



Rewarding Learning  
ADVANCED SUBSIDIARY (AS)  
General Certificate of Education  
2022

Centre Number

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Candidate Number

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# Life and Health Sciences

Assessment Unit AS 5  
*assessing*

Material Science

[SZ051]

TUESDAY 14 JUNE, MORNING



SZ051

## 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 **8(b)**.

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

Total Marks	
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1 The table below shows a set of results for an experiment carried out by a group of pupils using a piece of metallic wire of length 1.6 m and diameter 1.4 mm.

Examiner Only	
Marks	Remark

Tension /N	Stress /Pa	Extension /mm	Strain
0	0	0.00	0
100	$64.9 \times 10^6$	0.14	$87.5 \times 10^{-6}$
200	$130 \times 10^6$	0.28	$175 \times 10^{-6}$
300	$195 \times 10^6$	0.42	$263 \times 10^{-6}$
400	$260 \times 10^6$	0.56	$350 \times 10^{-6}$
500		0.70	

(i) Show that the cross-sectional area of a metal wire of length 1.6 m and diameter 1.4 mm is  $1.54 \times 10^{-6} \text{m}^2$ .

**You are advised to show your working out.**

[2]

(ii) In the box below, write in words the formula the student could use to calculate stress.

Stress =

[1]

(iii) In the box below, write in words the formula the student could use to calculate strain.

Strain =

[1]

(iv) Calculate the missing value for stress and strain in the table opposite.

Insert these values in the table correct to **three significant figures**.

[2]

Examiner Only	
Marks	Remark

(v) Using the completed table, plot a graph of stress against strain on the grid opposite.

Label the vertical axis, include an appropriate unit and select a suitable scale.

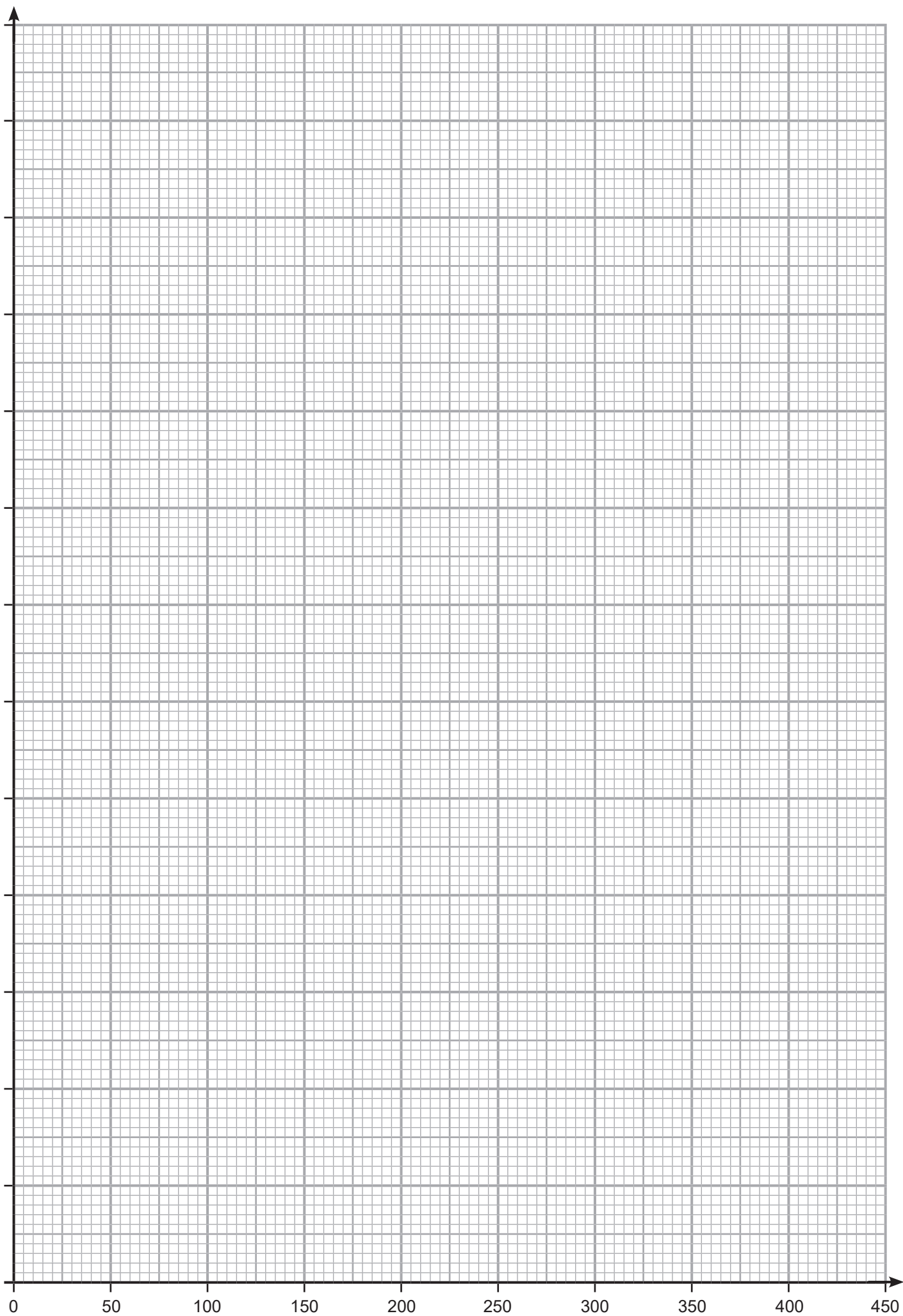
Draw the best-fit straight line. [5]

(vi) Use your graph to determine the Young Modulus.

