Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Life and Health Sciences

Assessment Unit AS 5

assessing

Material Science

[SZ051]

TUESDAY 14 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.

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

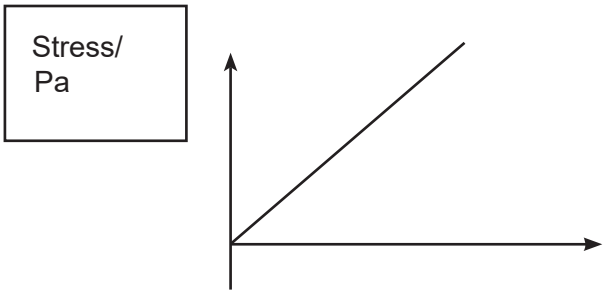
1 (a) (i) CSA = $\pi d^2/4$ (or equivalent) [1]
CSA = $\pi(1.4 \times 10^{-3})^2/4$ [1] [2]
CSA = 1.54×10^{-6} (m^2)

(ii) Stress = force/(cross-sectional) area (in words) [1]

(iii) Strain = extension/original length (in words) [1]

(iv) Stress: Strain:
325×10^6 [1] 438×10^{-6} [1] [2]
Note: –1 once only for 3 s.f. error.

(v)



y-axis labelled correctly with units [1]
y-axis scale [1]
Points plotted correctly (+/– 1sq)
5–6 correct [1] or 4 correct [1] [2]
Straight line through the origin [1] [5]

(vi) Gradient = $\Delta y/\Delta x$ (or equivalent) [1]
At least 5 cm [1]
= $7.40 \sim 7.60 \times 10^{11}$ [1]
Unit: Pa or Nm^{-2} [1] [4] 15

2 (a) (i) [$\frac{1}{2}$] each for each entry. Round down (example **and** property)

Category	Example	Property
Ceramic	*Fire brick*	*Low thermal conductivity*
Polymer	Parachute	Lightweight/strong/low density/ high tensile strength
Metal	Electrical wiring	Ductile/high electrical conductivity
Glass	Casserole dish	Won't rust/absorbs heat/inert/ high thermal conductivity/brittle/ chemical resistant
Composite	Fibreglass boat	Strong/long-lasting/excellent insulator/won't rust

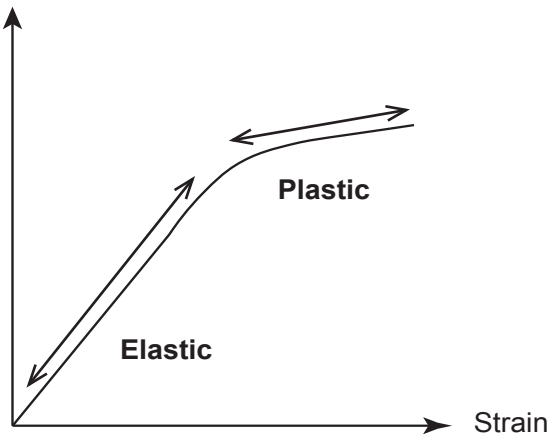
Other appropriate alternative properties acceptable. [4]

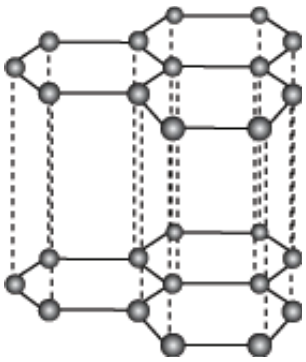
(b) (i) Pressure/current/electricity/electric field/stress/force [1]

(ii) Thermochromatic materials
Changes colour in response to temperature change/to show water has become too hot [2]

(iii) Photochromatic materials
Responds to changes in light/changes colour when exposed to light [2] 9

