Rewarding Learning

Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Life and Health Sciences

Assessment Unit AS 5
assessing
Material Science

SZ051

[SZ051]
WEDNESDAY 24 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 **5**.

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

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Examiner Only	
Marks	Remark

1 The Vickers Hardness Test (VHT) is one method to measure the hardness of a material.

In the VHT an indenter is used to make an indent in the material being tested.

(i) What material is the indenter generally made from?

_____ [1]

(ii) Describe fully the shape of the indenter.

_____

_____

_____ [2]

(iii) For approximately how long is the force applied to the material being tested?

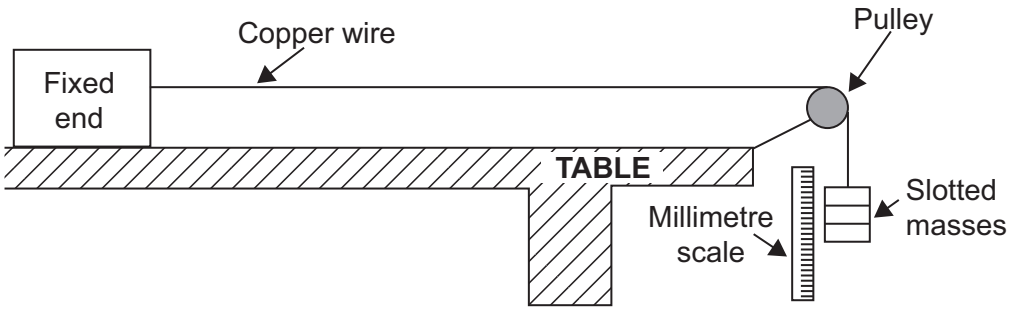
_____ [1]

(iv) What units may be used to express the Vickers Hardness Number?

_____ [1]

Examiner Only	
Marks	Remark

2 An unstretched copper wire is 2.00 m long and has a diameter of 0.28 mm. A student carries out an investigation on this wire to determine its Young Modulus. The student finds that a force of 5.50 N causes the wire to extend by 1.53 mm.



Source: Principal Examiner

Fig. 2.1

(i) Show **clearly** how it can be deduced that when the force in the wire is 5.50 N, the stress is approximately 8.93×10^7 N m^{-2}.

[4]

(ii) Calculate the strain in the wire.

You are advised to show your working.

Strain = _____ [3]

(iii) Calculate the Young Modulus for copper.

You are advised to show your working.

Young Modulus = _____ [4]

The student tests the wire to the point of fracture, **B**, and then sketches a graph of stress against strain.
The graph is shown below.

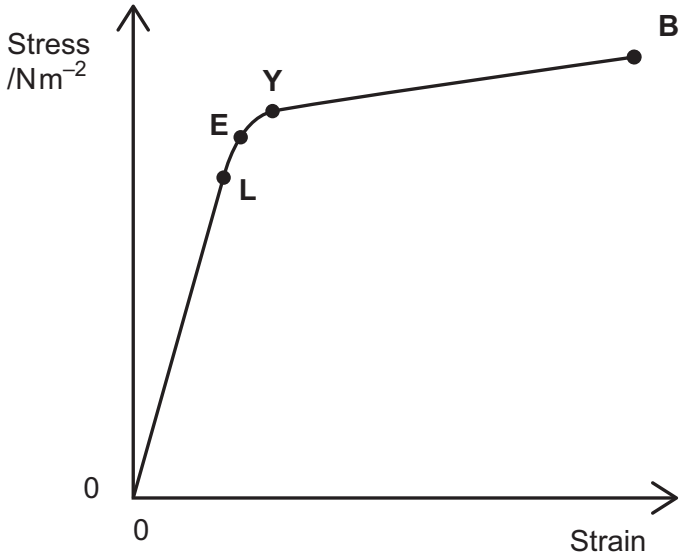


Fig. 2.2

(iv) Describe what is happening to the wire at points **L**, **E** and **Y**.

L: _____

_____ [1]

E: _____

_____ [1]

Y: _____

_____ [1]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

3 A laboratory has a supply of salt water solution of density 1.08 g cm^{-3}.

The density of pure water is 1.00 g cm^{-3}.

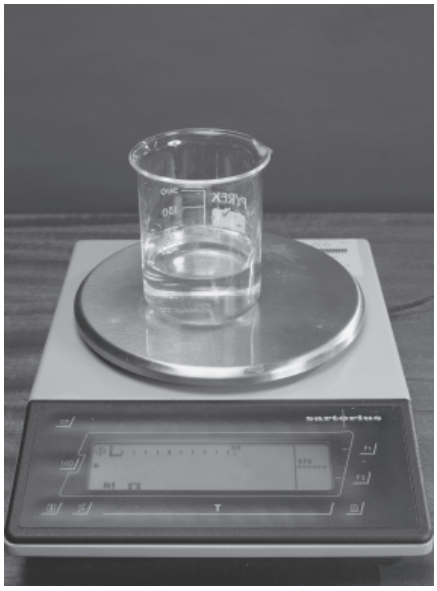


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Fig. 3.1

(i) Calculate the mass of salt present in 500 cm^3 of salt water solution of density 1.08 g cm^{-3}.

