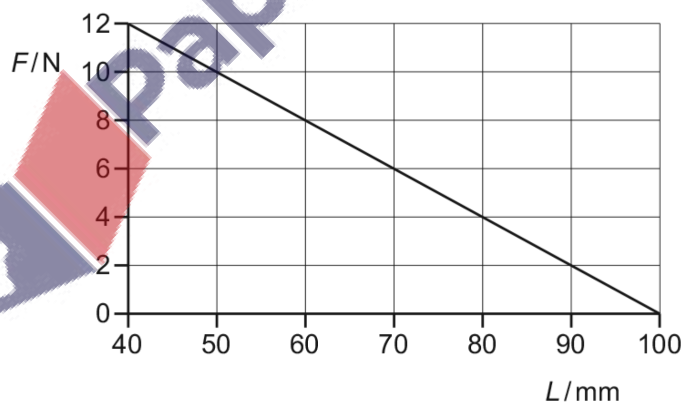
646. 9702_s19_qp_11 Q: 20

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



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

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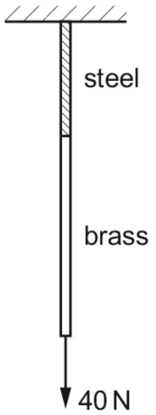
647. 9702_s19_qp_11 Q: 21

A 0.80 m length of steel wire and a 1.4 m length of brass wire are joined together. The combined wires are suspended from a fixed support and a force of 40 N is applied, as shown.



The Young modulus of steel is 2.0×10^{11} Pa.

The Young modulus of brass is 1.0×10^{11} Pa.

Each wire has a cross-sectional area of 2.4×10^{-6} m^2.

The wires obey Hooke's law.

What is the total extension? Ignore the weights of the wires.

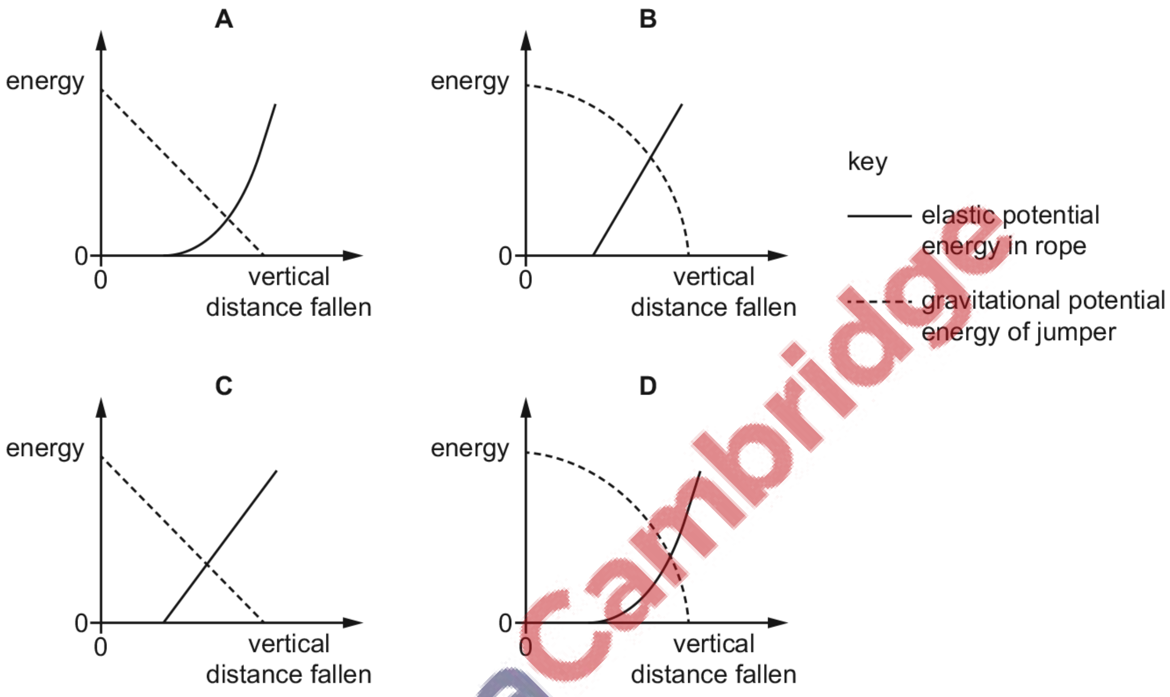
A 1.7×10^{-4} m **B** 3.0×10^{-4} m **C** 3.9×10^{-4} m **D** 9.0×10^{-4} m

648. 9702_s19_qp_12 Q: 18

A bungee jumper jumps off a high bridge, when attached to it by a long elastic rope which obeys Hooke's law.

The gravitational potential energy of the jumper is measured relative to the lowest point reached by the jumper.

Which graph shows the variation of the gravitational potential energy of the jumper, and the elastic potential energy in the rope, with the vertical distance fallen from the top of the bridge?



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649. 9702_s19_qp_12 Q: 20

A wire X is stretched by a force and gains elastic potential energy E.

The same force is applied to wire Y of the same material, with the same initial length but twice the diameter of wire X. Both wires obey Hooke's law.

What is the gain in elastic potential energy of wire Y?

A $0.25E$ **B** $0.5E$ **C** $2E$ **D** $4E$

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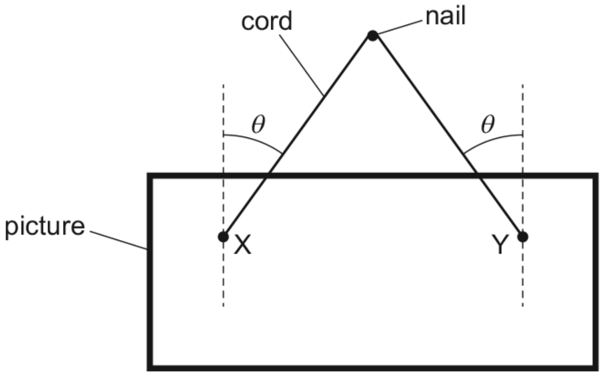
650. 9702_s19_qp_13 Q: 11

A picture is suspended from a nail by a single cord connected to two points X and Y on the picture. There is negligible friction between the cord and the nail so that the tension in both sides of the cord is the same. The picture hangs symmetrically, as shown.



The tension in the cord is T. The angle between the cord and the vertical is θ on both sides.

Which statement is correct?

A Increasing the length of the cord, with points X and Y in the same place on the picture, would reduce the tension in the cord.

B Moving points X and Y further apart on the picture while keeping the length of the cord constant would reduce the tension in the cord.

C Moving points X and Y to the top edge of the picture while keeping their distance apart constant and the length of the cord constant would reduce the tension in the cord.

D The weight of the picture is equal to $T\cos\theta$.

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651. 9702_s19_qp_13 Q: 19

Four solid steel rods, each of length 2.0 m and cross-sectional area 250 mm^2, equally support an object weighing 10 kN. The weight of the object causes the rods to contract by 0.10 mm. The rods obey Hooke's law.

What is the Young modulus of steel?

A $2.0 \times 10^8 \, N\,m^{-2}$

B $2.0 \times 10^{11} \, N\,m^{-2}$

C $8.0 \times 10^8 \, N\,m^{-2}$

D $8.0 \times 10^{11} \, N\,m^{-2}$

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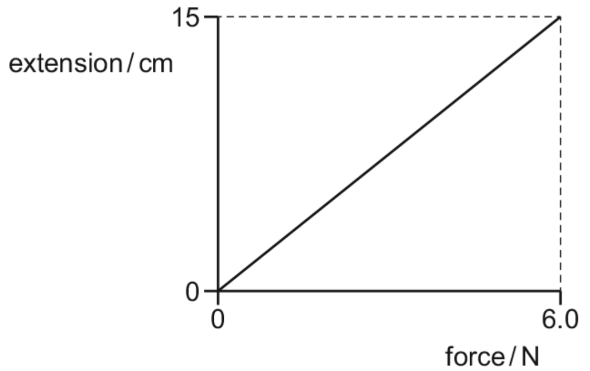
652. 9702_w19_qp_11 Q: 19

An extension–force graph for a spring is shown.



What is the spring constant of the spring?

A 0.025 N m^{-1} **B** 0.40 N m^{-1} **C** 2.5 N m^{-1} **D** 40 N m^{-1}

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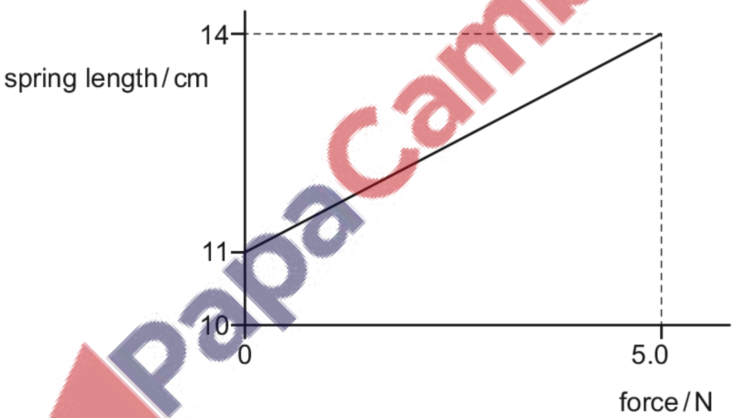
653. 9702_w19_qp_12 Q: 18

The graph shows the effect of applying a force of up to 5.0 N to a spring.



