



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2025

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit AS 5

assessing

Material Science



[SZ051]

SZ051

THURSDAY 5 JUNE, 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.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete questions in black ink and use a dark HB pencil for drawings and graphs.

Do not write with a gel pen.

Answer **all seven** questions.

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 a scientific calculator.

Quality of written communication will be assessed in question **6(b)**.

14678



16SZ05101

1 (a) In industry, a manufacturer selects materials with the properties that best meet the needs of the user.

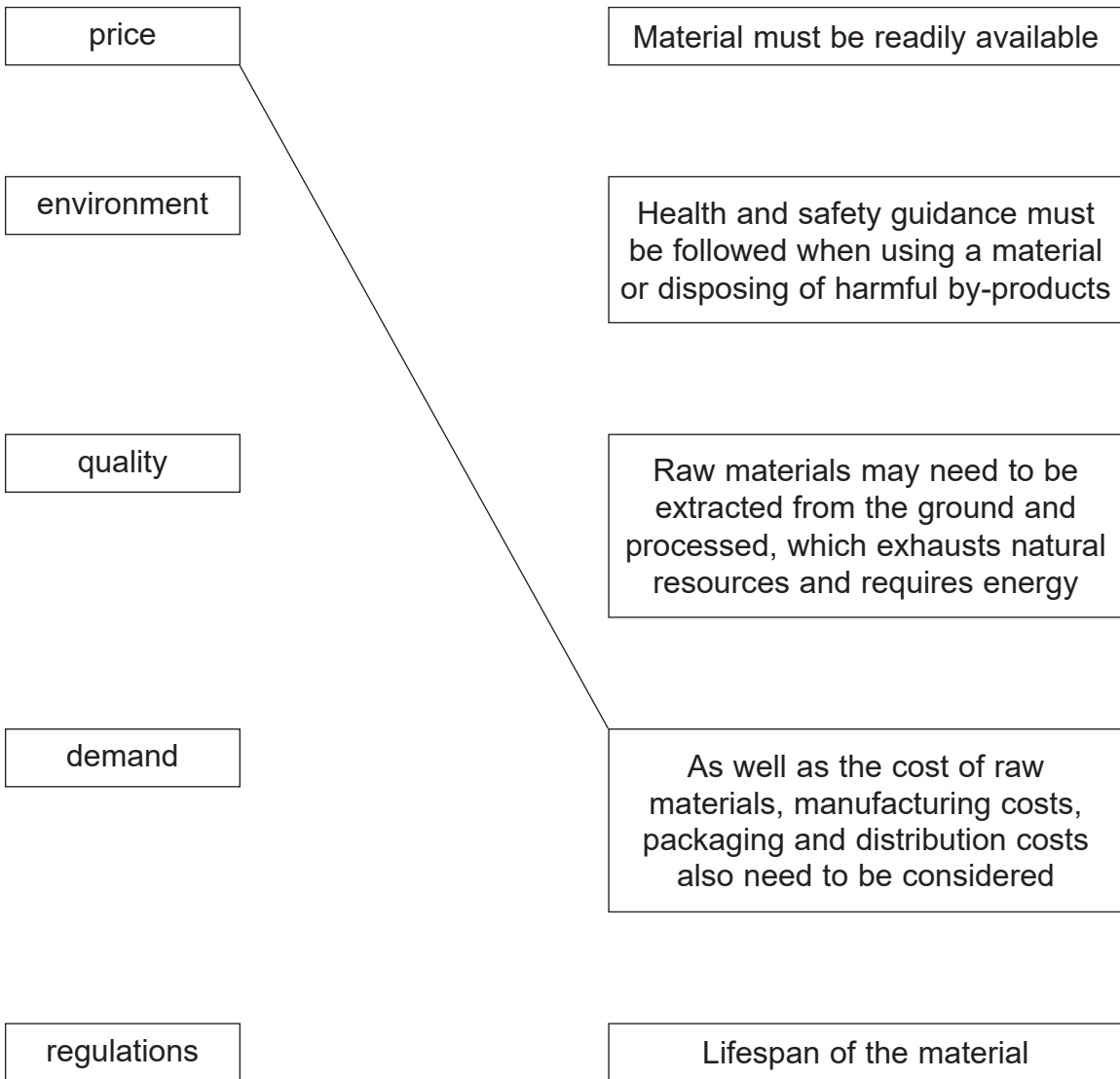
Factors that will influence the choice of material include price, environmental considerations, quality, demand and regulations.

