



GCE

Chemistry A

H032/02: Depth in chemistry

Advanced Subsidiary GCE

Mark Scheme for June 2019

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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
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:

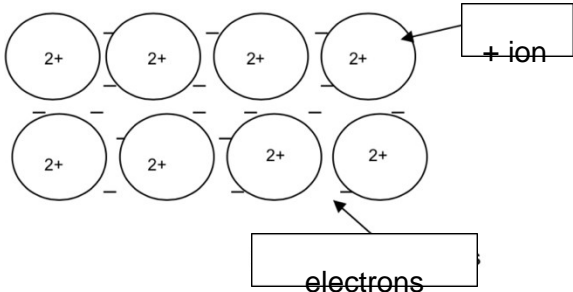
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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.

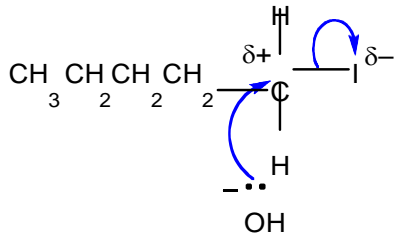
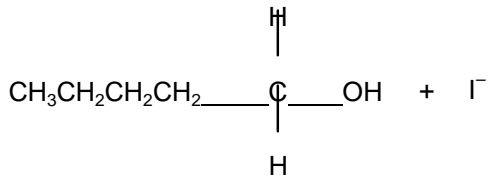
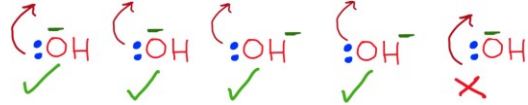
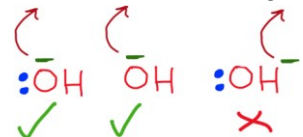

Question			Answer	Marks	AO element	Guidance
1	(a)	(i)	(Weighted) mean/average mass of an atom ✓ compared with 1/12th mass of carbon-12 OR compared with mass of carbon-12 which is 12 ✓	2	AO1.1 ×2	DO NOT ALLOW mean mass of an element <i>i.e. 'atom' essential</i> Both marks available based on mole: ALLOW mass of 1 mole of atoms ✓ compared to 1/12th 1 mole /12 g of carbon-12 ✓ ALLOW <u>mass of one mole of atoms</u> ✓ 1/12th mass of one mole/12 g of carbon-12 ✓
		(ii)	Use of isotope data Use of 87×6.9 AND 88×82.9 AND 10.2 anywhere ✓ Calculation of isotopic mass $\frac{(100 \times 87.73) - (87 \times 6.9) - (88 \times 82.9)}{10.2} = 86 \text{ OR } 86.03 \checkmark$	2	AO1.2 ×2	ALLOW $877.5 = 10.2A$ ALLOW $87.73 = \frac{(A \times 10.2) + 600.3 + 7295.2}{100}$ ALLOW $\frac{8773 - 600.3 - 7295.2}{10.2} = 86.03$ ALLOW $\frac{87.73 - 78.955}{0.102}$ OR $\frac{8.775}{0.102}$ 86 OR 86.03 DO NOT ALLOW Sr-86 with no working/justification ALLOW any unambiguous representation