You may assume that there is no change in the volume of the solution when salt is added to water.

You are advised to show your working.

Mass of salt = _____ g [4]

Examiner Only	
Marks	Remark

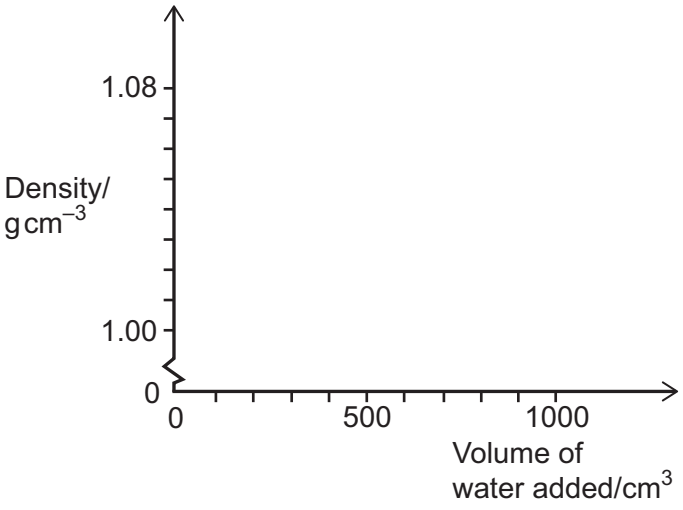
(ii) A technician is asked to prepare a solution of salt water of density $1.04\,g\,cm^{-3}$.
The technician does this by adding pure water to a $500\,cm^3$ sample of the salt water of density $1.08\,g\,cm^{-3}$.

Calculate how much additional pure water the technician must add, assuming the density of pure water is $1.00\,g\,cm^{-3}$.

You are advised to show your working.

Volume = _____ cm^3 [4]

(iii) Complete the graph below to illustrate how the density of the solution changes as increasing amounts of pure water are added to the solution.



[2]

Examiner Only	
Marks	Remark

4 **(a)** Graphite and graphene are two different forms of the same element.

(i) What is the **name** of the element?

_____ [1]

(ii) In the space below draw a diagram to show the structure of **graphite**.

[2]

(iii) In what way is the structure of **graphene** different from that of **graphite**?

_____

_____ [1]

(b) **(i)** Describe the structure of a carbon nanotube.

_____

_____ [1]

(ii) Suggest **two** properties of carbon nanotubes that make them particularly suitable in the treatment of cancer.

1. _____

2. _____ [2]

5 Alloys are sometimes prepared through the process of annealing.

State what is meant by an alloy and describe the process of annealing.
Explain the benefits of the annealing process.

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

Meaning of an **alloy**

Process of annealing

Explanation of benefits

[6]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

6 **(a)** What is meant by a biomaterial?

_____ [1]

Zirconia, also known as zirconium(IV) oxide, is a reliable bioinert material used extensively for dental implants.

(b) Describe fully what is meant by a bioinert material.

_____

_____ [2]

(c) Bioglass is a bioactive material used by bone surgeons to enhance bone formation after surgery. Such materials engage in ion transfer inside the patient where a fibrous capsule forms around the implant.

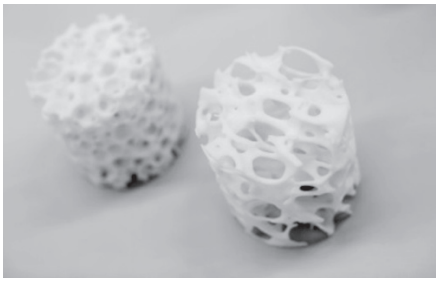


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Fig. 6.1

(i) Define the term bioactive.

_____

_____ [1]

Bioglass is commonly made of nanoparticles on the surface of a metal.

(ii) Approximately what size are nanoparticles?

_____ [1]

(d) When a patient has a section of jaw removed to treat a benign (non-cancerous) tumour, it is necessary to fit a surgical implant. Recommend an appropriate material which could be used to manufacture a suitable implant and suggest **two** reasons for your answer.

Material: _____

1. _____

_____

_____

2. _____

_____

_____ [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

7 Metals are generally excellent conductors of electricity.
This is due to the way that the particles within a metal are arranged.
Fig 7.1 below shows a simplified particle diagram for a metal.

