

GCSE (9-1)

Chemistry A (Gateway)

Unit **J248H/04**: Higher Tier – Paper 4

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.

Question			Answer	Marks	AO element	Guidance
1			D ✓	1	2.1	
2			C ✓	1	1.2	
3			C ✓	1	1.1	
4			D ✓	1	2.2	
5			D ✓	1	1.1	
6			C ✓	1	2.1	
7			A ✓	1	2.2	
8			D ✓	1	1.2	
9			C ✓	1	1.1	
10			C ✓	1	1.2	
11			C ✓	1	2.2	
12			A ✓	1	1.1	
13			B ✓	1	1.1	
14			B ✓	1	1.1	
15			A ✓	1	1.2	

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)		(Electric car) uses Less energy (needed to make it) ✓ Causes less global warming / less greenhouse gases produced ✓ Causes less ozone ✓	3	3 x 3.1b	IGNORE just a restatement of the data; must be a comparison IGNORE references to carbon footprint DO NOT ALLOW eg less greenhouses gases so less acid rain ALLOW less water pollution than (making) a diesel car / produces the second least water pollution IGNORE less (water) pollution

Question		Answer	Marks	AO element	Guidance
	(b)	MAX TWO FROM: Idea that (fractionating) column has a temperature gradient ✓ Idea that crude oil contains a range of molecular sizes ✓ Idea that molecules or fractions or hydrocarbons or alkanes have different boiling points ✓ Idea that molecules or fractions or hydrocarbons or alkanes condense at different levels (in the fractionating column) ✓ PLUS AT LEAST ONE FROM: Larger molecules have higher boiling points / ORA ✓ Intermolecular forces between larger molecules are strong(er) / ORA / larger molecules have more intermolecular forces / ORA ✓ The stronger the intermolecular forces the higher the boiling point or more energy is required to break these forces / ORA ✓ During boiling intermolecular forces are broken ✓	3	3 x 1.1	DO NOT ALLOW just idea that molecules or fractions have different melting points NB This marking point gains TWO MARKS as it also includes M3 above ALLOW longer chains molecules for larger molecules ALLOW bitumen or fuel oil as a named large molecule / LPG or petrol as a named small molecule ALLOW bonds between molecules for forces between molecules ALLOW heat for energy BUT the larger the molecule the stronger the intermolecular forces therefore the higher the boiling point scores 3 / ORA