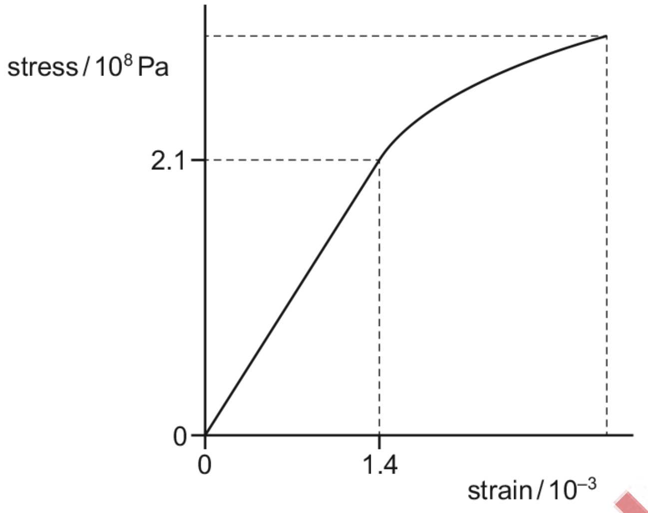
The spring obeys Hooke's law for forces up to 7.0 N.

What is the total extension of the spring produced by a 7.0 N force?

A 4.2 cm **B** 5.6 cm **C** 15 cm **D** 20 cm

654. 9702_w19_qp_13 Q: 19

The stress–strain graph for a wire is shown.



What is the Young modulus of the material of the wire?

A 6.7×10^{-12} Pa

B 6.7×10^{-9} Pa

C 1.5×10^{8} Pa

D 1.5×10^{11} Pa

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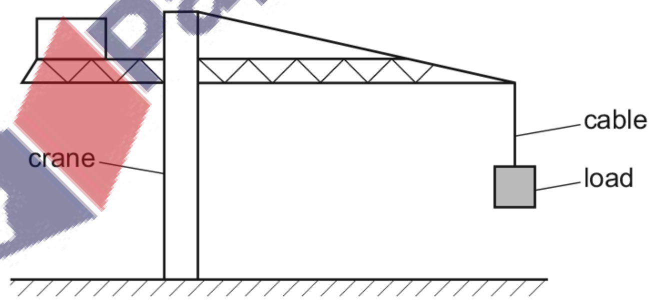
655. 9702_m18_qp_12 Q: 20

The diagram shows a large crane on a construction site lifting a cube-shaped load at a constant speed.



A model is made of the crane, its load and the cable supporting the load.

The material used for each part of the model is the same as that in the full-size crane, cable and load. The model is one tenth full-size in all linear dimensions.

What is the ratio $\dfrac{\text{stress in the cable on the full-size crane}}{\text{stress in the cable on the model crane}}$?

A 0.1 **B** 1 **C** 10 **D** 100

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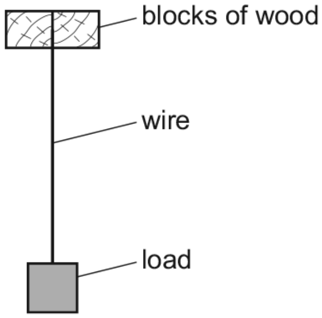
656. 9702_s18_qp_11 Q: 18

The diagram shows a wire of diameter *D* and length *L* that is firmly clamped at one end between two blocks of wood. A load is applied to the wire which extends its length by *x*.



A second wire is made of the same material, but of diameter 2*D* and length 3*L*. Both wires obey Hooke's law.

What is the extension of the second wire when the same load is applied?

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

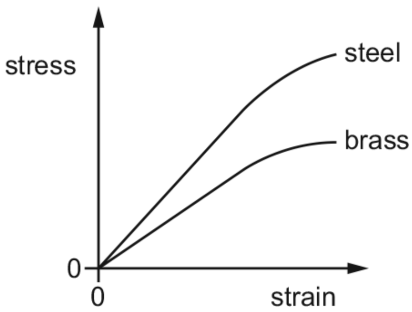
657. 9702_s18_qp_11 Q: 19

Two wires, one made of brass and the other of steel, are stretched in an experiment. Both wires obey Hooke's law during this experiment.

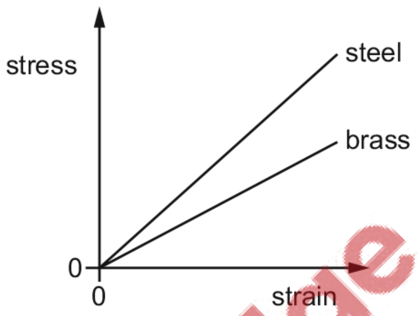
The Young modulus for brass is less than the Young modulus for steel.

Which graph shows how the stress varies with strain for both wires in this experiment?

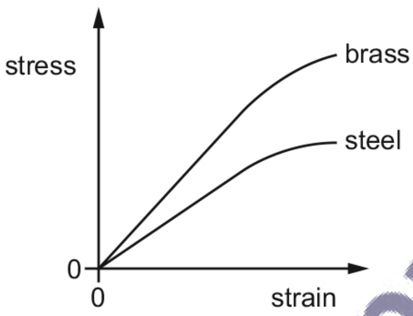
A



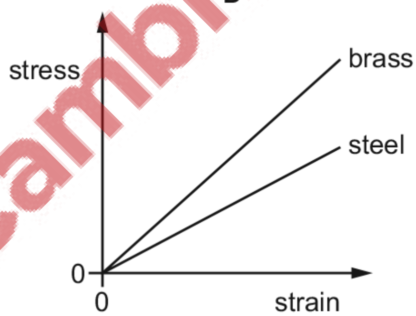
B



C



D



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658. 9702_s18_qp_12 Q: 20

An elastic material with Young modulus E is subjected to a tensile stress S. Hooke's law is obeyed.

What is the expression for the elastic energy stored per unit volume of the material?

A $\dfrac{E}{2S^2}$ **B** $\dfrac{2E}{S^2}$ **C** $\dfrac{S^2}{E}$ **D** $\dfrac{S^2}{2E}$

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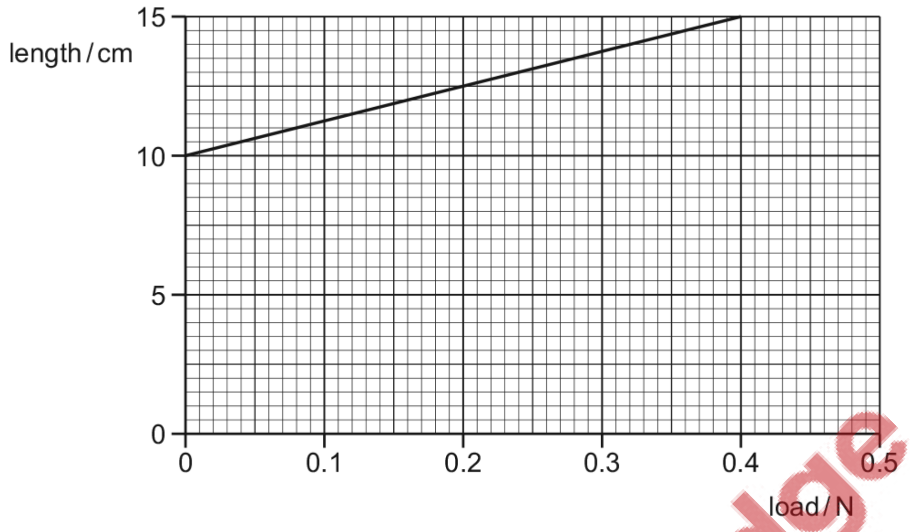
659. 9702_s18_qp_12 Q: 21

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



What is the spring constant of the spring?

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

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660. 9702_s18_qp_13 Q: 18

Data for a steel wire on an electric guitar are listed.

diameter = 5.0×10^{-4} m

Young modulus = 2.0×10^{11} Pa

tension = 20 N

The wire snaps and contracts elastically. Assume the wire obeys Hooke's law.

By what percentage does the length l of a piece of the wire contract?

