Unit 6: Deformation of solids:

Subunit 6.1: Stress and strain:

Topical Question No: 1

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

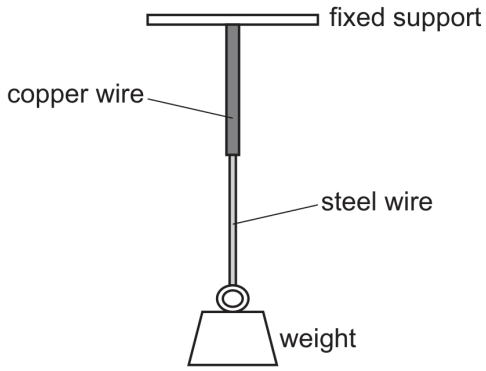
C the energy transferred into heat energy in the wire

D the work done in stretching the wire

Topical Question No: 2

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

Topical Question No: 3

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

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

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

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

Topical Question No: 4

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.

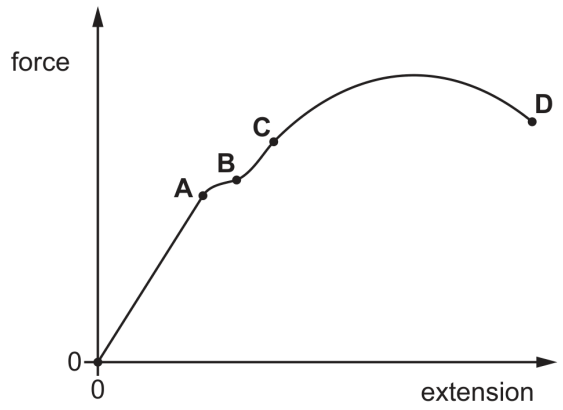
How much energy is stored in the compressed column?

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

Topical Question No: 5

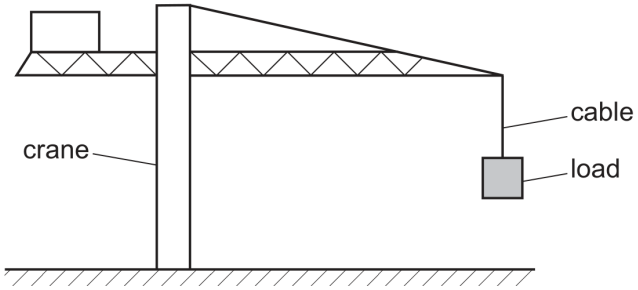
19 The force-extension graph of a metal wire is shown.

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



Topical Question No: 6

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

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

Topical Question No: 7

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

Topical Question No: 8

19 Which expression is equal to the stress on a wire?

A $\frac{\text{extension}}{\text{original length}}$

B $\frac{\text{force}}{\text{cross-sectional area}}$

C $\frac{\text{force}}{\text{extension}}$

D $\frac{\text{Young modulus}}{\text{original length}}$

Topical Question No: 9

18 A spring has an unstretched length of 4.50 cm. The spring is fixed at one end and a force of 35.0 N is applied to the other end so that the spring extends.

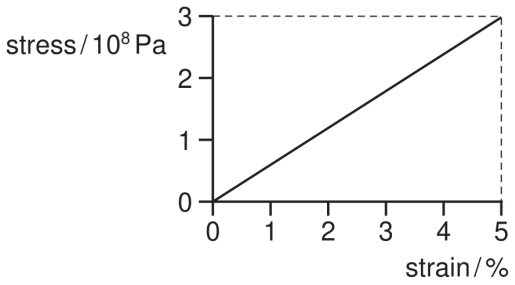
The spring obeys Hooke's law and has a spring constant of 420 $N\,m^{-1}$.

What is the strain of the extended spring?

A 0.019 **B** 0.083 **C** 1.85 **D** 2.67

Topical Question No: 10

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.



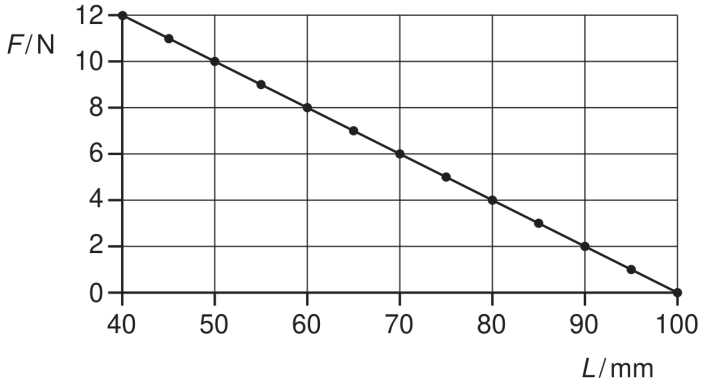
What is the value of the Young modulus for the material of the wire?