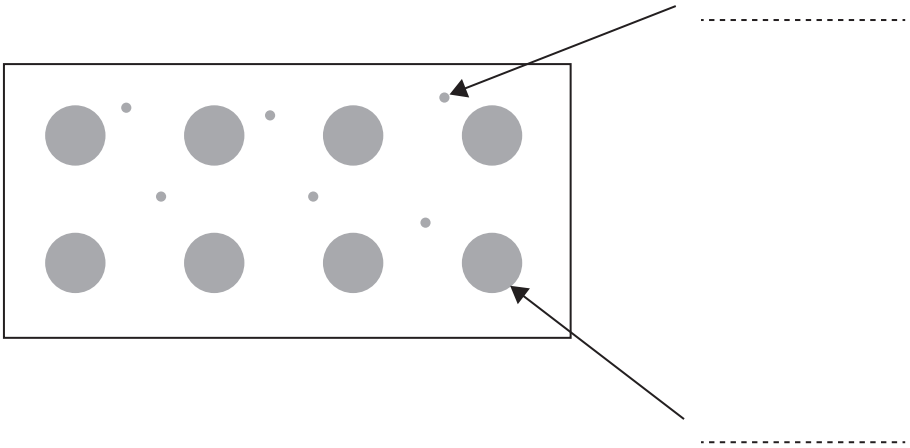


Fig. 7.1

(a) Complete **Fig 7.1** to identify the particles. [1]

(b) A neutral silicon atom has 14 electrons in total.

(i) Complete **Fig 7.2** below to show the electronic arrangement of the silicon atom.
Each electron should be represented as a dot in the appropriate shell. [1]

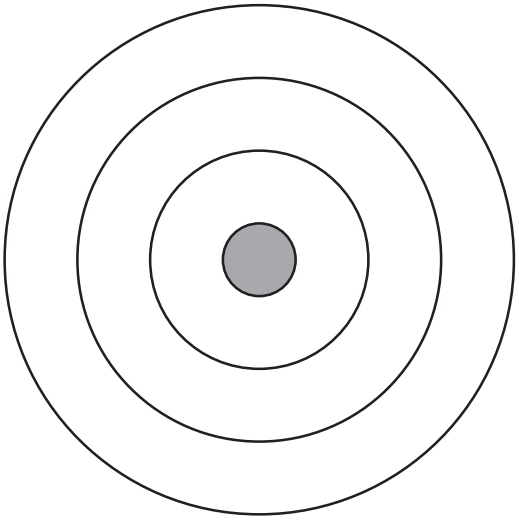


Fig. 7.2

(ii) Explain fully why pure silicon, at room temperature, is a poor conductor of electricity.

_____

_____ [2]

Both n-type and p-type silicon are better electrical conductors than pure silicon.

(iii) Tick (✓) the appropriate boxes in the table below to identify the majority electrical charge carriers in n-type and p-type silicon.

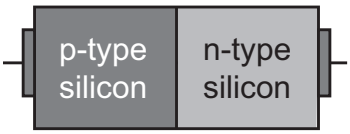
	n-type silicon	p-type silicon
Negative electrons		
Positive holes		
Negative holes		

[2]

(iv) What is added to pure silicon to change it into n-type silicon?

_____ [1]

(c) A PN junction diode consists of p-type silicon and n-type silicon joined together. At the PN junction the majority charge carriers combine to create a depletion layer.



PN junction diode

Fig 7.3

(i) Draw a circuit diagram showing a battery in series with a lamp and a diode in **reverse** bias.
Use the correct symbols for the three components.

[2]

(ii) Explain briefly why the diode does not conduct electricity when it is in **reverse** bias.

_____

_____

_____

_____

_____ [3]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

8 **(a)** **(i)** What is a polymer?

_____

_____ [1]

Some polymeric materials are called thermosets. Others are called thermoplastics.

(ii) Describe carefully the **differences** between thermosets and thermoplastics in terms of:

Response to heat

_____

_____

Molecular structures

_____

_____ [4]

(b) PVC, also known as poly (vinyl chloride) or poly (chloroethene) is a polymer. It comes in two forms: plasticised PVC and unplasticised PVC (uPVC).

uPVC is widely used to make sewage pipes.

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Fig. 8.1

(i) State two properties of **uPVC** that make it particularly suitable for this purpose.

1. _____

2. _____ [2]

Examiner Only	
Marks	Remark

(ii) State **two** common uses for **plasticised** PVC.

1. _____

2. _____ [2]

(c) Smart materials are finding increasing uses. For example, a quantum-tunnelling composite (QTC) is a flexible polymer which contains tiny metal particles.

(i) State **two** applications of QTCs.

1. _____

2. _____ [2]

(ii) A QTC is normally an electrical insulator. How can it be made to conduct?

_____ [1]

Spectacle frames often bend with misuse. Frames made of nitinol can return to their original shape on warming.

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Fig. 8.2

(iii) What specific type of smart material could be used to make nitinol spectacle frames?

_____ [1]

THIS IS THE END OF THE QUESTION PAPER