# Deformation of Solids

## Question Paper

| | |
|---|---|
| Level | Pre U |
| Subject | Physics |
| Exam Board | Cambridge International Examinations |
| Topic | Deformation of Solids |
| Booklet | Question Paper |

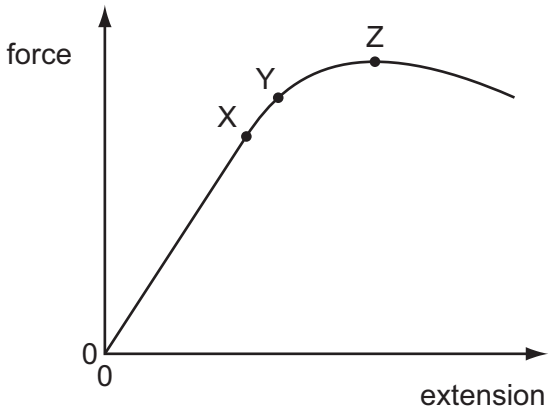
**Time Allowed:** **24 minutes**

**Score:** **/20**

**Percentage:** **/100**

**Grade Boundaries:**

1 A force-extension graph for a sample of metal wire is shown.




Which row identifies points X, Y and Z?

| | point X | point Y | point Z |
|---|---|---|---|
| **A** | elastic limit | limit of proportionality | breaking stress |
| **B** | elastic limit | limit of proportionality | yield point |
| **C** | limit of proportionality | elastic limit | breaking stress |
| **D** | limit of proportionality | elastic limit | yield point |

2 A guitarist fits two new strings of the same length and the same material to his guitar. They are tightened to the same tension. Neither string is stretched beyond its limit of proportionality.

One string has four times the radius of the other.

What is the ratio $\frac{\text{stress in the thicker string}}{\text{stress in the thinner string}}$?

**A** 0.0625 **B** 0.25 **C** 4 **D** 16

**Space for working**

3 A force of 20.0 N stretches a spring by 5.0 cm. The spring obeys Hooke's law.

Which row gives the spring constant and the work done in stretching the spring?

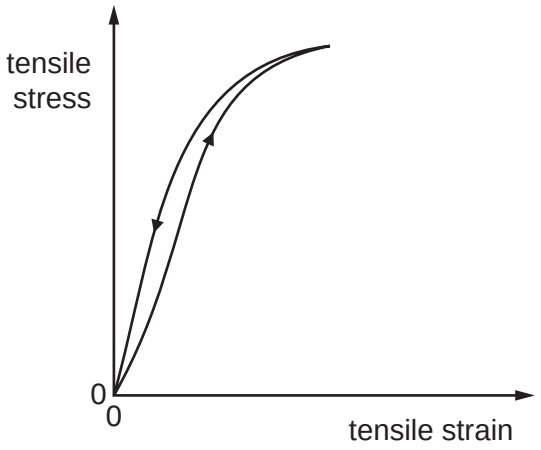
| | spring constant / N m$^{-1}$ | work done / J |
|---|---|---|
| **A** | 4 | 0.5 |
| **B** | 400 | 0.5 |
| **C** | 4 | 50 |
| **D** | 400 | 50 |

**Space for working**

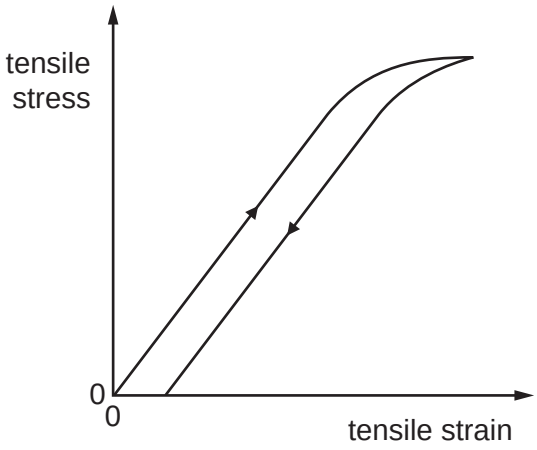
4 The graphs show stress-strain characteristics for four different materials.

Which characteristic is most likely to be that of a sample of copper wire?

