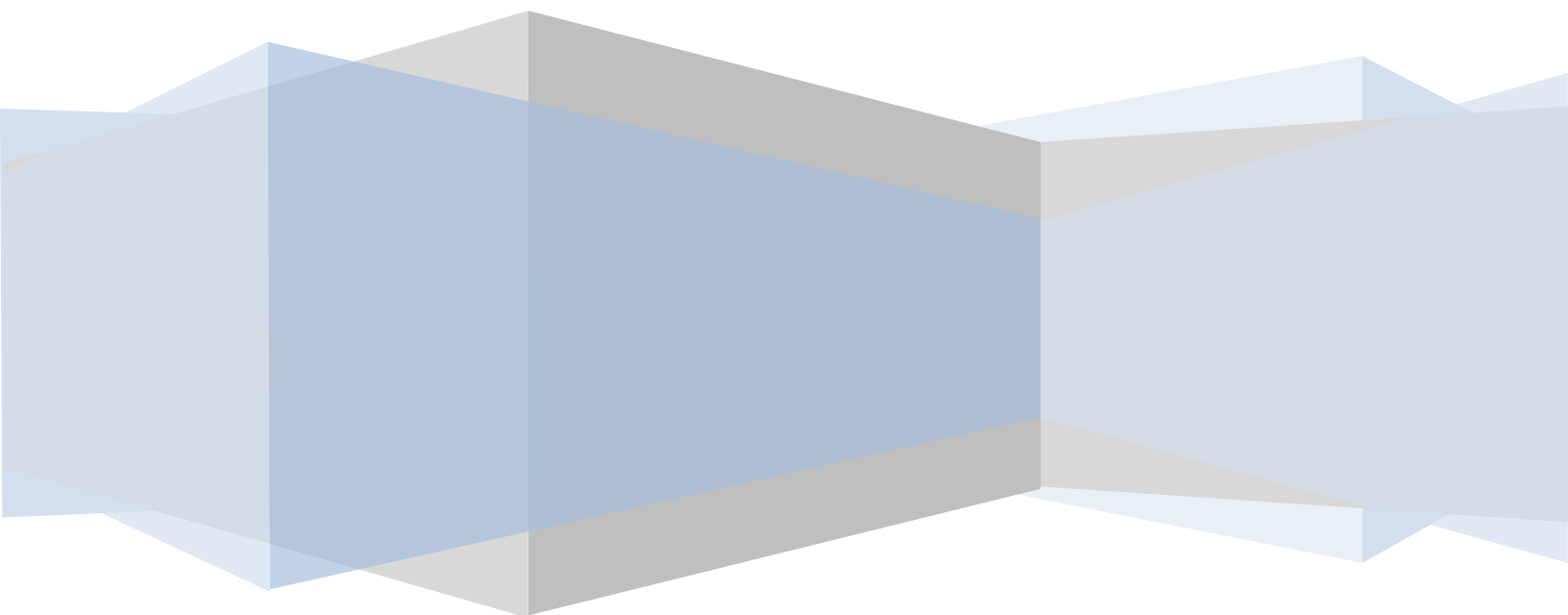


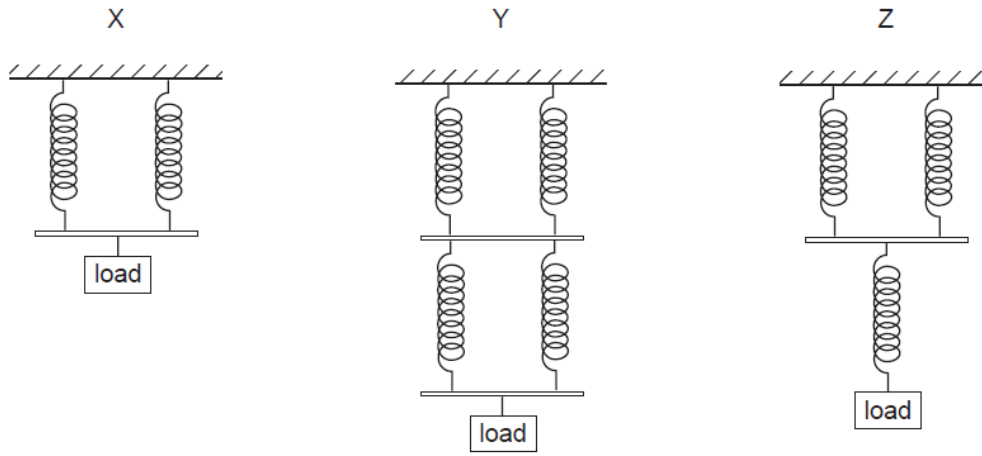
Properties of materials

Hook's Law

Problems by Topic



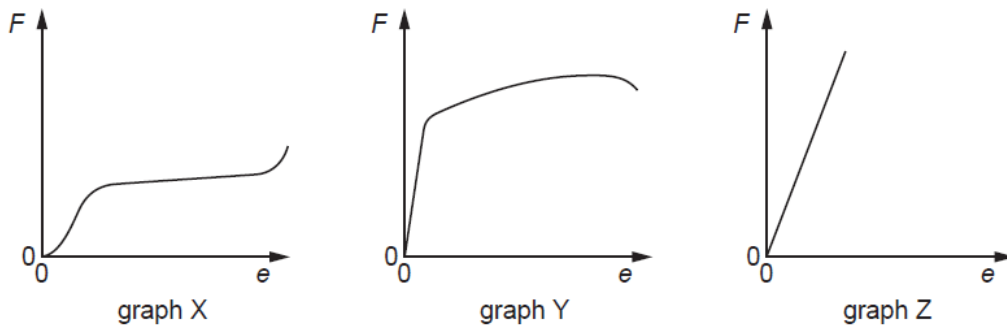
20 A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.



What is the order of increasing extension for these arrangements?

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

- 21 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 shown below.



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

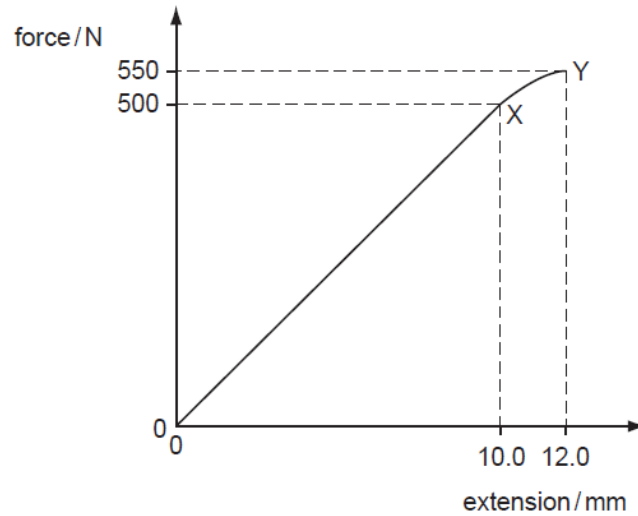
- 22 Two steel wires P and Q have lengths l and $2l$ respectively, and cross-sectional areas A and $\frac{A}{2}$ respectively. Both wires obey Hooke's law.

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** $\frac{4}{1}$

May/June 2005

