OCR
Oxford Cambridge and RSA

H

GCSE (9–1)

Chemistry A (Gateway Science)

J248/03: Paper 3 (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 A:

	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.

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

Question	Answer	Marks	AO element	Guidance
1	D ✓	1	1.1	
2	C ✓	1	2.1	
3	C ✓	1	1.1	
4	B ✓	1	2.1	
5	C ✓	1	1.1	
6	A ✓	1	2.2	
7	B ✓	1	2.1	
8	C ✓	1	1.1	
9	C ✓	1	2.2	
10	B ✓	1	2.1	
11	C ✓	1	2.1	
12	B ✓	1	2.2	
13	C ✓	1	1.2	
14	A ✓	1	1.1	
15	B ✓	1	2.1	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>16</td><td>(a)</td><td></td><td><table><tr><th>Allotrope</th><th>Covalent bonds</th></tr><tr><td>Diamond</td><td>4✓</td></tr><tr><td>Graphite</td><td>3✓</td></tr><tr><td>Graphene</td><td>3</td></tr></table></td><td>2</td><td>2 x 1.1</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Diamond has many strong covalent bonds ✓

Which require a lot of energy to break ✓</td><td>2</td><td>2 x 1.1</td><td>ALLOW idea that each carbon atom forms 4 strong covalent bonds / diamond is a giant covalent structure / diamond is macromolecular
DO NOT ALLOW references to intermolecular forces or ionic bonds – scores 0 for question

ALLOW idea that the bonds are hard to break</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Any two from:
Graphite forms layers of (covalently bonded) carbon atoms✓

Idea that graphite has weak(er) intermolecular forces / weak forces between layers ✓

Layers can slide / slip over each other✓</td><td>2</td><td>2 x 1.1</td><td>DO NOT ALLOW references to ionic bonds – scores 0 for question

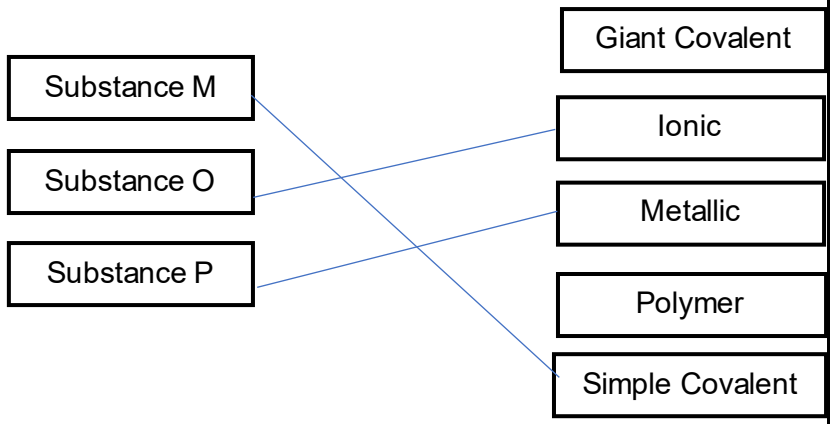
ALLOW sheets for layers</td></tr>
<tr><td></td><td>(c)</td><td></td><td>Any two from:

Carbon can bond to itself ✓

Carbon can form families / groups / series of compounds✓

Idea that carbon forms four bonds, which gives different bonding possibilities to different elements ✓

Idea that carbon can form single or double bonds (in different compounds) ✓</td><td>2</td><td>2 x 1.1</td><td></td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
17	(a)		Second box ticked ✓	1	3.2b	
	(b)	(i)	Add water to the mixture (to dissolve substance O) ✓ Filter to obtain a pure sample of substance P ✓ Evaporate / boil / distil off water to obtain a pure sample of substance O ✓	3	3 x 3.3a	Answer must relate to P and O and be in the correct order
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.19, award 3 marks** 2.6/6.2 = 0.41935 ✓ 0.41935 x 10 = 4.1935 ✓ 4.19 (3 significant figures) ✓	3	2 x 2.2 1.2	**ALLOW** ECF from incorrect division if answer x 10 **ALLOW** ECF for sig fig mark
	(c)		 One mark for each correct line	3	3 x 3.2b	

