

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.

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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

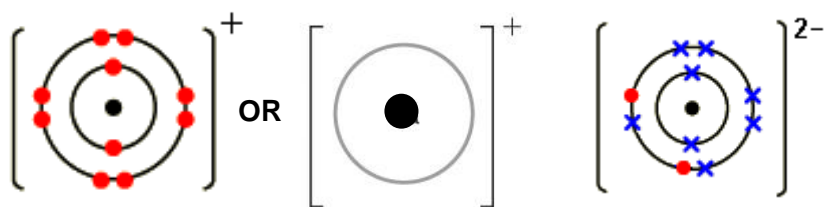
Question			Answer	Marks	AO element	Guidance
16	(a)	(i)	Particles close together / particles compact / particles already touching / particles tightly packed / AW ✓	1	1.1	<p>ALLOW idea of particles with no spaces between them ALLOW any type of particles</p> <p>Mark can be awarded from a diagram</p> <p>IGNORE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

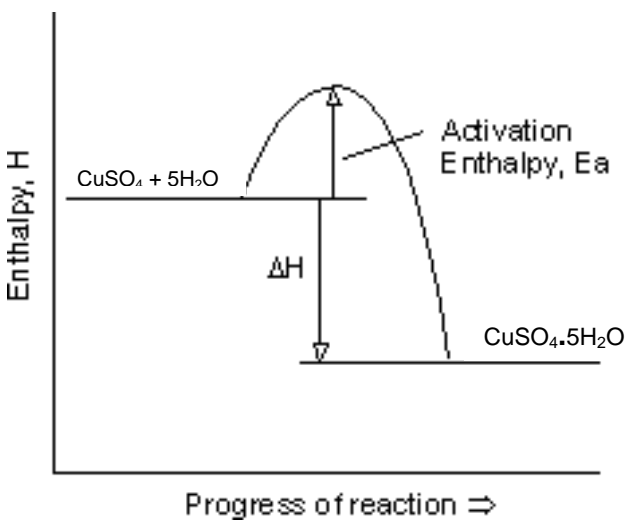
Question		Answer	Marks	AO element	Guidance
(a)	(iii)	<p>Any two from:</p> <p>Particles are moving quickly (in all directions) ✓</p> <p>Particles are far apart ✓</p> <p>Particles spread out ✓</p> <p>Weak forces between the particles ✓</p>	2	2 x 1.1	<p>ALLOW any type of particles</p> <p>ALLOW particles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

Question	Answer	Marks	AO element	Guidance												
17 (a)	<p>ANY FOUR FROM: Titration ✓</p> <p>Put acid in burette ✓ Pipette (a known volume of) sodium hydroxide into flask ✓</p> <p>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 ✓</p>	4	4 x 3.3a	<p>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</p> <p>ALLOW alkali in burette ALLOW acid in flask</p> <p>DO NOT ALLOW marks in incorrect context</p>												
(b)	$\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O} \checkmark$	1	2.2	<p>ALLOW = or = instead of → DO NOT ALLOW and or & instead of +</p> <p>ALLOW any correct multiples including fractions</p> <p>IGNORE any state symbols</p>												
(c)	<table border="1" data-bbox="322 1023 1115 1321"> <thead> <tr> <th data-bbox="322 1023 524 1082">Acid used</th> <th data-bbox="524 1023 860 1082">Other starting material</th> <th data-bbox="860 1023 1115 1082">Salt made</th> </tr> </thead> <tbody> <tr> <td data-bbox="322 1082 524 1145">sulfuric acid</td> <td data-bbox="524 1082 860 1145">copper oxide</td> <td data-bbox="860 1082 1115 1145">copper sulfate ✓</td> </tr> <tr> <td data-bbox="322 1145 524 1198">nitric acid ✓</td> <td data-bbox="524 1145 860 1198">zinc carbonate</td> <td data-bbox="860 1145 1115 1198">zinc nitrate</td> </tr> <tr> <td data-bbox="322 1198 524 1321">hydrochloric acid</td> <td data-bbox="524 1198 860 1321">magnesium oxide / magnesium hydroxide / magnesium carbonate / magnesium ✓</td> <td data-bbox="860 1198 1115 1321">magnesium chloride</td> </tr> </tbody> </table>	Acid used	Other starting material	Salt made	sulfuric acid	copper oxide	copper sulfate ✓	nitric acid ✓	zinc carbonate	zinc nitrate	hydrochloric acid	magnesium oxide / magnesium hydroxide / magnesium carbonate / magnesium ✓	magnesium chloride	3	3 x 2.2	<p>ALLOW correct formulae</p>
Acid used	Other starting material	Salt made														
sulfuric acid	copper oxide	copper sulfate ✓														
nitric acid ✓	zinc carbonate	zinc nitrate														
hydrochloric acid	magnesium oxide / magnesium hydroxide / magnesium carbonate / magnesium ✓	magnesium chloride														
(d)	Neutralisation ✓	1	2.2													