A 1.3×10^{-4} % **B** 5.1×10^{-4} % **C** 1.3×10^{-2} % **D** 5.1×10^{-2} %

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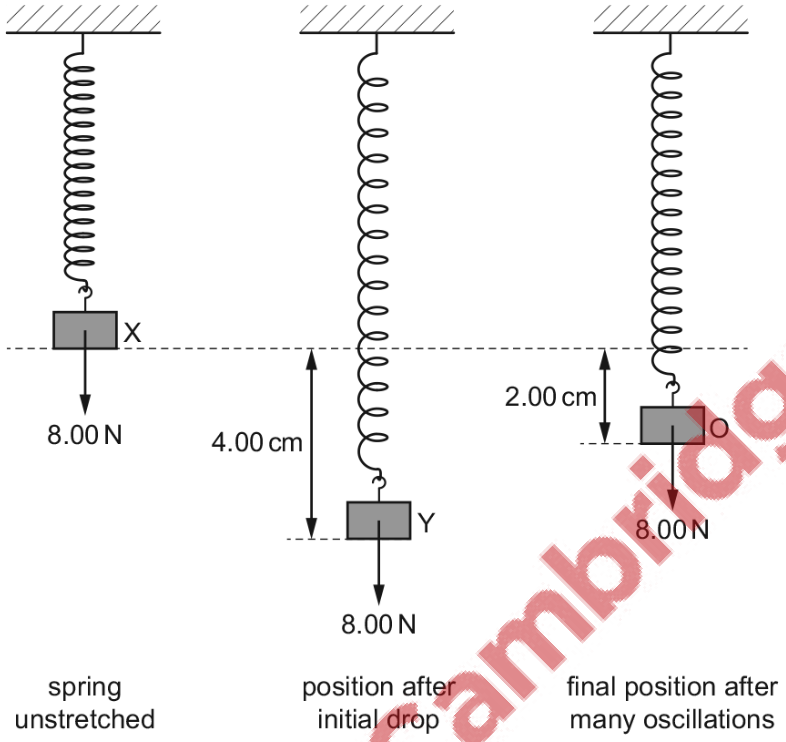
661. 9702_w18_qp_11 Q: 16

An 8.00 N weight is attached to the lower end of a spring which is fixed at its upper end. The weight is initially held at rest at position X and the spring is unstretched. The weight is then released and falls to position Y, which is 4.00 cm below X. The weight oscillates and then eventually comes to rest at O, which is 2.00 cm below X.

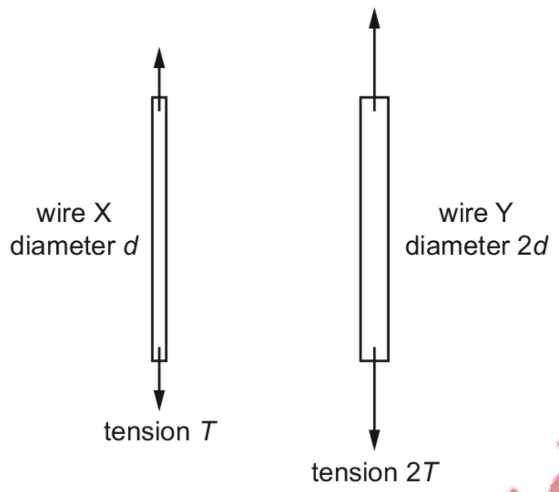


How much energy is lost from the system?

A 0.04 J **B** 0.08 J **C** 0.16 J **D** 0.32 J

662. 9702_w18_qp_11 Q: 18

Two wires X and Y are made from the same material. Wire Y has twice the diameter and experiences twice the tension of wire X. The wires obey Hooke's law and have the same original length.



Wire X has extension *e*.

What is the extension of wire Y?

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

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663. 9702_w18_qp_11 Q: 19

What is represented by the gradient of a graph of force (vertical axis) against extension (horizontal axis) for a wire obeying Hooke's law?

A elastic limit

B spring constant

C stress

D Young modulus

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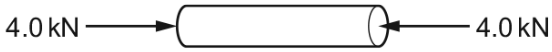
664. 9702_w18_qp_12 Q: 20

A metal cylinder is able to withstand a compressive force of 4.0 kN without deforming plastically.



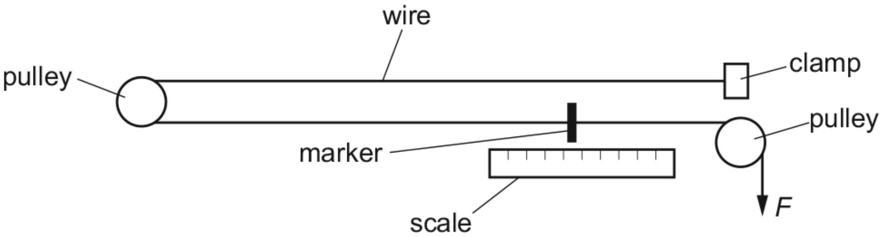
The cylinder has cross-sectional area A and would be at its elastic limit when a stress σ is applied.

What is a possible pair of values for A and σ?

	A / m^2	σ / MPa
A	1.5×10^{-5}	50
B	1.5×10^{-5}	80
C	7.5×10^{-5}	50
D	7.5×10^{-5}	80

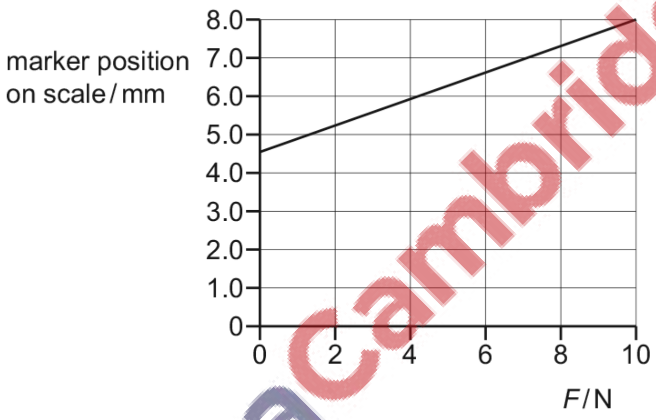
665. 9702_w18_qp_13 Q: 19

In an experiment to measure the Young modulus of a metal, a wire of the metal of diameter 0.25 mm is clamped, as shown.



The wire passes from a clamp, around a frictionless pulley, and then to a second frictionless pulley where loads *F* are applied to it. A marker is attached to the wire so that the total length of wire between the clamp and the marker is initially 3.70 m. A scale is fixed near to this marker.

The graph shows how the reading on the scale varies with *F*.



What is the Young modulus of the metal?

A 5.5×10^{10} Pa

B 9.4×10^{10} Pa

C 1.6×10^{11} Pa

D 2.2×10^{11} Pa

666. 9702_m17_qp_12 Q: 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 $\dfrac{\text{tension in wire X}}{\text{tension in wire Y}}$?

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

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667. 9702_s17_qp_11 Q: 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 $x = \dfrac{Ml}{\pi d^2 E}$ **B** $x = \dfrac{Mgl}{\pi d^2 E}$ **C** $x = \dfrac{4Mgl}{\pi dE}$ **D** $x = \dfrac{4Mgl}{\pi d^2 E}$

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668. 9702_s17_qp_12 Q: 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

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669. 9702_s17_qp_13 Q: 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

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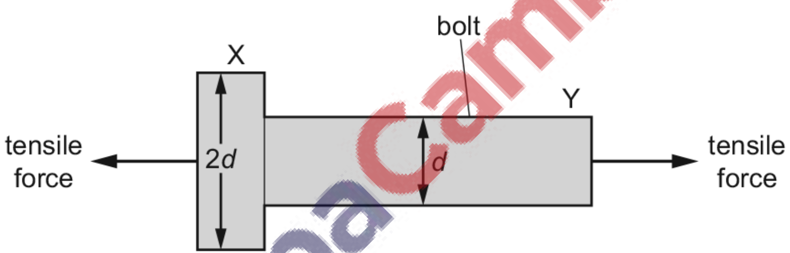
670. 9702_w17_qp_12 Q: 20

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

---

671. 9702_w17_qp_12 Q: 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

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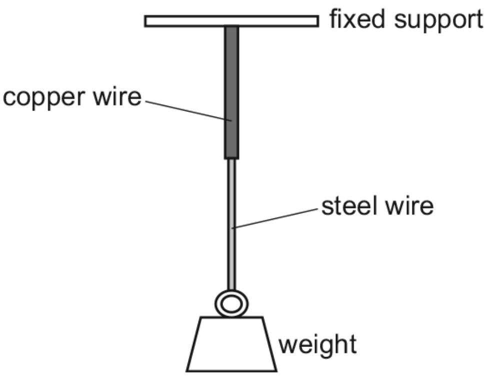
672. 9702_m16_qp_12 Q: 19

The Young modulus of steel is twice that of copper.

A 50 cm length of copper wire of diameter 2.0 mm is joined to a 50 cm length of steel wire of diameter 1.0 mm, making a combination wire of length 1.0 m, as shown.



The combination wire is stretched by a weight added to its end. Both the copper and the steel wires obey Hooke's law.

What is the ratio $\frac{\text{extension of steel wire}}{\text{extension of copper wire}}$?

