Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

APPLIED SCIENCE **SC05**
Unit 5 Choosing and Using Materials

Friday 23 May 2008 9.00 am to 10.30 am

For this paper you must have:
- a pencil and a ruler
- a calculator.

Time allowed: 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

Information
- The maximum mark for this paper is 80.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3			
4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Answer **all** questions in the spaces provided.

1 The materials used by scientists and engineers include metals, polymers, ceramics, glass and composites.

Some examples of these materials are

Aluminium **Nylon** **Fibre glass** **Brick**

1 (a) Which of the above materials is

a polymer .....

a ceramic .....

a composite? .....

(2 marks)

1 (b) Explain what is meant by a *composite material*.

.....

.....

(1 mark)

1 (c) Many polymers are manufactured from materials obtained from crude oil. Give **two** disadvantages of the increasing use of these polymers.

Disadvantage 1 .....

.....

Disadvantage 2 .....

.....

(2 marks)

Some ceramics contain alumina. Alumina is pure aluminium oxide, Al_2O_3.

1 (d) (i) The bonding between aluminium and oxygen in alumina is ionic. Describe this type of bonding.

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(2 marks)

1 (d) (ii) Explain why ceramics are suitable materials for lining furnaces.

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(1 mark)

Aluminium oxide is present in a type of glass used to make car windscreens.

1 (e) (i) What type of structure does glass have?

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(1 mark)

1 (e) (ii) During manufacture, the glass undergoes a heating and cooling stage called tempering.
What does the tempering process do to the glass?

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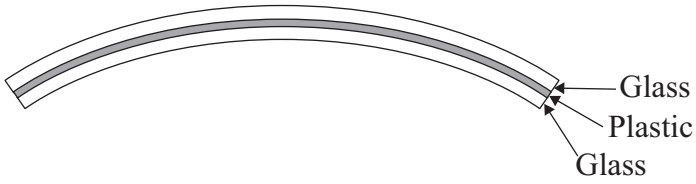
(1 mark)

Question 1 continues on the next page

1 (e) (iii) The diagram shows a section through a shaped windscreen after the tempering process. On the diagram, use an arrow labelled **C** to show the part of the glass which is in compression.

(1 mark)

1 (e) (iv) After tempering, the glass is laminated. The diagram shows a section through a laminated car windscreen.



Laminated windscreens crack when struck hard, but remain in one piece. Suggest a reason why.

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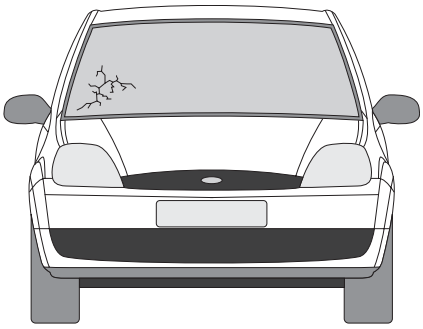
(1 mark)

1 (e) (v) The diagram shows a car with a cracked windscreen.



Give **two** reasons why it is important for a car windscreen to crack rather than shatter when struck hard.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

14

Turn over for the next question

2 Metals are very useful materials. The way metals are used depends on their properties.

2 (a) Explain the meaning of the following properties of metals.

good thermal conductivity .....

.....

malleability .....

.....

ductility .....

.....

strong in tension .....

.....

(4 marks)

The table shows some properties of some common metals.

Metal	**Melting point (°C)**	**Electrical conductivity $\times 10^{-8}(\Omega^{-1}\,m^{-2})$**	**density $(kg\,m^{-3})$**
Iron	1535	0.100	7860
Aluminium	660	0.382	2700
Copper	1083	0.593	8920

Use the data in the table to explain the following.

2 (b) (i) Aluminium is a good metal to use for the body and wings of aeroplanes.

.....

.....

(1 mark)

2 (b) (ii) Copper is a good metal to use for electrical wiring.

.....

.....

(1 mark)

2 (b) (iii) Iron is a good metal to use for saucepans.

