OCR
Oxford Cambridge and RSA

H

GCSE (9–1)

Chemistry A (Gateway Science)

J248/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for November 2020

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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

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.

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

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

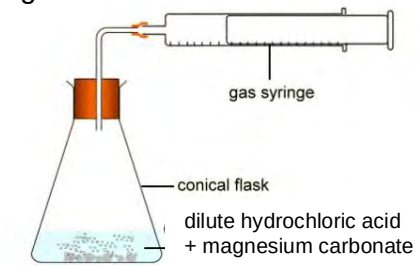
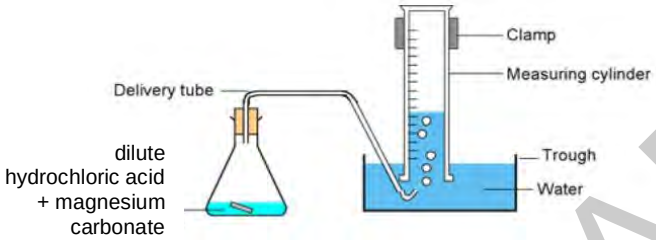
Question			Answer	Marks	AO element	Guidance
16	(a)		**Any three from:** (Metal wire is made of metal because) it is a good conductor (of electricity) ✓ it is flexible ✓ (Metal wire is coated with a polymer because) it is an insulator or poor conductor (of electricity) ✓ it is flexible ✓	3	3.2a	**IGNORE** references to other properties
	(b)		**Any one from:** Aluminium is higher in the reactivity series than carbon / aluminium is more reactive than carbon / ORA ✓ Carbon cannot displace aluminium (from bauxite) / bauxite cannot be reduced by carbon ✓	1	2.2	**Assume unqualified answers refer to aluminium** **IGNORE** aluminium is very reactive **Answers must be comparative** **ALLOW** bauxite does not react with carbon
	(c)	(i)	**Any two from:** Aluminium (metal) is sorted from other metals / materials ✓ Idea that aluminium/metal is shredded or crushed into smaller pieces ready for processing ✓ Idea that aluminium/metal is melted (by heating) ✓ Molten aluminium/metal is poured into moulds ✓	2	1.1	**DO NOT ALLOW** references to electrolysis **ALLOW** idea of cooling to form a solid (again)

Question			Answer	Marks	AO element	Guidance
		(ii)	**Any three from:** Idea that recycling aluminium saves energy (compared to extracting aluminium from bauxite) / ORA ✓ Idea that recycling makes more aluminium (than extraction from bauxite) ✓ Aluminium isn't wasted ✓ Use of data to back up either idea ✓ Idea of finite resource ✓ Idea of aluminium not being biodegradable, so recycling reduces landfill ✓ Idea that recycling aluminium produces less waste material (than extraction from bauxite) / ORA ✓ Idea that recycling aluminium produces less greenhouse gas emissions (than extraction from bauxite) / ORA ✓	3	3.2b	**IGNORE** just quoting numbers; answer must be comparative **IGNORE** references to cost **ALLOW** idea that recycling aluminium uses less raw materials

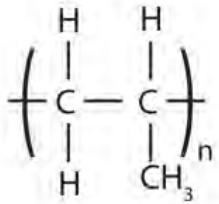
Question			Answer	Marks	AO element	Guidance
17	(a)		**Any two from:** Fertilisers increase crop yields ✓ Idea that growing populations mean that farmers need to grow more crops ✓ Idea that fertilisers provide essential elements for crops ✓ Idea that the quality of crops will be reduced without fertilisers ✓ Idea that fertilisers allow farmers to use the same land over and over again ✓	**2**	**1.1**	**IGNORE** just references to good / increased / faster growth **ALLOW** specific examples of essential elements, ie nitrogen / potassium / phosphorus **IGNORE** references to providing nutrients / minerals **ALLOW** specific example of reduced crop quality eg poor (root or fruit) growth / discoloured or yellow leaves etc **IGNORE** idea of controlling pests
	(b)		Sulfur (for sulfur trioxide) ✓ Air (for nitrogen) ✓	**2**	**1.1**	**IGNORE** sulfur dioxide
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 120 (tonnes) award 3 marks** M_r of NH_3 = 17 **AND** M_r of NH_4NO_3 = 80 ✓ Mass of ammonium nitrate = $\frac{80}{17}$ x 25.5 / 1.5 x 80 ✓ = 120 (tonnes) ✓	**3**	**2.1**	**ALLOW** ECF from incorrect RMMs