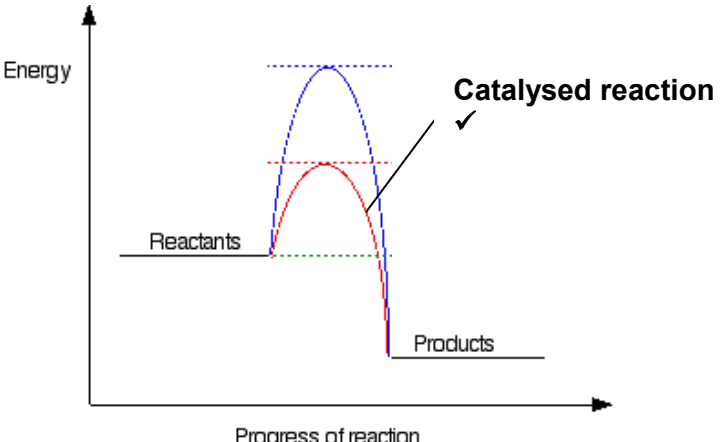
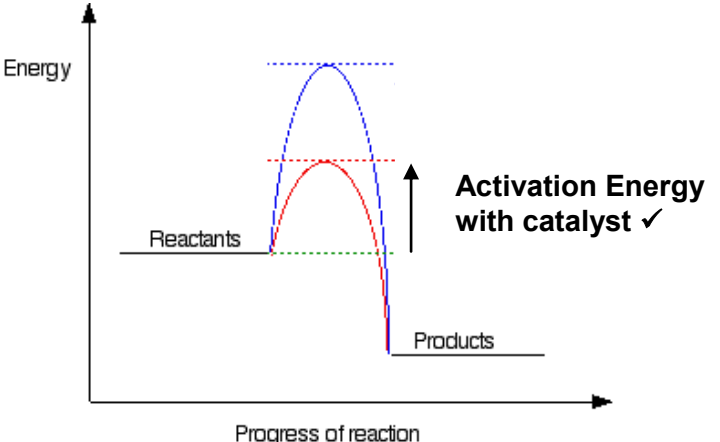
Question			Answer	Marks	AO element	Guidance
	(c)		A ✓ Idea that (LPG fraction) has the lowest boiling point ✓	2	3.2b 1.1	Second mark is dependent on correct choice of A ALLOW -2(°C) ALLOW A / LPG is a gas at room temperature ALLOW idea that LPG is collected at the top of the tower so must have the lowest (boiling) temperature IGNORE just quoting data from the table
	(d)		ANY TWO Advantages of fuel cell: Refuelling time (for a fuel cell) is less / ORA ✓ Fuel cell emits less CO₂ / ORA ✓ Mass (of car) is less (with fuel cell) / ORA ✓ AND Disadvantage of fuel cell: Cost of refuelling is more / ORA ✓	3	3 x 3.1b	Assume unqualified answer refers to fuel cell IGNORE just a restatement of the data; must be a comparison ALLOW fuel cell takes 356 minutes less to refuel / ORA ALLOW fuel cell only takes 4 minutes to refuel ALLOW fuel cell emits 12kg less CO₂ / ORA ALLOW fuel cell only emits 36 kg CO₂ ALLOW mass of car with fuel cell is 350(kg) less than electric car / ORA ALLOW mass of car with fuel cell is only 1200(kg) IGNORE electric car is faster ALLOW cost of refuelling car with fuel cell is £1 more than an electric car / ORA ALLOW cost of refuelling electric car is only £3.20 ALLOW costs more to run

Question			Answer	Marks	AO element	Guidance																		
17	(a)		All points plotted correctly scores 2 marks ✓✓ Straight line of best fit through the points ✓	3	3 x 2.1	ALLOW ± ½ square 3 or 4 points plotted correctly scores 1 mark ALLOW correctly drawn line of best fit through incorrectly plotted points; this may be a curve <table><tr><th>Name</th><th>Number of carbon atoms</th><th>Boiling point (°C)</th></tr><tr><td>methanol</td><td>1</td><td>65</td></tr><tr><td>ethanol</td><td>2</td><td>79</td></tr><tr><td>propanol</td><td>3</td><td>97</td></tr><tr><td>pentanol</td><td>5</td><td>138</td></tr><tr><td>hexanol</td><td>6</td><td>156</td></tr></table>	Name	Number of carbon atoms	Boiling point (°C)	methanol	1	65	ethanol	2	79	propanol	3	97	pentanol	5	138	hexanol	6	156
Name	Number of carbon atoms	Boiling point (°C)																						
methanol	1	65																						
ethanol	2	79																						
propanol	3	97																						
pentanol	5	138																						
hexanol	6	156																						
	(b)	(i)	Answer ± 2°C of their own graph ✓	1	2.1																			
		(ii)	H H H H H — C — C — C — C — O — H H H H H ✓	1	2.1	ALLOW diagram with –OH BUT DO NOT ALLOW -HO ALLOW diagram showing butan-2-ol eg H H O H H — C — C — C — C — H H H H H																		
	(c)		-OH ✓	1	1.1	ALLOW hydroxy / hydroxyl																		

Question			Answer	Marks	AO element	Guidance
	(d)		CH ₃ COOH ✓	1	2.2	ALLOW C ₂ H ₄ O ₂ ALLOW displayed formula, ie $\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{C} \\ \quad \diagup \\ \text{H} \quad \text{O} \\ \quad \quad \\ \quad \quad \text{O}-\text{H} \end{array}$ DO NOT ALLOW CH ³ COOH / CH ₃ COOH