- 22 The graph shows the behaviour of a sample of a metal when it is stretched until it starts to undergo plastic deformation.



What is the total work done in stretching the sample from zero extension to 12.0mm?
Simplify the calculation by treating the region XY as a straight line.

- A** 3.30J **B** 3.55J **C** 3.60J **D** 6.60J
- 21 In describing the behaviour of a spring, the spring constant is used.
Different loads are used to extend the spring by different amounts.
To find the spring constant, which quantities are required?
- A** the elastic limit and the loads
 - B** the elastic limit, extensions and the length of the spring
 - C** the loads and the extensions of the spring
 - D** the loads and the length of the spring

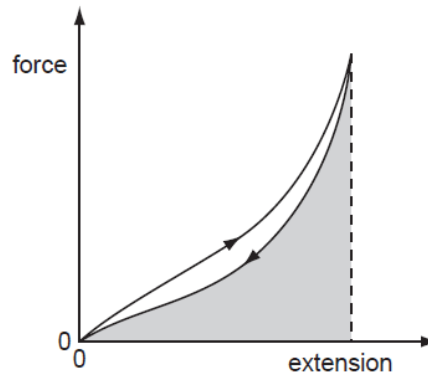
May/June 2006

17 A piece of copper is drawn into a continuous wire.

What behaviour is the copper exhibiting?

