Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2018

Centre Number

Candidate Number

Life and Health Sciences

SZ051

Assessment Unit AS 5
assessing
Material Science

[SZ051]
MONDAY 21 MAY, AFTERNOON

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all eight** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question, or part question.
You may use an electronic calculator.
Quality of written communication will be assessed in question **2(b)**.

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Only	
Marks	Remark

1 **Fig. 1.1** below represents the atom of an element.

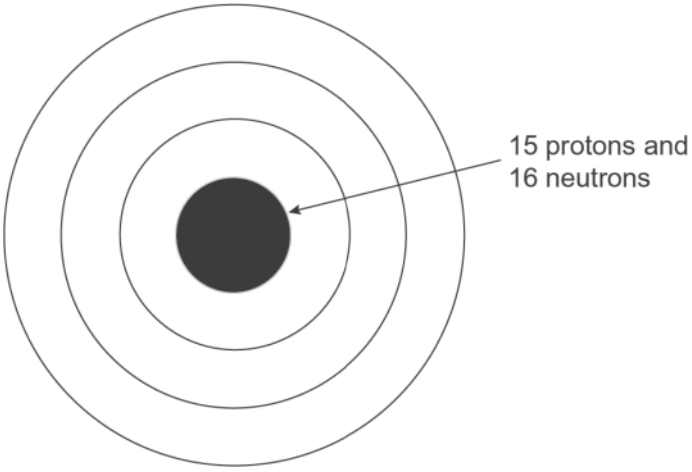

Fig. 1.1

Source: Principal Examiner

(a) **(i)** Name the part of the atom where the protons and neutrons are to be found.

_____ [1]

(ii) Explain why the atom is overall electrically neutral.

_____

_____ [1]

(iii) Complete **Fig. 1.1** above to show the electronic configuration of the atom, using an X to represent an electron. [1]

(iv) Is this atom likely to be a metal, a non-metal or a semiconductor? Circle your answer and give a reason for your response.

Metal **Non-metal** **Semiconductor**

Reason: _____ [2]

Metals are generally good conductors of heat.

Fig. 1.2 below shows a metal rod being heated in a Bunsen flame.

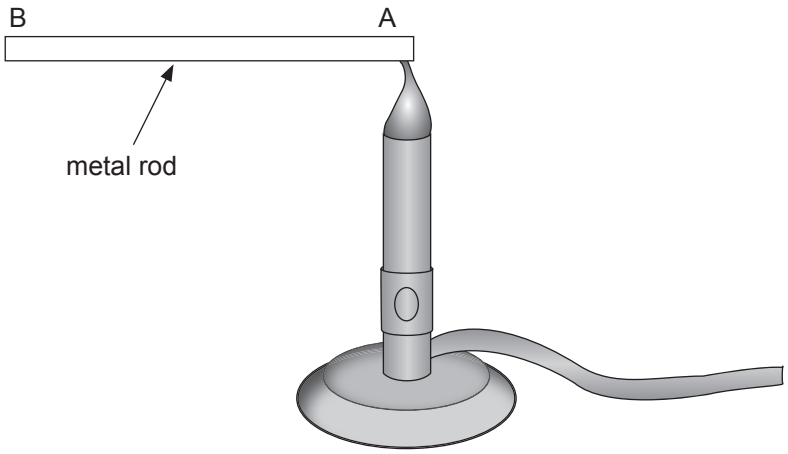

Fig. 1.2

(b) Using your knowledge of the atomic structure of metals describe, in detail, how heat is transferred along the metal rod from A to B.

[4]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

2 **(a)** **(i)** Define the term electrical conductivity in terms of electrical resistance, cross section area and length. If you give the definition in terms of an equation, state what each symbol means.

_____

_____

_____

_____ [1]

(ii) In what unit is electrical conductivity measured?

_____ [1]

(b) Describe an experiment to measure the electrical conductivity of the material of a thin metal wire. In your description you should:

- state what measurements you would make and the measuring instruments required;
- state what you would do to ensure the value obtained for electrical conductivity was both reliable and accurate; and
- state how you would use these measurements to calculate the electrical conductivity.

You will be assessed on the quality of your written communication in this question.

Measurements and instruments used

Reliability and accuracy

Calculations

[6]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 **Fig. 3.1** below shows the stress–strain graphs for four different materials.

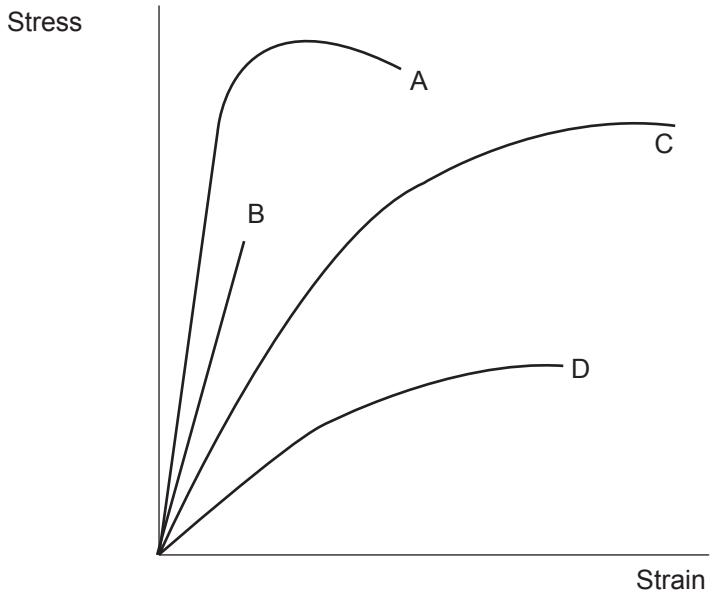

Fig. 3.1

(a) Using the letters A, B, C or D, write down which of these materials:

(i) has the greatest Young Modulus.