Question			Answer	Marks	AO element	Guidance
18	(a)		No atoms are made or lost during a chemical reaction / Idea that the mass of the products is equal to the mass of the reactants ✓	1	1.1	
	(b)		Magnesium carbonate is a solid ✓ (Solid) particles vibrate in a fixed position ✓	2	2.1 1.1	
	(c)	(i)	Idea that gas is formed / idea that the beaker is not sealed ✓ Gas particles are able to completely fill their container / gas particles (spread out and) escape from the beaker / AW ✓	2	2.2 1.1	**ALLOW** carbon dioxide for 'gas' **ALLOW** gas is released for 2 marks **IGNORE** references to evaporation
		(ii)	**Any two from:** Forces of attraction are not taken into account ✓ Size of particles are not taken into account ✓ Shape of particles are given as perfect spheres ✓	2	2 x 1.1	**IGNORE** references to bonds
	(d)	(i)	**Any one from:** Idea that $MgCl_2$ is aqueous / soluble (so can't be filtered) ✓ The solid is (left over / unreacted) magnesium carbonate / $MgCO_3$ ✓	1	2.2	
		(ii)	**Any two from:** Keep the (salt) solution / filtrate (not the solid) ✓ Evaporation (of the salt solution / filtrate) ✓ Crystallisation ✓	2	2 x 3.3b	**ALLOW** answers in any order **ALLOW** description of crystallisation

Question			Answer	Marks	AO element	Guidance
19	(a)	(i)	**Any two from:** The mass of the atom is all in the nucleus (rather than evenly spread throughout) ✓ Idea that atom has a nucleus (in the middle) ✓ The positive charge is in the nucleus ✓ Idea that the (negative charged) electrons orbit (rather than negative electrons embedded in a "pudding" of positive charge) ✓	2	2 x 1.1	**Assume unqualified answer refers to the current structure of the atom** **ALLOW** idea that atom has neutrons in the centre **ALLOW** idea that atom has protons in the centre **ALLOW** idea that electrons are found in shells (rather than throughout the atom)
		(ii)	A scientist giving feedback on another scientist's experiments is peer review. ✓ ✓ A scientist should have more confidence in results that have **not** been peer reviewed. ☐ Peer review is important to make sure results are reproducible. ✓ ✓ Peer review is not important as everyone can have a different opinion. ☐ Two friends discussing science is peer review. ☐ Two scientists discussing science is peer review. ☐	2	2 x 1.1	

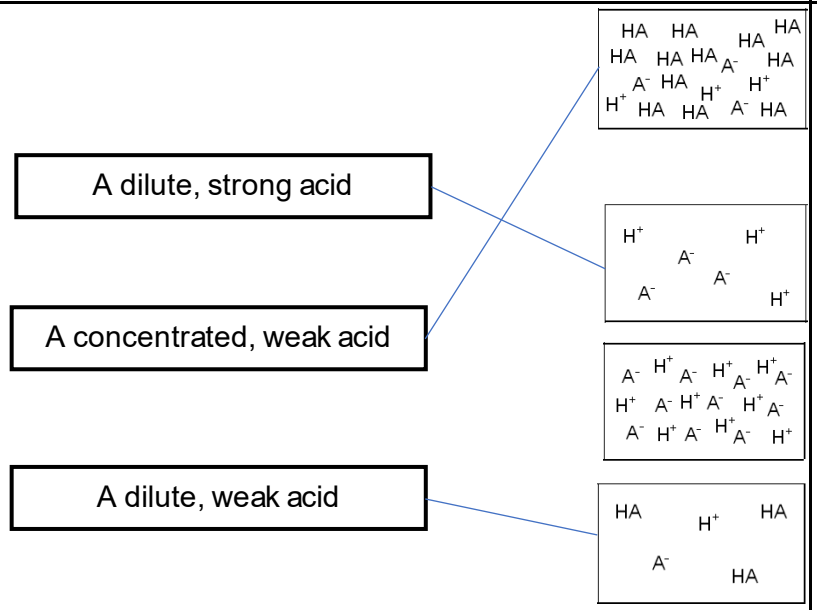
Question			Answer	Marks	AO element	Guidance
19	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.36 x 10^{-23} (g) award 3 marks** 20.2 ÷ 6.02 x 10^{23} ✓ = 3.355.. x 10^{-23} ✓ = 3.36 x 10^{-23}(g) (to 3 sf) ✓	3	**2 x 2.2** **1.2**	**ALLOW** ECF for sig fig mark
		(ii)	11 ✓	1	2.1	
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5 (mol) award 2 marks** 101 ÷ 20.2 ✓ = 5 ✓	2	2 x 2.2	
	(c)		**Any two from:** Group 0 elements have a full outer shell (of electrons) / 8 electrons in their outer shell ✓ Group 1 elements do not have a full outer shell (of electrons) / have 1 electron in their outer shell ✓ A full outer shell (of electrons) is unreactive / stable ✓	2	2 x 1.1	**ALLOW** named Group 0 and Group 1 elements **ALLOW** Group 8 instead of Group 0 **ALLOW** Group 1 elements lose their outer electron to become stable **for 2 marks**