- A brittle only
- B elastic only
- C plastic only
- D both brittle and elastic

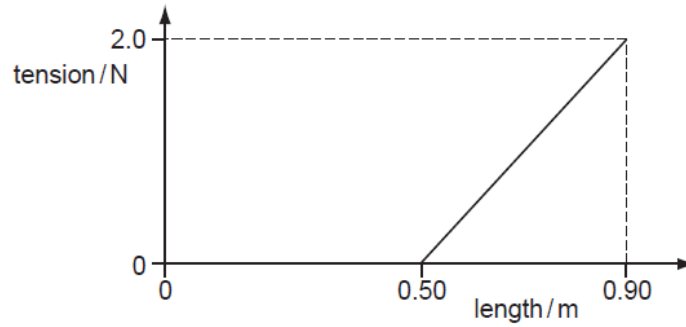
18 The force-extension graph of a particular sample of rubber as a load is applied and then removed is shown.



What does the shaded area represent?

- A the energy transformed into heat during the complete cycle
- B the recoverable elastic potential energy stored at maximum extension
- C the work done on the sample while loading
- D the work done on the sample while unloading

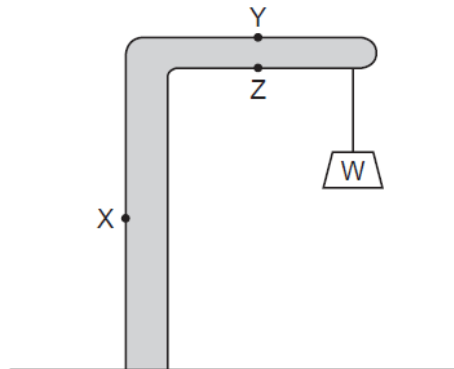
- 19 A spring of unextended length 0.50 m is stretched by a force of 2.0 N to a new length of 0.90 m. The variation of its length with tension is as shown.



How much strain energy is stored in the spring?

- A 0.40J B 0.80J C 0.90J D 1.8J

- 20 A simple crane consists of a rigid vertical pillar supporting a horizontal beam.



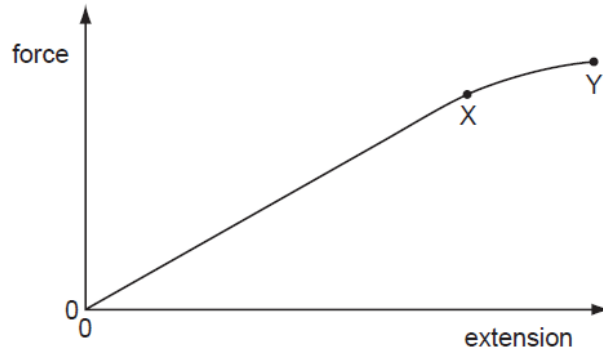
A weight W is lifted by a rope at the end of the beam.

What are the forces at points X , Y and Z due to the weight W ?

	force at X	force at Y	force at Z
A	tension	compression	tension
B	tension	tension	compression
C	compression	tension	compression
D	compression	compression	compression

May/June 2007

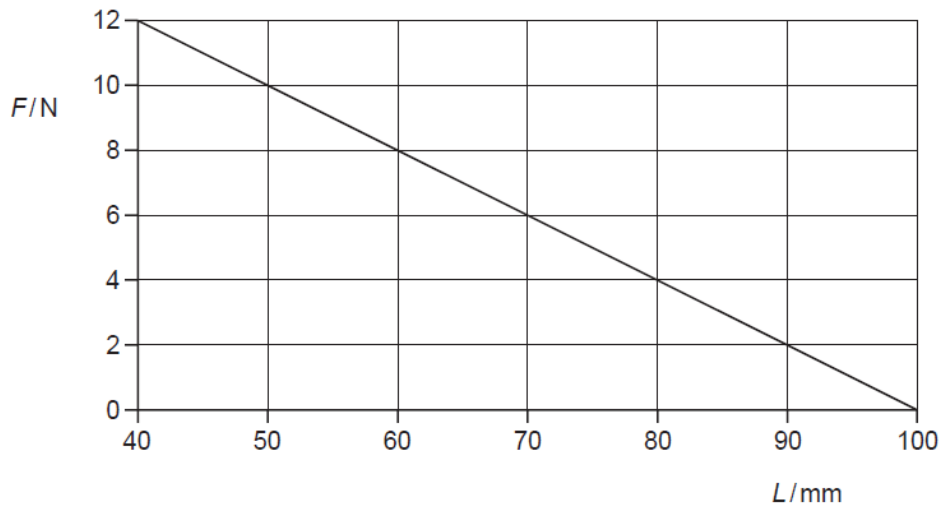
- 22 A sample of metal is subjected to a force which increases to a maximum value and then decreases back to zero. A force-extension graph for the sample is shown.



