

GCSE (9–1)

Chemistry A

(Gateway Science)

J248/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

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
/	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 A:

	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.

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

Question			Answer	Marks	AO element	Guidance
16	(a)		Any two from: (Kevlar®) has a <u>low(er) density</u> / is (more) lightweight (than steel) ✓ so it is easier to wear or carry / more comfortable to wear ✓ OR (Kevlar®) is strong(er) ✓ so it is less likely to be penetrated (by a bullet) ✓ OR (Kevlar®) is (more) flexible ✓ so it is easier to wear / more comfortable to wear / idea that it allows movement more easily ✓ OR (Kevlar®) does not corrode / does not rust ✓ so it will last longer ✓	4	3.2b	Explanation must be linked to description ALLOW 'light / lighter' only if supported by comparative data ALLOW idea that person can move more easily or more quickly ALLOW idea that (Kevlar®) can withstand a greater impact / is less easily damaged / is more resistant to wear IGNORE just the idea that (Kevlar®) is better at keeping you safe ALLOW idea that the vest can be worn in all weathers
	(b)		(Condensation) polymer ✓	1	1.1	ALLOW polyamide / polypeptide DO NOT ALLOW addition polymer DO NOT ALLOW chain
	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 100 award 3 marks Round each number to 1 significant figure: Silicon dioxide nanoparticle 20 nm ✓ Silicon atom 0.2 nm ✓ Number of times larger $\cong 20/0.2 = 100$ ✓	3	2.2	ALLOW $(18 \div 0.22 =) 81.8 / 82 / 80$ for 1 mark if no other mark awarded ALLOW $(18 \div 0.2 =) 90$ for 2 marks if no other mark awarded

Question			Answer	Marks	AO element	Guidance
	(c)	(ii)	(Silicon dioxide) nanoparticles have a greater surface area (to volume ratio than powder) / ORA ✓ Idea that chemical reactions take place on the surface of a catalyst ✓ Idea that there will be more (frequent) collisions / the rate of reaction will be faster ✓	3	1 x 2.1 2 x 1.1	ALLOW more active sites / idea that there are more places for the reaction to occur on IGNORE idea that there is more area of catalyst to react with

Question			Answer	Marks	AO element	Guidance
17	(a)		CO₂ emissions (in the UK) have decreased (from 1993 to 2013 / from 2006) ✓ Global sea levels have risen (from 1993 to 2013) ✓ (Therefore) data suggests that CO₂ emissions are not the (only) cause of rising sea levels / Idea that factors other than CO₂ emissions contribute to rising sea levels / data does not support a link (between human activity and climate change) ✓	3	3.1b	ALLOW idea that there is a negative correlation between CO₂ emissions and global sea levels / CO₂ emissions and global sea levels are inversely proportional for 2 marks ALLOW idea that sea levels were still rising when CO₂ emissions were decreasing for 2 marks ALLOW idea that the data does not completely support a link ALLOW idea that there is a mismatch between the data, ie one is UK but one is global
	(b)		Any two from: Idea that CO₂ emissions (from burning fossil fuels) are only from the UK and not a global figure ✓ Global CO₂ emissions could be increasing ✓ Idea that CO₂ emissions from other sources (not just burning fossil fuels) should be considered ✓ Idea that there is a lag between CO₂ emissions impacting on global sea levels ✓	2	3.2a	ALLOW idea that different countries produce different CO₂ emissions ALLOW idea that emissions from one country will not have a large impact on global CO₂ levels IGNORE idea that other factors may affect global sea levels IGNORE idea that there are other greenhouse gases

Question			Answer	Marks	AO element	Guidance
	(c)	(i)	Any one from: Idea of melting ice caps / melting glaciers / melting sea ice ✓ Altered weather patterns ✓	1	1.1	IGNORE 'melting ice' ALLOW specific examples or effects of altered weather patterns eg drought in some places or flooding in others ALLOW specific effects of rising sea levels eg coastal erosion / flooding of low lying land IGNORE rising temperatures
		(ii)	Any one from: Reduce consumption of fossil fuels ✓ Use biofuels ✓ Use renewable energy sources ✓ Stop carbon dioxide escaping when fuels are used ✓ Plant more trees / reduce deforestation / AW ✓ Recycle plastics etc (rather than burning) ✓	1	1.1	ALLOW specific examples eg car share / cycle to work / use public transport / use electric cars / don't leave appliances on standby ALLOW specific renewable energy sources eg wind / solar energy / tidal IGNORE use carbon neutral energy sources ALLOW use carbon capture (and storage)

