OCR
Oxford Cambridge and RSA

GCSE

Chemistry A

Unit **J248H/03**: Higher Tier – Paper 3

General Certificate of Secondary Education

Mark Scheme for June 2018

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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 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

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:

	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.

SECTION A

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			C ✓	1	1.2	
2			C ✓	1	1.1	
3			A ✓	1	1.1	
4			C ✓	1	1.1	
5			D ✓	1	2.1	
6			C ✓	1	1.1	
7			A ✓	1	1.1	
8			A ✓	1	1.2	
9			B ✓	1	1.1	
10			C ✓	1	1.1	
11			C ✓	1	1.2	
12			C ✓	1	1.1	
13			D ✓	1	1.1	
14			C ✓	1	1.1	
15			C ✓	1	1.1	

SECTION B

Question			Answer	Marks	AO element	Guidance
16	**(a)**	**(i)**	Particles close together / particles compact / particles already touching / particles tightly packed / AW ✓	**1**	1.1	**ALLOW** idea of particles with no spaces between them **ALLOW** any type of particles Mark can be awarded from a diagram **IGNORE** particles are in fixed positions **IGNORE** particles are in a regular arrangement / particles are in a lattice **IGNORE** intermolecular forces
	(a)	**(ii)**	**Any three from:** Particles in a solid are in fixed positions ✓ Particles in a solid vibrate ✓ Particles in a liquid can move (past each other) ✓ as forces between particles in a liquid are less than in a solid ✓	**3**	3 x 1.1	**ALLOW** any type of particles **ALLOW** particles in a solid cannot move (past each other) **IGNORE** solid cannot flow, but **ALLOW** particles in a solid cannot flow **IGNORE** particles move around on the spot **IGNORE** liquid can flow, but **ALLOW** particles in a liquid can flow **ALLOW** liquid particles have enough energy to overcome attractions (between particles) **DO NOT ALLOW** no forces between particles **IGNORE** intermolecular forces

Question			Answer	Marks	AO element	Guidance
	(a)	(iii)	**Any two from:** Particles are moving quickly (in all directions) ✓ Particles are far apart ✓ Particles spread out ✓ Weak forces between the particles ✓	**2**	2 x 1.1	**ALLOW** any type of particles **ALLOW** particles can move freely or randomly **ALLOW** M2 from a diagram showing no particles touching **IGNORE** intermolecular forces **IGNORE** no forces between particles
	(b)		$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$ Correct formulae ✓ Balancing ✓	**2**	1.1 2.2	Balancing mark is conditional on correct formulae **ALLOW** = or ⇌ instead of → **DO NOT ALLOW** and or & instead of + **ALLOW** any correct multiples including fractions e.g. $2Mg + 4H_2O \rightarrow 2Mg(OH)_2 + 2H_2$ **ALLOW** one mark for correct equation with minor errors in case, subscript or superscript e.g. $MG + 2H^2O \rightarrow 2Mg(OH)2 + H_2$ **IGNORE** state symbols
	(c)		148.3 ✓	**1**	2.2	**ALLOW** 148

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>17</td><td>(a)</td><td></td><td>ANY FOUR FROM:
Titration ✓

Put acid in burette ✓
Pipette (a known volume of) sodium hydroxide into flask ✓

Use a (named) indicator / use of a pH meter ✓
Add acid to sodium hydroxide until colour of indicator changes ✓
Repeat (to get an accurate value) ✓
Repeat again with no indicator ✓
Evaporate (off the water) / crystallise ✓</td><td>4</td><td>4 x 3.3a</td><td>ALLOW other methods involving adding acid to sodium hydroxide solution using the principles outlined on the LHS
eg ALLOW mix or react acid with alkali

ALLOW alkali in burette
ALLOW acid in flask

DO NOT ALLOW marks in incorrect context</td></tr>
<tr><td></td><td>(b)</td><td></td><td>$NaOH + HCl \rightarrow NaCl + H_2O$ ✓</td><td>1</td><td>2.2</td><td>ALLOW = or ⇌ instead of →
DO NOT ALLOW and or & instead of +