A 4 **B** 2 **C** 1 **D** 0.5

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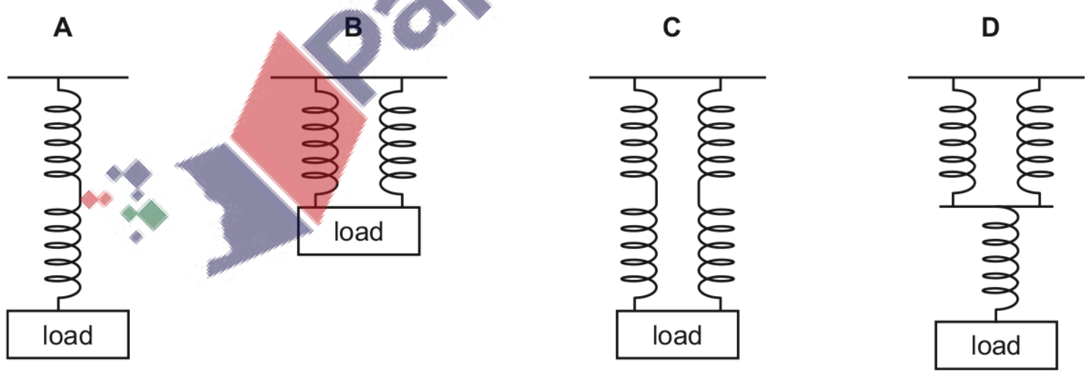
673. 9702_s16_qp_11 Q: 20

A number of identical springs are joined in four arrangements.

Which arrangement has the same spring constant as a single spring?



674. 9702_s16_qp_12 Q: 20

A spring balance consists of a spring of length 20.0 cm with a hook attached.

When a fish of mass 3.0 kg is suspended from the hook, the new length of the spring is 27.0 cm.

What is the spring constant of the spring?

A $4.2\,N\,m^{-1}$ **B** $43\,N\,m^{-1}$ **C** $110\,N\,m^{-1}$ **D** $420\,N\,m^{-1}$

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675. 9702_s16_qp_13 Q: 21

A metal wire of cross-sectional area $0.20\,mm^2$ hangs vertically from a fixed point. A load of 84 N is then attached to the lower end of the wire. The wire obeys Hooke's law and increases in length by 0.30%.

What is the Young modulus of the metal of the wire?

A 1.4×10^5 Pa

B 1.4×10^8 Pa

C 1.4×10^9 Pa

D 1.4×10^{11} Pa

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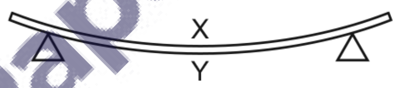
676. 9702_s16_qp_13 Q: 22

The diagram shows a beam supported on two pivots.



Which statement describes the state of the top surface X and of the bottom surface Y?

A Both X and Y are in compression.

B Both X and Y are in tension.

C X is in compression and Y is in tension.

D X is in tension and Y is in compression.

---

677. 9702_w16_qp_11 Q: 22

A copper wire hangs vertically from a fixed point. A load is attached to the lower end of the wire producing an extension *x*. The wire obeys Hooke's law.

Which single change gives an extension 2*x*?

A Halve the cross-sectional area of the wire.

B Halve the diameter of the wire.

C Halve the length of the wire.

D Halve the load on the wire.

---

678. 9702_w16_qp_12 Q: 22

Four solid steel rods, each of length 2.0 m and cross-sectional area 250 mm^2, equally support an object weighing 10 kN. The weight of the object causes the rods to contract by 0.10 mm.

What is the Young modulus of steel?

A $2.0 \times 10^8 \, N\,m^{-2}$

B $2.0 \times 10^{11} \, N\,m^{-2}$

C $8.0 \times 10^8 \, N\,m^{-2}$

D $8.0 \times 10^{11} \, N\,m^{-2}$

---

679. 9702_w16_qp_13 Q: 22

A copper wire hangs vertically from a fixed point. A load is attached to the lower end of the wire producing an extension *x*. The wire obeys Hooke's law.

Which single change gives an extension 2*x*?

A Halve the cross-sectional area of the wire.

B Halve the diameter of the wire.

C Halve the length of the wire.

D Halve the load on the wire.

---

680. 9702_s15_qp_12 Q: 21

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

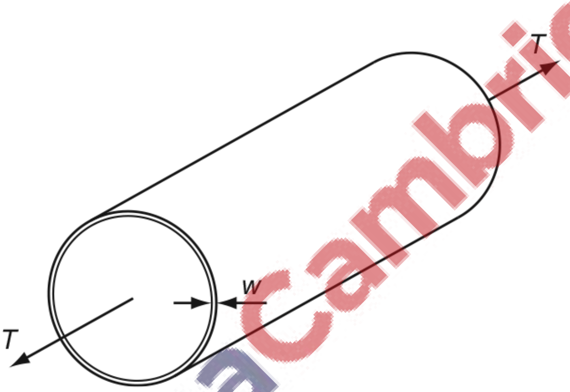
In which row can the measurement **not** be taken **directly** with the stated apparatus?

	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

---

681. 9702_s15_qp_12 Q: 23

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?

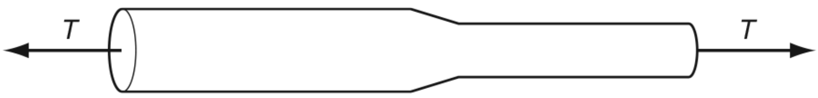
A $\frac{w}{2}$ **B** $\sqrt{2}\,w$ **C** $2w$ **D** $4w$

---

682. 9702_s15_qp_13 Q: 22

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.



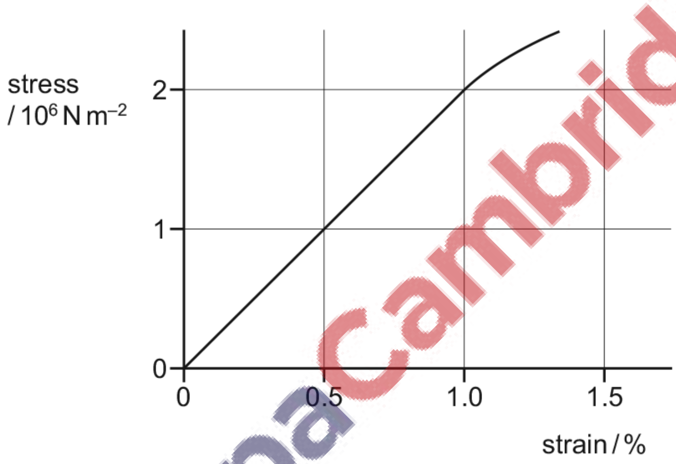
What is the value of $\frac{\text{stress in the wide portion}}{\text{stress in the narrow portion}}$?

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

---

683. 9702_s15_qp_13 Q: 24

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}

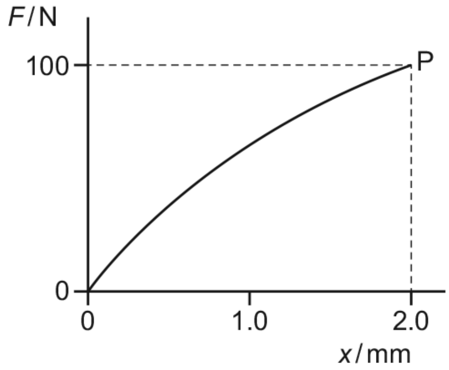
C 1×10^8 N m^{-2}

D 2×10^8 N m^{-2}

7.2 Elastic and plastic behaviour

684. 9702_m20_qp_12 Q: 20

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



What is the best estimate of the work done in stretching the wire to point P?

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

---

685. 9702_s20_qp_11 Q: 21

A tensile force is applied to an unstretched rubber band, causing it to stretch. The tensile force is then removed.

Which statement about the rubber band **must** be correct?

A If the rubber band stretches elastically and plastically, all the work done by the force is converted to thermal energy in the rubber.

B If the rubber band stretches elastically, it obeys Hooke's law.

C If the rubber band stretches elastically, the gradient of the force–extension graph represents the work done by the force.

D If the rubber band stretches plastically, the rubber band will be longer after the force is removed than it was before the force is applied.

---

686. 9702_s20_qp_12 Q: 20

Which statement describes what is meant by the plastic deformation of a material?

A It always obeys Hooke's law.

B It does not return to its original length when the extending force is removed.

C It never obeys Hooke's law.

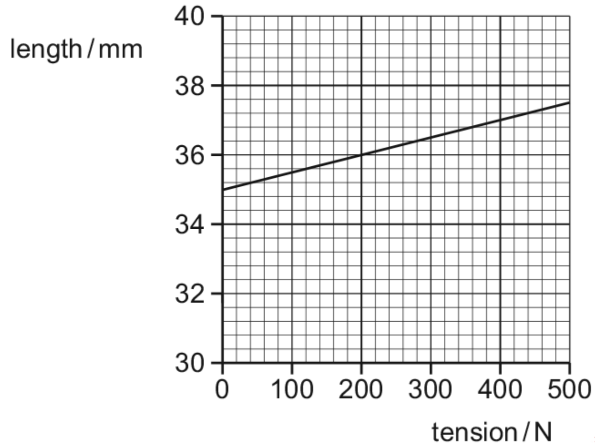
D It returns to its original length when the extending force is removed.