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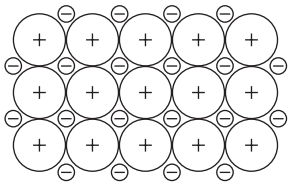
(1 mark)

The diagram shows a model of metallic bonding.



2 (c) (i) Name the particles shown in the diagram.

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(2 marks)

2 (c) (ii) Use the diagram to explain why metals have good electrical conductivity.

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(2 marks)

Question 2 continues on the next page

Brass and steel are alloys. Brass is made by adding a small amount of zinc to copper. The diagram shows the structure of brass.

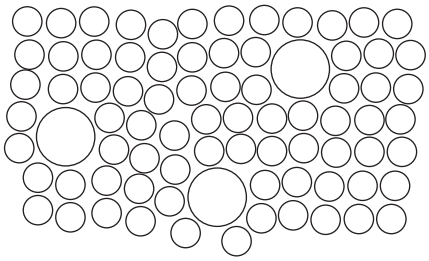

Diagram not drawn to scale

2 (d) (i) On the diagram label a copper atom (use Cu) and a zinc atom (use Zn).

(1 mark)

2 (d) (ii) Explain why brass is harder and less malleable than either pure copper or pure zinc. Use information about the structure of brass in your answer.

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(2 marks)

2 (d) (iii) Steel is an alloy of iron and carbon. Steel is harder than pure iron but can be made even harder by the process of quenching.
Explain how quenching is carried out.

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(2 marks)

2 (d) (iv) The quenching process alters the hardness of steel. State **one** other property that changes and describe how it changes.

Property .....

Description .....

.....

(2 marks)

2 (d) (v) A sample of steel has a mass of 3000 kg and a volume of 0.384 m^3. Calculate the density of the steel.
Give the correct unit in your answer.

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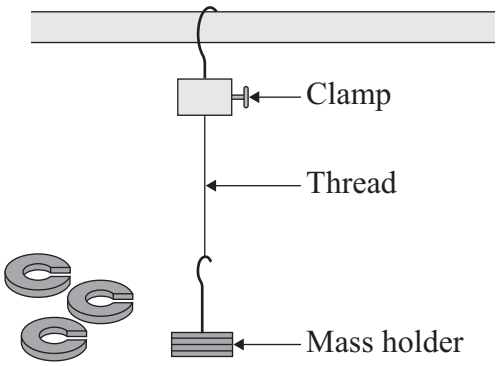
(3 marks)

21

Turn over for the next question

3 A manufacturer of sewing threads must ensure that the threads have the correct tensile strength. A technician tests samples of some threads. The diagram shows the apparatus that might be used.



The technician has samples of three different threads to test. The threads have the same diameter. He also has a mass holder and several separate 100 g masses. Describe how he could accurately and reliably compare the tensile strength of the different threads to the nearest 1 N (100 g).

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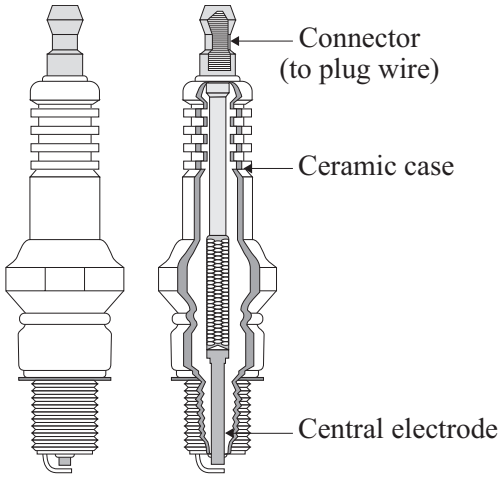
(8 marks)

8

4 The diagram shows a spark plug used to ignite the petrol/air mixture in a car engine.



4 (a) During ignition, high temperatures are produced and a very high voltage is generated. The high voltage is needed to produce the spark. The spark ignites the petrol/air mixture.

