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 Autumn 2021

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

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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.

1. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

2. 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

3. **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)		increases ✓	1	3.1a	
	(b)	(i)	He, Ne ✓	1	3.1a	**ALLOW** names helium, neon
		(ii)	18 / 8 / 0 ✓	1	2.2	**ALLOW** noble gases / inert gases
	(c)		Potassium is the largest atom - TRUE Atomic radius gets smaller across Period 1 of the Periodic Table - TRUE As proton number increases, atomic radius always decreases - FALSE ✓✓	2	3.2b	All correct = **(2)** 2 correct = **(1)** 1 correct = 0
	(d)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 76 (cm) award 3 marks** 68/1.7 ($x10^{-10}$) = 40 ✓ 40 x 1.9 ($x10^{-10}$) ✓ = 76 (cm) ✓	3	2.1	Correct answer scores (3) marks **ALLOW** (1) only for 1.7 <u>and</u> 1.9 shown in working Note: values are ($x\ 10^{-10}$ m) **IGNORE** any attempted unit conversions which cancel out
		(ii)	yellow ✓	1	1.2	**IGNORE** orange

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td></td><td>(e)</td><td></td><td>Number of protons = 11
Number of neutrons = 12
Number of electrons = 11

<table><tr><th>Type of particle</th><th>Charge</th><th>Relative Mass</th></tr><tr><td>proton</td><td>+1</td><td>1</td></tr><tr><td>neutron</td><td>0/neutral</td><td>1</td></tr><tr><td>electron</td><td>-1</td><td>0</td></tr></table>✓✓✓</td><td>3</td><td>1.2</td><td>All three numbers in first table correct and in correct places = (2)
OR
Two numbers correct in correct places OR 12 shown anywhere in table = (1)

AND

All three numbers correct and in correct places in second table = (1)

ALLOW answers expressed as decimals e.g. 11.0 and 12.0</td></tr>
</table>

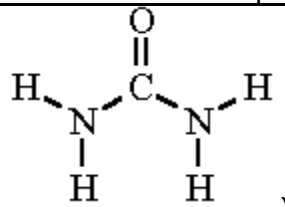
Question			Answer	Marks	AO element	Guidance
2	(a)	(i)	5 (minutes) ✓	1	3.1a	
		(ii)	82 (cm^3) ✓	1	3.1a	
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.273 (cm^3/s) award 2 marks** 5 x 60 = 300 s ✓ 82/300 = 0.273 ✓	2	 1.2 3.1b	 **ALLOW** (1) for 16.4 (no unit conversion) **ALLOW** 2 or more sig figs **DO NOT ALLOW** incorrect rounding **ALLOW** ECF from (a) (i) and (a) (ii)
	(b)		enzyme acts as a catalyst ✓ provides an alternative pathway/reduces activation energy ✓	2	2.1	**IGNORE** speeds up the reaction

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	All tablets are not the same / need to show the mass for all tablets idea ✓	1	2.1	**ALLOW** to spot/identify variation **IGNORE** unbiased/valid/reliable/repeatable
		(ii)	Choose tablets at random from each box. ✓ Choose tablets from more than one box of each brand. ✓	2	3.3a	
	(b)		A salt and water form. ✓ The pH changes during the reaction. ✓	2	1.1	
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.58(158) (g) award 3 marks** 15.8/1000 (= 0.0158) ✓ M_r = 40.1 + 12 + 48 (=100.1) ✓ 0.0158 x 100.1 = 1.58158 ✓	3	 1.2 2.2 x 2	**ALLOW** any number of sig figs **ALLOW** 100 (based on A_r Ca = 40) **ALLOW ECF** for incorrect M_r **ALLOW ECF** for no unit conversion
		(ii)	citric acid decreases volume and/or magnesium hydroxide increases volume ✓ citric acid also reacts with calcium carbonate / increases the acid available in the reaction / lowers pH/ makes the mixture more acidic ✓ magnesium hydroxide also reacts with acid / is an alkali/base has a high pH ✓	3	3.2b	 **IGNORE** citric acid is an acid **ALLOW** breaks down for react **IGNORE** dissolves

