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.

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:

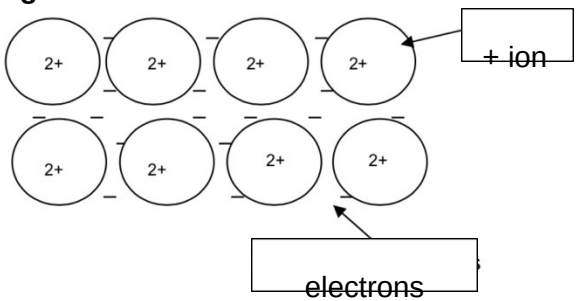
- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

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.e. 'atom' essential* **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** mass of one mole of atoms ✓ 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 **OR** 86.03 ✓	**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

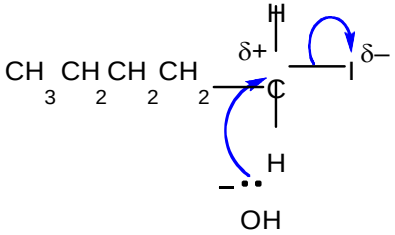
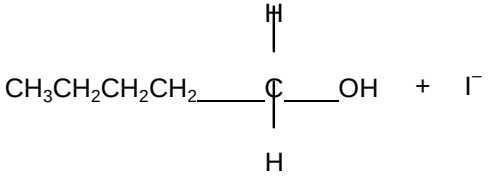
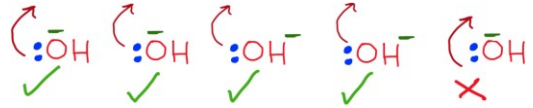
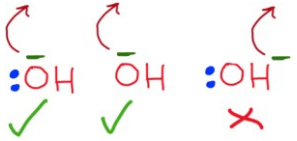
Question			Answer	Marks	AO element	Guidance
1	(b)		**Bonding and structure**  **Metallic bonding diagram** Regular arrangement of **labelled** + ions ✓ scattering of **labelled** electrons **between** other species ✓ **Properties linked to explanation** metallic bond or attraction between the electrons and the positive ions/cations ✓ bonds are strong/require a lot of energy to break **AND** high melting point ✓ Delocalised electrons move **AND** good conductivity ✓	**5**	AO1.1 ×3 AO2.1 ×2	**Diagram must have at least two rows and a minimum of two ions per row (allow Sr^{+} or Sr^{2+})** **ALLOW** for labels: + ions, positive ions, cations **ALLOW** e^{-} **OR** e as label for electron **DO NOT ALLOW** intermolecular forces **ALLOW** mobile electrons
	(c)	(i)	$Sr + 2H_2O \rightarrow Sr(OH)_2 + H_2$ ✓	**1**	AO2.6	**ALLOW** correct multiples including fractions **IGNORE** state symbols

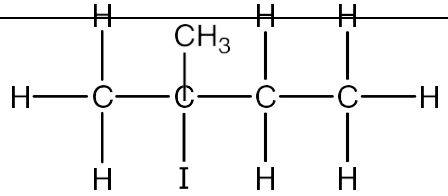
Question			Answer	Marks	AO element	Guidance
	(c)	(ii)	Two points (✓✓) from With calcium: **1.** less vigorous fizzing/bubbling/effervescence **2.** dissolves more slowly/slower reaction **3.** solution has a lower pH/less alkaline **4.** precipitate forms/less soluble	**2**	AO2.3 ×2	**IGNORE** gives out less/more heat, less reactive, less gas
1	**(d)**	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 5.8 award 3 marks** --- $n(SrCl_2) = \frac{1.62}{158.6}$ = 0.0102……. (mol) ✓ $n(H_2O) = \frac{1.07}{18}$ = 0.0594……. (mol) ✓ **x** = $SrCl_2 : H_2O = \frac{0.0594…..}{0.0102……}$ = 5.8 ✓	**3**	AO3.1 ×2 AO3.2	**Calculator:** 0.01021437579 **Calculator:** 0.05944444444 **ALLOW ECF** from $n(SrCl_2)$ and/or $n(H_2O)$ Answer must be to **TWO** significant figures **ALLOW** 2 marks for 5.83 (answer must be to 2 SF)

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)		*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)** Calculates the correct mass of $Mg(NO_3)_2 \bullet 6H_2O$ or $Mg(NO_3)_2$. **AND** Explains the preparation steps, with most fine detail. *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)** Attempts a calculation which is partly correct. **AND** Outlines the preparation steps, with some fine detail. *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)** Attempts the calculation but makes little progress or makes errors. **OR** Briefly outlines the preparation steps, which may be incomplete *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**	AO2.8 ×2 AO2.3 ×2 AO2.7 ×2	**Indicative scientific points may include:** **Calculation:** $n = \frac{250.0}{1000} \times 0.4000 =$ **0.1(000)** (mol) $M(Mg(NO_3)_2 \bullet 6H_2O) = 256.3$ Mass = $0.1000 \times 256.3 =$ **25.63** g **OR** $M(Mg(NO_3)_2) = 148.3$ Mass = **14.83** g **ALLOW** small slip/rounding errors such as errors on M_r (e.g. use of 24 instead of 24.3 for Mg A_r) **Preparation steps (apparatus and method):** • Weigh mass of crystals • Dissolve in (distilled/deionised) water • Transfer to 250 cm^3 volumetric flask • Make up to the mark with more water so that bottom of meniscus is on the mark **IGNORE** removing the water of crystallisation ***Fine detail:*** • 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