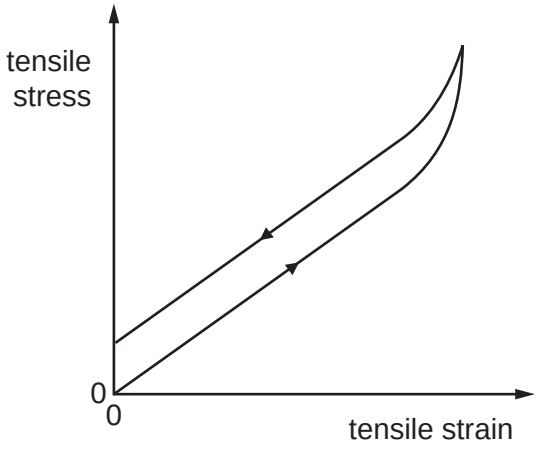
**A**



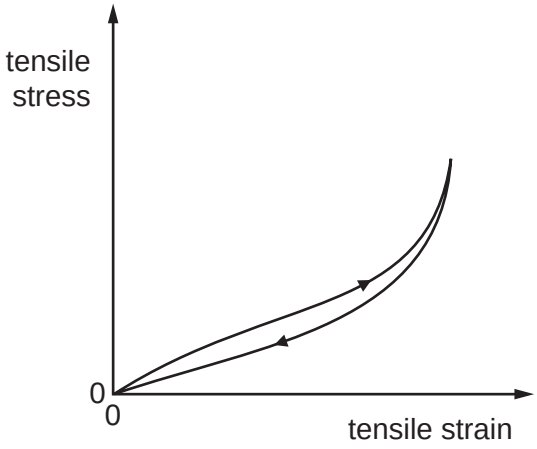

**B**




**C**




**D**




**Space for working**

5 Two cylindrical wires, X and Y, are made of the same material.

Wire X is twice as long as wire Y, but it has half the diameter. When the same load is applied to each wire, the stress in wire X is 2.0 GPa and its extension is 4.0 mm.

Which row is correct for wire Y?

| | stress in wire Y / GPa | extension of wire Y / mm |
|---|---|---|
| **A** | 0.5 | 0.5 |
| **B** | 0.5 | 1.0 |
| **C** | 1.0 | 0.5 |
| **D** | 1.0 | 1.0 |

6 A stone is attached to one end of a piece of elastic thread. The other end of the thread is fixed.

The stone is dropped.

When is the elastic strain energy in the thread greatest?

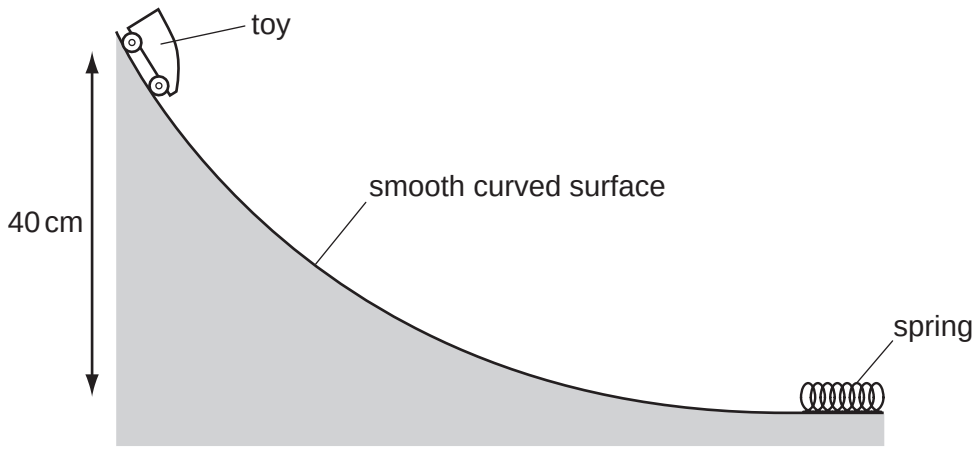
**A** as the stone is dropped

**B** when the thread first becomes taut

**C** at the lowest point of the stone's fall

**D** when the stone finally comes to rest in equilibrium hanging from the thread

7 A toy is released from rest on a smooth curved surface.




The toy, of mass 0.22 kg, runs down the curved surface through a vertical distance of 0.40 m. It strikes a spring of force constant 350 N m$^{-1}$ and compresses it a distance *x* before coming to rest.

Assuming no energy losses, what is the value of *x*?

**A** $4.9 \times 10^{-3}$ m **B** $7.2 \times 10^{-3}$ m **C** $2.2 \times 10^{-2}$ m **D** $7.0 \times 10^{-2}$ m

8 Which force will produce an extension of 1.0 mm in a steel wire of length 4.0 m and diameter 0.50 mm?
(Young modulus of steel = 200 GPa)

**A** 9.8 N **B** 39 N **C** 9800 N **D** 3900 N

9 Wire X and wire Y are both made of copper. Wire X has twice the length of wire Y. The wires are hung vertically and stretched by hanging identical weights from the bottom of each.