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
- 23 A spring of original length 100mm 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 70mm?

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

- 24 The Young modulus of steel is determined using a length of steel wire and is found to have the value E .

Another experiment is carried out using a wire of the same steel, but of twice the length and half the 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 $2E$

May/June 2008

- 19 Four materials are formed into rods of the same dimensions.

At room temperature, which can sustain the largest plastic deformation?

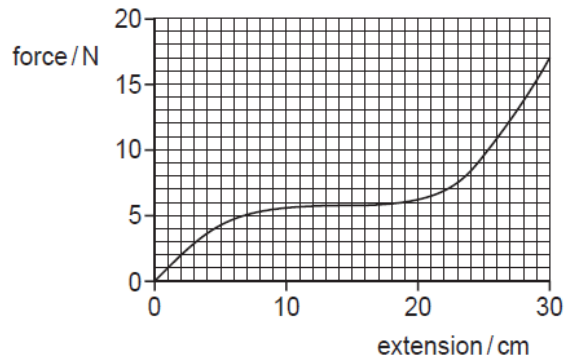
- A the ductile material aluminium
B the brittle material carbon
C the brittle material glass
D the ductile material steel

- 20 Two steel wires P and Q have lengths l and $2l$ respectively, and cross-sectional areas A and $\frac{A}{2}$ 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 $\frac{4}{1}$

- 21 A rubber band is stretched by hanging weights on it and the force-extension graph is plotted from the results.

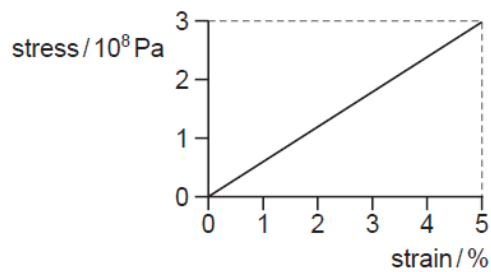


What is the best estimate of the strain energy stored in the rubber band when it is extended 30 cm?

- A 2.0J B 2.6J C 5.1J D 200J

May/June 2009

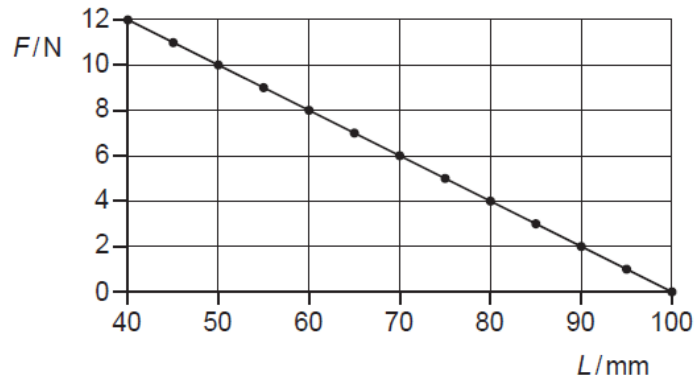
- 19 In stress-strain experiments on metal wires, the stress axis is often marked in units of 10^8 Pa and the strain axis is marked as a percentage. This is shown for a particular wire in the diagram.