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 \rightleftharpoons instead of \rightarrow 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. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ IGNORE state symbols

Question		Answer					Marks	AO element	Guidance																																			
19	(a)	Number of protons (in the nucleus of an atom) ✓					1	1.1	ALLOW number of electrons in an atom ALLOW answer in terms of <i>Cl</i> , ie it has 17 protons																																			
	(b)	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 ✓					1	1.1	IGNORE same number of electrons ALLOW answer in terms of <i>Cl</i> , ie one <i>Cl</i> atom has 18 neutrons and one <i>Cl</i> atom has 20 neutrons OR one <i>Cl</i> atom has a mass number of 35 and one <i>Cl</i> atom has a mass number of 37 IGNORE different relative atomic masses																																			
	(c)	<table border="1"> <thead> <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> </thead> <tbody> <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> </tbody> </table>					Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure	S	16	32	16	16	16	2.8.6 ✓	B	5	11	5	6	5 ✓	2.3	F ⁻	9	19	9	10 ✓	10	2.8	Li ⁺	3	7	3	4	2	2 ✓	4	1 x 1.1 3 x 2.1	Mark for each correct line of table
Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure																																						
S	16	32	16	16	16	2.8.6 ✓																																						
B	5	11	5	6	5 ✓	2.3																																						
F ⁻	9	19	9	10 ✓	10	2.8																																						
Li ⁺	3	7	3	4	2	2 ✓																																						

Question		Answer	Marks	AO element	Guidance
(d)	(i)	 <p>sodium ion, Na⁺ oxide ion, O²⁻</p> <p>Sodium ion drawn correctly ✓ Oxide ion drawn correctly ✓ Correct charges on both ions ✓</p>	3	3 x 2.1	<p>ALLOW electrons as all dots, all crosses, or a mix of dots and crosses</p> <p>ALLOW diagrams without inner electron shell, but inner shell must be correct if shown</p> <p>DO NOT ALLOW S for Na or O₂ for O (for drawing of ions marks)</p> <p>ALLOW answers showing the transfer of electrons providing the same electrons are not shown twice</p> <p>DO NOT ALLOW diagram showing sharing of electrons = 0 marks</p>
	(ii)	Na ₂ O ✓	1	2.1	<p>DO NOT ALLOW Na²O / Na2O</p> <p>ALLOW correct formula for Na₂O in an equation (even if unbalanced)</p>

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

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

Question		Answer	Marks	AO element	Guidance
22		<p>No of moles of CuO = 0.02 moles No of moles of H₂ = 0.1 moles No of moles of Cu = 0.02 moles No of moles of H₂O = 0.02 moles All four correctly calculated ✓✓ BUT two or three correctly calculated ✓</p> <p>Limiting reactant is copper oxide ✓ (because) it is (the starting material that is) present in the smaller quantity ✓</p>	4	4 x 2.1	<p>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 H₂</p>

