



Rewarding Learning
ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

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Candidate Number

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Life and Health Sciences

Assessment Unit AS 5
assessing

Material Science

[SZ051]

FRIDAY 24 MAY, AFTERNOON



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 **7(a)**.

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

Total Marks	
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(Questions continue overleaf)

- 2 The table below shows a set of results for an experiment using a piece of metallic wire of length 1.2 m and diameter 1.8 mm.

Tension, T /N	Extension, x /mm
0	0.00
100	0.18
200	0.42
300	0.60
400	0.82
500	1.00
600	1.24

- (a) Using the grid on the following page, plot a graph of tension against extension.

Label the horizontal axis and select a suitable scale.

Draw the best-fit straight line.

[5]

- (b) Find the gradient of the graph, in Nm^{-1} .

You are advised to show your working.

_____ Nm^{-1} [3]

- (c) Determine the cross-sectional area of the metallic wire, in m^2 .

You are advised to show your working.

Cross-sectional area: _____ m^2 [2]

Examiner Only

Marks

Remark

3 Carbon nanotubes have a number of potential uses in healthcare.

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

_____ [2]

(ii) State **two** other uses of nanotubes in healthcare.

1. _____
2. _____ [2]

(iii) Suggest **two** physical properties of nanotubes which make them suitable for the uses stated in your answer to (a)(ii).

_____ [2]

Examiner Only	
Marks	Remark

- 5 (a) Describe the Bohr model of the atom in terms of the names, locations and charges of the particles involved.

 [3]

- (b) Plastics are divided into the two categories of thermoplastics and thermosets (thermosetting plastics), with each type having different properties.

- (i) What is the difference in microscopic structure between thermoplastics and thermosets?

Thermoplastics: _____

Thermosets: _____

 [2]

- (ii) State one property for each of the following:

Thermoplastics

Thermosets

 [2]

- (iii) Complete the table below by placing one tick in the correct box for each use.

Use	Thermoplastic	Thermoset
Electrical insulation		
Plastic bottle		

[2]

Examiner Only

Marks Remark

6 (a) What is an alloy?

[2]

(b) The table below shows some main constituent materials and some alloys with a relevant common use.

Complete the table by filling in the empty boxes.

Main Constituent Materials	Alloy	Common Use
	Brass	
Iron & Chromium		Saucepans
	Nichrome	
Iron & Carbon		Construction

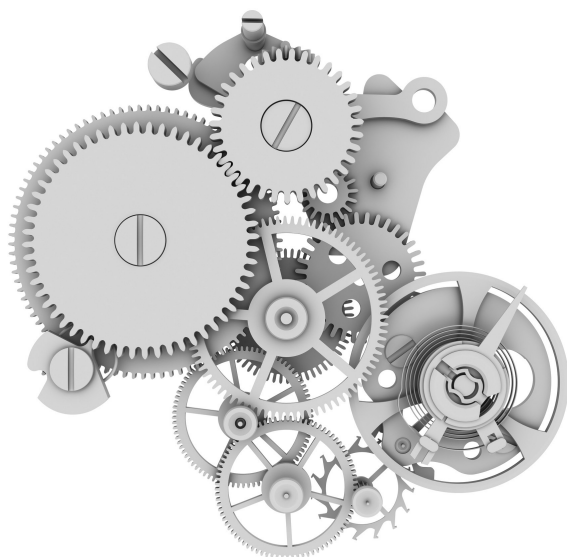
[6]

Examiner Only	
Marks	Remark

(c) **Fig. 6.1** shows the mechanical movement of a wristwatch. Its movement has two important components: a balance wheel and a hairspring.

The accuracy of a watch is influenced by changes in temperature. An increase in temperature produces a slight increase in the diameter of the balance wheel, which causes the wheel to oscillate more slowly and the watch to lose time.

Inaccuracies may be reduced by using a low-expansion alloy for the balance wheel.



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Fig. 6.1

The coefficient of thermal expansion is the fractional increase in the length when the temperature rises by 1 °C.

(i) From the table below, choose the best alloy for the balance wheel and explain your answer.

Low Expansion Alloy	Coefficient of Thermal Expansion / °C ⁻¹	Cost / £kg ⁻¹	Density / gcm ⁻³
Invar	1.6×10^{-6}	36.00	8.05
Super Invar	7.2×10^{-7}	40.00	8.15
Kovar	5.1×10^{-6}	42.00	8.36

Choice of alloy _____

Reason for your choice.

 _____ [2]

Examiner Only	
Marks	Remark

(ii) What other property, not shown in the table on page 11, should be considered when choosing the best alloy for the balance wheel?

_____ [1]

(d) The hairspring is a flat spiral spring.

It was originally made from steel but more recently it has been made from glass.

Suggest one advantage and one disadvantage of using glass for this purpose.

Advantage _____

Disadvantage _____

_____ [2]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

(b) A smart material is one in which the property of the material can change when there is a change to its surroundings. A number of examples of the uses of smart materials are:

- contact thermometers
- security markers
- spectacle frames
- touch screens on mobile phones

Complete the following table by choosing from the above list the most suitable example for each smart material.

State a feature which makes the smart material best suited to the chosen example.

Smart Material	Chosen example from above list	Feature
Photochromatic Material		
Shape Memory Alloy		
Thermochromatic Material		

[6]

Examiner Only	
Marks	Remark

8 Bronze is an alloy. It consists of 88% copper and 12% tin **by volume**.



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Fig. 8.1

A sculptor needs to determine the density of bronze used to make a statue.

Density of Copper / gcm^{-3}	Density of Tin / gcm^{-3}	Volume of Bronze Sculpture / cm^3
8.94	7.17	28750

Use the information in the table above to complete the following calculations.

For each part you are advised to show your working.

(a) Determine the volume of copper required to make a statue of bronze.

_____ cm^3 [1]

(b) Calculate the mass of copper required to make this statue.

_____ g [3]

Examiner Only

Marks Remark

- (c) By first finding the volume and mass of tin in this statue, calculate the density of bronze.

Give your answer to three significant figures.

Volume of tin _____ cm^3

Mass of tin _____ g

Density of bronze _____ gcm^{-3} [4]

Examiner Only

Marks Remark

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