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

Space for working

Topical Question No: 11

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



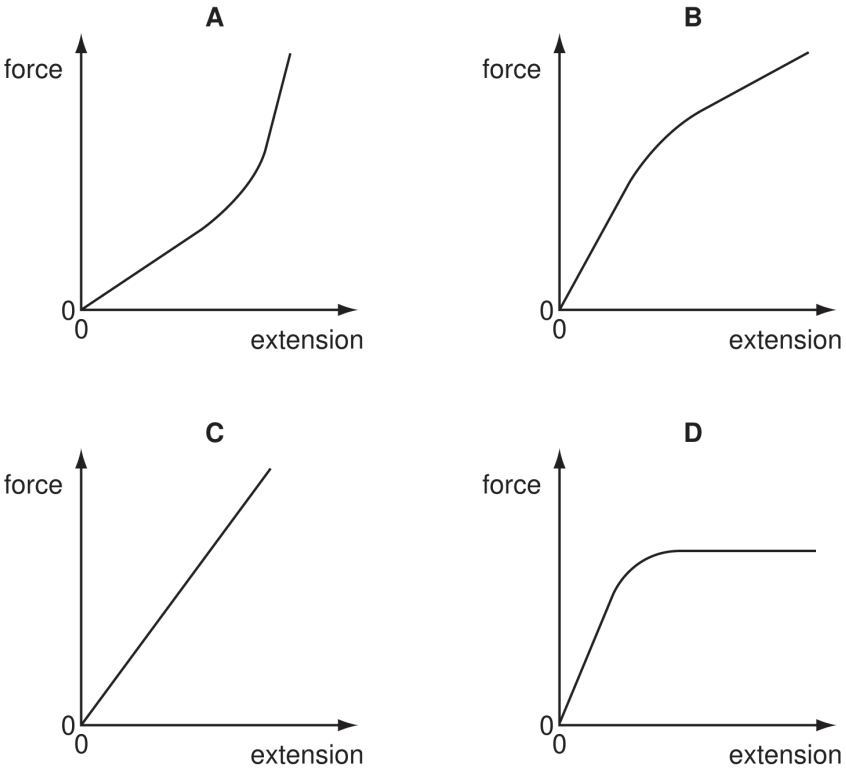
What is the spring constant of this spring?

A 0.2 $N\,m^{-1}$ **B** 5 $N\,m^{-1}$ **C** 100 $N\,m^{-1}$ **D** 200 $N\,m^{-1}$

Space for working

Topical Question No: 12

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



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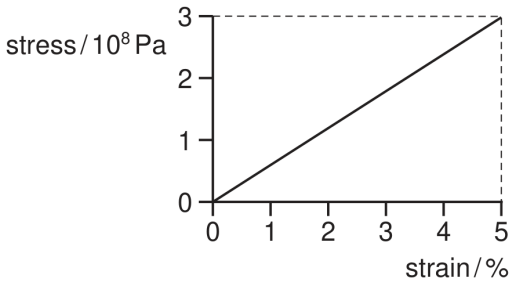
Topical Question No: 13

21 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

Topical Question No: 14

1 Stress has the same SI base units as

A $\frac{\text{force}}{\text{mass}}$.

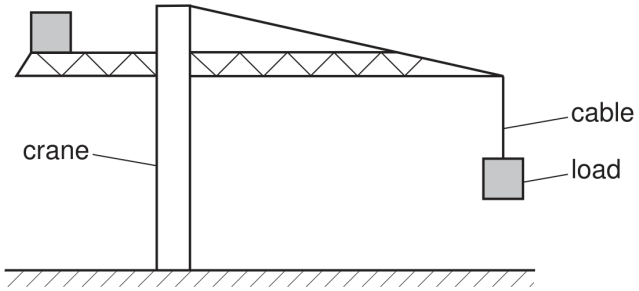
B $\frac{\text{force}}{\text{length}}$.

C $\frac{\text{force}}{\text{area}}$.

D energy.

Topical Question No: 15

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.

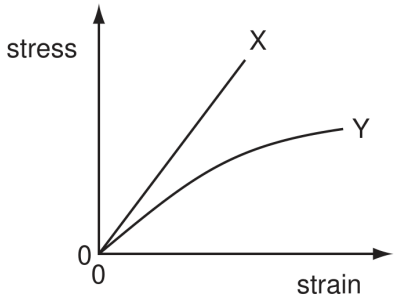
What is the ratio $\frac{\text{extension of the cable on the full-size crane}}{\text{extension of the cable on the model crane}}$?

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

Space for working

Topical Question No: 16

24 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.

Topical Question No: 17

23 What is meant by the ultimate tensile stress of a material?

A the maximum force that can be applied to a bar of the material before it bends

B the maximum inter-atomic force before the atomic bonds of the material break

C the maximum stretching force per unit cross-sectional area before the material breaks

D the maximum tensile force in a wire of the material before it breaks

Topical Question No: 18

1 What is the order of magnitude of the Young modulus for a metal such as copper?

A 10^{-11} Pa **B** 10^{-4} Pa **C** 10^{4} Pa **D** 10^{11} Pa

Topical Question No: 19

20 A known tensile force acts on a metal wire. The wire does not exceed its limit of proportionality.

Which two measurements enable the strain of the wire to be calculated?

A the unstretched length of the wire and the cross-sectional area of the wire

B the unstretched length of the wire and the extension of the wire

C the Young modulus of the metal and the extension of the wire

D the Young modulus of the metal and the unstretched length of the wire

Answer Key

1. N/A
2. N/A
3. N/A
4. N/A
5. N/A
6. N/A
7. N/A
8. B
9. C
10. N/A
11. N/A
12. N/A
13. N/A
14. N/A
15. N/A
16. N/A
17. N/A
18. N/A
19. B