---

687. 9702_s20_qp_13 Q: 21

The Achilles tendon in a rabbit's leg is stretched when the rabbit jumps.

The graph shows the variation with tension of the length of the tendon.



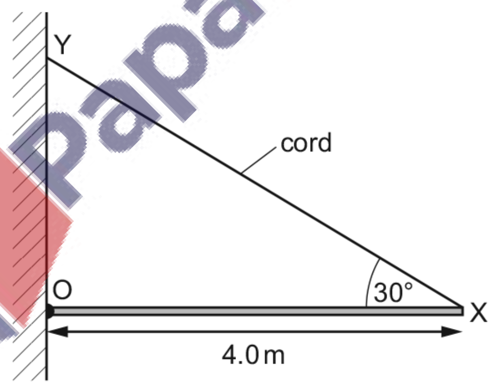
What is the strain energy in the tendon when the tension is 400 N?

A 0.40 J **B** 0.80 J **C** 2.4 J **D** 7.4 J

---

688. 9702_m19_qp_12 Q: 13

A uniform horizontal beam OX, 4.0 m long and weighing 100 N, is hinged at a wall at point O. It is supported by a cord XY which is attached to the wall at Y.



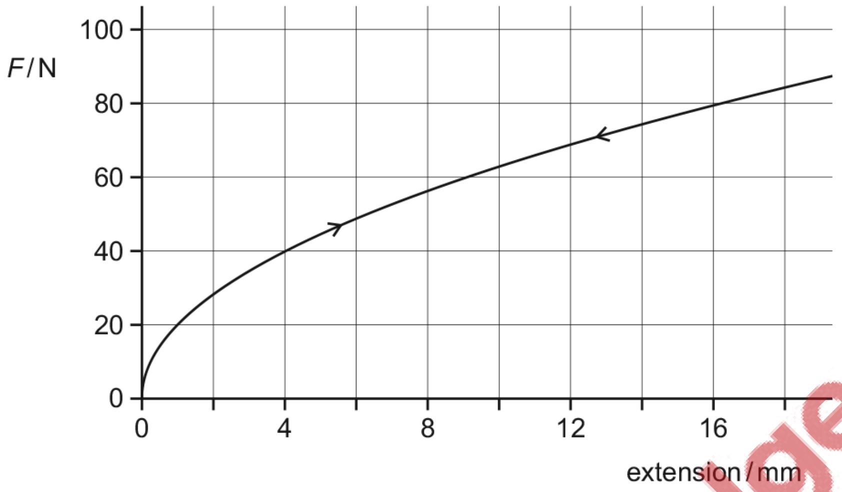
What is the tension in the cord?

A 50 N **B** 58 N **C** 86 N **D** 100 N

---

689. 9702_m19_qp_12 Q: 21

The graph shows the extension of a sample of a type of rubber as different loads *F* are applied and then gradually removed.



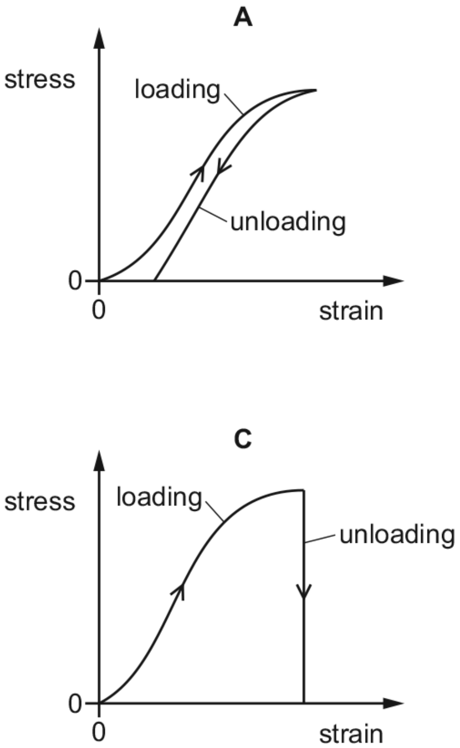
What is the best estimate of the strain energy in the rubber when a load of 80 N is applied?

A 0.40 J **B** 0.64 J **C** 0.88 J **D** 1.3 J

690. 9702_s19_qp_12 Q: 22

The stress-strain graphs for loading and unloading four different materials are shown.

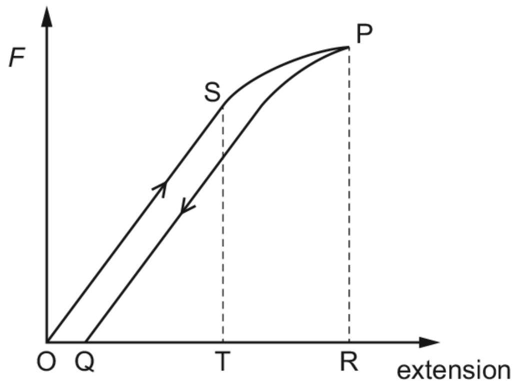
Which material exhibits purely elastic behaviour?



691. 9702_s19_qp_13 Q: 20

A wire is attached at one end to a fixed point. A tensile force F is applied to the other end of the wire, causing it to extend. This is shown on the graph by the line OSP.

The force F is then gradually reduced to zero and the wire contracts. This is shown on the graph by the line PQ.



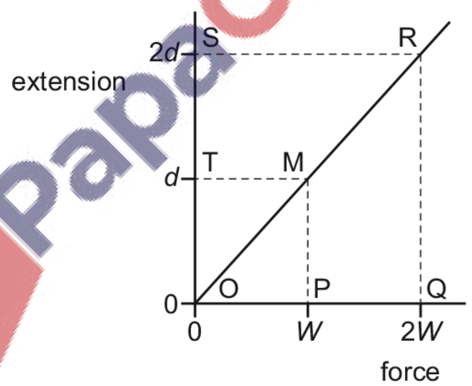
Which area on the graph represents the work done by the wire as it contracts?

A OSTO **B** OSPRO **C** QPRQ **D** OSPQO

---

692. 9702_w19_qp_11 Q: 20

A wire is extended by a force. The graph shows how the extension of the wire varies with the force applied.



Initially a force W gives an extension d. The force is then increased to $2W$. This increases the extension to $2d$.

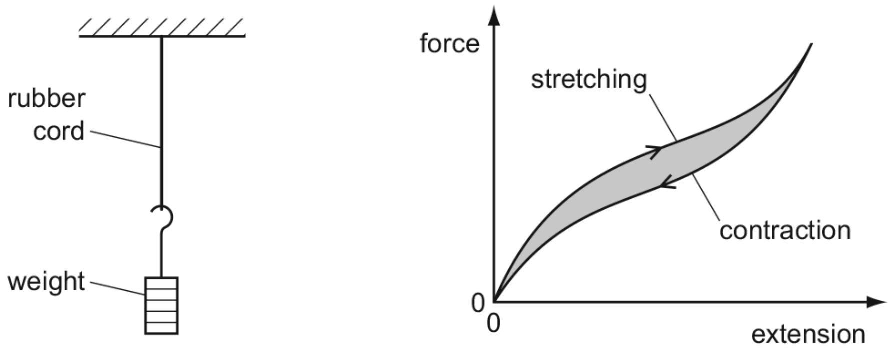
Which area of the graph represents the work done by the force when the force increases from W to $2W$?

A ORQ **B** OQRS **C** ORS **D** TMRS

---

693. 9702_w19_qp_12 Q: 19

A rubber cord hangs from a rigid support. A weight attached to its lower end is gradually increased from zero, and then gradually reduced to zero.



The force–extension curve for contraction is below the force–extension curve for stretching.

What does the shaded area between the curves represent?

A the elastic potential energy stored in the rubber cord

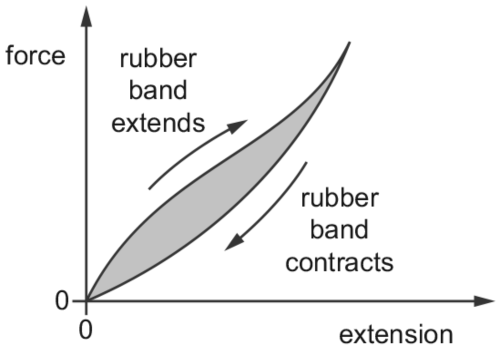
B the thermal energy dissipated in the rubber cord

C the work done on the rubber cord during stretching

D the work done by the rubber cord during contraction

694. 9702_w19_qp_13 Q: 20

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.

