Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**
**General Certificate of Education**
**2018**

# Life and Health Sciences

## Assessment Unit AS 5

*assessing*

Material Science

**[SZ051]**

**MONDAY 21 MAY, AFTERNOON**

# MARK SCHEME

## General Marking Instructions

### Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

### The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

| | | | | | AVAILABLE MARKS |
|---|---|---|---|---|---|
| **1** | **(a)** | **(i)** | Nucleus | [1] | |
| | | **(ii)** | Same number of positive/protons as negative/electrons<br>or 15 protons and 15 electrons | [1] | |
| | | **(iii)** | X in 2.8.5 pattern | [1] | |
| | | **(iv)** | Non-metal [1]<br>Does not have 1, 2 or 3 electrons in outer shell [1]<br>Accept "has 5 electrons in outer shell" | [2] | |
| | **(b)** | | Any **four** from:<br>Metals have delocalised/free electrons<br>(Delocalised) electrons absorb kinetic energy from the flame (at A)<br>(Delocalised) electrons move rapidly (and randomly) throughout rod<br>(Delocalised) electrons collide with vibrating (lattice) atoms/ions<br>Collisions increase vibration frequency/amplitude/KE of lattice ions<br>**or** cause more vigorous vibrations<br>This increase in KE is observed as an increase in temperature (at B) | [4] | 9 |
| **2** | **(a)** | **(i)** | Conductivity = length/(resistance × cross section area) | [1] | |
| | | **(ii)** | $Sm^{-1}$ **or** Mho $m^{-1}$ **or** $\Omega^{-1}$ $m^{-1}$ **or** in words, e.g. Siemens per metre | [1] | |
| | **(b)** | | **Indicative Content**<br>• Measure resistance with ohmmeter/voltage and current with voltmeter and ammeter<br>• Measure length using metre stick or ruler<br>• Measure diameter using micrometer<br><br>Reliability and accuracy [Any **two**]:<br>Repeat readings (of diameter)/long length of wire/no kinks in wire<br><br>• Average<br>Calculation [Any **one**]:<br>• $A = \pi \frac{d^2}{4}$ **or** $\pi r^2$<br>• $R = \frac{V}{I}$ | | |

| Response | Marks |
|---|---|
| Candidates identify clearly 5 or more of the points shown in the indicative content. There is widespread and accurate use of appropriate scientific terminology. Presentation, spelling, punctuation and grammar are excellent. They use the most appropriate form and style of writing. Relevant material is organised with clarity and coherence. | [5]–[6] |
| Candidates identify clearly between 3 and 4 of the points shown in the indicative content. There is good use of scientific terminology. Presentation, spelling, punctuation and grammar are sufficiently competent to make meaning clear. They use an appropriate form and style of writing. There is some attempt to organise material. | [3]–[4] |
| Candidates identify clearly at least 1 of the points shown in the indicative content. There is limited use of scientific terminology. Presentation, spelling, punctuation and grammar may contain some errors. The form and style are of a satisfactory standard. There is only a limited attempt to organise material. | [1]–[2] |
| Response is not worthy of credit | [0] |

AVAILABLE MARKS

[6] 8

**3** **(a)** **(i)** A [1]

**(ii)** C [1]

**(iii)** A [1]

**(b)** **(i)** Stress, $\sigma$ = F/A (or equivalent) [1]
= $120/3 \times 10^{-4}$ [1]
= $4 \times 10^{5}$ [1] [3]

**(ii)** Strain, $\varepsilon$ = $\sigma$/E (or equivalent) [1]
= $4 \times 10^{5}/7 \times 10^{10}$ (ecf for $\sigma$ from part **(b)(i)**) [1]
= $5.7(1) \times 10^{-6}$ [1] [3]

**(iii)** Extension = L × $\varepsilon$ (or equivalent) [1]
= $1.1 \times 5.71 \times 10^{-6}$(m) ecf from **(ii)** [1]
= $6.28/6.29 \times 10^{-6}$m [1] [3] 12

**4** **(a)** **(i)** Volume = Mass/Density (or equivalent) [1]
= 75.0/19.3 [1] [2]
( ≈ 3.89 $cm^3$)

**(ii)** Volume = 6.69 [1]
Density = 14.9 (g $cm^{-3}$) [1] [2]

**(iii)** Density = $19.3 \times 10^{-3}/1 \times 10^{-6}$ [1]
= 19300 (kg $m^{-3}$) [1] [2]

**(b)** **(i)** Change in shape when force is applied over time [2]

**(ii)** Creep can cause structural components to fail/break (e.g. turbine blades in aircraft or similar examples)/buckling of concrete. [1]