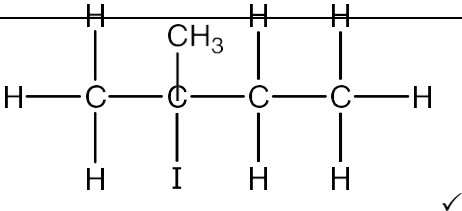
Question	Answer	Marks	AO element	Guidance
1 (b)	<p>Bonding and structure</p>  <p>Metallic bonding diagram Regular arrangement of labelled + ions ✓</p> <p>scattering of labelled electrons between other species ✓</p> <p>Properties linked to explanation metallic bond or attraction between the electrons and the positive ions/cations ✓</p> <p>bonds are strong/require a lot of energy to break AND high melting point ✓</p> <p>Delocalised electrons move AND good conductivity ✓</p>	5	<p>AO1.1 x3</p> <p>AO2.1 x2</p>	<p>Diagram must have at least two rows and a minimum of two ions per row (allow Sr⁺ or Sr²⁺)</p> <p>ALLOW for labels: + ions, positive ions, cations</p> <p>ALLOW e⁻ OR e as label for electron</p> <p>DO NOT ALLOW intermolecular forces</p> <p>ALLOW mobile electrons</p>
(c) (i)	$\text{Sr} + 2\text{H}_2\text{O} \rightarrow \text{Sr}(\text{OH})_2 + \text{H}_2 \checkmark$	1	AO2.6	<p>ALLOW correct multiples including fractions IGNORE state symbols</p>

Question			Answer	Marks	AO element	Guidance
		(ii)	To make sure all the water had been removed ✓	1	AO3.4	IGNORE just 'to weigh to constant mass'
		(iii)	Use balance that weighs to 3/more decimal places ✓ Use a larger mass (of hydrated strontium chloride) ✓	2	AO3.4 ×2	ALLOW more precise/more accurate/ more sensitive/higher resolution/smaller division/weigh to 0.001 IGNORE 'less error/smaller interval balance' IGNORE any reference to lid on crucible (water can't escape) IGNORE 'weigh straight after heating' IGNORE idea of repeating the experiment/ taking an average/ getting concordant results /larger sample size, etc.
			Total	18		

Question		Answer	Marks	AO element	Guidance
2	(a)	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Calculates the correct mass of $\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ or $\text{Mg}(\text{NO}_3)_2$. AND Explains the preparation steps, with most fine detail.</p> <p><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) Attempts a calculation which is partly correct. AND Outlines the preparation steps, with some fine detail.</p> <p><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) Attempts the calculation but makes little progress or makes errors. OR Briefly outlines the preparation steps, which may be incomplete</p> <p><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 No response or no response worthy of credit.</p>	6	<p>AO2.8 ×2</p> <p>AO2.3 ×2</p> <p>AO2.7 ×2</p>	<p>Indicative scientific points may include:</p> <p>Calculation: $n = \frac{250.0}{1000} \times 0.4000 = \mathbf{0.1(000)} \text{ (mol)}$ $M(\text{Mg}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}) = 256.3$ $\text{Mass} = 0.1000 \times 256.3 = \mathbf{25.63 \text{ g}}$ </p> <p>OR $M(\text{Mg}(\text{NO}_3)_2) = 148.3$ $\text{Mass} = \mathbf{14.83 \text{ g}}$</p> <p>ALLOW small slip/rounding errors such as errors on M_r (e.g. use of 24 instead of 24.3 for Mg A_r)</p> <p>Preparation steps (apparatus and method):</p> <ul style="list-style-type: none"> • Weigh mass of crystals • Dissolve in (distilled/deionised) water • Transfer to 250 cm³ volumetric flask • Make up to the mark with more water so that bottom of meniscus is on the mark <p>IGNORE removing the water of crystallisation</p> <p>Fine detail:</p> <ul style="list-style-type: none"> • 2 or more decimal place balance • Rinse beaker and transfer washings to flask • Use of dropping pipette when filling to mark • Stopper, invert several times to mix