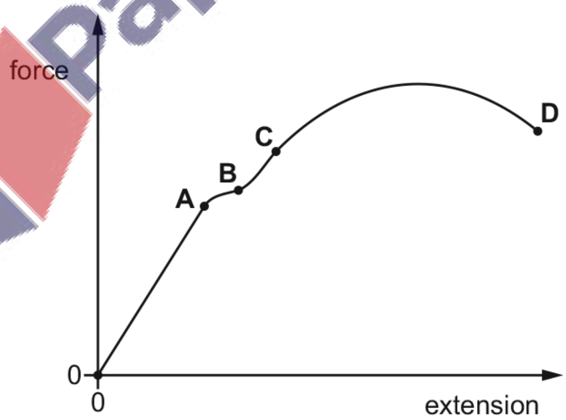
D The shaded area represents the work done in extending the rubber band.

---

695. 9702_m18_qp_12 Q: 19

The force-extension graph of a metal wire is shown.

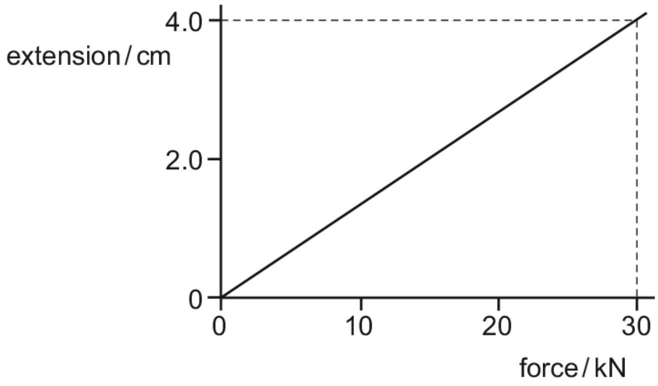
At which point on the graph does the metal wire stop obeying Hooke's law?



---

696. 9702_s18_qp_13 Q: 19

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

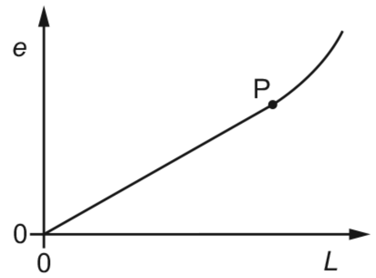


What is the strain energy in the spring when the extension is 4.0 cm?

A 60 J **B** 120 J **C** 600 J **D** 1200 J

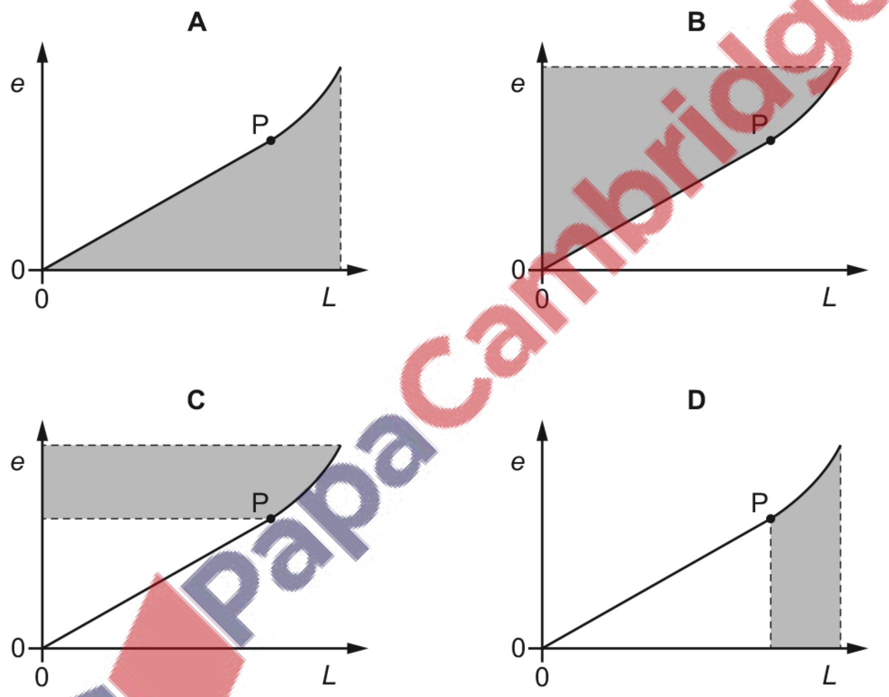
697. 9702_w18_qp_11 Q: 20

Forces are applied to the ends of a rod so that its length increases. The variation with load L of the extension e of the rod is shown.



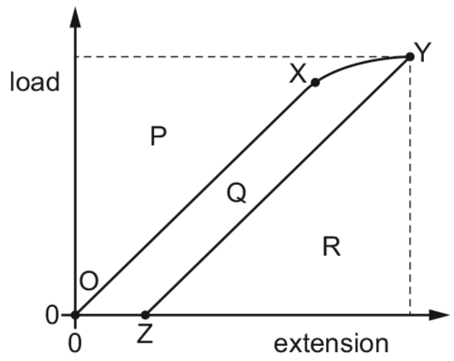
The point P is the elastic limit.

Which shaded area represents the work done during the plastic deformation of the rod?



698. 9702_w18_qp_12 Q: 21

A wire has both elastic and plastic properties. When it is slowly loaded, its extension varies with load as shown by line OXY. The removal of the load is represented by line YZ. This creates areas P, Q and R on the graph.



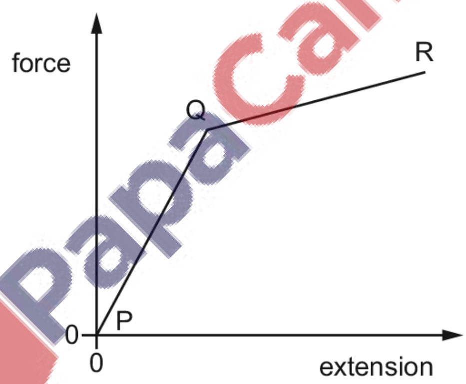
Which area represents the maximum elastic potential energy stored in the wire?

A P **B** Q **C** Q + R **D** R

---

699. 9702_w18_qp_13 Q: 20

A scientist is investigating the properties of a new material. She plots a force-extension graph for the material up to its breaking point.



Which statement must be correct?

A The area under the graph from P to R is the strain energy stored in the material.

B The area under the graph from P to R is the work done in stretching the material.

C The material stretches elastically from Q to R.

D The material stretches plastically from P to Q.

700. 9702_m17_qp_12 Q: 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.

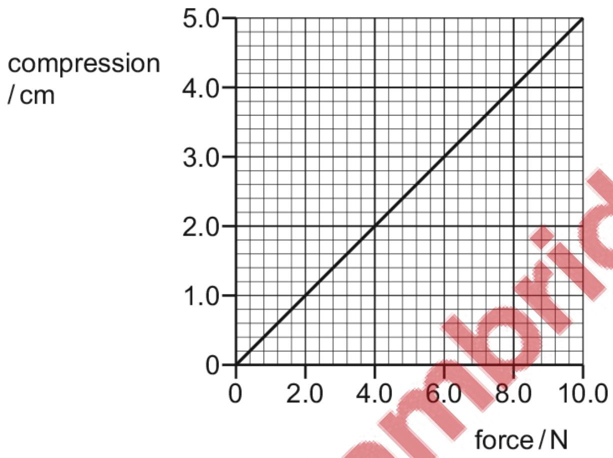
How much energy is stored in the compressed column?

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

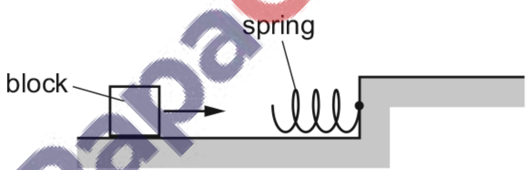
---

701. 9702_s17_qp_11 Q: 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?

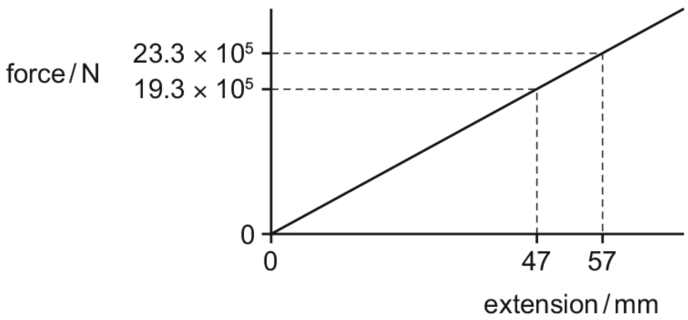
A 0.16 J **B** 0.32 J **C** 16 J **D** 32 J

---

702. 9702_s17_qp_12 Q: 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.

