

# Stress, Strain and the Young modulus

## Question Paper

Level	A Level
Subject	Physics
Exam Board	Edexcel
Topic	Materials
Sub Topic	Stress, Strain and the Young modulus
Booklet	Question Paper
Paper Type	Open-Response 2

Time Allowed: 78 minutes

Score: /65

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

**\*1** Explain the difference between elastic deformation and plastic deformation. Use the behaviour of the same material or object to illustrate both types of deformation.

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**(Total for Question = 4 marks)**

2 The photograph shows the top of an inspection cover for a drain.



(a) The cover is marked 'ductile'. It is made from ductile iron, which was invented in 1943. It replaced the previous form of cast iron, which was more brittle.

Explain the meaning of the following terms:

(2)

Ductile .....

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Brittle .....

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(b) The cover is also marked '35 kN'. This refers to the load it must be able to support.

Calculate the mass that would produce this load.

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Mass = .....

(Total for Question = 4 marks)

- 3 (a) Explain the meanings of the terms brittle and ductile.  
Sketch stress-strain graphs and use them to illustrate your answer.

(4)

Brittle .....

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Ductile .....

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- (b) Give an example of a ductile material and a situation where its ductile behaviour is desirable.

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**(Total for Question = 6 marks)**

4 Brass is an alloy made from copper and zinc. The ultimate tensile strength and hardness of brass increase as the zinc content increases.

(a) (i) State what is meant by the term strength.

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(ii) State what is meant by the term hardness.

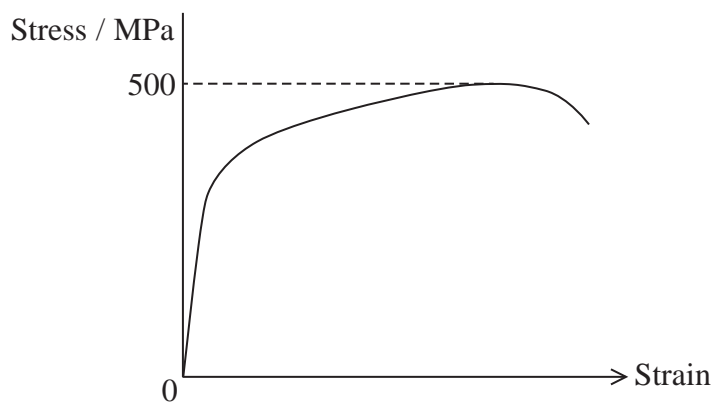
(1)

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(b) The stress-strain graph for a sample of brass is shown.



The typical stress when turning a key in a lock is about 10 MPa.

Use information from the graph to suggest why brass is a suitable material for use in keys.

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(Total for Question = 6 marks)

5 (a) Show that a unit for the Young modulus is  $\text{N m}^{-2}$ .

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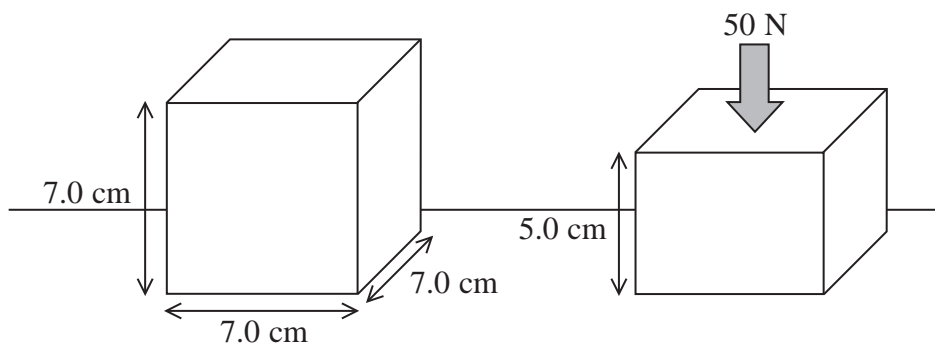
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(b) A foam cube of side 7.0 cm is compressed.

The cube is compressed with a force of 50 N and the vertical sides are reduced to 5.0 cm in length.



(i) Calculate the Young modulus of the foam. Assume that the other dimensions of the foam do not change.

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Young modulus = .....

(ii) The assumption in (i) is incorrect.