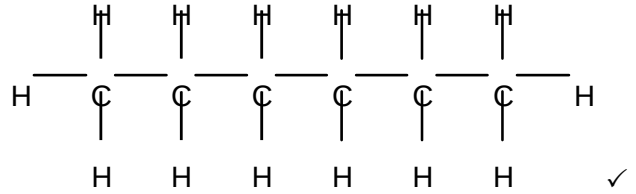
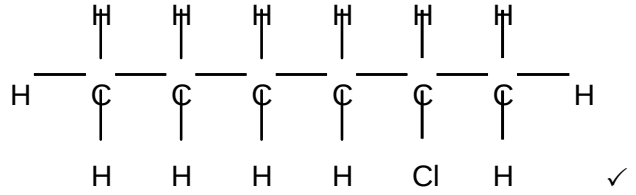
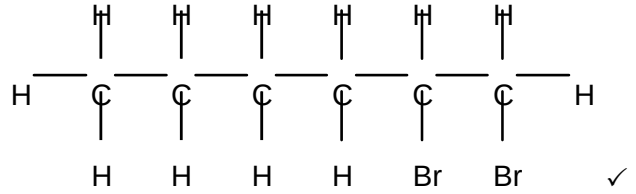
Question			Answer	Marks	AO element	Guidance
2	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 38.5 cm^3 award 3 marks** --- $n(Mg(NO_3)_2) = \frac{5.00}{148.3}$ = 0.0337..... (mol) ✓ $n(HNO_3)$ = 2 × 0.0337 ……. = 0.0674.....(mol) ✓ volume = 0.0674…….. × $\frac{1000}{1.75}$ = 38.5 (cm^3) ✓ **3 SF** required	3	AO2.8 ×3	**Calculator**: 0.03371544167 **ALLOW ECF** from $n(Mg(NO_3)_2)$ **Calculator**: 0.06743088334 **ALLOW ECF** from $n(HNO_3)$
	(c)		Element **oxidised**: Oxygen/O Change from: –2 to 0 ✓ Element **reduced**: Nitrogen/N: Change form + 5 to +4 ✓	2	AO2.2 ×2	**MAX 1 mark** if no '+' sign for oxidation number **ALLOW** 2– **ALLOW** 5+ **AND** 4+ **ALLOW** O_2 for oxygen **ALLOW** 1 mark for all oxidation numbers correct, but oxidised and reduced the wrong way around **IGNORE** numbers around equation *i.e. treat as rough working*
			Total	11		

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	Curly arrow from HO^- to carbon atom of C−I bond ✓ Dipole shown on C–I bond, $C^{\delta+}$ and $I^{\delta-}$ **AND** curly arrow from C−I bond to I atom ✓  **IGNORE** presence of Na^+ but OH^- needed i.e. Na^+OH^- can be allowed if the criteria are met --- Correct organic product **AND** I^- ✓  **IGNORE** presence of Na^+ but I^- needed i.e. Na^+I^- can be allowed BUT NaI does not show I^-	3	AO2.5 ×3	**ANNOTATE ANSWER WITH TICKS AND CROSSES** **NOTE**: curly arrows can be straight, snake-like, etc. but **NOT** double headed or half headed arrows **1st curly arrow** must • go to the C of C–I **AND** • start from, **OR** be traced back to **any point across width** of lone pair on O of OH^-  • **OR** start from – charge **on O** of ^-OH ion  *(Lone pair **NOT** needed if curly arrow shown from O^-)* **2nd curly arrow** must start from, **OR** be traced back to, **any part of** C–I bond and go to I 
		(ii)	**Time** for **precipitate** to appear ✓	1	AO3.3	Time **AND** precipitate required *Question asks for measurement*

