Deformation of Solids

Question paper 6

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Deformation of Solids
Sub Topic	
Paper Type	Theory
Booklet	Question paper 6

Time Allowed: **69 minutes**

Score: **/57**

Percentage: **/100**

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

1 **(a)** Distinguish between the structure of a metal and of a polymer.

metal: ....

....

....

polymer: ....

....

.... [4]

(b) Latex is a natural form of rubber. It is a polymeric material.

(i) Describe the properties of a sample of latex.

....

....

.... [2]

(ii) The process of heating latex with a small amount of sulphur creates cross-links between molecules. Natural latex has very few cross-links between its molecules.

Suggest how this process changes the properties of latex.

....

....

.... [2]

2 Fig. 5.1 shows the variation with force F of the extension x of a spring as the force is increased to F_3 and then decreased to zero.

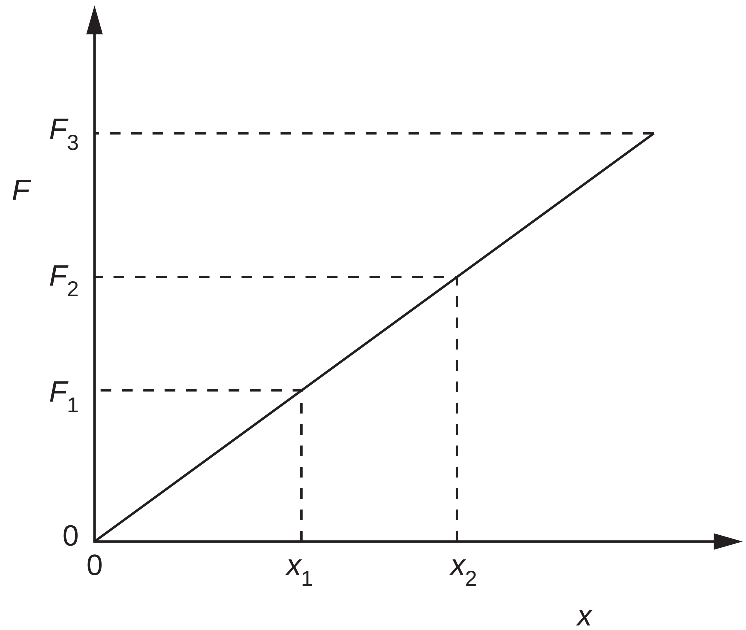

Fig. 5.1

(a) State, with a reason, whether the spring is undergoing an elastic change.

....

.... [1]

(b) The extension of the spring is increased from x_1 to x_2.

Show that the work W done in extending the spring is given by

$$W = \tfrac{1}{2}k(x_2^{\,2} - x_1^{\,2}),$$

where k is the spring constant.

[3]

(c) A trolley of mass 850 g is held between two fixed points by means of identical springs, as shown in Fig. 5.2.

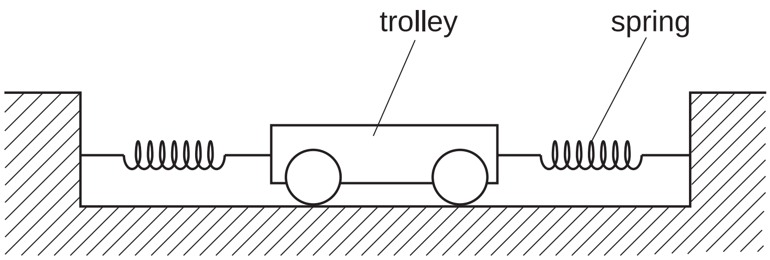

Fig. 5.2

When the trolley is in equilibrium, the springs are each extended by 4.5 cm. Each spring has a spring constant 16 N cm^{-1}.

The trolley is moved a distance of 1.5 cm along the direction of the springs. This causes the extension of one spring to be increased and the extension of the other spring to be decreased. The trolley is then released. The trolley accelerates and reaches its maximum speed at the equilibrium position.

Assuming that the springs obey Hooke's law, use the expression in **(b)** to determine the maximum speed of the trolley.

speed = ... m s^{-1} [4]

3 A glass fibre of length 0.24 m and area of cross-section $7.9 \times 10^{-7}\,\text{m}^2$ is tested until it breaks. The variation with load F of the extension x of the fibre is shown in Fig. 4.1.