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 10(g) award 2 marks** Actual mass = $\frac{80 \times 12.5}{100}$ ✓ = 10 (g) ✓	**2**	**1.2** **2.2**	**ALLOW** % yield = (am ÷ pm) x 100 **OR** 80 = (am ÷ 12.5) x 100 for 1 mark if no other mark awarded

Question			Answer	Marks	AO element	Guidance
18	(a)		$2Na + 2H_2O \rightarrow 2NaOH + H_2$ Formulae ✓ Balancing ✓	2	 1.1 2.1	**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 eg $2Na + 2H_2O \rightarrow 2NaoH + H2$
	(b)		(Sodium atom) loses an electron / Oxidation is loss of electrons ✓	1	1.1	
	(c)		**Any two from:** <u>Outer electron</u> in rubidium is further from the nucleus / ORA ✓ Idea that attraction of rubidium's nucleus for <u>outer electron</u> is less / ORA ✓ <u>Outer electron</u> in rubidium is lost more easily / ORA ✓	2	1.1	**Assume unqualified answer refers to rubidium** **ALLOW** <u>outer electron</u> in higher energy level / shell **ALLOW** more shielding in rubidium **IGNORE** idea that outer electron is lost more quickly **Reference to outer electron needed at least once**

Question			Answer	Marks	AO element	Guidance
19	(a)		Use of gas syringe / upturned measuring cylinder / burette to collect gas over water ✓ Apparatus will work ✓ eg  **OR**  **And any three from:** Measure known volume of acid ✓ Add known mass of magnesium carbonate ✓ Measure volume of gas every 30 seconds ✓ Repeat with different concentrations of acid ✓ Repeat using same temperature ✓	**5**	**3.3a**	**ALLOW** idea of same volume of acid in each experiment **ALLOW** idea of same mass of magnesium carbonate in each experiment **ALLOW** Measure volume of gas at any sensible time interval **ALLOW** just the idea of measuring the time taken for a fixed volume of gas to be produced or the volume of gas produced in a fixed time **IGNORE** measure the time taken for the reaction to finish

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	Linear scale on both x and y axes ✓ All points plotted correctly scores 2 marks **BUT** 3 or 4 points plotted correctly scores 1 mark Line of best fit through points ✓	**4**	**3 x 2.2** **1.2**	 **ALLOW** ± ½ square **NB** Check that 7.0×10^{-3} is plotted as 0.7×10^{-2}
		(ii)	(Rate of reaction) increases ✓	**1**	**3.1a**	
		(iii)	Idea that acid particles move faster / particles have more energy ✓ Idea of increased collision frequency (between acid and thiosulfate) ✓ Idea of more successful collisions / collisions (between acid and thiosulfate) are more energetic / more particles have the activation energy ✓	**3**	**2.2**	**IGNORE** references to 'faster' collisions **IGNORE** just 'more collisions'

Question			Answer	Marks	AO element	Guidance
20	(a)	(i)	**A** and **D** ✓	1	2.1	**Both required for the mark**
		(ii)	**Any two from:** Have the same general formula / both have the formula C_nH_{2n+2} ✓ Idea that they differ from each other by CH_2 ✓ Both hydrocarbons with only single bonds / both saturated hydrocarbons ✓	2	1.1	**ALLOW** have similar chemical properties **ALLOW** show trends in physical properties **ALLOW** both hydrocarbons with no double bonds **ALLOW A** and **D** have the same functional group or no functional group / **B** and **C** have different functional groups (from **A** and **D**) **ALLOW** both (**A** and **D**) are alkanes / **C** is an alkene and **B** is a carboxylic acid
	(b)	(i)	 Correct structure ✓ Brackets and 'n' ✓	2	2.1	**ALLOW** structure of $-CH_3$ group shown **ALLOW** round or square brackets **Second marking point is dependent on correct structure**

Question			Answer	Marks	AO element	Guidance
		(ii)	**Any one from:** Idea that in addition polymerisation monomers react together to form one large molecule/polymer whereas in condensation polymerisation one large molecule and a smaller molecule is formed ✓ A monomer (molecule) for addition polymerisation has one functional group whereas a monomer (molecule) for condensation polymerisation requires two different functional groups ✓ Addition polymerisation requires a catalyst (whereas condensation polymerisation can happen without a catalyst) / ORA ✓ Addition polymerisation requires high temperature (whereas condensation polymerisation can happen at room temperature) / ORA ✓ Addition polymerisation requires high pressure (whereas condensation polymerisation can happen at atmospheric pressure) / ORA ✓	1	1.1	**ALLOW** condensation polymerisation produces water (whereas addition polymerisation does not) **ALLOW** idea that addition polymerisation makes one product (whereas condensation polymerisation makes two products) / ORA **ALLOW** addition polymerisation requires (a monomer) with a C=C, but condensation polymerisation requires a $-NH_2$ group and a -COOH group