Question			Answer	Marks	AO element	Guidance
4	(a)		column 1: bromine ✓ column 2: iodine is purple/violet ✓ column 3: potassium iodide <u>and</u> lithium iodide ✓	3	1.2 x 2 2.2	 **DO NOT ALLOW** potassium/lithium iod<u>ine</u>
	(b)		potassium and chlorine ✓ potassium is most reactive element in Group 1 / reactivity increases down Group 1 ✓ chlorine is most reactive element in Group 7 / reactivity decreases down Group 7 ✓	3	2.2 1.2 x 2	
	(c)		Dissolve salts in water / dilute nitric acid (and add silver nitrate solution) ✓ precipitates form ✓ white for chloride <u>and</u> cream for bromide ✓	3	3.3a 1.2 x 2	

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)** Discusses properties of diamond and graphene related to their structure and use. *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 **two** properties and relates these to structure. OR discusses **two** properties and relates these to use. OR discusses **one** property related to structure and **one** property related to use *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)** Discusses a similarity or a difference between the properties or structures of diamond and graphene. *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	2.1	**Applies knowledge and understanding to compare properties and/or structures of diamond and graphene (AO2.1)** • both have high melting points • both are strong • graphene conducts electricity and diamond does not • both are covalently bonded • diamond is 3-D lattice/giant covalent and graphene is a nanoparticle / graphene exists as very thin sheets • graphene has delocalised electrons, diamond does not • diamond each C atom bonded to 4 others / graphene bonded to three others **Applies knowledge and understanding to link the properties of diamond and graphene to structure (AO2.1)** • links nanoparticle to molecular scale / very small particles • high melting point because of (strong) covalent bonds • hardness/strength because of (strong) covalent bonds • Graphene conducts electricity because of delocalised electrons • Graphene thin sheets because sheets of atoms are very thin / are one atom thick. **Applies knowledge and understanding to link the properties of diamond and graphene to uses (AO2.1)** • graphene used in electrical components/batteries because it conducts electricity / is a nanoparticle so is very small. • diamond used in drill bits because it is very strong / idea of strength in all three dimensions.

Question			Answer	Marks	AO element	Guidance
5	(b)	(i)	**Any two from:** (effect on health due to) very small size / cross blood-brain barrier / go through cell membranes ✓ Not enough research yet done / don't know long term effects / more research on properties/uses than on health risks ✓ Risk / benefit analysis idea that risk to health may not outweigh benefit of new battery✓	2	1.1	**IGNORE** 'affect your health' alone.
		(ii)	**Any two from:** Raw materials used ✓ Life span of battery ✓ Use of water in manufacture ✓ Use of energy in manufacture ✓ Waste products produced in manufacture ✓ Landfill / disposal ✓ Biodegradability ✓	2	1.1	

Question			Answer	Marks	AO element	Guidance
6	(a)	(i)	carbon dioxide **AND** nitrogen **AND** water ✓	1	2.1	**ALLOW** correct formulae. If both are given, names take precedence and ignore formula.
		(ii)	(g) is gas (and (l) is liquid) / water is produced as steam ✓ At high temperatures of engine, water is a gas / temperature is above boiling point of water ✓	2	1.1 2.1	
		(iii)	urea decomposes at 100 °C / otherwise it would decompose idea ✓	1	2.1	**IGNORE** change in state from liquid to gas
		(iv)	oxidation is gain of oxygen **AND** reduction is loss of oxygen ✓ nitrogen (oxide) is reduced / nitrogen (oxide) loses oxygen ✓ hydrogen is oxidised / oxygen gained (by hydrogen) ✓	3	1.1 2.1 x 2	**ALLOW** answer in terms of electrons **IGNORE** 'oxidised' or 'oxidation' or 'reduced' or 'reduction' alone
	(b)	(i)	nitrogen has 3 bonds and oxygen has 2 ✓ Shows nitrogen (18-15) ✓ Shows oxygen (18-16)✓	3	2.1	**ALLOW (1)** for Nitrogen is in Group 5/15 and Oxygen is in Group 6/16
		(ii)	<u>Hydrogen has one bond and</u> is not in Group 17/7 / does not have a group number / shown above Group 1 ✓	1	3.2b	**ALLOW** 'it is in Group 1'
		(iii)	 ✓✓	2	2.2	Fully correct structure **(2)** All bonds must be shown Correct numbers of each atom in incorrect structure with C=O double bond **(1)**