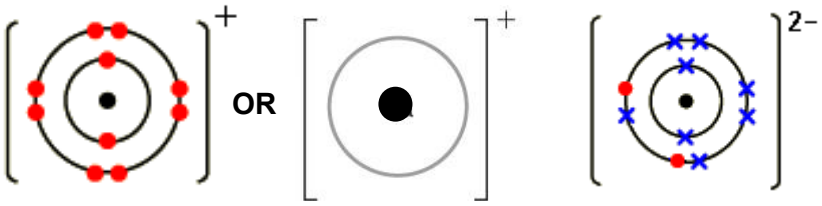
ALLOW any correct multiples including fractions

IGNORE any state symbols</td></tr>
<tr><td></td><td>(c)</td><td></td><td><table><tr><th>Acid used</th><th>Other starting material</th><th>Salt made</th></tr><tr><td>sulfuric acid</td><td>copper oxide</td><td>copper sulfate ✓</td></tr><tr><td>nitric acid ✓</td><td>zinc carbonate</td><td>zinc nitrate</td></tr><tr><td>hydrochloric acid</td><td>magnesium oxide/ magnesium hydroxide / magnesium carbonate / magnesium ✓</td><td>magnesium chloride</td></tr></table></td><td>3</td><td>3 x 2.2</td><td>ALLOW correct formulae</td></tr>
<tr><td></td><td>(d)</td><td></td><td>Neutralisation ✓</td><td>1</td><td>2.2</td><td></td></tr>
</table>

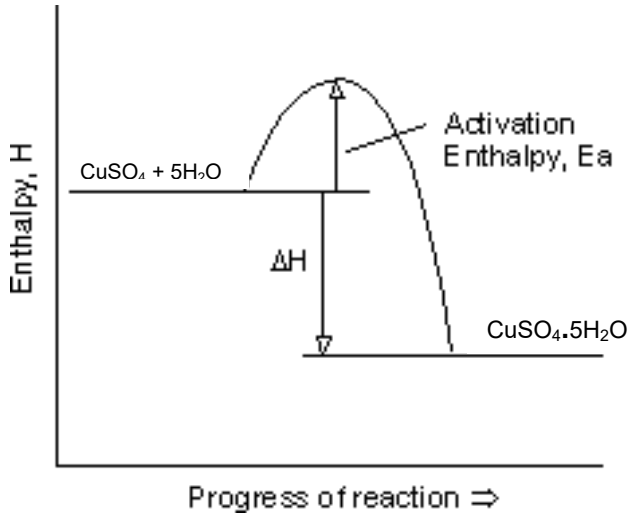
Question			Answer	Marks	AO element	Guidance
18	(a)		Idea that ethanol and /or petrol are flammable ✓ So need to use a water bath or heating mantle ✓	2	2 x 3.3b	Marking points are independent **ALLOW** use an electric heater
	(b)		State of propane is **gas** ✓ State of hexane is **liquid** ✓	2	2 x 2.1	
	(c)		$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ Correct formulae ✓ Balancing ✓	2	2 x 2.1	Balancing mark is conditional on correct formulae **ALLOW** = or ⇌ instead of → **DO NOT ALLOW** and or & instead of + **ALLOW** any correct multiples including fractions e.g. $2C_3H_8 + 10O_2 \rightarrow 6CO_2 + 8H_2O$ **ALLOW** one mark for correct equation with minor errors in case, subscript or superscript e.g. $C_3H_8 + 5O2 \rightarrow 3CO_2 + 4H_2o$ **IGNORE** state symbols

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>19</td><td>(a)</td><td></td><td>Number of protons (in the nucleus of an atom) ✓</td><td>1</td><td>1.1</td><td>ALLOW number of electrons in an atom
ALLOW answer in terms of Cl, ie it has 17 protons</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Isotopes have the same number of protons but different numbers of neutrons / same atomic number but different mass numbers /
atoms of the same element with the different number of neutrons or different mass numbers ✓</td><td>1</td><td>1.1</td><td>IGNORE same number of electrons
ALLOW answer in terms of Cl, ie one Cl atom has 18 neutrons and one Cl atom has 20 neutrons
OR
one Cl atom has a mass number of 35 and one Cl atom has a mass number of 37