Draw a straight line to link the external factors that influence the choice of material with one example of a consideration.

One example has already been completed for you.

EXTERNAL FACTORS

CONSIDERATIONS



[4]



(b) The Vickers Hardness Test is a method used to measure the hardness of a material.

In this test an object is pressed into a material to make an indentation.

(i) Describe fully the shape of the indenter.

_____ [2]

(ii) What material is the indenter made from?

_____ [1]

(iii) For how long is the indenter pressed on the material?

_____ [1]

(iv) What measurement is taken from the **material** to determine its hardness?

_____ [1]

(v) How does the hardness of the material affect the size of the indentation?

_____ [1]

(vi) Suggest a reason why a manufacturer might want to test the hardness of a material.

_____ [1]

[Turn over



2 The properties of **metallic materials** and **crystalline materials** are related to their microscopic structure.

(a) Complete the table by describing the microscopic structure which determines the properties of each of the materials listed below.

Material	Property	Microscopic structure
Metallic	Good conductors of heat	
Crystalline	Brittle	

[2]

(b) Polymers are composed of many simple molecules which are repeating structural units.

(i) What is the name given to these repeating structural units?

_____ [1]

Thermosetting and **thermoplastic** polymers have different molecular structures.

(ii) Describe the **difference** between the molecular structures of thermosetting and thermoplastic polymers.

_____ [1]



Thermosetting and thermoplastic materials have household and industrial uses, but only one of these materials is easily recyclable.

(iii) Which of these materials is easy to recycle?
Explain your answer.

Material most easily recycled _____

Explanation _____

[3]

(c) Glass and rubber are amorphous materials.

Describe the molecular structure of an amorphous material.

_____ [1]

(d) Crystalline structure can be examined using a polarising light microscope.

(i) Explain fully what is meant by the term **polarised light**.

_____ [2]

(ii) Suggest a reason why a polarising light microscope is used to study crystalline structure.

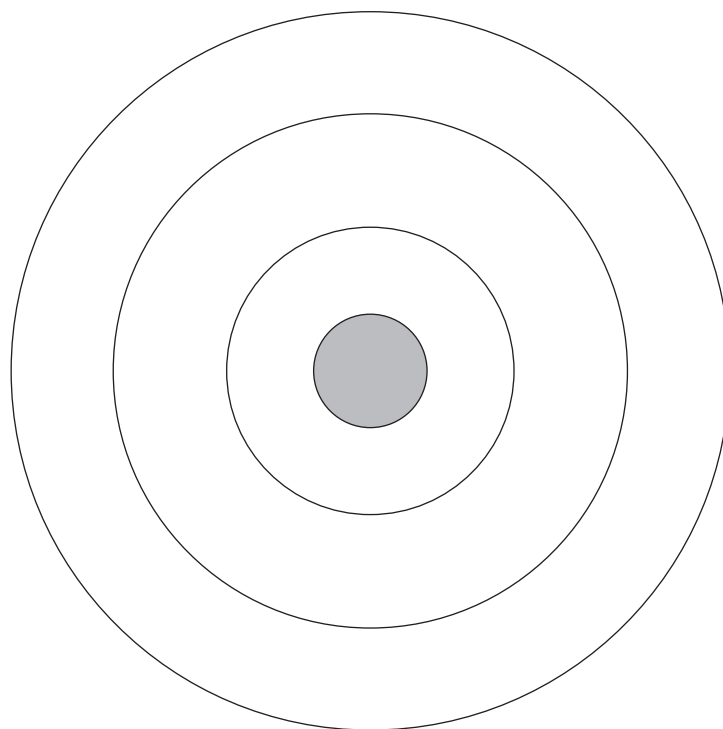
_____ [1]

[Turn over



3 An atom of element X has 13 protons and 14 neutrons.

(a) (i) Complete the diagram below to show the electronic arrangement of a neutral atom of element X.