Explain fully why the case of the spark plug is made of a ceramic material.

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(2 marks)

4 (b) The central electrode must be a very good conductor of electricity and be able to withstand extremely high temperatures in a corrosive atmosphere.
Spark plugs with a nickel electrode have been produced for many years but only last a short time. As the electrode wears out combustion becomes less efficient and the petrol is not burnt completely.
Spark plugs with a platinum electrode are now available. These last longer, are more efficient and help to reduce air pollution.

How does a spark plug with a platinum electrode reduce air pollution?

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(2 marks)

Question 4 continues on the next page

4 (c) The table shows some properties of platinum and nickel.

	Melting point (°C)	**Boiling point (°C)**	**Reactivity**
Nickel	1455	2920	Medium
Platinum	1769	4170	Low

Suggest **two** reasons why spark plugs with a platinum electrode last longer than spark plugs with a nickel electrode. Explain each reason by linking it to information in the table.

Reason 1 .....

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Explanation .....

.....

Reason 2 .....

.....

Explanation .....

.....

(4 marks)

4 (d) Suggest a disadvantage of using platinum spark plugs compared to nickel.

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(1 mark)

9

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

5 The manufacturer of a ski-lift is testing different steel cables before deciding which one to use. One of the properties being considered is the stiffness of the cables.

5 (a) Give the definition of *stiffness*.

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(1 mark)

The results of the tests on one of the cables are shown in the table.

Stress (MNm^{-2})	0	6	9	12	15	18	21
Strain ($\times 10^{-5}$)	0	2	3	4	5	6	7

5 (b) (i) Define *stress*.

.....

.....

(1 mark)

5 (b) (ii) Define *strain*.

.....

.....

(1 mark)

5 (b) (iii) Plot the data from the table onto the grid on **page 15**. Draw a line of best fit.

5 (b) (iv) Use your graph to find the strain when the stress is 13 $MN\,m^{-2}$.

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(1 mark)

5 (b) (v) Calculate the Young modulus for the cable.

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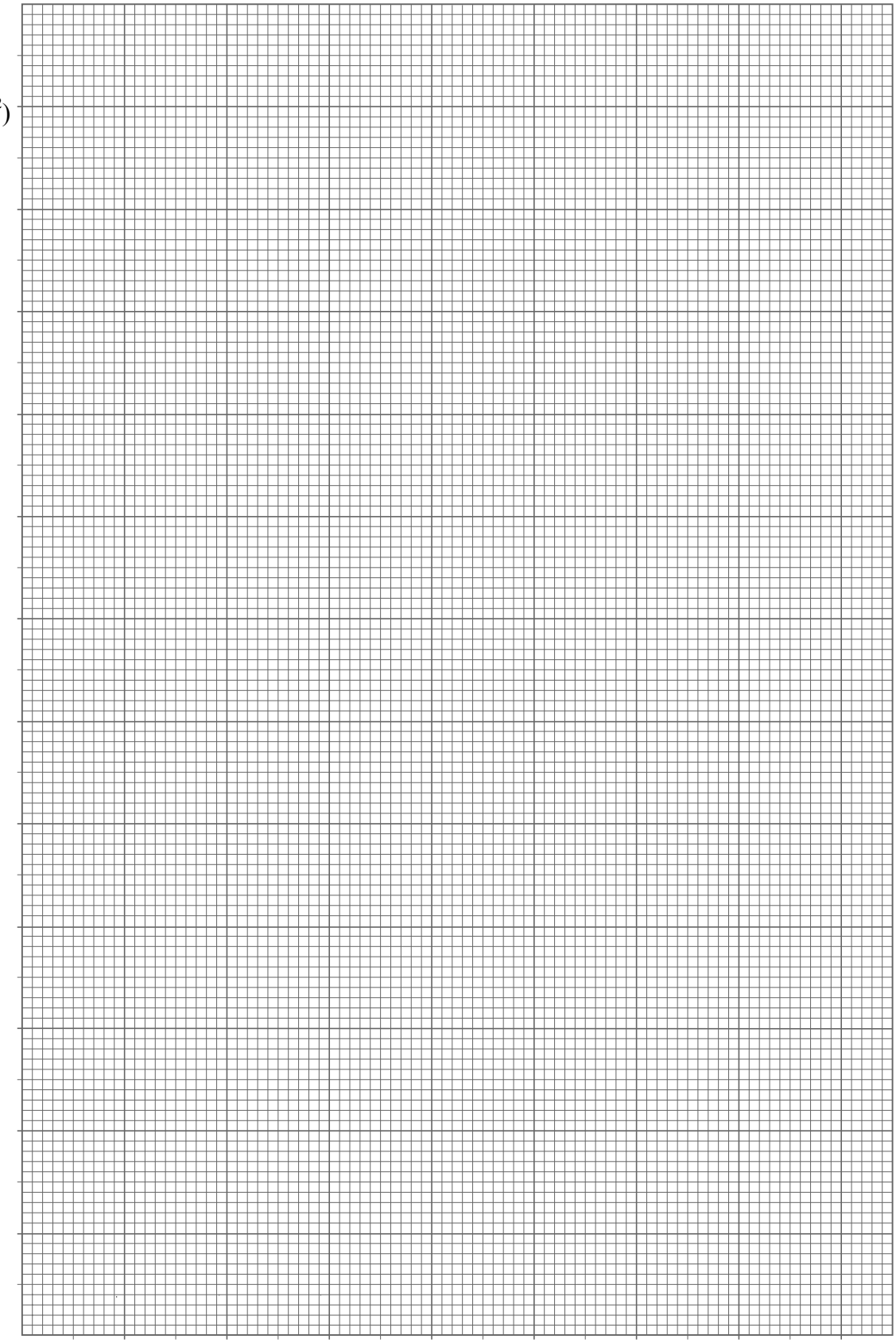
(3 marks)