Question			Answer	Marks	AO element	Guidance
20	(a)		**Any one from:** Copper anode is decreased in mass / the graphite anode does not decrease in mass ✓ Oxygen is formed at the graphite anode / oxygen is not formed at the copper anode ✓ Copper anode takes part in the reaction / graphite anode doesn't take part in the reaction ✓ Copper anode forms copper ions ✓	1	2.2	**ALLOW** positive electrode for anode and negative electrode for cathode throughout
	(b)	(i)	$2H^+ + 2e^- \rightarrow H_2$ Formulae ✓ Balancing ✓	2	2 x 2.2	**ALLOW** any correct multiple, including fractions **DO NOT ALLOW** and / & instead of '+' Balancing mark is dependent on the correct formulae but **ALLOW** 1 mark for a balanced equation with a minor error in subscripts / formulae e.g. $2h^+ + 2e^- \rightarrow H2$
		(ii)	Chlorine / Cl_2 ✓	1	2.2	**DO NOT ALLOW** Cl **DO NOT ALLOW** Chloride / Cl^-
		(iii)	**Any two from:** Ions are free to move in aqueous solution ✓ Ions cannot move in solid ✓ Ions carry a charge / current ✓	2	2 x 2.1	**DO NOT ALLOW** electrons moving

Question			Answer	Marks	AO element	Guidance
	(c)		B ✓ An (inert) electrode has to conduct electricity ✓ An (inert) electrode has to remain solid / not dissolve ✓	3	3 x 3.2a	**If C or D is chosen, score 0 for the question** **If A is chosen, allow 1 mark for an (inert) electrode has to conduct electricity**

Question			Answer	Marks	AO element	Guidance
21	(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)** Analyses and explains the information provided to correctly identify which samples contain painkiller AND determines the purity of the samples **AND** Provides an explanation of how melting point data AND thin layer chromatograms relate to purity of samples *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)** Analyses and explains the information provided to correctly identify which samples contain the painkiller **OR** Analyses and explains the information provided to correctly determine the purity of the samples **AND** Provides an explanation of how melting point data OR thin layer chromatograms relate to purity of samples. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	2 x 2.2 2 x 3.1 2 x 3.2b	**AO2.2 Knowledge of melting points and chromatography** • Chromatography / TLC separates mixtures into pure compounds. Different substances move at different rates up the stationary phase. • A pure substance only has one spot on a chromatogram. • A mixture has multiple spots on a chromatogram. • Pure substances have a sharp melting point. • Mixtures melt over a range of temperatures. • Impurities lower the melting point of a sample. • Samples with the same R_f value(s) and the same melting point (range) are likely to be the same substance/mixture. **AO3.1a Analyses melting point data and thin layer chromatogram to determine purity** • Sample A has 2 spots so is not a pure substance/is a mixture. Sample B has 2 spots so is not a pure substance/is a mixture. • Sample C has one spot, so is a pure substance.