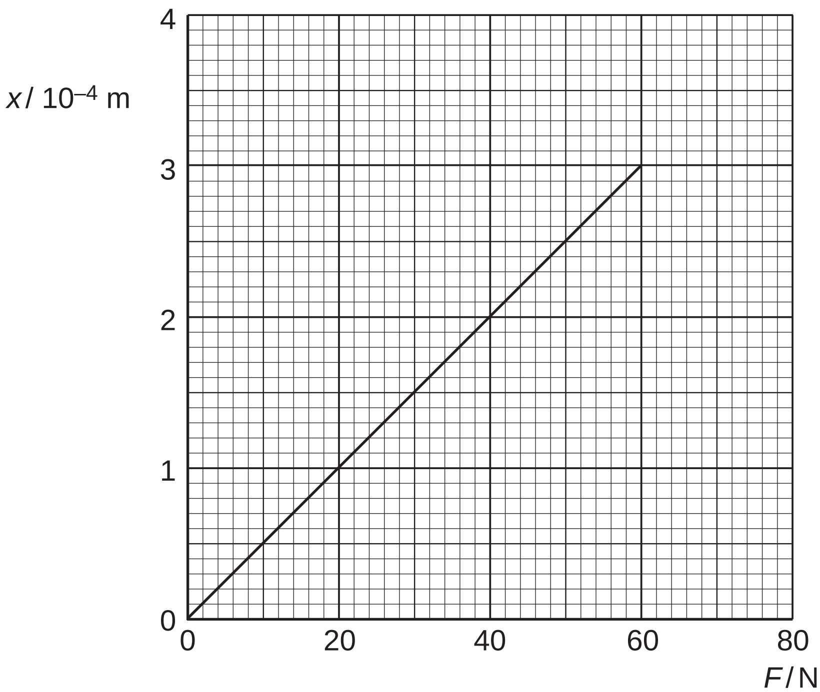

Fig. 4.1

(a) State whether glass is ductile, brittle or polymeric.

....[1]

(b) Use Fig. 4.1 to determine, for this sample of glass,

(i) the ultimate tensile stress,

ultimate tensile stress = ... Pa [2]

(ii) the Young modulus,

Young modulus = ... Pa [3]

(iii) the maximum strain energy stored in the fibre before it breaks.

maximum strain energy = ... J [2]

(c) A hard ball and a soft ball, with equal masses and volumes, are thrown at a glass window. The balls hit the window at the same speed. Suggest why the hard ball is more likely than the soft ball to break the glass window.

....

....

....

....[3]

4 **(a)** A metal wire has an unstretched length L and area of cross-section A. When the wire supports a load F, the wire extends by an amount ΔL. The wire obeys Hooke's law.

Write down expressions, in terms of L, A, F and ΔL, for

(i) the applied stress,

....

(ii) the tensile strain in the wire,

....

(iii) the Young modulus of the material of the wire.

....
[3]

(b) A steel wire of uniform cross-sectional area 7.9×10^{-7} m^2 is heated to a temperature of 650 K. It is then clamped between two rigid supports, as shown in Fig. 5.1.

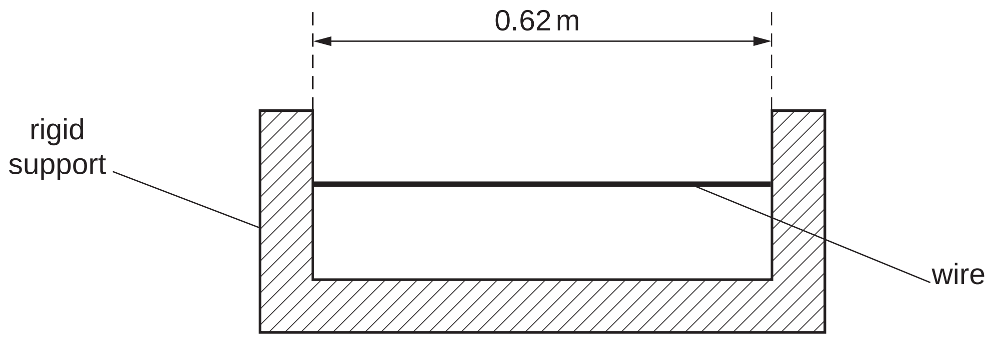

Fig. 5.1

The wire is straight but not under tension and the length between the supports is 0.62 m. The wire is then allowed to cool to 300 K.

When the wire is allowed to contract freely, a 1.00 m length of the wire decreases in length by 0.012 mm for every 1 K decrease in temperature.

(i) Show that the change in length of the wire, if it were allowed to contract as it cools from 650 K to 300 K, would be 2.6 mm.

[2]

(ii) The Young modulus of steel is 2.0×10^{11} Pa. Calculate the tension in the wire at 300 K, assuming that the wire obeys Hooke's law.

tension = ………………………….. N [2]

(iii) The ultimate tensile stress of steel is 250 MPa. Use this information and your answer in **(ii)** to suggest whether the wire will, in practice, break as it cools.

....

.... [3]

5 (a) Fig. 3.1 shows the variation with tensile force of the extension of a copper wire.