Question	Answer	Marks	AO element	Guidance
(c)*	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)** Describes tests, the results, and identifies each of the three samples **AND** Includes correct balanced symbol equations for the reactions which occur. *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)** Describes tests, the results, and identifies each of the three samples **OR** Describes a test and the result, to identify one of the three samples and attempts to identify the other two **AND** Includes a balanced symbol equation for the reaction which occurs. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	6	3 x 1.2 3 x 2.2	**AO1 Knowledge and understanding of alkanes, alkenes and acids** • Alkanes do not react with bromine water • Alkenes react with bromine water / bromine water is decolourised • Acids react with carbonates to give off carbon dioxide / fizzing observed **AO2 Application and knowledge of tests and results** • Add sodium carbonate (or any suitable carbonate) • Ethanoic acid effervesces • Pentane and pentene do not effervesce • ALLOW other suitable reactions, eg addition of a metal; ethanoic acid effervesces • ALLOW use of universal indicator to identify ethanoic acid • Add bromine water to separate samples of pentane and pentene and shake • With pentene bromine water changes from orange to colourless / bromine water is decolourised • With pentane and ethanoic acid bromine water stays orange **AO2.1 Application of knowledge and understanding to produce balanced symbol equations** $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2 + H_2O$ $C_5H_{10} + Br_2 \rightarrow C_5H_{10}Br_2$

Question			Answer	Marks	AO element	Guidance
			Level 1 (1–2 marks) Describes a test and the result, to identify one of the three samples. *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.*			

Question			Answer	Marks	AO element	Guidance
21	(a)		**Any one from:** Use a single indicator / named single indicator eg methyl orange / phenolphthalein (instead of universal indicator)✓ Idea that universal indicator does not give a sudden colour change / universal indicator gives a continuous colour change / ORA ✓ **OR** Fill the burette exactly to the 0.00 cm^3 line ✓ Idea that this will give accurate volume of acid ✓ **OR** Idea of adding acid to the alkali <u>slowly</u> **or** <u>dropwise</u> (near the end point) ✓ Idea that indicator should change colour on addition of one drop (of acid) ✓ **OR** Idea of swirling the alkali while adding the acid ✓ To ensure mixing of acid and alkali / AW ✓ **OR** Use a white tile under the conical flask ✓ To see the colour change easily / clearly ✓ **OR** Repeat the experiment <u>until concordant or consistent results are obtained</u> ✓ To obtain a more accurate titre / AW ✓ **OR** Idea of doing a rough titration ✓ As this will give you an idea of the endpoint ✓	**2**	**3.3b**	**Explanation must be linked to improvement** **ALLOW** idea of using a pH probe or pH meter to give a more accurate indication of when neutralisation occurs **ALLOW** idea of missing the end point **ALLOW** two improvements, with no explanation, for 1 mark if no explanations given

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 23.65 (cm^3) award 2 marks** Use of volume of acid from titrations 2, 3 & 4 / Use of 23.60, 23.70 & 23.65 ✓ Accurate volume of acid = 23.65 (cm^3) ✓	**2**	**2.2**	**DO NOT ALLOW** 23.7 (cm^3) **ALLOW** 1 mark for average calculated using all results, ie 24.18 / 24.175 (cm^3) but **DO NOT ALLOW** 24.2 (cm^3)
	(b)	(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.106 (mol/dm^3) award 4 marks** moles of alkali = $\frac{0.200\times25.0}{1000}$ / 0.200 x 0.0250 / 0.005 / 5.0×10^{-3} ✓ moles of acid = $\frac{0.005}{2}$ = 0.0025 / 2.5×10^{-3} ✓ concentration of acid = $\frac{0.0025}{0.02365}$ / $\frac{0.0025 \times 1000}{23.65}$ / $\frac{2.5\times10^{-3}}{0.02365}$ / $\frac{2.5\times10^{-3} \times 1000}{23.65}$ / 0.1057 (mol/dm^3) ✓ concentration = 0.106 (mol/dm^3) (3 sig. figs) ✓	**4**	**3x 2.2** **1.2**	**ALLOW** ECF from moles of alkali **ALLOW** ECF from average titre in **(b)(i)** **ALLOW** ECF from moles of acid i.e. conc = $\frac{\text{moles}}{0.02365}$ or $\frac{\text{moles} \times 1000}{23.65}$