Question 5 continues on page 16



(3 marks)

Turn over ▶

5 (b) (vi) Draw another line on your graph on **page 15** to show the result that would be obtained if a stiffer cable were used.

Label this line **S**. *(2 marks)*

5 (c) Give **one** physical property, other than stiffness, that the ski-lift manufacturer should consider when choosing a cable.

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(1 mark)

13

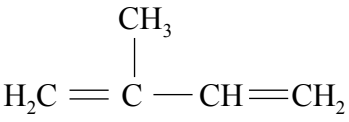
Read this article about modifying polymers and use the information and your own knowledge to answer Question 6.

Modifying Polymers

It is possible to modify polymers to alter their properties. Two examples, natural rubber and PVC, are explained below.

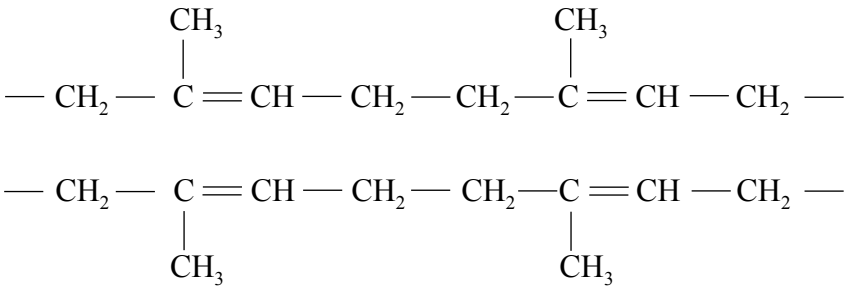
Natural rubber is a soft material obtained from trees. It is a polymer of isoprene. The structure of an isoprene molecule is shown in **Figure 1**.