[2]

(ii) Name the part of the atom where protons and neutrons are located.

[1]

Silicon is a poor conductor at low temperatures.
Small amounts of element X are added to pure silicon to increase its ability to conduct.
This process is called doping.

(iii) Why is silicon a poor conductor of electricity at low temperatures?

[1]



(iv) Identify the type of semiconductor material that can be made using element X.

Place a tick (✓) in one of the boxes below.

P-type

N-type

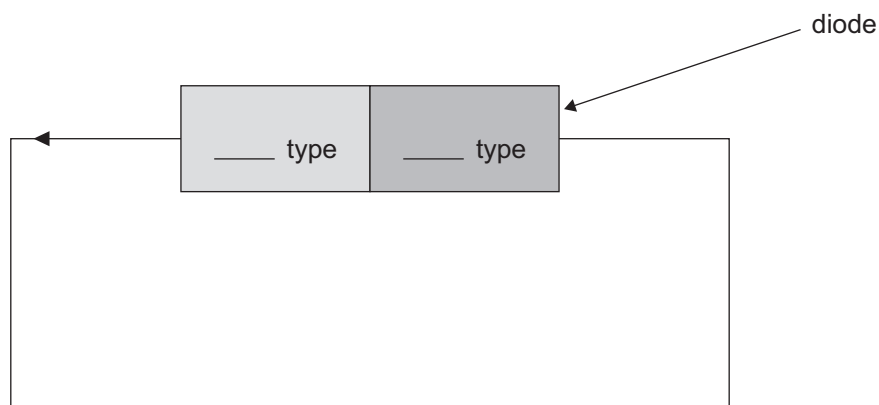
Explain your answer.

[3]

(b) When p-type and n-type are joined together they form a diode which can conduct electricity in only one direction.

A simplified diagram of a diode is shown below.

The direction of the current when in **forward bias** is shown.



(i) Complete the circuit diagram by adding a cell.

[1]

(ii) Label the p-type **P** and the n-type **N** silicon in the circuit diagram above.

[1]



- 4 Smart materials are materials which have physical properties that change in response to an external condition.
The change in smart materials is reversible and can be repeated many times.

The table below shows three examples of smart materials.

Complete the table to show the property that changes, the external condition that causes the change and a use of the smart material.

The first row has been completed for you.

Smart material	Property that changes	External condition	Use
Piezoelectric	Produces a voltage	Applied force	Sensor mat
Electroluminescent			
Quantum-tunnelling composites			

[6]



5 Steel and stainless steel are alloys which can be annealed.

(a) (i) What is an **alloy**?

[2]

(ii) Briefly describe the process of annealing.

[2]

(iii) Suggest one benefit of annealing steel alloys.

[1]

(b) Steel and stainless steel contain different percentages of iron.

State another difference in the main materials used to make steel and stainless steel.

[2]

[Turn over



- (c) Nichrome, invar, bronze and brass are other examples of alloys. The table below shows typical values for some of the physical properties of each alloy.

Alloy	Melting point /°C	Electrical conductivity /MSm ⁻¹	Young modulus /GPa	Density /kgm ⁻³	Tensile strength /MPa
Nichrome	1710	0.91	245	8650	2300
Invar	1430	1.3	141	8050	490
Bronze	950	14	70	8900	635
Brass	996	16	90	8730	469

Each of the alloys in the table above is used to make different wires with exactly the same dimensions.

- (i) A 500 N stretching force is applied to the ends of each wire. In each case the stretching is elastic.

Which wire which will have the largest extension?

Place a tick (✓) in one of the boxes below to show the correct alloy.

Nichrome Invar Bronze Brass [1]

- (ii) Which wire can withstand the greatest stretching force without breaking?