Question			Answer	Marks	AO element	Guidance
18	(a)		$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ Formulae ✓ Balancing ✓	2	2 x 2.2	ALLOW any correct multiple, including fractions ALLOW = / $\Rightarrow$ 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 e.g $\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ IGNORE state symbols
	(b)	(i)	0 – 30 seconds ✓	1	3.1a	ALLOW correct answer ticked, circled or underlined in list if answer line is blank
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.44 award 3 marks (Rate =) $20 \div 45$ ✓ = 0.4444.... ✓ 2 sig figs = 0.44 ✓	3	1.2 2 x 2.2	ALLOW volume of 19 or 19.5 ALLOW 0.4222.... (vol=19) or 0.4333.... (vol=19.5) ALLOW ECF from incorrect volume ALLOW 0.42.... (vol=19) or 0.43.... (vol=19.5) ALLOW ECF from calculation IGNORE answer with recurring dot

Question		Answer	Marks	AO element	Guidance
	(c)	ANY FOUR FROM: More dilute acid: - idea of less crowded acid particles / less acid particles in same volume ✓ - idea of reduced collision frequency (between acid and calcium carbonate) ✓ Decreasing the temperature of the acid: - idea that acid particles move slower / particles have less energy ✓ - idea of reduced collision frequency (between acid and calcium carbonate) ✓ - idea of less successful collisions / collisions between marble chips and acid are less energetic ✓	4	4 x 2.2	ALLOW molecules or ions but DO NOT ALLOW atoms IGNORE references to just 'less (acid) particles' ALLOW particles collide less often IGNORE references to 'faster' collisions IGNORE references to successful collisions ALLOW particles collide less often IGNORE references to 'faster' collisions ALLOW eg less successful collisions per second for 2 marks

Question	Answer	Marks	AO element	Guidance
(d) (i)		1	1.1	ALLOW unlabelled reaction profile
(ii)		1	1.1	ALLOW ECF from incorrect reaction profile DO NOT ALLOW double headed arrow or line without arrow

Question	Answer	Marks	AO element	Guidance
19*	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 information about the reaction and applies knowledge and understanding of chemical equilibria to fully explain why the conditions used for the process are chosen. <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 information about the reaction and applies knowledge and understanding of chemical equilibria to attempt to explain why the conditions used for the process are chosen. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Applies knowledge and understanding to describe factors that affect rate of reaction or position of equilibrium. <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>	6	2 x 3.2b 2 x 3.1a 2 x 2.2	AO3.2b Analyses information to draw conclusions about the conditions used for the process • (Increasing temperature moves equilibrium to left because) forward reaction is exothermic • (Increasing pressure moves equilibrium to right because) 1 (gaseous) mole on RHS and 2 (gaseous) moles on LHS / fewer (gaseous) moles on RHS • (By removing ethanol from the equilibrium mixture position of equilibrium shifts to right because) system shifts to replace ethanol AO3.1a Analyses information to interpret the conditions used for the process • Increasing temperature shifts position of equilibrium to left / increasing temperature decreases (percentage) yield / increasing temperature favours backward reaction / ORA • Increasing pressure shifts position of equilibrium to right / increasing pressure increases (percentage) yield / increasing pressure favours forward reaction / ORA • (By removing ethanol from the equilibrium mixture) position of equilibrium shifts to right / forward reaction is favoured AO2.2 Applies knowledge and understanding of the conditions used for the process • Increasing temperature increases rate of reaction / temperature used to have a high rate of reaction • But higher temperatures are expensive (to generate and maintain) • Higher pressures increase rate of reaction • But higher pressures are expensive (to generate and maintain) so higher pressure not used • Catalyst increases rate of reaction • Catalyst does not change position of equilibrium / does not change (percentage) yield