The extension of wire Y is twice that of wire X.

What is the ratio: $\frac{\text{diameter of wire X}}{\text{diameter of wire Y}}$ ?

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

**Space for working**

10 A tensile force causes a wire of length $L$, Young modulus $E$ and cross-sectional area $A$ to be stretched by a length $x$.

Which expression gives the elastic energy stored in the wire?

**A** $\frac{EAL}{2}$ **B** $\frac{ExA}{L}$ **C** $\frac{Ex^2A}{L}$ **D** $\frac{Ex^2A}{2L}$

11 What is the best estimate of the stress in your neck when it supports your head in a vertical position?

**A** 0.3 Pa **B** 30 Pa **C** 3000 Pa **D** 300 000 Pa

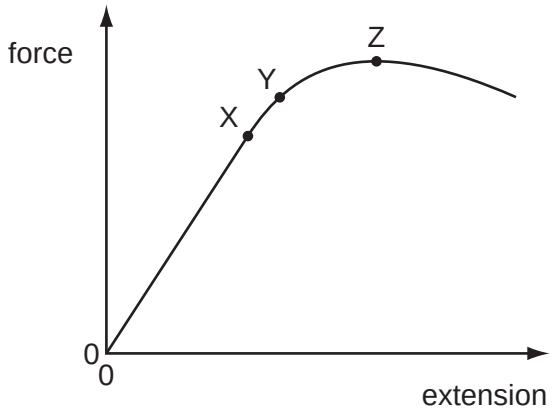
12 Two wires, G and H, are made of the same metal. They are stretched by the same force without exceeding the limit of proportionality. G has twice the length and half the diameter of H.

What is the ratio: $\frac{\text{extension of G}}{\text{extension of H}}$ ?

**A** $\frac{1}{8}$ **B** $\frac{1}{4}$ **C** 4 **D** 8

**Space for working**

13 A force-extension graph for a sample of metal wire is shown.




Which row correctly identifies points X, Y and Z?

| | point X | point Y | point Z |
|---|---|---|---|
| **A** | elastic limit | proportional limit | breaking stress |
| **B** | elastic limit | proportional limit | yield point |
| **C** | proportional limit | elastic limit | breaking stress |
| **D** | proportional limit | elastic limit | yield point |

14 A guitarist fits two new strings of the same length and material to his guitar. They are tightened to the same tension. One string has four times the radius of the other.

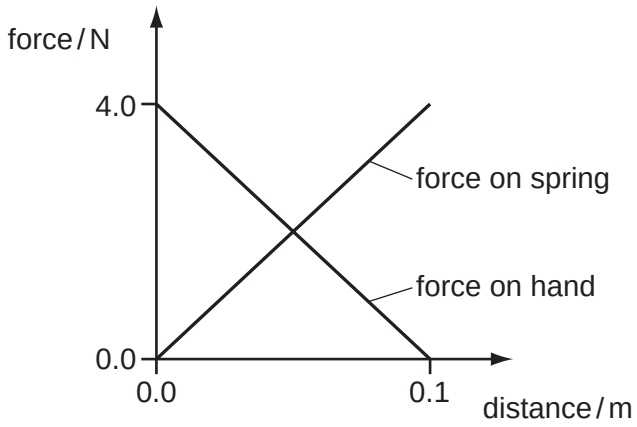
What is the ratio $\frac{\text{stress in the thicker string}}{\text{stress in the thinner string}}$?

**A** 0.0625 **B** 0.25 **C** 4 **D** 16

**Space for working**

15 A load of weight of 4.0 N is attached to the end of an unstretched spring. The load is lowered slowly by hand until it is in equilibrium. The hand is then removed and the load does not oscillate.

The graph shows how the forces exerted by the load vary as it is lowered.




How much energy is stored in the spring?

**A** 0.0 J **B** 0.1 J **C** 0.2 J **D** 0.4 J

**Space for working**

16 A heavy weight is hung from a steel cable. The cable is then replaced by a similar steel cable with half the diameter.

What will be the tensile stress and strain in the new cable compared with the original one?