Place a tick (✓) in one of the boxes below to show the correct alloy.

Nichrome Invar Bronze Brass [1]



(iii) Some wires are chosen to provide an electrical heating circuit.

Which wire will be the best choice to use as resistance wire in an electrical heating circuit?

Place a tick (✓) in one of the boxes below to show the correct alloy.

Nichrome Invar Bronze Brass [1]

(iv) Each wire is 1.5 m long and has a diameter of 0.32 mm.

Calculate the volume of each wire.

Show your working out.

Volume = _____ m³ [3]

(v) Use your answer to (iv) to calculate the mass of the wire made from brass.

Show your working out.

Mass = _____ kg [3]

[Turn over



6 Both graphene and graphite are allotropes of carbon, but they have different structures.

(a) (i) Describe one similarity and one difference between the structures of graphene and graphite.

Similarity _____

Difference _____

_____ [2]

(ii) What is a nanomaterial?

_____ [1]

(iii) Name the allotrope used to form a carbon nanotube.

_____ [1]

(iv) Describe the shape of a carbon nanotube.

_____ [1]



(b) Carbon nanotubes are used to penetrate cell membranes to deliver drugs directly into cells.

Evaluate the benefits and risks of using carbon nanotubes in healthcare.

Include the following in your discussion:

- two physical properties of carbon nanotubes which make them useful for the delivery of drugs;
- two other uses of carbon nanotubes in healthcare; and
- two potential risks of using carbon nanotubes in medicine.

In this question you will be assessed on the quality of your written communication skills, including the use of specialist scientific terms.

Two physical properties

Two other uses

Two potential risks

[6]

[Turn over

14678



16SZ05113

- 7 In an experiment, a length of copper wire was stretched.
The initial length of the copper wire was 250 cm.
When a force of 300 N was applied to the wire, the new length was 255 cm.
The cross-sectional area of the wire was $1.13 \times 10^{-7} \text{ m}^2$.

(a) (i) Calculate the value of the stress on the copper wire.

Give your answer to 3 significant figures.

Include a unit with your answer.

Show your working out.

Stress = _____ Unit = _____ [4]

(ii) Calculate the value of the strain on the copper wire.

Show your working out.

Strain = _____ [3]

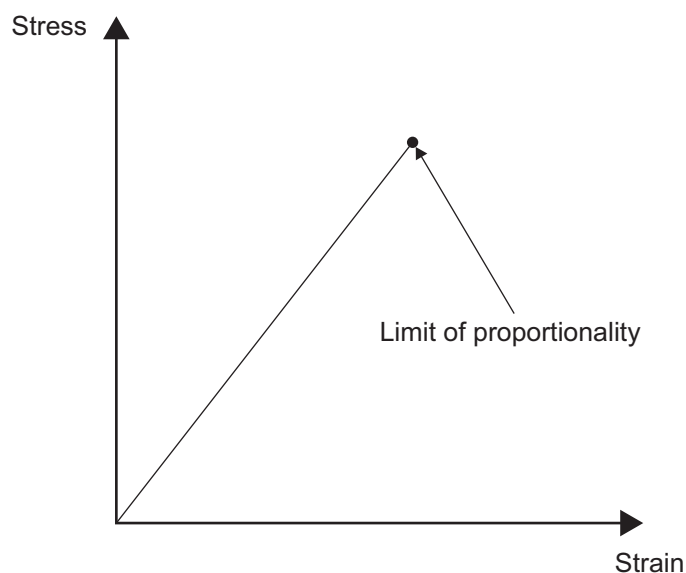


(iii) Calculate the Young modulus for copper.

Show your working out.

Young modulus = _____ Pa [3]

(b) The copper wire was extended further until the wire snapped. Continue the graph below to show its shape beyond the limit of proportionality.



[1]

THIS IS THE END OF THE QUESTION PAPER



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Question Number	Marks
1	
2	
3	
4	
5	
6	
7	

Total Marks	
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Examiner Number

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