Question			Answer	Marks	AO element	Guidance
22	(a)		C most reactive A D B least reactive correct order – 2 marks C as most reactive and B as least – 1 mark	2	3.2b	
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.00125 / 1.25×10^{-3} award 2 marks** Moles = $\frac{\text{volume}}{24} / \frac{0.030}{24} / \frac{30}{24{,}000}$ ✓ = 0.00125 / 1.25×10^{-3} ✓	2	2.2	**ALLOW** 1 mark only for 30 ÷ 24 or 0.030 ÷ 24,000, correctly calculated
		(ii)	0.0025 / 2.5×10^{-3} (g) ✓	1	2.2	**unit not needed** **ALLOW** ECF from **(b)(i)** ie 2 x answer from **(b)(i)**
	(c)		Moles of chromium = $\frac{10.40}{52.0} = 0.2$ ✓ Moles of nickel = $\frac{17.61}{58.7} = 0.3$ ✓ Idea that ratio is 2:3 / ratio isn't 1:1 so equation 2 ✓	3	2.2	**ALLOW** other methods of calculation eg 10.40g of chromium forms $\frac{10.40}{52.0} \times 58.7$ = 11.74g nickel $\frac{11.74}{3} \times 2$ = 17.61g of nickel So, equation 2 **ALLOW** answers that show equation 1 is not correct **Third marking point is dependent on correct mathematical reasoning**

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	**Any two from:** (Bioleaching is) cheaper or uses less energy (than traditional mining) ✓ Idea that (bioleaching) allows copper to be extracted from low-grade ores ✓ Bacteria used occur naturally / bacteria do not need any special treatment ✓ (Bioleaching) does not release harmful sulfur dioxide (into the atmosphere) ✓ Idea that (bioleaching) does not lead to destruction of the landscape like mining ✓	**2**	**1.1**	**IGNORE** bioleaching is safer **IGNORE** less harmful to the environment, unless qualified
		(ii)	(Sulfuric acid) may escape into water supplies / (Sulfuric acid) may escape into the soil ✓	**1**	**1.1**	**ALLOW** an effect of acid escaping into soil eg changes pH of soil / makes soil acidic / stops plants growing / damage ecosystems **ALLOW** sulfuric acid can kill wildlife **IGNORE** references to acid rain

Question			Answer	Marks	AO element	Guidance
23	(a)		Idea that both carbon dioxide levels and variation in air temperature shows an increasing trend ✓ (Therefore) data suggests that carbon dioxide emissions are linked to global warming ✓ **OR** Idea that carbon dioxide levels have increased steadily but variation in air temperature has fluctuated ✓ (Therefore) data does not support a link between carbon dioxide emissions and global warming ✓	2	2 x 3.1b	**Evidence and conclusion must be linked** **ALLOW** there is a positive correlation (between carbon dioxide levels and variation in air temperature)
	(b)		**Any three from:** Idea that energy transferred by radiation from the Sun warms up the Earth's surface ✓ Idea that infrared radiation is emitted by the Earth's surface ✓ Idea that some infrared radiation goes directly into space ✓ Idea that greenhouse gases absorb (some) infrared radiation (radiated by the Earth's surface) ✓ Idea that greenhouse gas molecules emit infrared radiation (in all directions), warming the Earth's surface / atmosphere ✓	3	1.1	**DO NOT ALLOW** references to the ozone layer **ALLOW** energy instead of infrared radiation throughout **IGNORE** idea of trapping infrared radiation **ALLOW** named greenhouse gases eg carbon dioxide / methane

Question			Answer	Marks	AO element	Guidance
	(c)	(i)	**Any one from:** Burning fossil fuels ✓ Deforestation ✓ Intensive use of fertilisers (by farmers) ✓ Cement manufacture ✓	1	1.1	**ALLOW** example of burning fossil fuels
		(ii)	**Any two from:** Global warming / increased temperature of Earth's atmosphere ✓ Melting ice caps ✓ Rising sea levels ✓ Altered weather patterns / extreme weather events ✓ Flooding ✓ Increasing ocean acidity ✓	2	1.1	**ALLOW** climate change

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