Oxford Cambridge and RSA

H

GCSE (9–1)

Chemisty B (Twenty First Century Science)

J258/04: Depth in chemistry (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for November 2020

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Chemistry B:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Question			Answer	Marks	AO element	Guidance
1	(a)		Any **two** from: (Symbol) can (easily) separate / can identify / gives recycling instructions ORA ✓ symbol is international / people overseas can read it / people might not know what symbol means ✓ ORA ✓ don't need words / no need to read / name very long / visual symbols are easier to read ORA ✓	**2**	**2.1**	
	(b)	**(i)**	UV does not go through glass / is absorbed by glass ✓	**1**	**2.1**	**ALLOW** reflects off glass
		(ii)	chlorine / Cl_2 ✓	**1**	**1.1**	**ALLOW** ozone **DO NOT ALLOW** chloride
	(c)	**(i)**	Stage 3 / shredding and separation ✓	**1**	**2.1**	
		(ii)	Stage 2 / washing and drying ✓	**1**	**2.1**	
	(d)		Links reusing as a bottle (to clean water)/using the bottles again and recycling to padding/using it to make it into different product ✓ Reusing uses the bottle in its same form idea / not changed / recycled polymer is processed/shredded/melted/shaped ✓	**2**	**1.1** **2.1**	 **IGNORE** wear jacket several times
	(e)		Any **two** from: Using bottles to treat water does not need any processing / process is different / only need washing (and drying) / padding has been processed/shredded/melted/shaped ✓ Different life spans ✓ Bottles reused many times ✓	**2**	**2.1**	

Question			Answer	Marks	AO element	Guidance
			Jackets thrown away after use ✓ Different disposal or waste implications / different waste produced / more packaging for jackets ✓ Different energy use ✓ Different water use ✓			

Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	Copper chloride: (Positive electrode -) chlorine (gas) **AND** (negative electrode -) copper (metal) ✓ Sodium sulfate: (Positive electrode -) oxygen (gas) ✓ (Negative electrode -) hydrogen (gas) ✓	3	2.1	**DO NOT ALLOW** one mark for any other permutation **DO NOT ALLOW** chloride **ALLOW** correct formula i.e. Cl_2, Cu, O_2, H_2
		(ii)	✓✓ **Gas** **Test and result** chlorine → turns blue litmus paper red and then bleaches it oxygen → relights a glowing splint hydrogen → makes a lighted splint go 'pop' turns lime water milky turns red litmus paper blue and then bleaches it	2	1.2	All correct = 2 marks 2 correct = 1 mark
		(iii)	Idea that copper is less reactive (than hydrogen) ORA ✓ Sodium is more reactive <u>than hydrogen</u> ORA ✓	2	2.1	**ALLOW** (1) for copper is less reactive than sodium / copper is unreactive

Question			Answer	Marks	AO element	Guidance
	(b)		2 correctly labelled apparatus: electrodes, battery, beaker, solution ✓ Shows battery connected to leads connected to electrodes **AND** electrodes are at least partially submerged into solution ✓	**2**	**1.2** **3.3a**	**ALLOW** anode and cathode for electrodes **ALLOW** NaCl (aq) for solution **ALLOW** correct symbol for battery without label **DO NOT ALLOW** circuit unless current can flow

Question			Answer	Marks	AO element	Guidance
3	(a)		Crude oil contains hydrocarbons which are used as fuels. ✓ Compounds from crude oil are used as a feedstock for petrochemicals. ✓	2	1.1	
	(b)		**Any three from**: propane has a lower boiling point than octane / ORA ✓ propane has a shorter chain/fewer carbon atoms/is a smaller molecule ORA ✓ propane has weaker intermolecular forces than octane / ORA / less energy is needed to break the intermolecular forces in propane / ORA ✓ octane condenses ✓ idea that molecules with higher boiling points condense at higher temperatures ✓	3	1.2	**ALLOW** propane has less intermolecular forces IMFs than octane / ORA
	(c)	(i)	cyclooctane ✓ cyclobutane✓	2	2.1	**ALLOW** one mark for 'oct' and 'but' used in names
		(ii)	C_nH_{2n} ✓ $C_nH_{(2n+1)}OH$ ✓	2	2.1	**ALLOW** $C_nH_{2n+2}O$
		(iii)	Carbon forms four covalent bonds.✓ Carbon atoms can join together in chains and rings. ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
4	(a)		zinc chloride ✓ 2HC*l* **AND** H_2 ✓	2	1.1 2.1	
	(b)		gas syringe with label / burette or measuring cylinder over water with label ✓ no leaks and no seals to prevent gas flow ✓	2	1.2 3.3a	
	(c)	(i)	answer = 210-220 ✓ Shows correct working based on a triangle or coordinates or readings from graph ✓	2	1.2	**ALLOW** both marks if answer is correct
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.13-1.19 award 2 marks** Evidence of 250/their gradient ✓ Answer between 1.13-1.19 ✓	2	2.2	**ALLOW** ECF on incorrect gradient **ALLOW** answers to 2 sig figs 1.1 - 1.2
	(d)	(i)	All five points correctly plotted ✓ Appropriate best fit single line goes through origin ✓	2	2.2	
		(ii)	Rate of reaction is higher for sulfuric acid ✓ Because concentration of hydrogen ions is higher / sulfuric acid is dibasic or diprotic / produces more hydrogen ions ✓	2	3.1a	**ALLOW** gradient of line is steeper