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

Question		Answer		Marks	AO element	Guidance									
24	(a)	<table border="1"> <thead> <tr> <th>Experiment</th> <th>What happens at cathode (-)</th> <th>What happens at anode (+)</th> </tr> </thead> <tbody> <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> </tbody> </table>		Experiment	What happens at cathode (-)	What happens at anode (+)	1	copper deposited / formed ✓	oxygen made	2	copper deposited	(copper) anode dissolves ✓	2	2 x 1.2	<p>ALLOW copper atoms form (at cathode) IGNORE copper purified (at cathode)</p> <p>ALLOW (anode) loses mass / copper loses electrons / copper ions made / copper is lost (at anode) DO NOT ALLOW copper ions lose electrons</p>
		Experiment	What happens at cathode (-)	What happens at anode (+)											
1	copper deposited / formed ✓	oxygen made													
2	copper deposited	(copper) anode dissolves ✓													
(b)	Non-inert electrodes are changed during electrolysis ✓	1	1.2	ALLOW idea that non-inert electrodes can react (with the solution or the electrode products)											
	(c)	$\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$ <p>formulae ✓ balancing ✓</p>		2	2 x 2.2	<p>balancing mark is conditional on correct formulae ALLOW = or \rightleftharpoons instead of arrow</p> <p>DO NOT ALLOW and or & instead of +</p> <p>ALLOW $\text{Cu}^{2+} \rightarrow \text{Cu} - 2\text{e}^{-}$</p> <p>ALLOW any correct multiples including fractions e.g. $2\text{Cu}^{2+} + 4\text{e}^{-} \rightarrow 2\text{Cu}$</p> <p>ALLOW one mark for correct equation with minor errors in case, subscript or superscript e.g. $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{CU}$</p> <p>IGNORE state symbols</p>									

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 *	<p>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</p> <p>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 <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p>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 <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>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 <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i></p> <p>0 marks <i>No response or no response worthy of credit.</i></p>	6	2 x 3.2b 2 x 3.1a 2 x 2.1	<p>AO3.2b Analyses information to draw conclusions about the three substances</p> <ul style="list-style-type: none"> 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 <p>AO3.1a Analyses information to interpret the type of bonding present in all three substances</p> <ul style="list-style-type: none"> 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 <p>AO2.1 Applies knowledge and understanding about the information for the three substances to explain the properties</p> <ul style="list-style-type: none"> 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	<p>ALLOW number of atoms in 12g of carbon-12 IGNORE number of atoms in 1 mole of an element</p> <p>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)</p>
	(b)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.41×10^{24} award 3 marks</p> <p>72 g of water = $72/18 = 4$ moles ✓</p> <p>number of molecules of water = $4 \times 6.02 \times 10^{23}$ or 2.408×10^{24} ✓</p> <p>answer to 3 sig figs = 2.41×10^{24} ✓</p>	3	3 x 2.1	<p>ALLOW ECF from incorrect number of moles</p> <p>ALLOW ECF if significant figures correct from incorrect calculation of number of moles of water</p> <p>BUT $72 \times 6.02 \times 10^{23}$ (= 4.33×10^{25}) scores 0</p>

Question		Answer	Marks	AO element	Guidance
	(c)	<p>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</p> <p>RFM of $\text{Mg}(\text{NO}_3)_2 = 148 / 148.3$ and $\text{MgO} = 40 / 40.3$ and $\text{HNO}_3 = 63$ ✓</p> <p>number of moles of $\text{Mg}(\text{NO}_3)_2 = 14.8 \div 148 = 0.1$ moles ✓</p> <p>mass of magnesium oxide needed = $0.1 \times 40 = 4.0\text{g}$ ✓</p> <p>mass of nitric acid needed = $0.2 \times 63 = 12.6\text{g}$ ✓</p>	4	4 x 2.1	<p>Units NOT needed</p> <p>ALLOW 126 for 2HNO_3</p> <p>ALLOW $14.8 \div 148.3$ ALLOW ECF from incorrect RFM values</p> <p>ALLOW 4g ALLOW 4.02g / 4.021g, ie $\frac{14.8 \times 40.3}{148.3}$</p> <p>ALLOW 4.03g ALLOW ECF from incorrect number of moles</p> <p>ALLOW 12.575g / 12.57g / 12.58g ALLOW ECF from incorrect number of moles</p>

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