_____ [1]

(ii) is the most ductile.

_____ [1]

(iii) has the greatest tensile strength.

_____ [1]

In the showroom of an Irish crystal manufacturer a chandelier of weight 120 N hangs from the ceiling, supported only by a cylindrical aluminium rod of cross section area $3.00 \times 10^{-4}\,m^2$ and length 1.10 m.
The Young Modulus of aluminium is 7.00×10^{10} Pa.

For each part you are advised to show your working.

(b) Calculate:

(i) the stress in the aluminium rod.

Stress = _____ Pa [3]

(ii) the strain in the aluminium rod.

Strain = _____ [3]

(iii) the extension of the aluminium rod caused by the weight of the chandelier.

Extension = _____ m [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

4 The density of pure gold is 19.3 g cm^{-3}.

(a) (i) Show carefully that 75.0 g of pure gold has a volume of 3.89 cm^3.

You are advised to show your working.

[2]

A jeweller mixes together 75.0 g of pure gold with 2.80 cm^3 of pure copper in order to produce 100 g of 18 carat gold from which jewellery products can be made.

(ii) By first calculating the volume of the mixture, find the density of the 18 carat gold.

You are advised to show your working.

Density = _____ g cm^{-3} [2]

(iii) Gold is stored in banks in the form of heavy bullion bars. Its density is 19.3 g cm^{-3}.

Fig. 4.1

© ktsimage / iStock / Thinkstock

Calculate the density of gold in kg m^{-3}.

You are advised to show your working.

Density = _____ kg m^{-3} [2]

Examiner Only

Marks	Remark

Creep is a useful concept when considering the behaviour of materials used in the manufacture of aircraft.

Examiner Only	
Marks	Remark

(b) (i) Describe briefly what is meant by creep.

_____

_____

_____ [2]

(ii) Give one situation where creep is an undesirable property of a material.

_____

_____ [1]

(iii) When a sheet of aluminium foil is repeatedly folded and unfolded along the same line it quickly becomes so weak that the aluminium foil breaks very easily.

What undesirable property of the aluminium is being displayed by this process?

_____ [1]

Carbon fibre reinforced plastic is a composite material which is used in making aircraft structures. In many cases it is replacing alloys of steel and aluminium.

Examiner Only	
Marks	Remark

(c) (i) Explain fully why carbon fibre reinforced plastic can be described as a composite material.

_____

_____

_____ [2]

(ii) Suggest why the use of carbon fibre reinforced plastic has reduced the cost of air travel.

_____

_____

_____ [2]

(iii) Suggest a major disadvantage of using composite materials.

_____ [1]

Examiner Only	
Marks	Remark

5 **(a)** Describe and explain the main differences between the behaviour of thermoplastics and thermosets (thermosetting plastics) when they are heated.

Description:

_____

_____

_____ [2]

Explanation:

_____

_____

_____

_____

_____ [4]

(b) Give a common everyday use for a thermoset and thermoplastic.

Thermoset: _____

_____ [1]

Thermoplastic: _____

_____ [1]

(c) Material scientists sometimes use a polarising light microscope.

(i) What is the difference between polarised and unpolarised light?

_____

_____

_____

_____ [2]

(ii) State one use of a polarising light microscope.

_____ [1]

Examiner Only	
Marks	Remark

6 **(a)** The following materials are all made of mixtures of metals. In each case one of the metals is identified. Complete the table by naming the other metals.

Material	Main Metal	Second metal
Brass	Copper	
Stainless steel	Steel	
Bronze		Tin

[3]

Some metals are very hard, which makes them difficult to work and cut.

(b) **(i)** What name is given to the process which softens metals so that they become easier to work and cut?

_____ [1]

(ii) Describe briefly the process identified in **(b)(i)**.

_____

_____

_____

_____

_____ [3]

(c) Copper is a very ductile metal. Explain what this means.

_____ [1]

Examiner Only	
Marks	Remark

7 Carbon nanotubes are made from a particular form (allotrope) of carbon.

(a) (i) What name is given to this particular allotrope?

_____ [1]

(ii) What is a carbon nanotube?

_____ [1]

(b) Carbon nanotubes are finding increasing use in healthcare. One use is in scaffolding for tissue regeneration.

Identify three **other** applications of carbon nanotubes in healthcare.

1. _____

2. _____

3. _____ [3]

Examiner Only	
Marks	Remark

8 Diodes are made of a single crystal consisting of N-type silicon and P-type silicon.

Fig. 8.1 shows a silicon diode.

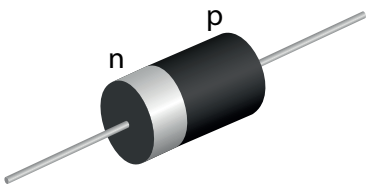

Fig. 8.1

(a) In what way is the doping of N-type silicon different to P-type silicon?

N-type silicon _____

P-type silicon _____ [2]

(b) At the junction between the N-type silicon and P-type silicon there is a depletion layer.

(i) Describe what is meant by a silicon diode being in reverse bias.

_____

_____

_____ [2]

(ii) What, if anything, happens to the width of the depletion layer when the diode is in reverse bias?

_____ [1]

(iii) Explain why the depletion layer behaves as you have described in **(ii)**.

_____

_____

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER

11105.04