IGNORE different relative atomic masses</td></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><th>Atom or ion</th><th>Atomic number</th><th>Mass number</th><th>Number of protons</th><th>Number of neutrons</th><th>Number of electrons</th><th>Electronic structure</th></tr>
<tr><td>S</td><td>16</td><td>32</td><td>16</td><td>16</td><td>16</td><td>2.8.6 ✓</td></tr>
<tr><td>B</td><td>5</td><td>11</td><td>5</td><td>6</td><td>5 ✓</td><td>2.3</td></tr>
<tr><td>F^-</td><td>9</td><td>19</td><td>9</td><td>10 ✓</td><td>10</td><td>2.8</td></tr>
<tr><td>Li^+</td><td>3</td><td>7</td><td>3</td><td>4</td><td>2</td><td>2 ✓</td></tr>
</table>
</td><td>4</td><td>1 x 1.1
3 x 2.1</td><td>Mark for each correct line of table</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	 sodium ion, Na^+ oxide ion, O^{2-} Sodium ion drawn correctly ✓ Oxide ion drawn correctly ✓ Correct charges on both ions ✓	**3**	3 x 2.1	**ALLOW** electrons as all dots, all crosses, or a mix of dots and crosses **ALLOW** diagrams without inner electron shell, but inner shell must be correct if shown **DO NOT ALLOW** S for Na or O_2 for O (for drawing of ions marks) **ALLOW** answers showing the transfer of electrons providing the same electrons are not shown twice **DO NOT ALLOW** diagram showing **sharing** of electrons = 0 marks
		(ii)	Na_2O ✓	**1**	2.1	**DO NOT ALLOW** Na^2O / Na2O **ALLOW** correct formula for Na_2O in an equation (even if unbalanced)

Question			Answer	Marks	AO element	Guidance
20	(a)		Filter to remove the sand ✓ (as) sand is insoluble in water / sodium chloride is soluble ✓	4	3.3a 3.1b	**ALLOW** MAX 3 marks if method is in wrong order, eg distillation before filtration
			Distil the filtered mixture ✓		3.3a	**ALLOW** fractional distillation **ALLOW** boil and condense for 'distil' **DO NOT ALLOW** evaporation / crystallisation
			(Solid) sodium chloride stays in flask and pure water condenses ✓		3.1b	**ALLOW** idea that (solid) sodium chloride stays in flask once pure water has evaporated
	(b)		No (no mark) **Any two from:** Idea that sample 4 has range **higher** than 110°C ✓ Pure sample of **B** cannot have melting point above 110°C ✓ Idea that pure samples do not melt over a range (of temperatures) / ORA / Pure samples have a specific melting point / ORA ✓ Impurities lower the melting point ✓ **AND** Sample 1 is likely to be most pure ✓	3	 2 x 3.2a 1 x 3.2b	**MAX 2** if answer refers to boiling points **IGNORE** just 'the melting point of sample 4 is 110 - 112°C'

Question			Answer	Marks	AO element	Guidance
21	(a)			3		
			Reactants and products labelled in words or formulae, with **products shown below reactants** ✓		2.2	
			Energy change labelled ✓		1.2	**DO NOT ALLOW** double headed arrow or line without arrow
			Activation energy labelled ✓		1.2	**DO NOT ALLOW** double headed arrow or line without arrow **ALLOW** 1 mark MAX for correctly labelled activation energy on an **endothermic** reaction profile