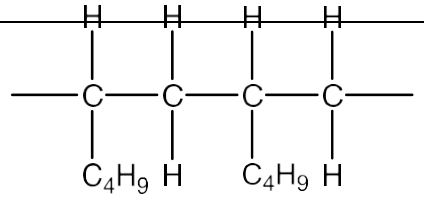
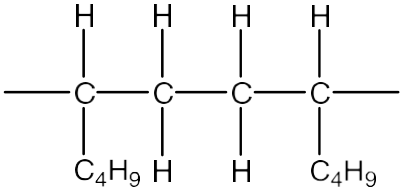
3	(a)	(iii)	C–I bond is weaker (than C–Br bond) **OR** C–I bond has a lower bond enthalpy (than C–Br bond) ✓ Carbon – halogen **bond breaks** ✓	**2**	AO3.2	**For 2 marks,** **ALLOW** C–I is broken more easily (than C–Br) as the bond is weaker There must be a **comparison** between C–Br and C–I bonds
	(b)	**(i)**	Molecular mass ✓	**1**	AO1.1	**IGNORE** 'relative' **IGNORE** 'molecular ion' alone, answer must relate to **mass** **ALLOW** M_r / molar mass
		(ii)	**Y**: $CH_3CH_2CH_2CH_2CH_2^+$ ✓ **Z**: $CH_3CH_2CH_2^+$ ✓ ***If positive charge is missing*** *but the structures of* ***Y AND Z*** *are correct, award one mark*	**2**	AO3.2 ×2	**FOR ONE MARK** **ALLOW** $C_5H_{11}^+$ **AND** $C_3H_7^+$ **ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
	(c)	**(i)**	 ✓	**1**	AO1.1	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous
		(ii)	**Similarity** Both have a peak at (*m*/*z* =) 198 (X) **OR** 71 (Y) **OR** 29 ✓ **Difference** 2-iodo-2-methylbutane has **no** peak at (*m*/*z* =) 43 (Z) ✓	**2**	AO3.2 ×2	**ALLOW** same molecular ion peak / M_r **IGNORE** statements where no specific ion peak is suggested e.g. "different ion peaks"
			Total	**12**		

Question			Answer	Marks	AO element	Guidance
4	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 60 cm^3 award 3 marks** --- $n(HCl) = \frac{50.0}{1000} \times 0.100 = 5.00 \times 10^{-3}$ (mol) ✓ $n(H_2) = \frac{5.00 \times 10^{-3}}{2} = 2.50 \times 10^{-3}$ (mol) ✓ Volume = $2.5(0) \times 10^{-3} \times 24.0 \times 1000 = 60(.0)$ cm^3 ✓	**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(HCl) **ALLOW ECF** from n(HCl) and/or $n(H_2)$
	(b)	(i)	**Use of graph paper** linear numerical scale chosen for x axis **AND** Time / s added as label **AND** ALL points plotted correctly ✓	**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 ✓	**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 ✓	**1**	AO3.1	
	(c)		Initial slope is steeper **AND** curve levels off at an earlier time ✓ **Same** volume of gas produced (58 cm^3) ✓	**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)	**Product with H_2**  ✓ **Product with HCl**  ✓ **Product with Br_2**  ✓	**3**	AO1.2 ×3	**ALLOW** any combination of skeletal **OR** structural **OR** displayed formula as long as unambiguous **ALLOW** part molecular formulae but not full
		(ii)	Nickel/Ni ✓	**1**	AO1.2	**ALLOW** Pt **OR** Pd **OR** Rh
		(iii)	(orange to) colourless **OR** bromine is decolourised ✓	**1**	AO1.2	**ALLOW** 'it decolourises / turns colourless' **IGNORE** colour change

Question			Answer	Marks	AO element	Guidance
5	(b)	(i)	*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)** Calculates the correct mass of hexan-1-ol. **AND** Explains the purification steps, with most fine detail. *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)** Attempts a calculation of the mass of hexan-1-ol which is partly correct. **OR** Outlines the purification steps, with some fine detail. *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)** Attempts the calculation but makes little progress. **OR** Briefly outlines the purification steps, which may be incomplete. *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**	AO2.8 ×2 AO3.3 ×4	**Indicative scientific points may include:** **Calculation from moles** ☐ n(hex-1-ene) = $\frac{4.20}{84.0}$ = 0.0500 (mol) ☐ n(hexan-1-ol) needed = 0.0500 × $\frac{100}{62.5}$ = 0.0800 (mol) ☐ mass needed = 0.0800 × 102 = **8.16** g ☐ **OR** volume $\frac{8.16}{0.82}$ = 9.95 cm^3 **CHECK** for extent of errors by **ECF.** **Calculation from mass** ☐ Theoretical mass hex-1-ene = 4.20 × $\frac{100}{62.5}$ = 6.72 g ☐ Theoretical n(hex-1-ene) = $\frac{6.72}{84}$ = 0.0800 (mol) ☐ Mass of hexan-1-ol = 102 × 0.0800 = **8.16** 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) --- **Purification** ☐ Use of a **separating funnel** to separate organic and aqueous layers ☐ **Drying** with an anhydrous salt ☐ **Distillation** ***Fine detail*** ☐ Collection of upper layer (less dense from separating funnel) ☐ Example of drying agent, e.g. $MgSO_4$, $CaCl_2$ ☐ Collection of fraction distilling at 63ºC (boiling point of hex-1-ene) Incorrect purification method **NOT** creditworthy ***Examples of partly correct calculations*** Mass = 5.1 g from 0.0500 × 102 *% yield omitted* Mass = 3.1875 g from 0.0500 × $\frac{62.5}{100}$ × 102 *% yield inverted*

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_4H_9– is allowed for $CH_3CH_2CH_2CH_2$–	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		

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

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Facsimile: 01223 552553