GCE PHYSICS

S21-A420QS

Assessment Resource number 14

Electricity and the Universe Resource E

1

(a) Two parallel plate capacitors, X and Y, have equal plate areas. The capacitance of X is greater than the capacitance of Y. Suggest **two** possible reasons for the difference. [2]

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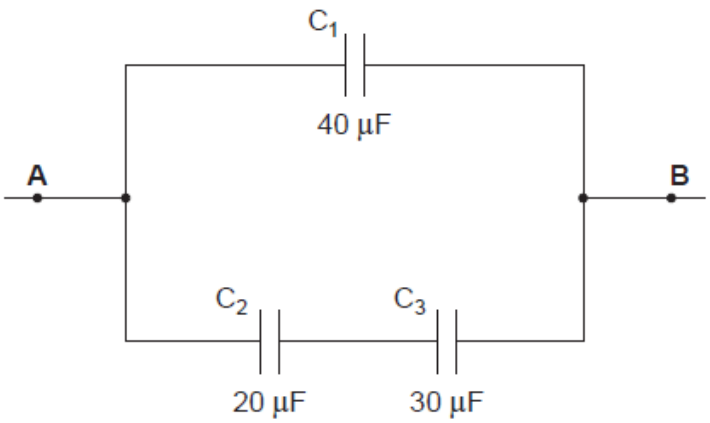
(b) The diagram shows an arrangement of 3 capacitors.



(i) Calculate the total capacitance of this combination of capacitors. [3]

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(ii) Explain why:

$$\text{pd across } C_2 = 1.5 \times \text{pd across } C_3. \quad [2]$$

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(iii) Hence, calculate the pd across C_3 given that 100 V is applied between A and B. [1]

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(iv) Explain which of the three capacitors stores the greatest charge, and calculate the size of this charge. [2]

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(c) A 1.6 mF capacitor is charged from a 300 V d.c supply. Engineers wish to use the energy stored in this capacitor to heat a small coil embedded in a thermally insulated block of aluminium of mass 0.10 kg. It is required that the heating process be at least 80% efficient. Experiments show that when the capacitor is discharged through the coil, the temperature of the block increases by 0.60 K.

Determine whether this method of heating meets the efficiency specified.
[Specific heat capacity of aluminium, c = 910 J kg^{-1} K^{-1}]. [5]

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2 *(a)* **Describe** how the resistance of a metal varies between 0 K and 1000 K.
[Assume that the metal is superconducting below a certain temperature.]
Account for this variation in resistance at higher temperatures. [6 QER]

(b) Superconductors are used in MRI scanners and particle accelerators. Consider which of these two applications has been of greater benefit to society. [3]

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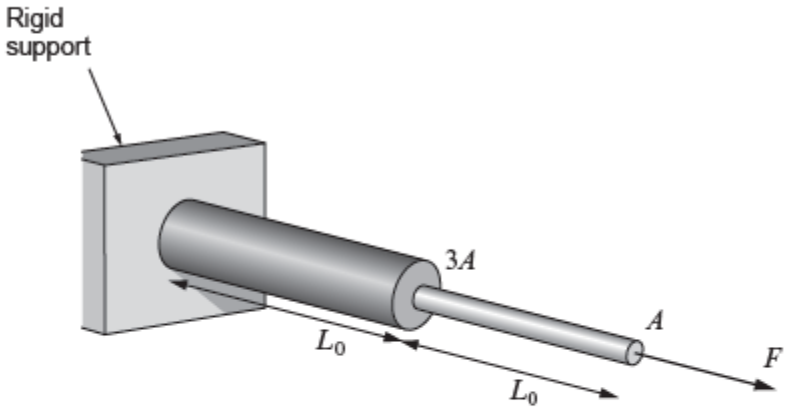
(a) The bar in the figure below is made from a **single piece of metal**. It consists of two parts of equal length L_0 and cross-sectional area A and $3A$. The diagram is not drawn to scale.