Question			Answer	Marks	AO element	Guidance
5	(a)*		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Relates number of atoms/ions in formula to number of electrons lost and gained for both compounds OR Relates number of atoms/ions in formula to charge on ions in both compounds. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Discusses number of electrons gained or lost for two or more ions. **OR** Relates number of outer shell electrons to ionic charge for two or more ions. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Gives a basic description of what happens when ionic bonds form *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	6	2 x 1.1 4x2.1	**Demonstrates knowledge and understanding of what happens when ionic bonds are formed AO1.1** **<u>Description of what happens</u>** • electrons are transferred between atoms • magnesium and sodium lose electrons. • oxygen gains electrons • to form a full shell/complete shell. **Applies knowledge and understanding to explain electronic changes shown on the diagram and relates this to the formulae of the compounds AO2.1** **<u>Number of electrons gained or lost</u>.** • Na has one electron in its outer shell and forms a +1 ion / Na loses ONE electron to form an ion • Mg has two electrons in its outer shell and forms a +2 ion / Mg loses TWO electrons to form an ion • O has six electrons in its outer shell and forms a -2 ion / gains TWO electrons to form an ion **<u>Formulae of compounds.</u>** • In Na_2O sodium ion has a +1 charge and O has 2- charge / sodium loses one electron and oxygen needs to gain two • In MgO magnesium ion has a +2 charge and O has 2- charge / magnesium loses two electrons and oxygen needs to gain two • idea that charges / electrons need to balance • two sodium ions per oxygen ion • one magnesium ion per oxygen ion

Question			Answer	Marks	AO element	Guidance
	(b)		Their boiling points are > 100°C. ✓ They conduct electricity when molten. ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
6	(a)		To make sure the reaction has finished / Mg reacts fully ✓	1	3.3b	
	(b)		Magnesium because it is in the shortest supply / limitless oxygen idea / limited <u>amount</u> / gets used up ✓	1	2.1	**ALLOW** 'Mg is limited' alone.
	(c)		1.2 ✓ 0.8 ✓ 2.0✓	3	2.2	 **IGNORE** 2 **ALLOW** ECF on mass of magnesium oxide if first two answers are incorrect
	(d)		Idea that overall mass/number of atoms does not change / law of conservation of mass means matter is not created or destroyed / total mass of products and reactants are equal ✓ In the experiment mass only (apparently) increases / does not really increase ✓ This is due to oxygen from the air / idea that mass of oxygen needs to be taken into account ✓	3	1.1 3.1b 2.1	 **ALLOW** 'gas'
	(e)	(i)	32 <u>and</u> 0.1 ✓ 0.2 ✓	2	2.1	 **ALLOW** 0.19851…. (from use of Mg as 24.3)
		(ii)	In the equation 2 mols Mg react with 1 mol O_2 (to form 2 moles MgO) / table shows 0.2 mols Mg react with 0.1 mol O_2 (to form 0.2 mols MgO) ✓ The ratios in the table agree with the ratios in the equation ✓	2	2.1	 **ALLOW** ECF from incorrect moles in (i) leading to an answer of 'no because the ratios in the table do not agree with the ratios in the equation'