**(iii)** Fatigue [1]

| | | | | | AVAILABLE MARKS |
|---|---|---|---|---|---|
| **(c)** | **(i)** | It combines (the properties of) two (or more) materials to form a better, more useful **or** improved product **or** one with better properties | [1]<br>[1] | [2] | |
| | **(ii)** | Carbon fibre reinforced plastic is less dense/lighter than steel/aluminium<br>So aircraft needs less fuel or is more efficient | [1]<br>[1] | [2] | |
| | **(iii)** | Any **one** from:<br>Idea of high (initial) cost<br>Can be complicated to fabricate | | [1] | 15 |
| **5** | **(a)** | Description:<br>Thermoplastics become pliable/mouldable/melt above a specific temperature (when heated)<br>Thermosets do not melt **or** thermosets decompose/char | [1]<br>[1] | [2] | |
| | | Explanation<br>Thermoplastics –<br>Each polymer chain is independent of the other **or** there are no cross links between chains.<br>Becomes pliable/melts as crystalline structure disappears | [1]<br>[1] | | |
| | | Thermosets –<br>Polymer chains are (chemically) cross-linked which prevents slippage (of individual chains).<br>The mechanical properties (tensile strength, compressive strength, and hardness) are not temperature dependent **or**<br>Decomposition occurs when temperature is high enough | [1]<br>[1] | [4] | |
| | **(b)** | **Thermosets**<br>Bakelite – (old) telephones, radio/TV casings, musical instruments, door knobs, jewellery, toys<br>Epoxy resin – casting and encapsulation, adhesives, bonding of other materials<br>Melamine – laminates for work surfaces, electrical insulation, tableware<br>Polyester resin – casting and encapsulation, bonding of other materials<br>Urea formaldehyde – Electrical fittings, handles, control knobs, adhesives | | [1] | |
| | | **Thermoplastic**<br>Nylon (polyamide) – bearings, gear wheels, casings, hinges, curtain rails, clothing etc.<br>Acrylic (polymethyl methacrylate) – Signs, aircraft canopies/windows, light covers, wash basins, baths<br>Polypropylene – Medical equipment, lab equipment, plastic seats, string, rope, kitchen equipment<br>Polystyrene – toys (modelling kits), plastic boxes (for take-away food), packaging, containers, drink cups<br>Low Density polythene LDPE – bottles, toys, packaging film, bags<br>High Density polythene HDPE – plastic bottles, tubing, household equipment | | [1] | |
| | **(c)** | **(i)** In unpolarised light the vibrations occur in every possible plane (perpendicular to the direction of the light propagation).<br>In polarised light the vibrations are confined to a single plane (perpendicular to the direction of the light propagation).<br>(Allow “direction” instead of “plane”) | [1]<br>[1] | [2] | |
| | | **(ii)** To examine crystal structure | | [1] | 11 |

| | | | | | | AVAILABLE MARKS |
|---|---|---|---|---|---|---|
| **6** | **(a)** | | | | | |

| Material | Main Metal | Second Metal | |
|---|---|---|---|
| Brass | | **Zinc** | [1] |
| Stainless steel | | **Chromium** | [1] |
| Bronze | **Copper** | | [1] |

[3]

**(b)** **(i)** Annealing [1]

**(ii)** Metal is **heated** [1] to **above its recrystallisation temperature** [1]
And then the metal is **slowly** allowed to cool [1] [3]

**(c)** It can be drawn into wire [1] — 8

**7** **(a)** **(i)** Graphene [1]

**(ii)** Sheet of graphene curved into a closed cylinder/tube [1]

**(b)** Any **three** from:
Biosensors (e.g. nitric oxide sensors, bio stress sensors, glucose detection biosensors, cancer detection/diagnosis)
drug delivery
selective cancer cell destruction
blood toxins removal (dialysis replacement therapy) [3] — 5

**8** **(a)** N-type silicon is doped with a Group V element or named Group V element (e.g. phosphorus) [1]
P-type silicon is doped with a Group III element or named Group III element (e.g. aluminium) [1] [2]

**(b)** **(i)** Reverse bias occurs when the n-type material (or cathode) is connected to positive terminal [1]
and p-type material (or anode) is connected to negative terminal of a battery [1] [2]

**(ii)** Depletion layer increases in width in reverse bias [1]

**(iii)** Electrons in n-type material are pulled away from depletion layer/towards battery positive terminal [1]
Positive holes in p-type material are pulled away from depletion layer/towards battery negative terminal [1] [2] — 7

**Total** — **75**