Question			Answer	Marks	AO element	Guidance
	(b)		Student B (no mark) **FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 411 (kJ/mol) award 3 marks** Energy needed to make new bonds = 3434(kJ) ✓ Energy needed to break bonds = 3434 – 802 = 2632(kJ) ✓ C-H bond energy = $\frac{2632 - (2 \times 494)}{4}$ = 411 (kJ/mol) ✓	3	 2.1 2.1 3.2b	**ALLOW** correct calculation of 411 (kJ/mol) without mention of Student B **NB There must be evidence of correct working out to score 3 marks** **411 on its own scores 0** **ALLOW** alternative calculation eg Energy needed to make new bonds = 3434(kJ) 432 x 4 = 1728 (kJ) 411 x 4 = 1644 (kJ) 2 x O=O bond energy = 2 x 494 = 988 (kJ) Energy needed to break bonds either 988 + 1728 = 2716 (kJ) or 988 + 1644 = 2632 (kJ) 3434 – 2716 = 718 (kJ) 3434 – 2632 = 802 (kJ) ie proving that C-H bond energy = 411 (kJ/mol)

Question			Answer	Marks	AO element	Guidance
22			No of moles of CuO = 0.02 moles No of moles of H_2 = 0.1 moles No of moles of Cu = 0.02 moles No of moles of H_2O = 0.02 moles All four correctly calculated ✓✓ **BUT** two or three correctly calculated ✓ Limiting reactant is copper oxide ✓ (because) it is (the starting material that is) present in the smaller quantity ✓	**4**	4 x 2.1	**ALLOW** ECF from incorrectly calculated number of moles **ALLOW** idea of less moles of copper oxide than hydrogen / lower amount of reactant moles / idea that all copper oxide is used up but there is hydrogen left **IGNORE** just restatement of the number of moles of CuO and H_2

Question			Answer	Marks	AO element	Guidance
23			**Any three from:** Mendeleev's table has no noble gases or Group 8 or Group 0 / ORA ✓ Mendeleev's table has no transition elements / ORA ✓ Mendeleev's table has gaps (left for elements to be discovered) / no gaps in modern-day table / AW ✓ (Mendeleev's table ordered by atomic mass whereas) modern-day table ordered by atomic number ✓ Mendeleev's table doesn't have atomic number (whereas modern-day table does) ✓ Mendeleev swapped iodine and tellurium to reflect chemical properties ✓	3	3 x 1.1	**ALLOW** Mendeleev's table only has 7 groups / ORA **ALLOW** reference to specific elements missing from Mendeleev's table eg gallium / germanium

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>24</td><td>(a)</td><td></td><td>
<table>
<tr><th>Experiment</th><th>What happens at cathode (-)</th><th>What happens at anode (+)</th></tr>
<tr><td>1</td><td>copper deposited / formed ✓</td><td>oxygen made</td></tr>
<tr><td>2</td><td>copper deposited</td><td>(copper) anode dissolves ✓</td></tr>
</table>
</td><td>2</td><td>2 x 1.2</td><td>ALLOW copper atoms form (at cathode)
IGNORE copper purified (at cathode)

ALLOW (anode) loses mass / copper loses electrons / copper ions made /
copper is lost (at anode)
DO NOT ALLOW copper ions lose electrons</td></tr>
<tr><td></td><td>(b)</td><td></td><td>Non-inert electrodes are changed during electrolysis ✓</td><td>1</td><td>1.2</td><td>ALLOW idea that non-inert electrodes can react (with the solution or the electrode products)</td></tr>
<tr><td></td><td>(c)</td><td></td><td>$Cu^{2+} + 2e^- \rightarrow Cu$

formulae ✓
balancing ✓</td><td>2</td><td>2 x 2.2</td><td>balancing mark is conditional on correct formulae
ALLOW = or ⇌ instead of arrow

DO NOT ALLOW and or & instead of +

ALLOW $Cu^{2+} \rightarrow Cu - 2e^-$

ALLOW any correct multiples including fractions
e.g. $2Cu^{2+} + 4e^- \rightarrow 2Cu$

ALLOW one mark for correct equation with minor errors in case, subscript or superscript e.g.
$Cu^{2+} + 2e^- \rightarrow CU$

IGNORE state symbols</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
	(d)		Idea that hydrogen is less reactive than sodium / ORA ✓ So is discharged before sodium / ORA ✓	2	2 x 1.2	**ALLOW** idea that hydrogen gains electrons more easily (than sodium) / idea that hydrogen is reduced more easily (than sodium) **IGNORE** hydrogen is made