Question			Answer	Marks	AO element	Guidance
7	(a)	(i)	**Any two from:** NH_4^+ (& NO_3^-) ions have single positive and negative charges ✓ calcium has a +2 charge which is not represented in the diagram ✓ There is a 1:1 ratio for ammonium nitrate ✓ There needs to be a 1:2 ratio for calcium nitrate ✓	2	3.1b	
		(ii)	**Any two from:** Ions are not inelastic (spheres) ✓ Ions are not spherical ✓ Vibration of ions is not shown ✓ there are many more ions in a real ionic compound ✓ ions in an ionic compound are arranged in 3D✓ ions contain multiple atoms ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
	(b)*		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes differences between the energy changes on the diagrams and explains the differences in terms of energy changes when bonds break and form. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Describes differences between the energy changes on the diagrams and explains one energy change when bonds break or form. **OR** Describes a difference between the energy changes on the diagrams and correctly links this to the energy change when bonds break or form *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Describes a difference between the energy changes on the diagrams *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**2 x 3.1a 2 x 1.1 2 x 2.1**	**AO3.1a Interprets the diagrams to identify differences.** • Activation energy (E_a) is higher for calcium nitrate ORA • Energy change of reaction has a larger value for calcium nitrate / more energy given out ORA • Energy change of reaction is negative for calcium nitrate/ is exothermic • Energy change of reaction for ammonium nitrate is positive/is endothermic **AO2.1 – Applies knowledge and understanding to explains the differences in the two diagrams** • energy is taken in to break bonds / energy is given out when bonds form • more energy is taken in to break bonds in calcium nitrate (to provide E_a) • more energy is given out when bonds form when calcium nitrate dissolves **AO1.1 – Recalls differences between exothermic and endothermic reactions** • overall reaction is exothermic for calcium nitrate because overall more energy is given out (when bonds form) than is taken in (when bonds break) • overall reaction is endothermic for ammonium nitrate because overall less energy is given out (when bonds form) than is taken in (when bonds break) **For L1 IGNORE** incorrect statements
	(c)		$Ca_3(PO_4)_2$ and KNO_3 ✓	**1**	**1.1**	

Question			Answer	Marks	AO element	Guidance
8	(a)		Neutral solution: **F** Alkali solution: **E** ✓	1	1.2	Both answers required for the mark
	(b)		4(.0) ✓	1	1.2	
	(c)		The higher the concentration of hydrogen ions, the lower the pH ✓	1	3.2b	
	(d)		pH meter 1 is most accurate because the readings are closest to the actual pH / within 0.1 ✓ pH meter 2 is not accurate because all of the readings are too high / up to 0.4 difference ✓ pH meter 3 less accurate than 1 or 2 because readings furthest from the actual pH / up to 0.7 / both above and below ✓	3	3.2b	**ALLOW** 1 mark for pH meter 1 is most accurate and pH meter 3 is least accurate, if no other mark awarded.
	(e)		wash the pH meter between readings / use separate pH meters for each sample ✓	1	3.3b	

Question			Answer	Marks	AO element	Guidance
9	(a)		there is a correlation between the air temperature and the concentration of sulfur dioxide in the air / as the air temperature increases, so does the concentration / concentration is reduced by (heavy) rain/wind ✓ Fri/19°C has a higher concentration but a lower temperature than Tues/20°C / Tues/20°C has a lower concentration than Wed/21°C ✓ sulfur dioxide is not produced in the air / it is produced in the power station / correlation is not cause idea / cause is due to another factor ✓	3	3.2a 2.1 1.1	
	(b)		Saturday 0-3.4 ✓ Lower than Thursday / compare with Thursday but windy / heavy rain and wind (both decrease concentration) / heavy rain and wind will be lower than heavy rain with no wind ✓ Sunday 9.5 – 24.0✓ Lower than Monday / similar to Monday but windy / similar to Friday or Tuesday but no rain / higher than Friday/Tuesday / concentration will be lower than (no rain and) no wind / higher than light rain, wind ✓	4	2.2 3.2a 2.2 3.2a	**DO NOT ALLOW** explanation marks for links to air temperature due to previous question disproving cause link between sulfur dioxide and temperature IF no comparison marks are awarded, **ALLOW (1) mark** for stating weather conditions in both 'Heavy rain and wind (Sat) and no rain and windy (Sun)
	(c)		needs to measure at intervals of 20 mins or less ✓ take a mean for each hour, each day and over the year ✓ idea of comparing data to the target values ✓	3	3.3a	

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