Figure 1



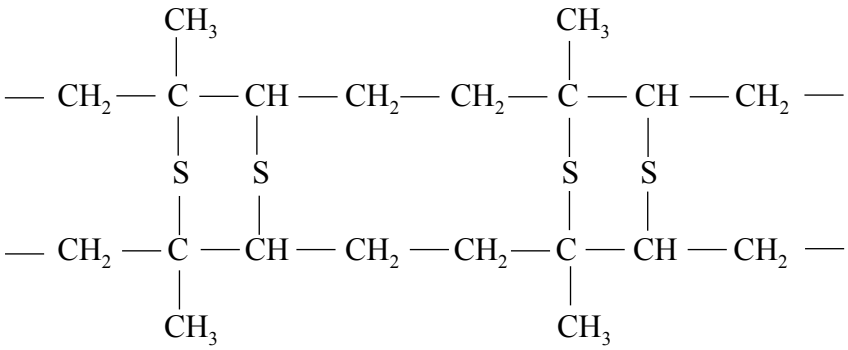
The structure of part of two polymer chains in natural rubber, lying side-by-side, is shown in **Figure 2**.

Figure 2



In 1839 Charles Goodyear discovered that natural rubber could be hardened by heating it with sulphur. He called the product vulcanised rubber. **Figure 3** shows part of the polymer formed.

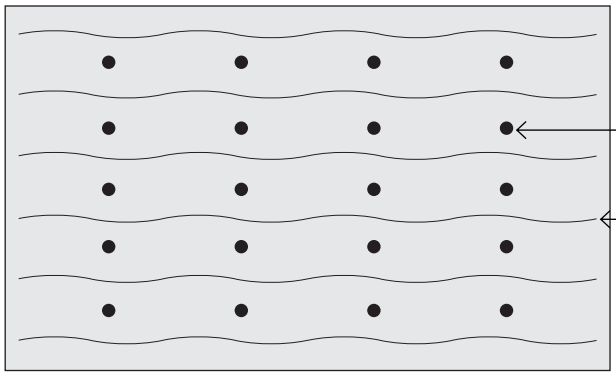
Figure 3

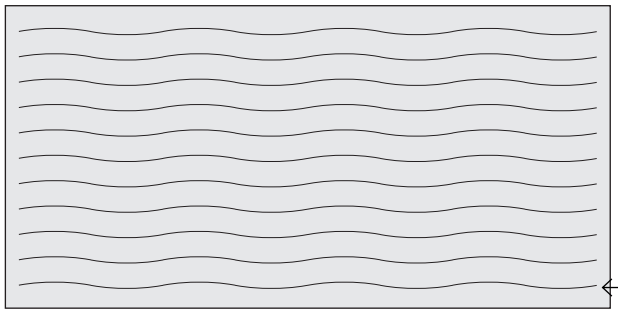


Vulcanised rubber is used for making car tyres. Rubber is elastic because the polymer chains can adjust in position and shape relative to one another.

Turn over ▸

PVC (polyvinyl chloride) is a polymer made from the monomer vinyl chloride. PVC is used for making window frames and guttering, these need to be durable and rigid. PVC is also used to make children's toys, these need to be softer and more flexible than window frames and guttering. To do this a plasticizer is added to the polymer mix. The plasticizer is usually an oily liquid with small molecules. The small molecules fit between the polymer chains.





PVC is a thermosoftening plastic. This means it can be moulded when it is hot and can be remoulded. Some other plastics are described as thermosetting. Thermosetting plastics do not melt and they cannot be remoulded. The difference in properties between thermosoftening and thermosetting plastics is due to cross links between the polymer chains of thermosetting plastics. These cross links prevent chains of a thermosetting plastic from moving past each other.

6 (a) (i) Name the type of bond in the isoprene molecule.

.....

(1 mark)

6 (a) (ii) Describe this type of bonding.

.....

.....

(1 mark)

6 (a) (iii) Explain the difference between single and double bonds.

.....

.....

(1 mark)

6 (b) What word is used to describe the simple molecules from which polymers are made?

.....

(1 mark)

6 (c) What is the formula of isoprene?

.....

(1 mark)

6 (d) What part of the structure of isoprene molecules allows them to be polymerised?