			Level 1 (1-2 marks) Analyses the information provided to correctly identify whether a sample contains painkiller OR determines the purity of a sample **OR** Provides an explanation of how melting point data relate to purity of samples **OR** Provides an explanation of how thin layer chromatograms relate to purity of samples. *There is an attempt at 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.*			• Sample A melts over a temperature range, so is a mixture. Sample B melts over a temperature range so is a mixture. • Sample C has a sharp melting point, so it is a pure substance. **AO3.2b Analyses data provided for pure painkiller and compares data with samples** • Sample A contains painkiller and another substance. • Sample B contains two substances, neither of which are aspirin. • Sample C only contains painkiller. • The R_f value of painkiller is 0.73 (0.71 – 0.75). Samples A and C also contain spots with R_f values of 0.73. Sample B does not have a spot with R_f value of 0.73. • Sample C has the same melting point as painkiller. • Substances in samples A and C contain spots with the same R_f value as painkiller.

Question			Answer	Marks	AO element	Guidance
	(b)		A formulation has a specific / consistent proportion of components or AW ✓	1	1.1	
	(c)	(i)		3	3 x 1.1	
		(ii)	(No), the painkiller is a weak acid ✓ The starting pH is 4 / the starting pH is not 1 / the starting pH is not low enough for a strong acid ✓	2	2 x 3.1b	

Question			Answer	Marks	AO element	Guidance
22	(a)	(i)	Limiting reactant is the reactant that is used up first / limiting reactant has fewer moles (than other reactants) ✓	1	1.1	**ALLOW** the reactant that is fully used up in the reaction **ALLOW** idea that there isn't enough of the reactant
		(ii)	Idea that reaction <u>stops</u> once limiting reactant is consumed or used up ✓	1	1.1	
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 192.3 (g) award 3 marks** M_r of H_2S = 34.1 **AND** M_r of SO_2 = 64.1 ✓ Moles H_2S = (102.3 ÷ 34.1) = 3 (mol) ✓ Mass SO_2 = (3 x 64.1) = 192.3 (g) ✓	3	3 x 2.2	**DO NOT ALLOW** 34 and 64 **ALLOW** ECF from incorrect M_r **ALLOW** ECF from incorrect moles of H_2S

Question			Answer	Marks	AO element	Guidance
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = -1030 (kJ) award 4 marks**	4		
			Bonds broken = 1388 + 1482 / 2870 (kJ) ✓ 4 x 347 = 1388 3 x 494 = 1482		3 x 2.2	
			Bonds formed = 2092 + 1836 / 3928 (kJ) ✓ 4 x 523 = 2092 4 x 459 = 1836			
			(Bonds broken – bonds formed =) 2870 - 3928 = -1058 (kJ) ✓			**ALLOW** ECF from incorrect bonds broken and bonds formed calculations **IGNORE** (+)1058 (kJ)
			To 3 **sig figs** = -1060 (kJ) ✓		1 x 1.2	**ALLOW** ECF for sig fig mark from (+)1058 (kJ)
	(d)	(i)	Exothermic ✓	2	2 x 1.1	**Second mark is dependent on correct choice of exothermic**
			Products are lower in energy than reactants / energy released in making bonds is greater than the energy taken in to break bonds / AW ✓			**IGNORE** energy needed / energy used **ALLOW** more energy is released than is taken in **IGNORE** energy at the end is less than at the start

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4 award 3 marks** 990 + 10 = 1000 (cm^3) ✓ (Volume has increased by a factor of 1000 ÷ 10 = 100, so concentration has been decreased by a factor of) 1000 ÷ 10 = 100 ✓ (When concentration of H^+ is decreased by factor of 100, pH is increased by 2,) 2 + 2 = 4 ✓	**3**	**3 x 2.2**	

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