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

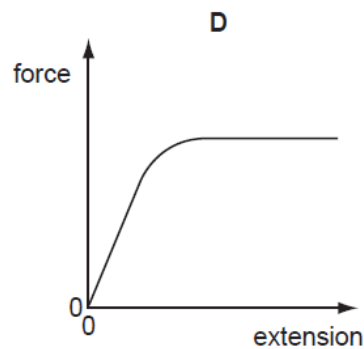
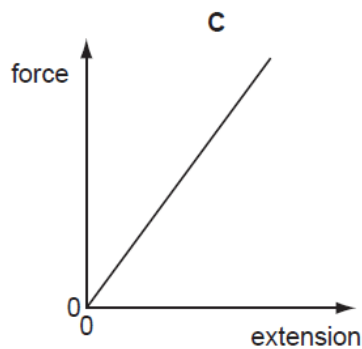
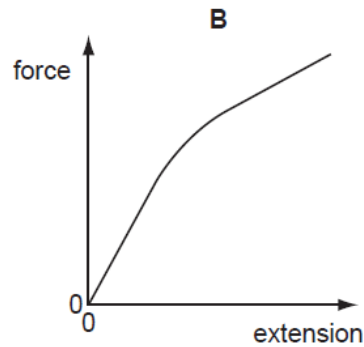
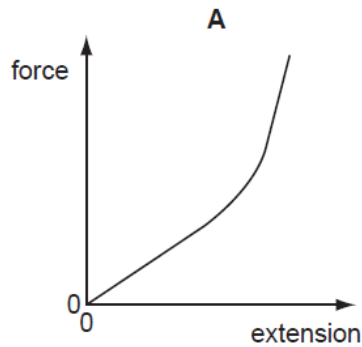
- A 6.0×10^7 Pa B 7.5×10^8 Pa C 1.5×10^9 Pa D 6.0×10^9 Pa

- 20 A spring is compressed by a force. The graph shows the compressing force F plotted against the length L of the spring.



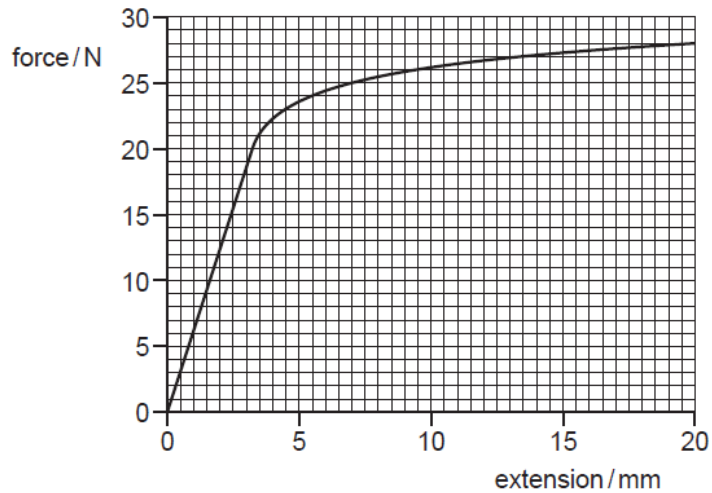
What is the spring constant of this spring?

- A 0.2 Nm^{-1} B 5 Nm^{-1} C 100 Nm^{-1} D 200 Nm^{-1}
- 21 Which graph represents the force-extension relationship of a rubber band that is stretched almost to its breaking point?



May/June 2011 (11)

24 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

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

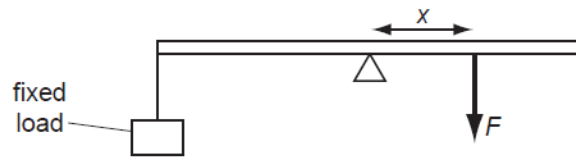
A second wire of the same material, with half the diameter and a quarter of the original length of the first wire, is stretched by the same load.

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

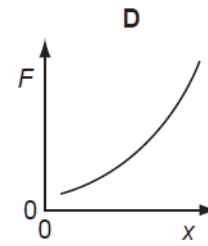
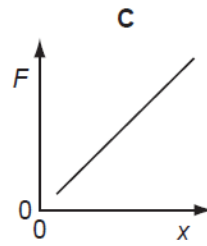
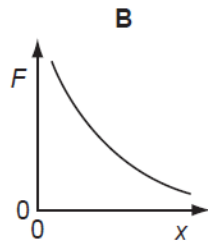
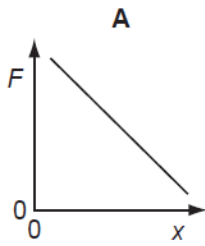
- A 1 mm B 4 mm C 8 mm D 16 mm

May/June 2012 (12)

- 14 A horizontal bar is supported on a pivot at its centre of gravity. A fixed load is attached to one end of the bar. To keep the bar in equilibrium, a force F is applied at a distance x from the pivot.