Explain how this would affect the calculated value of the Young modulus.

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(Total for Question = 7 marks)



(b) (i) Use the graph to determine the Young modulus of spider silk for small stresses. (2)

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Young modulus = .....

(ii) An insect flies into a spider’s web and becomes attached to a single thread. This creates a tension in the thread of  $580 \mu\text{N}$ . The thread extends by approximately 3% of the original length.

Calculate the radius of a single thread of spider silk. (4)

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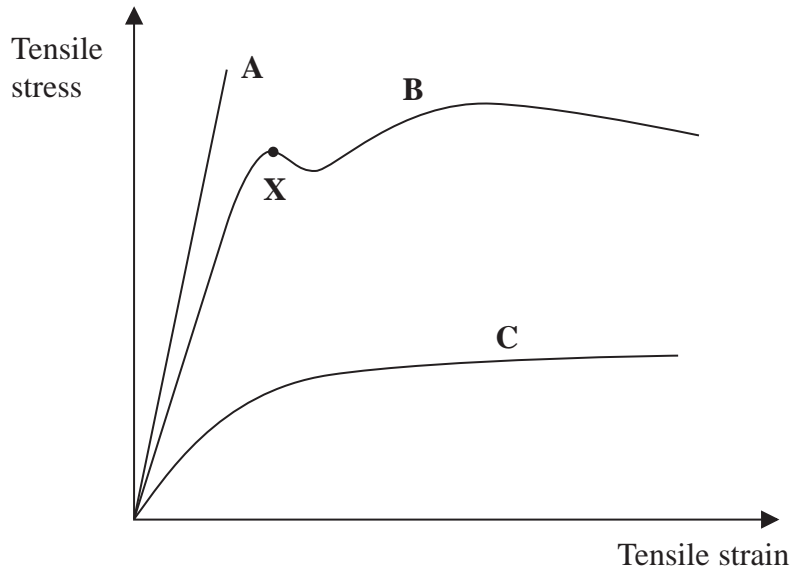
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Radius = .....

**(Total for Question = 11 marks)**



7 The graph shows the stress-strain curves for three materials A, B, and C up to the point of fracture.



(a) (i) Identify which of the materials A, B or C is

(4)

a brittle material .....

a ductile material .....

the strongest material .....

the least stiff material .....

(ii) The three materials are copper, glass and steel.

Identify which graph refers to each material.

(2)

A .....

B .....

C .....

(b) Explain why steel is a suitable material for making paper clips.

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(c) State the name for the point marked X on graph B and explain its significance.

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**(Total for Question = 11 marks)**

**8** Explain the difference between compressive strain and tensile strain.

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**(Total for Question = 2 marks)**

\*9 The metal copper probably gets its name from the Mediterranean island of Cyprus, which was an important source of the metal in ancient times. Copper was versatile because it could be beaten to make large flat objects, such as shields, as well as being drawn into wires which could be used decoratively.

Name and define the property of copper that makes it suitable for this method of making shields and the property that makes it suitable for making wires.

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**(Total for Question = 5 marks)**

**\*10** Explain why the wire used when measuring the Young Modulus of copper in a school laboratory is long and thin.

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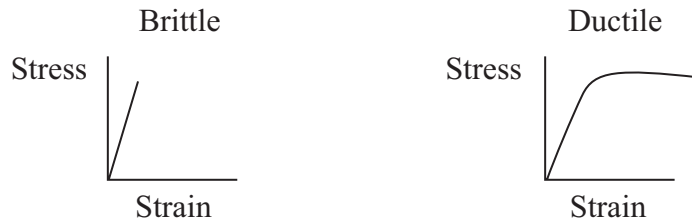
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**(Total for Question = 5 marks)**

11 The graphs show the behaviour of brittle and ductile materials.



(a) Use the graphs to help you describe brittle and ductile behaviour.

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(b) In 2006, three Chinese vases, dating from the 17th Century, were smashed when a man fell down the stairs at the Fitzwilliam Museum in Cambridge. The vases were made of porcelain.

A restoration expert put the vases back together. She said, “It wasn’t a difficult job. The museum collected all the pieces and they fitted back together perfectly.”

Explain why it was possible to fit the pieces back together perfectly.

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**(Total for Question = 4 marks)**