Question		Answer	Marks	AO element	Guidance
2	(b)	<p>FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 38.5 cm³ award 3 marks</p> <hr/> <p>$n(\text{Mg}(\text{NO}_3)_2) = \frac{0.00}{148.3} = 0.0337 \dots \dots \dots (\text{mol}) \checkmark$</p> <p>$n(\text{HNO}_3) = 2 \times 0.0337 \dots \dots \dots = 0.0674 \dots \dots \dots (\text{mol}) \checkmark$</p> <p>volume = $0.0674 \dots \dots \dots \times \frac{1000}{1.75} = 38.5 (\text{cm}^3) \checkmark$</p> <p>3 SF required</p>	3	AO2.8 ×3	<p>Calculator: 0.03371544167</p> <p>ALLOW ECF from $n(\text{Mg}(\text{NO}_3)_2)$ Calculator: 0.06743088334</p> <p>ALLOW ECF from $n(\text{HNO}_3)$</p>
	(c)	<p>Element oxidised: Oxygen/O Change from: -2 to 0 ✓</p> <p>Element reduced: Nitrogen/N: Change form + 5 to +4 ✓</p>	2	AO2.2 ×2	<p>MAX 1 mark if no '+' sign for oxidation number</p> <p>ALLOW 2–</p> <p>ALLOW 5+ AND 4+</p> <p>ALLOW O₂ for oxygen</p> <p>ALLOW 1 mark for all oxidation numbers correct, but oxidised and reduced the wrong way around</p> <p>IGNORE numbers around equation <i>i.e. treat as rough working</i></p>
		Total	11		

Question	Answer	Marks	AO element	Guidance
3 (a) (i)	<p>Curly arrow from HO⁻ to carbon atom of C–I bond ✓</p> <p>Dipole shown on C–I bond, C^{δ+} and I^{δ-} AND curly arrow from C–I bond to I atom ✓</p>  <p>IGNORE presence of Na⁺ but OH⁻ needed i.e. Na⁺OH⁻ can be allowed if the criteria are met</p> <hr/> <p>Correct organic product AND I⁻ ✓</p>  <p>IGNORE presence of Na⁺ but I⁻ needed i.e. Na⁺I⁻ can be allowed BUT NaI does not show I⁻</p>	3	AO2.5 ×3	<p>ANNOTATE ANSWER WITH TICKS AND CROSSES NOTE: curly arrows can be straight, snake-like, etc. but NOT double headed or half headed arrows</p> <p>1st curly arrow must</p> <ul style="list-style-type: none"> go to the C of C–I <p>AND</p> <ul style="list-style-type: none"> start from, OR be traced back to any point across width of lone pair on O of OH⁻  <ul style="list-style-type: none"> OR start from – charge on O of ⁻OH ion  <p>(Lone pair NOT needed if curly arrow shown from O⁻)</p> <p>2nd curly arrow must start from, OR be traced back to, any part of C–I bond and go to I</p> 
	(ii) Time for precipitate to appear ✓	1	AO3.3	Time AND precipitate required Question asks for measurement

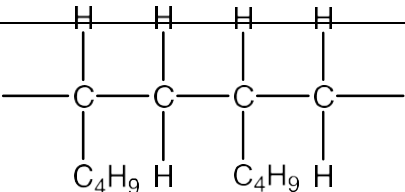
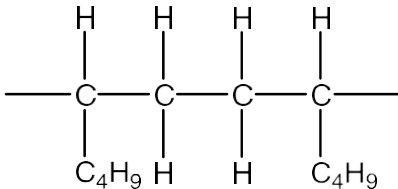
3	(a)	(iii)	<p>C–I bond is weaker (than C–Br bond) OR C–I bond has a lower bond enthalpy (than C–Br bond) ✓</p> <p>Carbon – halogen bond breaks ✓</p>	2	AO3.2	<p>For 2 marks, ALLOW C–I is broken more easily (than C–Br) as the bond is weaker</p> <p>There must be a comparison between C–Br and C–I bonds</p>
	(b)	(i)	Molecular mass ✓	1	AO1.1	<p>IGNORE ‘relative’ IGNORE ‘molecular ion’ alone, answer must relate to mass</p> <p>ALLOW M_r / molar mass</p>
		(ii)	<p>Y: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2^+$ ✓ Z: $\text{CH}_3\text{CH}_2\text{CH}_2^+$ ✓</p> <p><i>If positive charge is missing but the structures of Y AND Z are correct, award one mark</i></p>	2	AO3.2 ×2	<p>FOR ONE MARK ALLOW $\text{C}_5\text{H}_{11}^+$ AND C_3H_7^+</p> <p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p>
	(c)	(i)		1	AO1.1	ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous
		(ii)	<p>Similarity Both have a peak at ($m/z =$) 198 (X) OR 71 (Y) OR 29 ✓</p> <p>Difference 2-iodo-2-methylbutane has no peak at ($m/z =$) 43 (Z) ✓</p>	2	AO3.2 ×2	<p>ALLOW same molecular ion peak / M_r</p> <p>IGNORE statements where no specific ion peak is suggested e.g. “different ion peaks”</p>
			Total	12		

