GCE PHYSICS

S21-A420QS

Assessment Resource number 17

Electricity and the Universe Resource H

1

(a) Materials can be classified as being *crystalline*, *amorphous* or *polymeric*. Making reference to their microscopic structures explain what is meant by each of these terms. Give **one** example of each type of material. [3]

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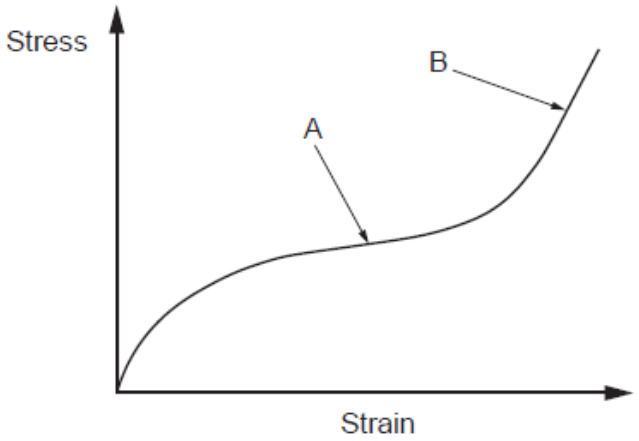
(b) Experiments are carried out on a specimen of rubber. The diagram shows a stress-strain curve for the specimen when it is gradually loaded.



(i) By referring to the molecular structure of rubber, explain why the gradient at A is less than the gradient at B. [3]

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(ii) When the specimen is gradually unloaded, it is noted that the curve for unloading is different from the curve for loading.

I. Name this phenomenon and account for it in terms of energy. [2]

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II. **Sketch the curve** for unloading on the graph opposite. [1]

2

Two students, Simon and Natalie are investigating the mechanical properties of a steel wire of length 2.5 m and cross-sectional area 1.0 mm^2.

(a) They are given the following information.
[Young modulus, $E_{steel} = 2.0 \times 10^{11}\,N\,m^{-2}$, Stress, σ_{steel} (at elastic limit) $= 1.0 \times 10^{8}\,N\,m^{-2}$].

(i) Show that the maximum extension possible for the wire without the elastic limit being exceeded is 1.25 mm. [2]

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(ii) Simon believes that this maximum extension (1.25 mm) of the steel wire depends on the radius of the wire. Natalie disagrees. Discuss who is correct, explaining carefully how you arrive at your answer. [3]

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(b) Natalie suspends a mass, m, from the wire vertically. The wire can be considered to be weightless.

(i) Show that the force per unit extension, k, of the wire is 80 $kN\,m^{-1}$. [3]

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(ii) Determine the mass, m, that causes an equilibrium extension of 1.0 mm. [2]

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(c) This mass is given a small downward displacement and released from rest. The mass oscillates with simple harmonic motion (SHM) **provided that the maximum extension of the wire never exceeds the elastic limit**.

(i) Calculate the period of this oscillation. [2]

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(ii) Calculate the maximum possible velocity of the mass, m. [3]

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(iii) Assuming the mass is released when the wire is at maximum extension without exceeding the elastic limit, sketch a graph showing how the stress in the wire varies with time **for one complete oscillation** from the moment of release of the mass. Indicate appropriate numerical values on the stress axis of your graph.
Space for calculations. [4]