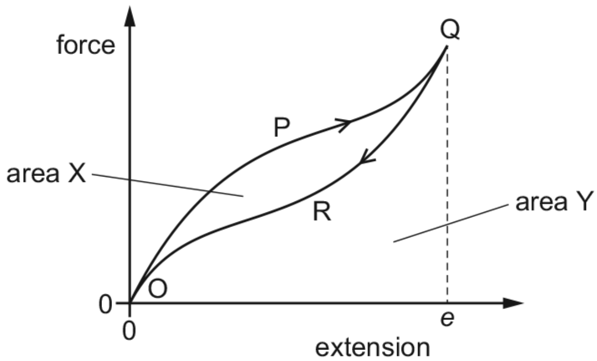


What is the **increase** in strain energy in the cable when the lorry is crossing the bridge?

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

703. 9702_s17_qp_12 Q: 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*.

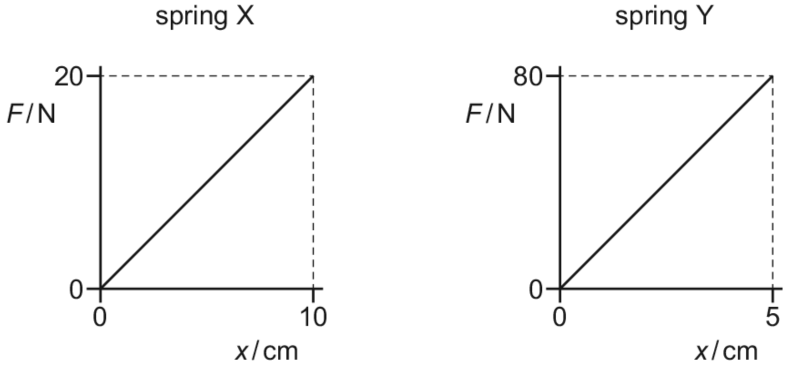
B (Area X + area Y) is the minimum energy required to stretch the band to extension *e*.

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.

704. 9702_s17_qp_13 Q: 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.

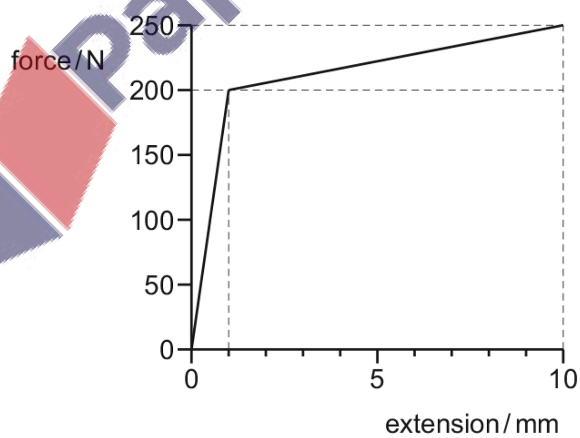
C When the same force is applied to each spring, the energy stored in Y is 4 times the energy stored in X.

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

---

705. 9702_s17_qp_13 Q: 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

---

706. 9702_w17_qp_11 Q: 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

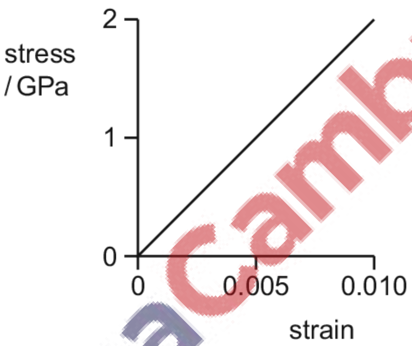
C neither elastic nor plastic deformation

D plastic deformation only

---

707. 9702_w17_qp_11 Q: 21

The stress-strain graph for a metal is shown.



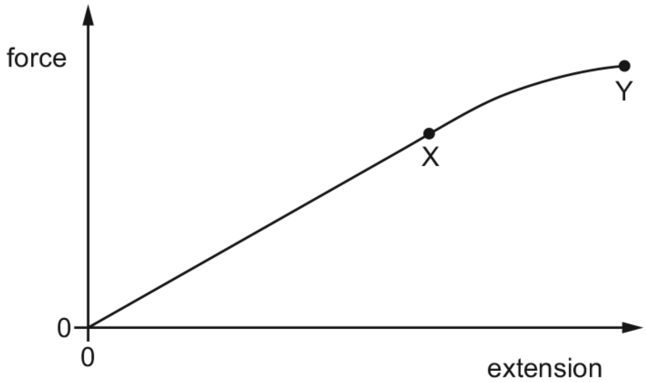
What is the strain energy per unit volume of a rod made from this metal when the strain of the rod is 0.010?

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

---

708. 9702_w17_qp_13 Q: 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

---

709. 9702_w17_qp_13 Q: 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

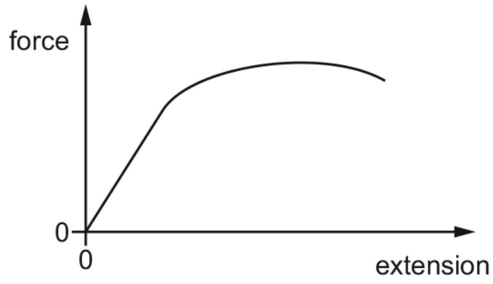
When the load is 4.0 kN, what is the strain energy stored in the wire?

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

---

710. 9702_m16_qp_12 Q: 18

A metal wire is stretched by a load. The force-extension graph is shown.



What is represented by the area under the whole graph?

A the change in gravitational potential energy of the wire

B the energy that would be released from the wire if the final load was removed

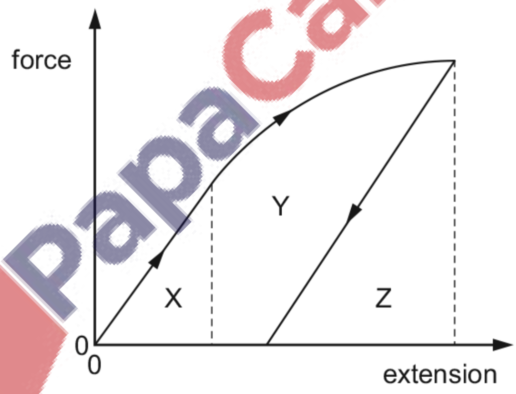
C the energy transferred into heat energy in the wire

D the work done in stretching the wire

---

711. 9702_s16_qp_11 Q: 21

A sample of material is stretched by a tensile force to a point beyond its elastic limit. The tensile force is then reduced to zero. The graph of force against extension is shown below.



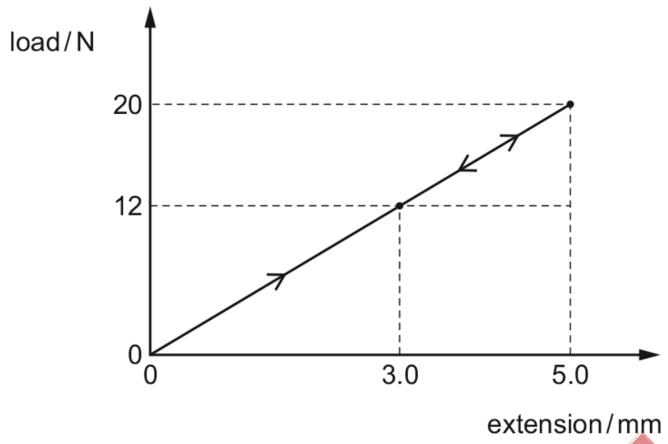
Which area represents the net work done on the sample?

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

---

712. 9702_s16_qp_12 Q: 21

A metal wire is attached at one end to a fixed point and a load is hung from the other end so that the wire hangs vertically. The load is increased from zero to 20 N. This causes the wire to extend elastically by 5.0 mm. The load is then reduced to 12 N and the extension decreases to 3.0 mm.



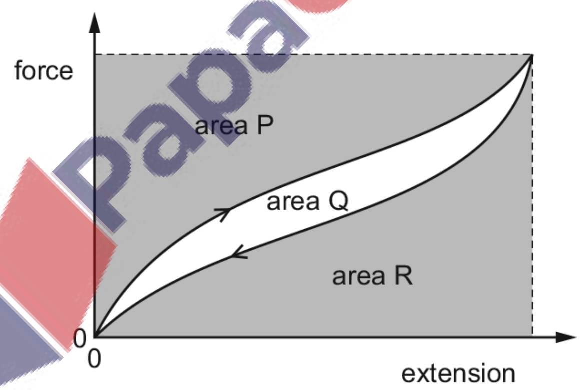
How much strain energy is released during the unloading process?

A 0.8×10^{-2} J **B** 1.8×10^{-2} J **C** 2.4×10^{-2} J **D** 3.2×10^{-2} J

---

713. 9702_s16_qp_13 Q: 20

The diagram shows the force-extension graph for a sample of material. The sample is stretched and then returns to its original length.



Which area represents the work done to stretch the sample?