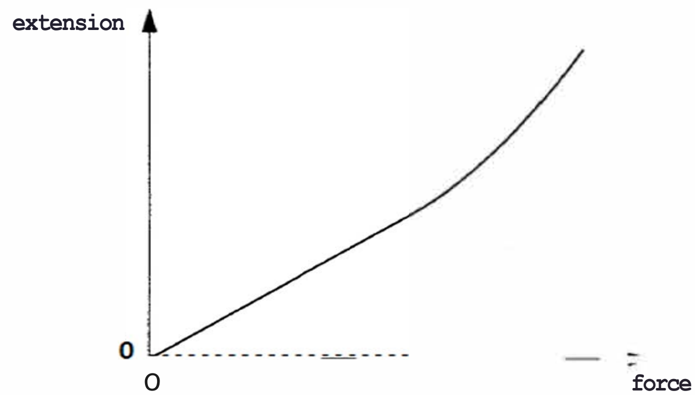

Fig. 3.1

(i) State whether copper is a ductile, brittle or polymeric material.

....

(ii) 1. 0 , Fig.3.1, mark with the letter L the point en the line beyond which Hooke's law does **not** apply.

2. State how the spring constant for the wire may be obtained from Rg. 3.1.

....

....

[3]

(b) A copper wire is fixed at a,e end and passes over a pulley. A mass hangs from the free end of the wire, as shown i, Fig. 3.2.

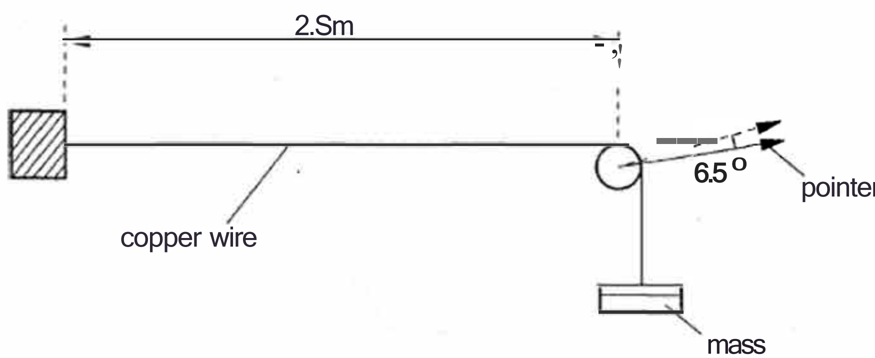

Fig.3.2

The **length** of wire between the fixed end and the pulley is 2.5 m Wren the mass a, the wire is increased bf 6.0 kg, a pointer attached to the pulley rotates through a, angle d 6.S·. The pulley, of diameter 3.0 an, is **rough** so that the wire **does** not **slide** over it

) For this increase i, mass,

1. show that the wire extends by< 0.17 cm,

2. calculate the increase i, strain of the wire.

increase ii strain = ...

[4]

(ii) 1re area of cross-section of the wire is 7.9 x 1 7 m2. Calculate the increase i, stress produced by< the increase i, load.

increase i, stress = ... Pa [3]

(iii) Use your answers to (i) 2 and (ii) to determine the YOU19 modulus of copper.

Yourg modulus= .... Fa [2]

(iv) Suggest hem you could check that the elastic limit of the wire is not exceeded when the extra load is added.

....

.... m

6 An aluminium wire of length 1.8 m and area of cross-section $1.7 \times 10^{-6}\,m^2$ has one end fixed to a rigid support. A small weight hangs from the free end, as illustrated in Fig. 9.1.

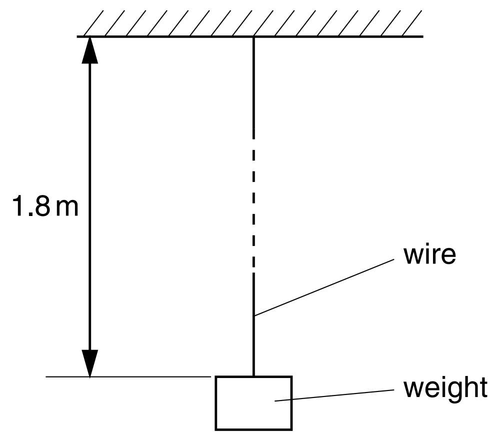

Fig. 9.1

The resistance of the wire is 0.030 Ω and the Young modulus of aluminium is 7.1×10^{10} Pa.

The load on the wire is increased by 25 N.

(a) Calculate

(i) the increase in stress,

increase = ... Pa

(ii) the change in length of the wire.

change = ... m
[4]

(b) Assuming that the area of cross-section of the wire does not change when the load is increased, determine the change in resistance of the wire.

change = ... Ω [3]