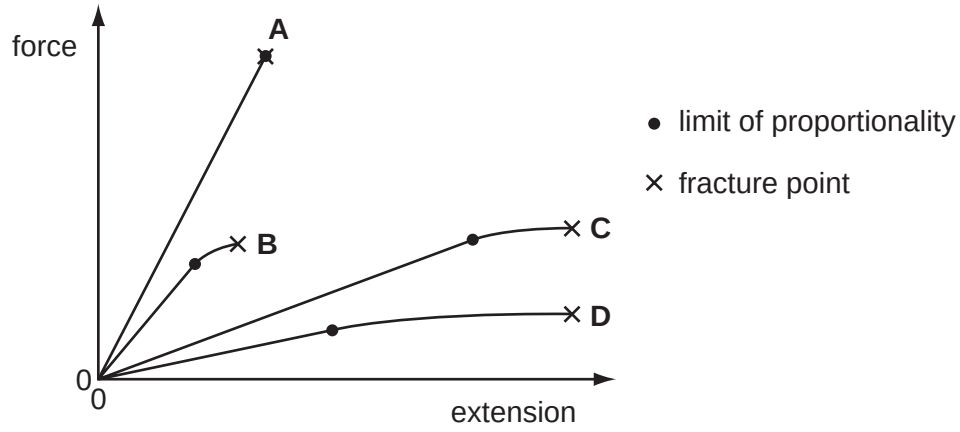
| | stress | strain |
|---|---|---|
| **A** | ×2 | ×2 |
| **B** | ×2 | same |
| **C** | ×4 | ×4 |
| **D** | ×4 | same |

**Space for working**

17 Four materials, **A**, **B**, **C** and **D**, are elastic only up to the limit of proportionality.

A graph of force against extension for each of the four materials is shown.

Which material undergoes the most plastic deformation before breaking?



18 A scale model of a table is made so that all its linear dimensions are one tenth of those of the real table (scale 1 : 10). The model is made from the same wood as the table.

What is the value of $\frac{\text{stress in the legs of the model}}{\text{stress in the legs of the real table}}$?

**A** 0.001 **B** 0.01 **C** 0.1 **D** 1

19 When a force is applied to a metal wire, the wire can undergo elastic or plastic deformation.

Which statement is correct?

**A** In elastic deformation, stress is always proportional to strain.

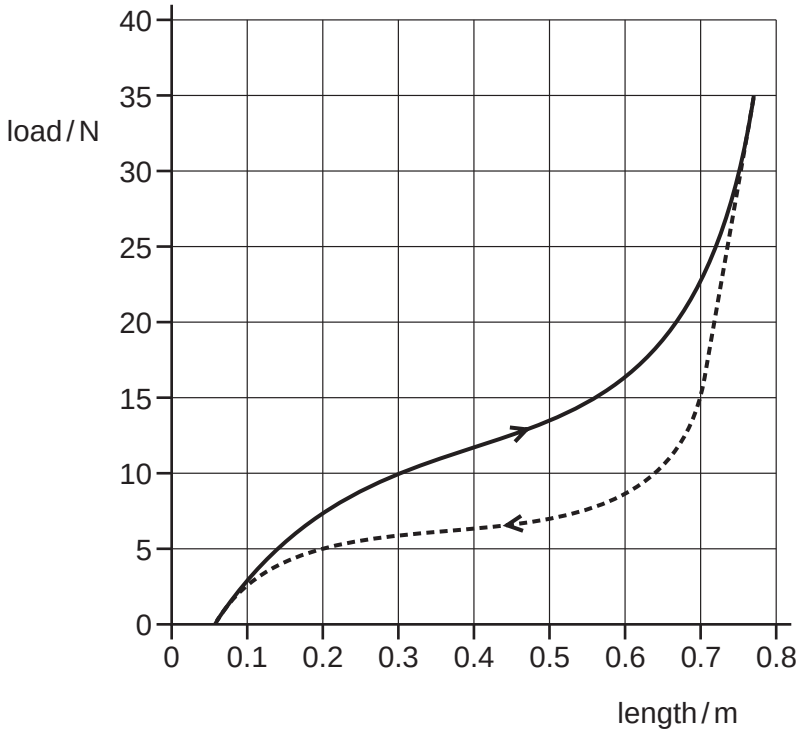
**B** In plastic deformation, the original length is regained when the load is removed.

**C** Plastic deformation always starts at the limit of proportionality.

**D** There is no elastic deformation past the yield point.

**Space for working**

20 The solid line on the graph shows how the length of a rubber band varies when an increasing load is applied. The dotted line shows how the length subsequently varies as the load is gradually decreased.




Which statement is correct?

**A** The energy recovered when the load is removed is about 10 J.

**B** The energy remaining in the rubber band after one cycle of loading and unloading is about 3 J.

**C** The total work done on the rubber band during one cycle of loading and unloading is about 14 J.

**D** The work done in stretching the rubber band is about 5 J.

**Space for working**