Remember to include the appropriate unit.

Young Modulus \_\_\_\_\_ [4]

Examiner Only	
Marks	Remark



2 (a) The table below shows different categories in which materials can be grouped.

Complete the table by choosing the example of material from the list below that best matches each category.

State a property suited to your chosen example.

The first one has been done for you.

Examples:

**casserole dish      electrical wiring      fire-brick**  
**fibreglass boat      parachute**

Category	Example of Material	Property
Ceramic	fire-brick	low thermal conductivity
Polymer		
Metal		
Glass		
Composite		

[4]

Examiner Only	
Marks	Remark







4 (a) What is a polymer?

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[1]

(b) Compare the differences between thermosets (thermosetting plastics) and thermoplastics in terms of:

(i) Molecular structures

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[1]

(ii) Response to heat

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[1]

Examiner Only	
Marks	Remark





(b) Which of the following substances has the greatest density if:

Substance A has a density of  $5 \times 10^{-3} \text{ kg cm}^{-3}$

Substance B has a density of  $5 \times 10^2 \text{ mg cm}^{-3}$

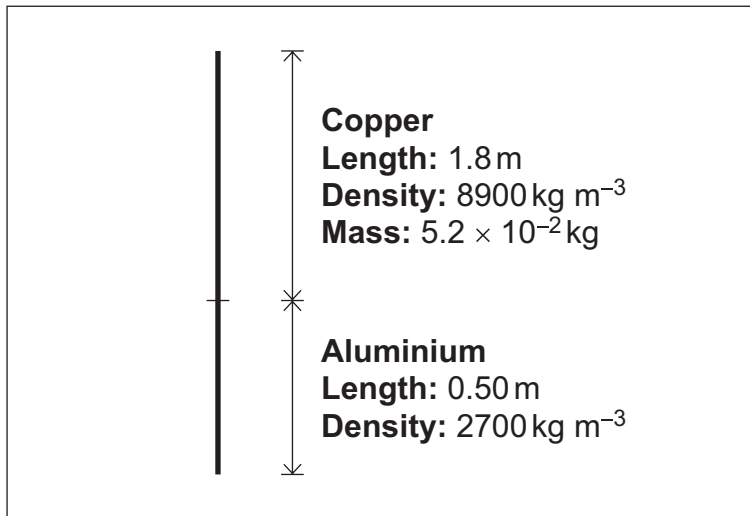
Substance C has a density of  $5 \times 10^{-2} \text{ g cm}^{-3}$

Substance \_\_\_\_\_ [1]

Examiner Only	
Marks	Remark

(c) The diagram below shows two lengths of wire joined together.

Each wire has a cross-sectional area of  $3.2 \times 10^{-6} \text{ m}^2$ .



Calculate the **total mass** of the combined wire to **two significant figures**.

You are advised to show your working out.

Total mass: \_\_\_\_\_ kg [4]

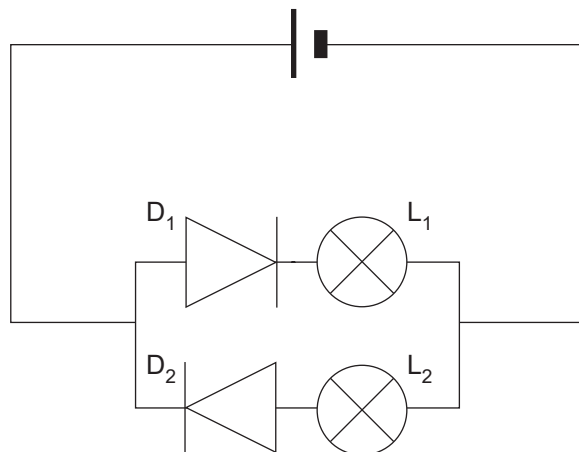
Examiner Only	
Marks	Remark

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**(Questions continue overleaf)**



(c) The circuit below shows two bulbs and two diodes in parallel.



(i) What is the effect of the diodes on lamps  $L_1$  and  $L_2$  in the circuit above?

$L_1$ : \_\_\_\_\_

$L_2$ : \_\_\_\_\_ [1]

(ii) In what state of bias are the diodes  $D_1$  and  $D_2$  in the circuit above?

$D_1$ : \_\_\_\_\_

$D_2$ : \_\_\_\_\_ [1]

(iii) Describe and explain the movement of free electrons and positive holes in diode  $D_1$ .

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

8 In modern construction, steel is commonly used to provide the primary structural support for walls, floors and roofs.

An alternative material for structural support in buildings is concrete.

(a) Some materials used in construction are composites. Explain the term 'composite'.

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[1]

(b) Study the information in the table below.

	Steel	Concrete
<b>Tensile strength /MPa</b>	560~670	2~5
<b>Density /kg m<sup>-3</sup></b>	7850	2300
<b>Ductility</b>	High	Low
<b>Compression</b>	Weaker than concrete	Stronger than steel
<b>Tension</b>	Strong	Weak
<b>Environmental considerations</b>	Fabrication carried out at factory i.e. possibly a distance away from site	Can be mixed on site i.e. minimum energy needed to transport to site

Evaluate the factors that influence the choice of material for the construction of a newly built multi-storey office block in the city.

Your answer should include:

- a definition of tensile strength and a comparison between steel and concrete;
- a definition of ductility and what this means in terms of steel and concrete;
- a brief explanation of the importance of environmental considerations;
- another factor, not listed in the table, which is important to consider when choosing the most suitable material for this purpose and why;
- the material(s) you would choose for the construction of the office block and why.

**Quality of written communication will be assessed in this question.**

Examiner Only

Marks Remark











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