Question			Answer	Marks	AO element	Guidance
18	(a)		$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ Formulae ✓ Balancing ✓	2	2.2	ALLOW any correct multiple, including fractions DO NOT ALLOW and / & instead of '+' balancing mark is dependent on the correct formulae but ALLOW = / → instead of ⇌ ALLOW 1 mark for a balanced equation with a minor error in subscripts / formulae eg $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$
	(b)	(i)	Increases / AW ✓	1	1.1	
	(b)	(ii)	(No) (because) higher temperature favours endothermic reaction / backward reaction / ORA ✓ (so) equilibrium shifts to left hand side / yield of ammonia is reduced / ORA ✓	2	2.1	Marks are for explanation ALLOW idea that the yield does not increase, in correct context References to reduced yield must not be in the context of rate
	(c)		Any two from: Idea that rate of reaction will be slower ✓ As there will be less frequent collisions / less collisions per second / particles collide less often ✓ Idea that yield of ammonia will be less ✓ (Lower pressure) favours backward reaction / equilibrium shifts to left hand side / ORA ✓ As there are fewer (gaseous) molecules on right hand side / ORA ✓	2	2.1	ALLOW idea that reaction will take longer time IGNORE idea that the reaction will not be at equilibrium

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	Repeat the titration until concordant results are obtained ✓ Repeat the experiment without the indicator ✓	2	3.3b	ALLOW note how much sulfuric acid is needed to neutralise the ammonia ALLOW idea of using (activated) charcoal to remove the indicator BUT IGNORE idea of just removing indicator before crystallising ALLOW idea of doing a rough titration and then repeating without indicator for 2 marks
		(ii)	Volumes of solution are too large for titration method / large volumes of liquid need to be heated and then allowed to crystallise ✓	1	1.1	ALLOW idea that industrial method is on a much larger scale / ORA ALLOW titration is a batch process / not a continuous process ALLOW idea that industry wants the reaction to be continually occurring IGNORE idea that it takes too long to do on a large scale

Question			Answer	Marks	AO element	Guidance
19	(a)		$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$ Formulae ✓ Balancing ✓	2	2x 2.2	ALLOW any correct multiple, including fractions ALLOW = / $\rightleftharpoons$ instead of $\rightarrow$ 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 $\text{Mg} + 2\text{HCL} \rightarrow \text{Mgc}_2 + \text{H}_2$ IGNORE state symbols

Question	Answer	Marks	AO element	Guidance
(b)*	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 results to describe that the results in relation to the volume of acid DO NOT support the prediction but that the results in relation to the concentration of the acid DO support the prediction with reference to experimental data (that includes fair testing) AND explains the results in detail using the reacting particle model, using the idea of collision frequency, that the greater the concentration the faster the reaction rate. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Analyses the results to describe that the results in relation to the volume of acid DO NOT support the prediction AND that the results in relation to the concentration of the acid DO support the prediction with reference to experimental data AND explains the results using the reacting particle model, using idea of more collisions (rather than collision frequency) that the greater the concentration the faster the reaction rate. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i>	6	3 x 3.2b 3 x 2.2	AO3.2b Analyse information and ideas to draw conclusions. VOLUME To include fair testing, candidates should compare EXPERIMENTS 1 & 2 CONCENTRATION To include fair testing, candidates should compare EXPERIMENTS 2 & 3 • results (in experiments 1 & 2) show as volume decreases reaction time does not change so reaction rate does not change • results show that as concentration increases reaction time gets less so reaction rate gets faster • the reaction in experiment 3 is faster, or has a shorter reaction time, than experiment 2 AO2.2 Apply knowledge and understanding of scientific enquiry, techniques and procedures. • concentration is higher in experiment 3 (than experiment 2) • acid particles are more crowded in experiment 3 / acid particles are closer together / more acid particles per unit volume / more acid particles per cm³ / more acid particles in the same space • more (successful) collisions per second / collisions more often / increased collision frequency / more chance of a collision IGNORE references to ‘faster’ collisions NB Correct points may be credited from annotation on the results table

Question			Answer	Marks	AO element	Guidance
			Level 1 (1–2 marks) Analyses the results to describe that the results in relation to the volume of acid DO NOT support the prediction OR analyses the results to describe that the results in relation to the concentration of the acid DO support the prediction OR explains using the reacting particle model, using idea of more collisions (rather than collision frequency) that the greater the concentration the faster the reaction rate. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>			
	(c)		Any two from: Heating the acid: - idea that acid particles move faster / particles have more energy ✓ - idea of increased collision frequency ✓ - idea of more successful collisions / collisions are more energetic ✓ AND Predicted reaction time – Any time less than 30s ✓	3	3 x 2.2	ALLOW the reaction time will decrease / the reaction time will be less than 30 seconds DO NOT ALLOW reaction time increases DO NOT ALLOW faster reaction time