Question			Answer	Marks	AO element	Guidance
4	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 60 cm³ award 3 marks <hr/> $n(\text{HCl}) = \frac{50.0}{1000} \times 0.100 = 5.00 \times 10^{-3} \text{ (mol) } \checkmark$ $n(\text{H}_2) = \frac{5.00 \times 10^{-3}}{2} = 2.50 \times 10^{-3} \text{ (mol) } \checkmark$ $\text{Volume} = 2.5(0) \times 10^{-3} \times 24.0 \times 1000 = 60(.0) \text{ cm}^3 \checkmark$	3	AO2.6 ×3	ALLOW 120 cm ³ for 2 marks (no ÷ 2) ALLOW 240 cm ³ for 2 marks (× 2 not ÷ 2) IGNORE absence of trailing zeroes, e.g. for 0.100, ALLOW 0.1 ALLOW ECF from $n(\text{HCl})$ ALLOW ECF from $n(\text{HCl})$ and/or $n(\text{H}_2)$
	(b)	(i)	Use of graph paper linear numerical scale chosen for x axis AND Time / s added as label AND ALL points plotted correctly \checkmark	1	AO2.4 ×1	ALLOW Time (s) OR Time in s ALLOW seconds OR sec OR secs Tolerance ± 1 small square Point at 0,0 NOT required ALLOW up to 3 plotting errors
		(ii)	Anomaly point at 80 s circled \checkmark	1	AO2.4 ×1	ALLOW one more anomalous point NOT on the curve drawn in (iii)
		(iii)	Line smooth curve using all points EXCEPT point at 80 s \checkmark	1	AO3.1	
	(c)		Initial slope is steeper AND curve levels off at an earlier time \checkmark Same volume of gas produced (58 cm ³) \checkmark	2	AO2.8 ×2	Tolerance ± 1 small square

Question			Answer	Marks	AO element	Guidance
4	(d)		Rate (Acid) concentration decreases. ✓ Collisions Fewer collisions per second OR less frequent collisions ✓	2	AO1.1 ×2	IGNORE amount of acid decreases, response must imply a volume and NOT area, e.g. fewer particles/molecules/ions in same space /volume 'fewer collisions' alone is not sufficient (no rate)
	(e)	(i)	Catalyst lowers the activation energy (by providing an alternative route) ✓ A greater proportion of molecules have more energy greater than/equal to activation energy ✓	2	AO1.2 ×2	ALLOW 'more' for 'greater proportion' ALLOW more molecules have sufficient energy to react IGNORE (more) successful collisions
		(ii)	Reactants have different physical states ✓	1	AO2.1	ALLOW idea that copper(II) sulfate solution is homogeneous in relation to the acid, but heterogeneous in relation to the zinc
			Total	13		

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	<p>Product with H₂</p> <pre> H H H H H H H — C — C — C — C — C — C — H H H H H H H </pre> <p>✓</p> <p>Product with HCl</p> <pre> H H H H H H H — C — C — C — C — C — C — H H H H H Cl H </pre> <p>✓</p> <p>Product with Br₂</p> <pre> H H H H H H H — C — C — C — C — C — C — H H H H H Br Br </pre> <p>✓</p>	3	AO1.2 ×3	<p>ALLOW any combination of skeletal OR structural OR displayed formula as long as unambiguous</p> <p>ALLOW part molecular formulae but not full</p>
		(ii)	Nickel/Ni ✓	1	AO1.2	ALLOW Pt OR Pd OR Rh
		(iii)	(orange to) colourless OR bromine is decolourised ✓	1	AO1.2	<p>ALLOW 'it decolourises / turns colourless'</p> <p>IGNORE colour change</p>