(i) Show that the **total** extension, Δx_{total}, of the bar under the action of an applied force, F, as shown in the diagram, can be given by:

$$\Delta x_{\text{total}} = \frac{4FL_0}{3AE}$$

where E represents the Young modulus of the metal in the bar. [3]

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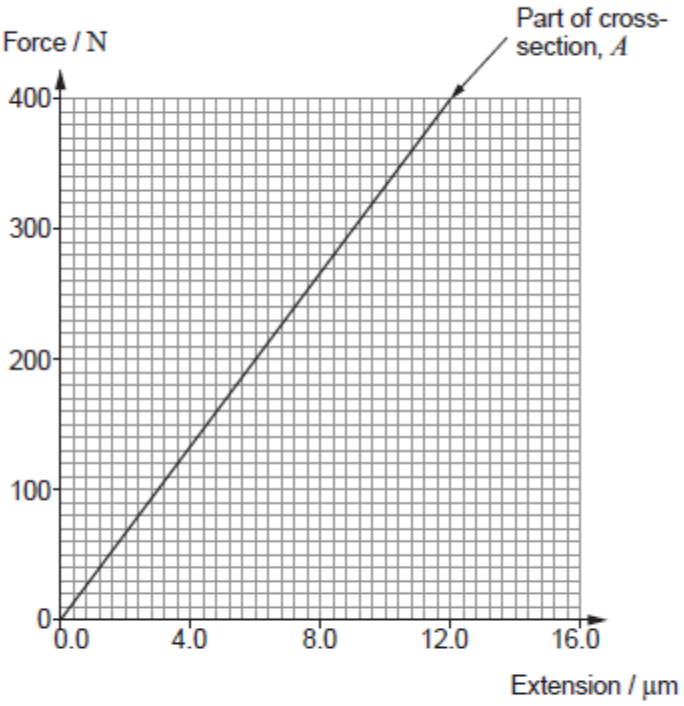
(ii) The graph shows the variation of extension with applied force for the part of cross-section, A. **Draw** (on the same grid) the expected force-extension graph for the segment of cross-section $3A$. [1]



(iii) Determine the Young modulus of the metal in the bar given that L_0 = 1.2m and $A = 2.0 \times 10^{-4}\,m^2$. [3]

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(iv) Calculate the elastic potential energy stored in the whole bar when $F = 400\,\text{N}$. [2]

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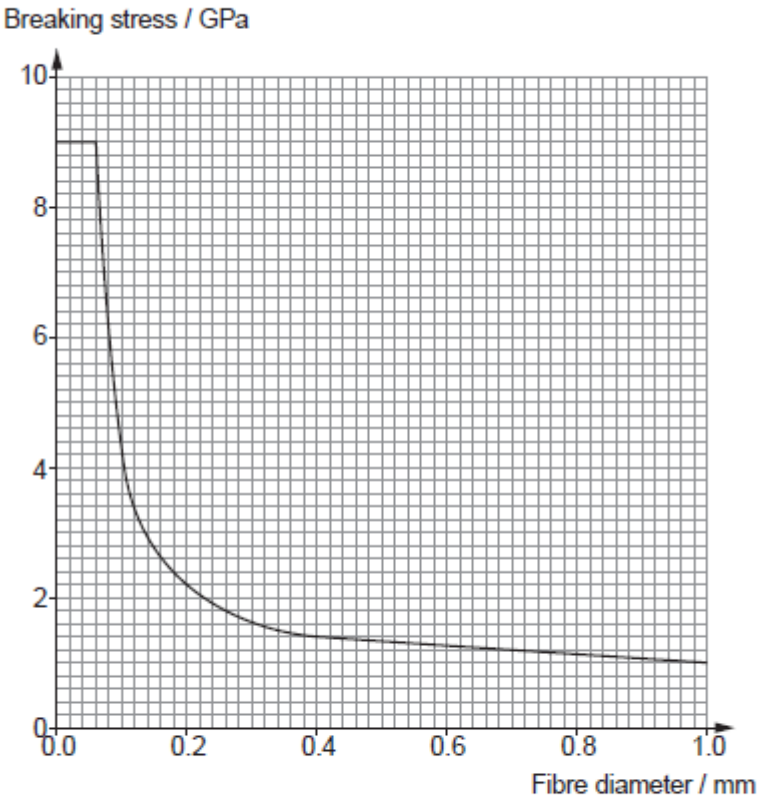
(b) Glass is a brittle material. The graph shows how the breaking stress of glass, in the form of thin fibres and rods, varies with the diameter of the fibre.



(i) Use the graph to estimate the greatest mass which can be hung from a glass fibre of diameter 0.2 mm. [3]

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(ii) Explain the term *brittle fracture* as it applies to glass and give a reason why very thin fibres have a greater breaking stress than thicker ones. [2]

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