Question		Answer	Marks	AO element	Guidance
	(d)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.67×10^{-3} (g/s) award 3 marks $8.33 \times 10^{-4} \times 240 = 0.19992 = 0.2$ or $100 \times 2.00 \times 10^{-3} = 0.2$ or $50 \times 4.00 \times 10^{-3} = 0.2 \checkmark$ $0.2 \div 120 = 0.00166666\dots$ or $0.2 \div 120 = 0.00167 \checkmark$ $= 1.67 \times 10^{-3}$ (g/s) $\checkmark$ <u>OR</u> $8.33 \times 10^{-4} \times 2 \checkmark$ $= 0.001666 \text{ or } 0.00167 \checkmark$ $= 1.67 \times 10^{-3}$ (g/s) $\checkmark$	3	2 x 2.2 1.2	ALLOW 1.66×10^{-3} / 1.7×10^{-3} for 2 marks IGNORE 0.0016 / 1.6×10^{-3} ALLOW 1.66×10^{-3} / 1.7×10^{-3} for 2 marks IGNORE 0.0016 / 1.6×10^{-3} ALLOW ECF from incorrect calculation for 3 sig fig and standard form mark

Question			Answer	Marks	AO element	Guidance																				
20	(a)		Any two from: (Potassium) reacts violently / sparks / ignites / explodes✓ floats / moves around on surface of water ✓ moves quickly (on water) ✓ lilac flame ✓ melts (into a ball) ✓ dissolves ✓ (hydrogen gas ignites with) a squeaky pop ✓	2	2.2	ALLOW (potassium) disappears / gets smaller																				
	(b)		Any two from: (Down Group 1) <u>outer</u> electron or <u>outer</u> shell gets further from the nucleus / more shielding / atomic radius increases / more electron shells / ORA ✓ Idea of less attraction between nucleus and <u>outer</u> shell electron ✓ <u>Outer</u> shell electron is lost more easily ✓	2	1.1	ALLOW <u>outer</u> electron in potassium is further from the nucleus than in lithium / ORA IGNORE potassium has more electrons (than lithium) DO NOT allow idea that outer electron is lost more quickly / AW																				
	(c)		<table><tr><th>Element</th><th>Formula</th><th>Colour</th><th>State at room temperature</th></tr><tr><td>Fluorine</td><td>F₂</td><td>pale yellow</td><td>gas</td></tr><tr><td>Chlorine</td><td>Cl₂</td><td>green ✓</td><td>gas ✓</td></tr><tr><td>Bromine</td><td>Br₂</td><td>brown</td><td>liquid</td></tr><tr><td>Iodine</td><td>I₂</td><td>grey</td><td>solid ✓</td></tr></table>	Element	Formula	Colour	State at room temperature	Fluorine	F ₂	pale yellow	gas	Chlorine	Cl ₂	green ✓	gas ✓	Bromine	Br ₂	brown	liquid	Iodine	I ₂	grey	solid ✓	3	1.1	
Element	Formula	Colour	State at room temperature																							
Fluorine	F ₂	pale yellow	gas																							
Chlorine	Cl ₂	green ✓	gas ✓																							
Bromine	Br ₂	brown	liquid																							
Iodine	I ₂	grey	solid ✓																							

Question			Answer	Marks	AO element	Guidance
	(d)		(Fluorine has) weak intermolecular forces / weak forces between molecules ✓ which only require a small amount of energy to break / which are easy to break ✓	2	1.1	ALLOW weak intermolecular bonds DO NOT ALLOW references to covalent bonds between <u>molecules</u> OR weak forces between <u>atoms</u> – scores 0
	(e)		(Group 0 elements) have a full / complete outer shell ✓ Idea that they have no tendency to lose or gain electrons ✓	2	1.1	ALLOW 8 electrons in outer shell IGNORE idea that they have no tendency to react unless linked to gaining a full outer shell (of electrons)