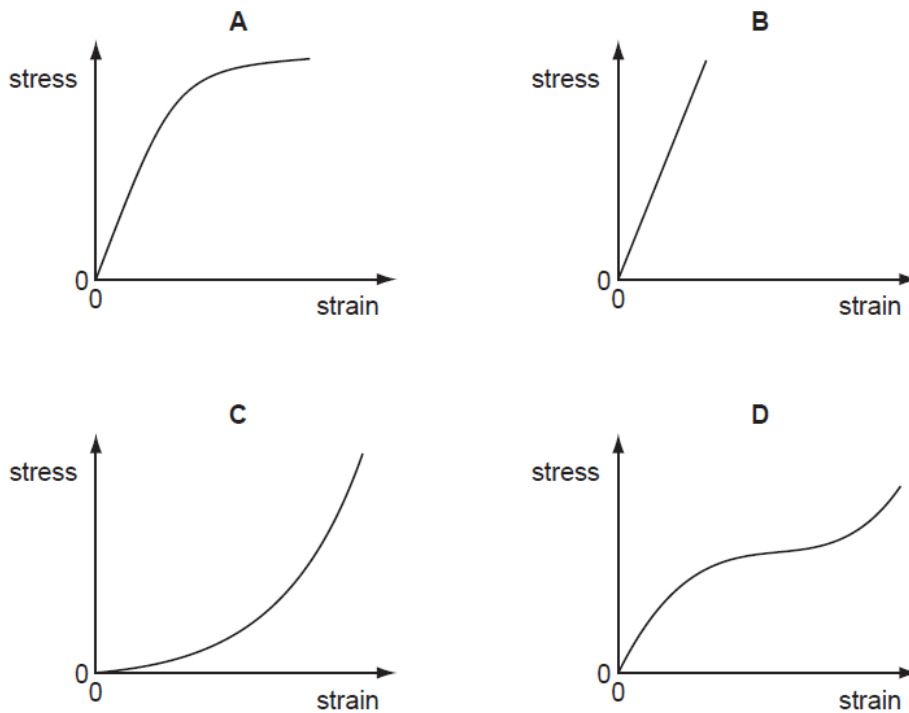


How does F vary with x ?



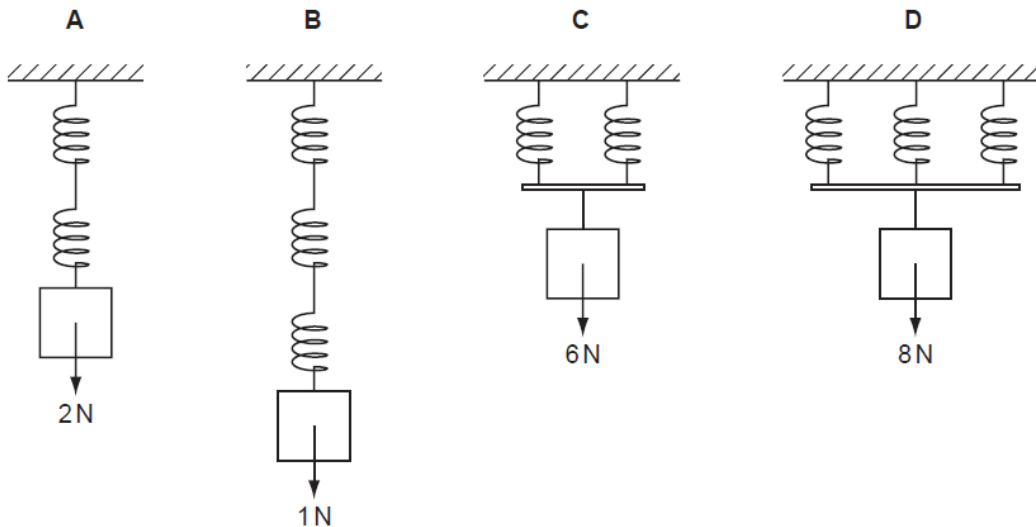
22 The stress-strain graphs for four different materials are shown below.

Which diagram shows the stress-strain graph for a ductile metal?

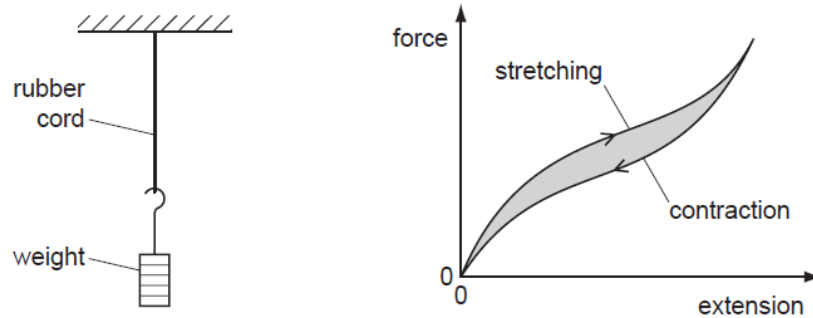


23 A number of identical springs, each having the same spring constant, are joined in four arrangements. A different load is applied to each arrangement.