Question			Answer	Marks	AO element	Guidance
25	*		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 the information to identify the type of bonding present in all three substances AND** **provides a correct explanation for all of them** *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 the information to identify the type of bonding present in two of the substances AND** **provides a correct explanation for both of them** **OR** **Analyses the information to identify the type of bonding present in all three substances AND provides a partial explanation for at least two of them** *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)** **Analyses the information to identify the type of bonding present in one of the substances AND** **provides a correct explanation** **OR** **Analyses the information to identify the type of bonding present in two of the substances AND provides a partial explanation for one of them** *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 3.2b 2 x 3.1a 2 x 2.1	**AO3.2b Analyses information to draw conclusions about the three substances** • substance **A** is covalently bonded • substance **A** is simple molecular • substance **B** is a covalently bonded • substance **B** is a giant covalent structure • substance **C** is an ionic compound **AO3.1a Analyses information to interpret the type of bonding present in all three substances** • substance **A** has a low melting point & boiling point and does not conduct electricity, so is likely to be water or other covalent structure • substance **B** has high melting point & boiling point and is a poor conductor, so is likely to be diamond or other giant covalent structure • substance **C** has a high melting point & boiling point and does not conduct electricity as a solid, but does when molten or dissolved in water, so is likely to be sodium chloride or another ionic compound **AO2.1 Applies knowledge and understanding about the information for the three substances to explain the properties** • substance **A** has a low melting point and boiling point because there are weak intermolecular forces • substance **A** does not conduct electricity because there are no free electrons or ions • substance **B** has high melting point and boiling point because there are many strong covalent bonds • substance **B** is a poor conductor because there are no free electrons or ions • substance **C** has a high melting point and boiling point because there are strong electrostatic forces of attraction between (oppositely charged) ions • substance **C** does not conduct as a solid because the ions cannot move but does when molten or dissolved in water because the ions can move

Question			Answer	Marks	AO element	Guidance
26	(a)		Number of entities in 1 mole ✓	1	1.1	**ALLOW** number of atoms in 12g of carbon-12 **IGNORE** number of atoms in 1 mole of an element If 'number of atoms' or 'number of molecules' in one mole of **a substance** is stated, then it must be linked to a correct substance eg number of molecules in a mole of oxygen (but not number of atoms in a mole of oxygen)
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 2.41 x 10^{24} award 3 marks** 72 g of water = 72/18 = 4 moles ✓ number of molecules of water = 4 x 6.02 x 10^{23} or 2.408 x 10^{24} ✓ answer to 3 sig figs = 2.41 x 10^{24} ✓	3	3 x 2.1	**ALLOW** ECF from incorrect number of moles **ALLOW** ECF if significant figures correct from incorrect calculation of number of moles of water **BUT** 72 x 6.02 x10^{23} (= 4.33 x 10^{25}) scores 0

Question			Answer	Marks	AO element	Guidance
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If mass of magnesium oxide needed = 4.0(g)** **AND** **mass of nitric acid needed = 12.6(g) award 4 marks**	**4**	4 x 2.1	Units **NOT** needed
			RFM of $Mg(NO_3)_2$ = 148 / 148.3 and MgO = 40 / 40.3 and HNO_3 = 63 ✓			**ALLOW** 126 for $2HNO_3$
			number of moles of $Mg(NO_3)_2$ = 14.8 ÷148 = 0.1 moles ✓			**ALLOW** 14.8 ÷ 148.3 **ALLOW** ECF from incorrect RFM values
			mass of magnesium oxide needed = 0.1 x 40 = 4.0g ✓			**ALLOW** 4g **ALLOW** 4.02g / 4.021g, ie $\frac{14.8}{148.3}$ x 40.3 **ALLOW** 4.03g **ALLOW** ECF from incorrect number of moles
			mass of nitric acid needed = 0.2 x 63 = 12.6g ✓			**ALLOW** 12.575g / 12.57g / 12.58g **ALLOW** ECF from incorrect number of moles

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