Question			Answer	Marks	AO element	Guidance
21	(a)		Idea of swapping the position of boiling tube X and the boiling tube of limewater ✓ Idea that any liquid that condenses in boiling tube X must have come from the burning methane or not from the limewater ✓	2	3.3b	ALLOW idea that water condenses before the limewater is reached ALLOW idea of carrying out 2 experiments, one to test for carbon dioxide and one to test for water for 2 marks
	(b)		Type of polymerisation – condensation (polymerisation) ✓ Correct choice of ethane-1,2-diol and ethanedioic acid ✓ Equation: $ \begin{array}{c} \text{H} & \text{H} \\ & \\ \text{HO}-\text{C}-\text{C}-\text{OH} \\ & \\ \text{H} & \text{H} \end{array} + \begin{array}{c} \text{O} \\ \\ \text{HO}-\text{C}-\text{C}-\text{OH} \\ \\ \text{O} \end{array} \rightarrow \begin{array}{c} \text{O} & \text{O} & & \text{H} & \text{H} \\ & & & & \\ -\text{C}-\text{C}-\text{O}-\text{C}-\text{C}-\text{O}- \\ & & & & \\ \text{H} & \text{H} & & \text{H} & \text{H} \end{array} + \text{H}_2\text{O} $ Correct ester (link) formed ✓ Water molecule eliminated ✓	4	1 x 1.1 1 x 3.1a 2 x 2.1	ALLOW mark for correct choice of monomers from correct reactant structures in an equation ALLOW mark for 'water' from an equation, even if incorrect
	(c)	(i)	4 / four ✓	1	1.1	
		(i)	Amino acids ✓	1	1.1	

Question			Answer	Marks	AO element	Guidance
	(d)	(i)	Carboxylic acids ✓	1	1.1	IGNORE carboxyl group
		(ii)	Alcohol X <pre> H H H H - C - C - C - O - H H H H ✓ </pre> Compound Y <pre> H H O H - C - C - C \ H H O - H ✓ </pre>	2	2.1	ALL covalent bonds must be shown in both displayed formulae BUT ALLOW 1 mark if both displayed formulae are correct, but show '-OH' without covalent bond

Question			Answer	Marks	AO element	Guidance
22	(a)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.24 / 2.243 / 2.2 (dm³) award 2 marks Moles of ammonium chloride = $5.00 \div 53.5$ or 0.0935 ✓ Volume of ammonia = moles x 24 $= 0.0935 \times 24$ $= 2.24 / 2.243 / 2.2 \text{ (dm}^3\text{)} \checkmark$ OR $2 \times 53.5 = 107\text{g}$ ammonium chloride produces 2×24 $= 48 \text{ dm}^3$ ammonia ✓ So 5.00g of ammonium chloride produces $\frac{5 \times 2 \times 24}{2 \times 53.5}$ $= 2.24 / 2.243 / 2.2 \text{ (dm}^3\text{)} \text{ ammonia } \checkmark$	2	2.2	ALLOW 0.09 / 0.094 ALLOW ECF from moles of ammonium chloride if first mark not awarded ALLOW 2.16 (ECF from 0.09)
	(b)	(i)	Moles of acid / HCl = $35.0 \div 1000 \times 0.075$ $= 0.002625 / 0.0026 / 2.625 \times 10^{-3} /$ $2.6 \times 10^{-3} \checkmark$ Moles of alkali / NaOH = $25.0 \div 1000 \times 0.100$ $= 0.0025 / 2.5 \times 10^{-3} \checkmark$ The acid is in excess ✓	3	2.2	ALLOW 1 mark for moles of acid = 2.625 and moles of alkali = 2.5 (ie use of cm³ instead of dm³) Third mark dependent on clear attempt at a calculation of moles of acid and alkali ALLOW ECF from calculated moles of acid and alkali

Question			Answer	Marks	AO element	Guidance
		(ii)	Correct choice of concordant results – 36.3 and 36.2 ✓ Mean = $(36.30 + 36.20) \div 2$ = 36.25 (cm ³) ✓	2	2.2	ALLOW 1 mark for ECF from any incorrect choice of concordant values eg 35.875 / 35.88 / 35.9 (cm ³) if all values are used
	(c)		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.3968 / 0.397 / 0.40 (mol / dm³) award 4 marks Moles of acid = $\frac{0.200 \times 24.80}{1000}$ or 0.00496 / 4.96 x 10 ⁻³ ✓ Moles of KOH = 2 x 0.00496 or 0.00992 / 9.92 x 10 ⁻³ ✓ Concentration of KOH = $\frac{0.00992}{25.0} \times 1000$ ✓ = 0.3968 / 0.397 / 0.40 (mol / dm ³) ✓	4	2.2	ALLOW 0.005 / 5.00 x 10 ⁻³ ALLOW clear indication that the ratio of KOH:acid is 2:1 ALLOW 0.01 / 1.00 x 10 ⁻² ALLOW ecf from incorrect moles of acid ie 2 x moles of acid ALLOW ecf from incorrect moles of KOH eg $\frac{0.00496}{25.0} \times 1000 = 0.1984$ ie 0.1984 would score 3 marks

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