Question			Answer	Marks	AO element	Guidance
7	(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)** Explains how the results support the order and identifies the uncertainty about aluminium. **AND** Gives a full order of reactivity *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)** Makes a statement to compare the reactivity of two or more metals and **AND** uses the results to support their order. *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 partial order of reactivity. *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 2.2** **2 x 3.2b** **2 x 3.2a**	**Analyses information and ideas to draw conclusions about trends (AO3.2b)** **Full order:** Ca, Mg, Zn, Cu (**ignore** Al) **Partial order:** • calcium is the most reactive / reacts fastest • magnesium is more reactive than zinc • copper is unreactive / least reactive • Expt 1 does not distinguish between Mg and Zn and between Cu and Al **ALLOW Level 1 only** for statement that 'copper does not react with water or dilute acid' **Applies knowledge and understanding to explain how results support order (AO2.2)** • more reactive metals make bubbles/ fizz in water • with acid the less time to collect gas the more reactive the metal / the faster the reaction with acid the more reactive the metal • idea that copper does not react with either water or acid **Analyses information and ideas to make a judgement about the uncertainty of reactivity of aluminium (AO3.2a)** • Al does not react with water but reacts with acids faster than Mg • Unsure whether Al comes between Mg and Ca or whether it is unreactive/same as Cu .

	(b)		Some metals form positive ions more easily. ✓ Some metals are oxidised more easily. ✓	**2**	**1.1**	

Question			Answer	Marks	AO element	Guidance
8	(a)	(i)	sodium ions have a +1 charge / are Na^+ / total positive charges are +6 ✓ fluoride ions have a -1 charge / total negative charges are -6 ✓	2	2.1	**ALLOW** idea that 6 electrons need to be transferred
		(ii)	solid aluminium oxide does not conduct / only conducts when molten or in solution ✓ allows ions to move / movement of ions allows conduction of electricity ✓	2	1.1	
	(b)	(i)	aluminium ions move to negative electrode/cathode / oxide ions move to positive electrode/anode / idea that aluminium ions react at the negative electrode/cathode and oxide ions react at the positive electrode/anode ✓ aluminium ions gain (three) electrons (to form aluminium) ✓ oxide ions lose (two) electrons ✓ oxygen is formed (at the negative electrode) ✓	4	1.1	**ALLOW** M2, M3 and M4 from correct ionic equations **ALLOW** carbon dioxide forms at the negative electrode (from reaction of oxygen with carbon)
		(ii)	> 660°C	1	2.1	
	(c)		copper is a better conductor (but has a high density) ✓ Links idea of low density to use for overhead power lines ✓	2	2.1	**IGNORE** quoted number 58 and 35 (MS/m)

Question			Answer	Marks	AO element	Guidance
9	(a)		(concentration of acid) 0.01 (pH) 3.0 (concentration of hydrogen ions) 0.20 or 2.0×10^{-1} ✓✓	2	2.2	**ALLOW** one mark for any two correct
	(b)		0.30 mol/dm^3 sulfuric acid ✓	1	3.2b	
	(c)	(i)	α means proportional to ✓	1	1.1	**ALLOW** when the concentration of hydrogen ions increases, the pH increases
		(ii)	(no) because when concentration of hydrogen ions doubles, pH does not double / correctly <u>compares</u> two values of concentration of hydrogen ions / when concentration of hydrogen ions increases, pH does not increase/pH decreases ✓ quotes two values of concentration and two pH values from the table to justify their point ✓	2	3.2a	**ALLOW (1) max** If 'yes' is selected. **IGNORE** two quoted values of concentration alone
	(d)	(i)	Cl^- ✓ SO_4^{2-} ✓	2	2.2	**ALLOW** SO_4^{-2}
		(ii)	sulfuric acid is dibasic / contains two hydrogen ions (per unit formula) / concentration of hydrogen ions in sulfuric acid is higher / is double ✓ pH of sulfuric acid is lower ✓	2	2.1	**ALLOW** 'sulfuric acid contains more hydrogen'

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