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(1 mark)

6 (e) Suggest the name for the polymer in natural rubber.

.....

(1 mark)

6 (f) Explain how the vulcanisation process makes natural rubber harder.

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(2 marks)

Question 6 continues on the next page

6 (g) Explain why plasticized PVC is softer and more flexible than unplasticized PVC.

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(2 marks)

Most electric sockets are made from plastic polymers.

6 (h) (i) Why is this safer than making them from metal?

.....

.....

(1 mark)

6 (h) (ii) Is the plastic used to make electric sockets thermosoftening or thermosetting? Explain your answer.

Type of plastic .....

Explanation .....

.....

(1 mark)

6 (i) Which of the diagrams below shows the molecular structure of a thermosetting plastic? State the reason for your choice.

Diagram .....

Reason .....

.....

(1 mark)

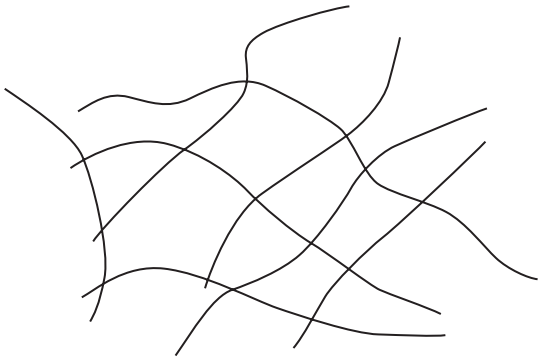


Diagram A

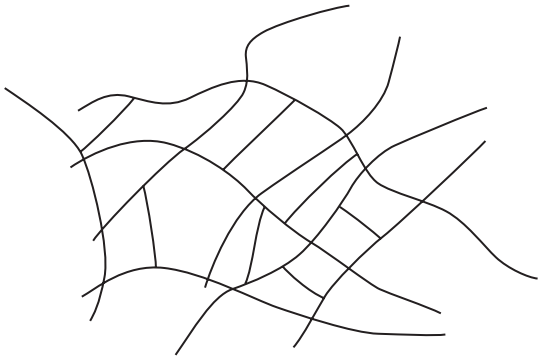
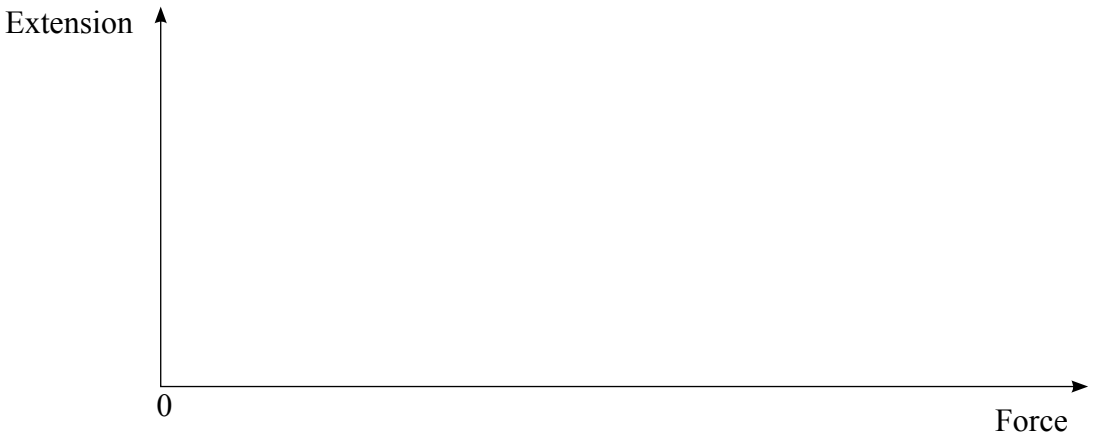


Diagram B

6 (j) Vulcanised rubber is elastic. On the axes below sketch a graph which shows the relationship between force and extension for rubber up to its elastic limit.



(1 mark)

END OF QUESTIONS

15

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