Question			Answer	Marks	AO element	Guidance
5	(b)	(i)	<p><i>Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5–6 marks) Calculates the correct mass of hexan-1-ol. AND Explains the purification steps, with most fine detail.</p> <p><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) Attempts a calculation of the mass of hexan-1-ol which is partly correct. OR Outlines the purification steps, with some fine detail.</p> <p><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) Attempts the calculation but makes little progress. OR Briefly outlines the purification steps, which may be incomplete.</p> <p><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 No response or no response worthy of credit.</p>	6	<p>AO2.8 ×2</p> <p>AO3.3 ×4</p>	<p>Indicative scientific points may include:</p> <p>Calculation from moles <input type="checkbox"/> $n(\text{hex-1-ene}) = \frac{4.20}{84.0} = 0.0500 \text{ (mol)}$ <input type="checkbox"/> $n(\text{hexan-1-ol}) \text{ needed} = 0.0500 \times \frac{100}{62.5} = 0.0800 \text{ (mol)}$ <input type="checkbox"/> mass needed = $0.0800 \times 102 = \mathbf{8.16 \text{ g}}$ <input type="checkbox"/> OR volume $\frac{8.16}{0.82} = 9.95 \text{ cm}^3$ </p> <p>CHECK for extent of errors by ECF.</p> <p>Calculation from mass <input type="checkbox"/> Theoretical mass hex-1-ene = $4.20 \times \frac{100}{62.5} = 6.72 \text{ g}$ <input type="checkbox"/> Theoretical $n(\text{hex-1-ene}) = \frac{6.72}{84} = 0.0800 \text{ (mol)}$ <input type="checkbox"/> Mass of hexan-1-ol = $102 \times 0.0800 = \mathbf{8.16 \text{ g}}$ ALLOW small slip/rounding errors such as errors on M_r (e.g. use of 83 instead of 84 for hex-1-ene M_r) </p> <p>-----</p> <p>Purification <input type="checkbox"/> Use of a separating funnel to separate organic and aqueous layers <input type="checkbox"/> Drying with an anhydrous salt <input type="checkbox"/> Distillation </p> <p>Fine detail <input type="checkbox"/> Collection of upper layer (less dense from separating funnel) <input type="checkbox"/> Example of drying agent, e.g. MgSO_4, CaCl_2 <input type="checkbox"/> Collection of fraction distilling at 63°C (boiling point of hex-1-ene) Incorrect purification method NOT creditworthy </p> <p>Examples of partly correct calculations Mass = 5.1 g from 0.0500×102 % yield omitted Mass = 3.1875 g from $0.0500 \times \frac{62.5}{100} \times 102$ % yield inverted </p>

Question			Answer	Marks	AO element	Guidance
5	(b)	(ii)	Yield of hex-1-ene is less ✓ A mixture of hex-1-ene and hex-2-ene forms ✓	2	AO3.2 ×2	ALLOW hex-2-ene also forms
	(c)	(i)	 NOTE: C ₄ H ₉ – is allowed for CH ₃ CH ₂ CH ₂ CH ₂ – ✓	1	AO2.5	ALLOW correct structural OR displayed OR skeletal formula Must show two repeat units Polymer must have side links IGNORE brackets and use of 'n' ALLOW alternating side chains, i.e. 
		(ii)	Combustion for energy production ✓ for production of plastics OR other useful organic compounds ✓	2	AO1.1 ×2	For energy production, ALLOW generate electricity/heating ALLOW as an (organic) feedstock
			Total	16		

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