Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2023

Life and Health Sciences

Assessment Unit AS 5
assessing
Material Science

[SZ051]

THURSDAY 8 JUNE, MORNING

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)**	$\mu = \frac{12}{30}$ [1] and [1]		
			= 0.4 [1]	[3]	
		(ii)	No unit	[1]	
	(b)	**(i)**	Vickers (method)	[1]	
		(ii)	Diamond	[1]	
		(iii)	Between 10 N and 1000 N	[1]	
		(iv)	10~15 seconds	[1]	
		(v)	Any **one** from: • Average of the lengths of two diagonals of indentation left on the surface of material (d_1 & d_2) • Area (of sloping surface) of indentation	[1]	
		(vi)	(Hardness =) force load ÷ area (of indentation) or Hardness = $1.854\left(\frac{f}{d^2}\right)$	[1]	10

			AVAILABLE MARKS
2	**(i)**	$L_o = \Delta L/\text{strain}$ (or equivalent) [1] Conversion ΔL mm $\rightarrow$ m [1] (or carried out at the end) $L_o = \dfrac{1.35 \times 10^{-3}}{9.64 \times 10^{-4}}$ [1] $L_o = 1.40$ (m) [1] [4]	
	(ii)	Metre rule(rs)/tape measure [1]	
	(iii)	$d = \sqrt{(4A/\pi)}$ (or equivalent) [1] $d = \sqrt{((4 \times (6.16 \times 10^{-8)}))/\pi}$ [1] $d = 2.80 \times 10^{-4}$ (m) [1] $d = 0.28$ (mm) [1] [4]	
	(iv)	Micrometer screw gauge [1]	
	(v)	stress = F/A [1] stress $= \dfrac{5.50}{6.16 \times 10^{-8}}$ [1] stress $= 8.93 \times 10^{7}$ [1] E = stress/strain (or substitution as below) $(E = \dfrac{8.93 \times 10^{7}}{9.64 \times 10^{-4}})$ [1] $E = 9.26 \times 10^{10}$ (Pa) [1] [5]	15

AVAILABLE MARKS

3 **(a)**

Property	Category of material			
	metals	ceramics	glasses	polymers
Chemically resistant				
Good conductor of electricity	✓			
Good thermal insulator		✓	✓	✓
Brittle		✓	✓	

[1] [1] [1]

Exact answer required for each mark [3]

(b) Metals – Crystalline **or** regular/ordered arrangement (of particles)

Glass – Amorphous **or** no regular arrangement (of particles) [2]

(c) Thermoplastic – Threshold

No crosslinks [2]
(cannot accept chemical resistant or lightweight as they are also for thermosets)

(d) **(i)** The deformation (change in shape) that occurs when a force is applied on a material over time [1]

(ii) The deformation that occurs when a material is repeatedly being stressed and having the stress removed [1]

(e) Expensive/high (initial) cost/can be complicated to fabricate [1]

(f) **(i)** Vibrations are confined to a single plane, (perpendicular to the direction of the light propagation) [1]

(ii) Improves contrast/image quality [1] 12

				AVAILABLE MARKS
4	**(i)**	• A mixture of two (or more) elements, • of which (at least) one is a metal.	[2]	
	(ii)	Any **two**: ([1] for each correct line) (correct for the particular alloy) Steel – Iron and carbon (and others)/Steel and Chromium – Car bodies/bridges/ships Stainless steel – Iron and chromium (and others) – Medical tools/machine parts/cutlery Bronze – Copper and tin – Statues/bells/ships' propellers Brass – Copper and zinc – Musical instruments/door locks/bolts Nichrome – Nickel and chromium – Flame test wires/heating elements	[6]	8

5 Indicative Content

Definition:
A material in which the property can change when there is a change to the surroundings

Feature:
Give out light when a small electric **current** is applied to them/have a low power consumption

Comparison:
Thermochromatic – change colour in response to a change in temperature
Photochromatic – change colour in response to a change in light
The colour change is temporary/reversible

Other types:
Any **two** from:
SMA
QTCs
Piezoelectric materials

Response	Marks
Candidates describe 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 describe clearly **3 or 4** of the points shown in the indicative content. There is good reference 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 **1 or 2** of the points shown in the indicative content. There is limited reference 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

			AVAILABLE MARKS
6	**(i)**	$\rho = m/V$ **or** $m = \rho V$ [1]	
		mass of A = 7850 × 6.4 = 50 240 (kg) [1]	
		mass of B = 8900 × 3.6 = 32 040 (kg) [1]	
		mass of C = 82 280 (kg) [1] [4]	
	(ii)	Total V = 6.4 + 3.6 = 10 [1]	
		ρ = 82 280 / 10 allow e.c.f. from **(i)** [1]	
		= 8228 (kgm^{-3})(accept 8200 or 8230) [1]	
		or	
		$\rho = (\rho_A V_A + \rho_B V_B) / V_{TOTAL}$ [1]	
		correct subs [1]	
		ρ = 8228 (kgm^{-3}) [1] [3]	
	(iii)	8.228 (gcm^{-3})(accept 8.2, 8.23 or 8.230)	
		allow e.c.f. from **(ii)** [1]	
	(iv)	No effect [1]	9

				AVAILABLE MARKS
7	**(a)**	Any **two** from: • Chemically unreactive • High melting point • Malleable/can be bent/worked	[2]	
	(b)	(Any **two** with correct description) • Price Affordable for customer/selling price needs to cover all overhead costs (manufacturing costs/packaging, etc.) • Environmental considerations Try to use renewable resources/renewable energy where possible. • Quality required/Maint How long a product will last for its purpose. • Demand/availability/Transport Is there a demand for the product? Is the material readily available?	[4]	6
8	**(a)**	**(i)** A material that has the ability to conduct electricity under some conditions but not others	[1]	
		(ii) 2, 8, 4	[1]	
		(iii) 4 outer shell electrons	[1]	
	(b)	**(i)** Doped with a group III element/element with fewer electrons/Boron	[1]	
		(ii) Doped with a group V element/element with more electrons/ Phosphorus	[1]	
	(c)	**(i)** Reverse	[1]	
		(ii) • Negative terminal of battery pulls positive holes from the p-type material away from depletion layer. [1] • Electrons in n-type material pull away from depletion layer. [1] • Depletion layer widens. [1]	[3]	9
			Total	**75**