Which arrangement has the largest extension?



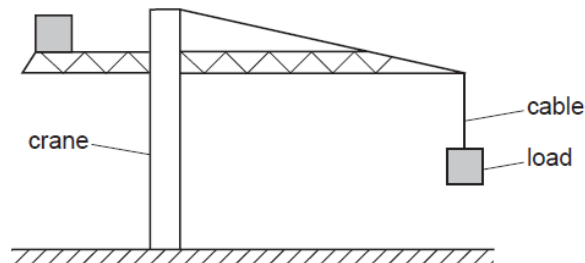
- 22 A rubber cord hangs from a rigid support. A weight attached to its lower end is gradually increased from zero, and then gradually reduced to zero.



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 amount of elastic energy stored in the rubber
 - B the amount of thermal energy dissipated in the rubber
 - C the work done on the rubber cord during stretching
 - D the work done by the rubber cord during contraction
- 23 The diagram shows a large crane on a construction site lifting a cube-shaped load.



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

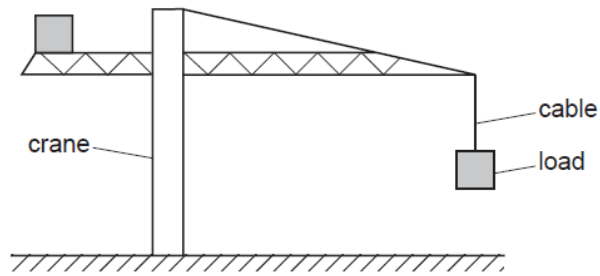
The material used for each part of the model is the same as that in the full-size crane, cable and load. The model is one tenth full-size in all linear dimensions.

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

- A 10^0
- B 10^1
- C 10^2
- D 10^3

May /June 2013 (12)

- 19 The diagram shows a large crane on a construction site lifting a cube-shaped load.



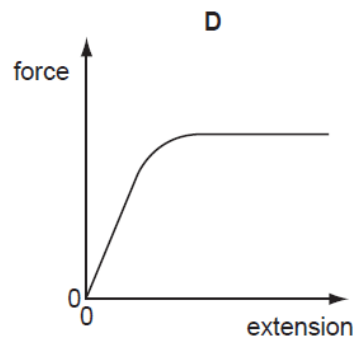
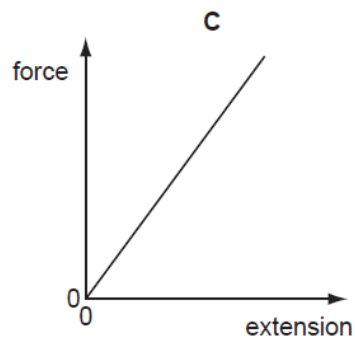
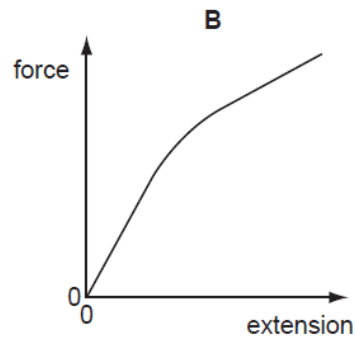
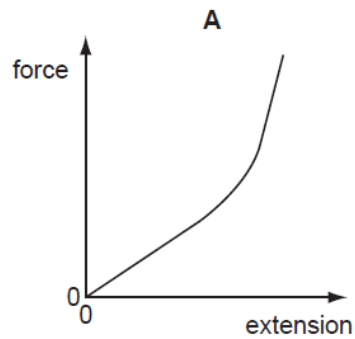
A model is made of the crane, its load and the cable supporting the load.

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 $\frac{\text{extension of the cable on the full-size crane}}{\text{extension of the cable on the model crane}}$?

- A 10^0 B 10^1 C 10^2 D 10^3

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



- 21 A spring is stretched over a range within which elastic deformation occurs. Its spring constant is 3.0N 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

May/June 2013 (13)