A P + Q **B** P only **C** Q + R **D** R only

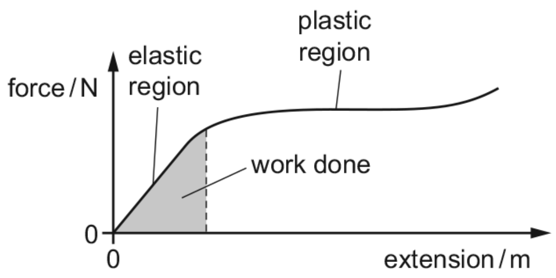
---

714. 9702_w16_qp_11 Q: 21

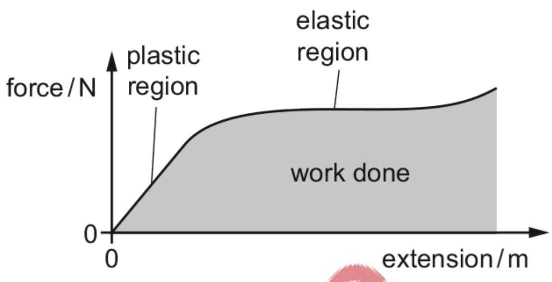
A metal wire is stretched to breaking point and the force-extension graph is plotted.

Which graph is correctly labelled with the elastic region, the plastic region and the area representing the work done to stretch the wire until it breaks?

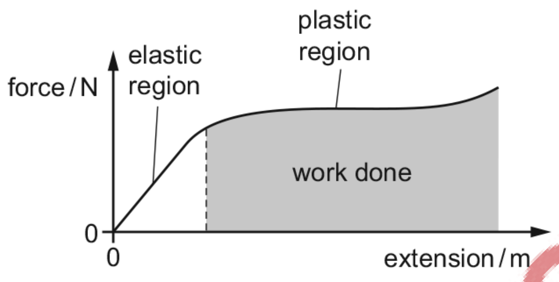
A



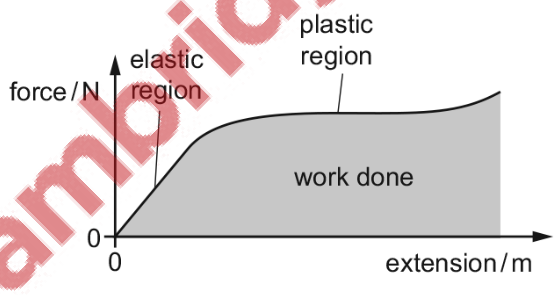
B



C

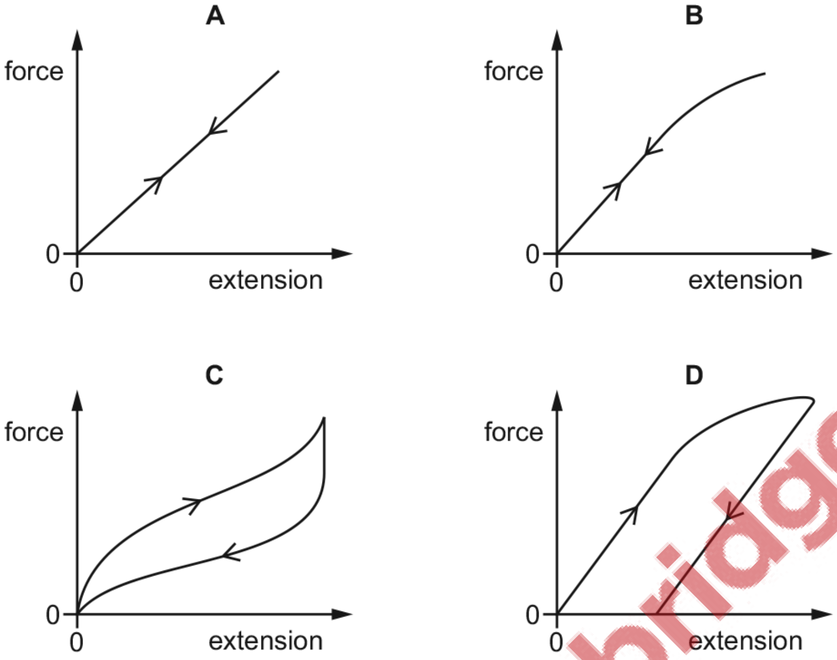


D



715. 9702_w16_qp_12 Q: 21

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

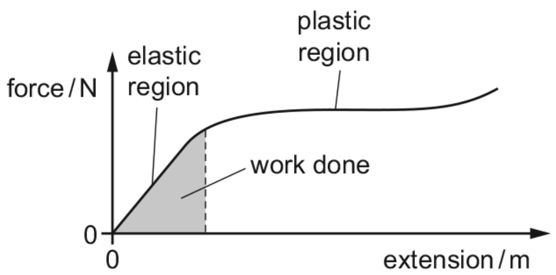


716. 9702_w16_qp_13 Q: 21

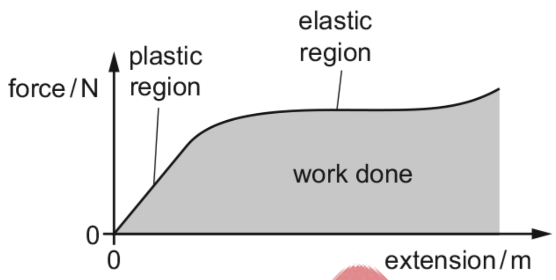
A metal wire is stretched to breaking point and the force-extension graph is plotted.

Which graph is correctly labelled with the elastic region, the plastic region and the area representing the work done to stretch the wire until it breaks?

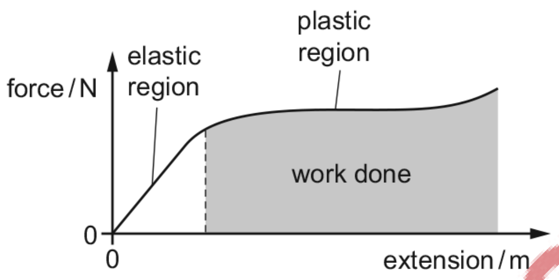
A



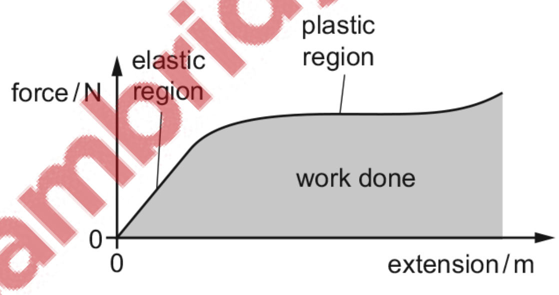
B



C

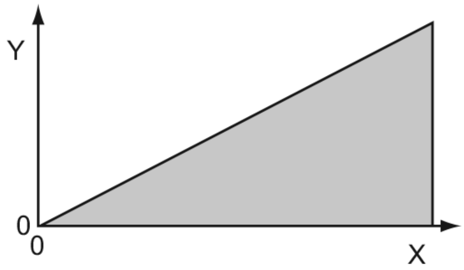


D



717. 9702_s15_qp_11 Q: 22

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



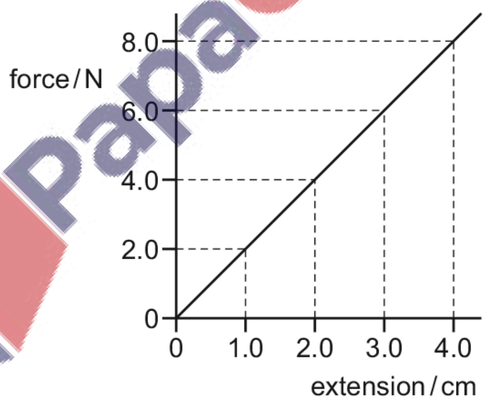
The shaded area represents the total strain energy stored in stretching the wire.

How should the axes be labelled?

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

718. 9702_s15_qp_11 Q: 23

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?

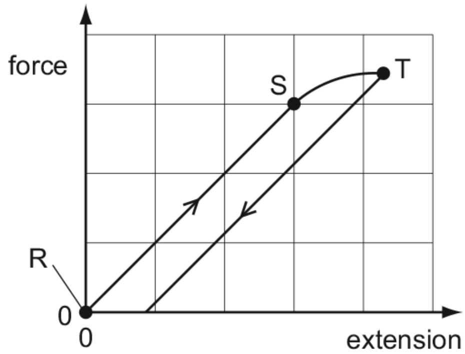
A 0.020 J **B** 0.030 J **C** 0.040 J **D** 0.050 J

719. 9702_s15_qp_12 Q: 22

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

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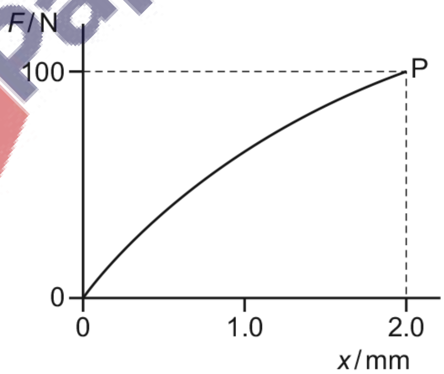
720. 9702_s15_qp_13 Q: 23

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