AVAILABLE MARKS

		AVAILABLE MARKS
3	**(a)** $\sigma = (1250 \times 10^{-3})/(25 \times 0.5 \times 10^{-6})$ [1] $= 1 \times 10^{5}$ [1] Unit = $\Omega^{-1}m^{-1}/Sm^{-1}$ [3]	
	(b) • When a material is permanently deformed/won't return to its original shape or size • When the force is removed [2]	
	(c) **(i)** Labelled diagram to include test wire, load, metre ruler, correctly labelled (Diagram in the form of YM or Hooke's Law) [$\frac{1}{2}$] each, round down [2]	
	(ii) Any **four** of the following points: • Measure length of test wire using metre ruler • Measure diameter of test wire using micrometer • 3 times and calculate an average diameter • Apply load to test wire and measure extension (with metre ruler) • Repeat/continue until fracture [4]	
	(iii) Stress  Straight line through the origin then curve [1] 'Elastic' and 'Plastic' regions correctly labelled [1]	13
4	**(a)** A large molecule, or macromolecule composed of many repeated subunits/chain of monomers/string of monomers (NOT a long chain molecule unless qualified) [1]	
	(b) **(i)** **Molecular structure** Thermosets have cross-links whereas thermoplastics have no cross-links [1]	
	(ii) **Response to heat** Thermosets cannot be successfully remoulded/strengthen whilst being heated Whereas thermoplastics can be reheated after initial heating/can be successfully remoulded/soften when heated and harden or strengthen after cooling [1] [2]	3

					AVAILABLE MARKS
5	**(a)**	**(i)**	Carbon	[1]	
		(ii)			
			• Honeycomb structure, atoms arranged in hexagons (minimum 2 per layer) • With one layer parallel above another	[2]	
		(iii)	One (atom or) layer thick of graphite or carbon	[1]	
	(b)	**(i)**	Use: (Any two from) • nitric oxide sensors • drug loading capacity, • selective cancer cell destruction, • bio stress sensors, • glucose detection biosensors • scaffolding for tissue regeneration	[2]	
		(ii)	Property: (Any two from) • Bioinert/don't react with the body/non toxic • Small/Thin • Loaded with various types of drugs/Hollow • Can be targeted • Large surface area	[2]	8
6	**(a)**	**(i)**	Volume = Mass/Density = 100/19.3 = 5.18 cm^{-3}	[1] [1]	
		(ii)	Volume = 5 L = 5000 cm^3 [1] Mass = (density × Vol) = 19.3 × 5000 = 96 500 g [1] Mass = 96.5 (kg) [1]	[3]	
	(b)		Substance A (5 × 10^{-3} $kgcm^{-3}$) A = 0.005 $kgcm^{-3}$ B = 0.00005 $kgcm^{-3}$ C = 0.0005 $kgcm^{-3}$	[1]	
	(c)		Vol = CSA × L [1] Al: Vol = (3.2 × 10^{-6} × 0.5 =) 1.6 × 10^{-6} [1] Al: m = (2700 × 1.6 × 10^{-6} =) 4.3 × 10^{-3} [1] Total mass = 5.6 × 10^{-2} kg [1]	[4]	10

						AVAILABLE MARKS
7	**(a)**	**(i)**	**Surplus of** negative (charge carriers) (or **deficiency of** positive charge carriers)	[1]		
		(ii)	Phosphorus/arsenic/group V	[1]		
	(b)	**(i)**	**Surplus of** positive (charge carriers)/holes (or **deficiency of** negative charge carriers)	[1]		
		(ii)	Aluminium/boron/group III	[1]		
	(c)	**(i)**	L_1 : on, L_2 : off	[1]		
		(ii)	D_1 : Forward D_2 : Reverse	[1]		
		(iii)	Any 2 from: • Free electrons in the n-type get attracted to the positive terminal of the battery (or repel negative terminal) [1] • Positive holes in the p-type get attracted to the negative terminal of the battery (or repel positive terminal) [1] • Causing depletion layer to become smaller/disappear [1]	[2]		8
8	**(a)**		The properties of two (or more) materials combined to form a better, more useful/improved product/one with better properties	[1]		
	(b)		Any 8 from: • Tensile strength – measure of force (or tensile stress) a material can withstand before failure (breaking). • Mention steel having an extremely large tensile strength value compared to concrete (or similar). • Ductility – ability to deform under stress/be stretched into wires (or similar). • Mention concrete having low ductility compared to steel. • Environmental – with concrete being able to be fabricated or poured on site means less fuel and time needed from factory to site. • Another factor – e.g. Cost Planners and contractors are building on a budget so need to be cost effective. • Pupil choice – e.g. Steel as it is greatest tensile strength, highly ductile and widely recyclable. • Both steel and concrete • Need a selection of all properties from both materials	[8]		9

Response	Marks
Candidates identify clearly 7 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.	[7]–[8]
Candidates identify clearly 5 or 6 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.	[5]–[6]
Candidates identify clearly 3 or 4 of the points shown in the indicative content. There is some reference of scientific terminology. Presentation, spelling, punctuation and grammar may contain some errors. The form and style are of a fair standard. 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