Question			Answer	Marks	AO element	Guidance
20	(a)		ANY FOUR FROM: Do not add more sodium hydroxide after the indicator changes colour ✓ As indicator changes colour at endpoint / idea that addition of more sodium hydroxide will make the solution alkaline ✓ Add the sodium hydroxide dropwise or slowly (towards the endpoint) ✓ As indicator should change colour on addition of one drop (of alkali) ✓ Idea of using a single indicator rather than a mixed indicator (such as universal indicator) ✓ As single indicator will give a sharp endpoint ✓ Idea of swirling the conical flask during the addition of sodium hydroxide ✓ To ensure mixing of acid and alkali / AW ✓ Idea of washing down the side of the conical flask with distilled water close to the endpoint ✓ Idea of ensuring all the alkali enters the reaction mixture ✓ Use a white tile under the conical flask ✓ Idea of seeing the endpoint more clearly ✓	4	4 x 3.3b	All marking points are independent IGNORE repeat the titration IGNORE idea of using a pH probe or meter ALLOW idea of obtaining an exact endpoint ALLOW named single indicator eg methyl orange ALLOW idea that method is incorrect, and they read the burette to find out how much alkali reacts with 25.0 cm³ of sulfuric acid
	(b)		Idea that endpoint can be determined more accurately using a pH probe / datalogger ✓	1	3.3b	ALLOW idea that a pH probe or datalogger doesn't rely on human judgement ALLOW idea that pH probe or datalogger gives a numerical value / specific pH IGNORE pH probe / datalogger is more reliable

Question			Answer	Marks	AO element	Guidance
	(c)	(i)	1.4 ✓	1	2.2	
		(ii)	30 (cm ³) ✓	1	2.2	
	(d)	(i)	Titrations 2 and 4 are consistent or concordant / only consistently close readings should be included / the volumes are close to one another / the volumes are within 0.2 cm ³ ✓	1	3.2b	ALLOW volumes are similar ALLOW titrations 1 and 3 are inaccurate / idea that titrations 1 and 3 show a wider range / idea that titration 1 is a rough titration and titration 3 is an outlier or is anomalous

Question			Answer	Marks	AO element	Guidance
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.25 award 4 marks average titre = $(25.1 + 25.0) \div 2 = 25.05 \text{ cm}^3 / 0.02505 \text{ dm}^3$ ✓ no of moles in alkali = $\frac{0.200 \times 25.05}{1000} / 0.200 \times 0.02505 /$ $0.00501 / 5.01 \times 10^{-3}$ ✓ concentration of acid = $\frac{0.00501}{0.02} / \frac{0.00501 \times 1000}{20} /$ $\frac{5.01 \times 10^{-3}}{0.02} / \frac{5.01 \times 10^{-3} \times 1000}{20} /$ $0.2505 \text{ (mol/dm}^3\text{)} \checkmark$ 2 Sig figs: concentration = $0.25 \text{ (mol/dm}^3\text{)} \checkmark$	4	4 x 2.2	ALLOW 0.005 ALLOW ECF from average titre eg 25.1 cm^3 gives moles of alkali = $0.00502 / 5.02 \times 10^{-3}$ ALLOW ECF from moles of alkali i.e. conc = $\frac{\text{moles}}{0.02} / \frac{\text{moles} \times 1000}{20}$ unit not needed

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	0.25 (dm ³) ✓	1	2.2	
		(ii)	2.4 (g/dm ³) ✓	1	2.2	ALLOW ECF from (a)(i), ie conc = 0.6 ÷ (a)(i)
	(b)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.05 award 2 marks Moles of Zn = 3.27 ÷ 65.4 / 0.05 ✓ Idea that 1 mole of Zn forms 1 mole of H ₂ , so Moles of H ₂ = 0.05 ✓	2	1.2 2.2	ALLOW correct calculations using 65 for RAM of zinc rather than 65.4 i.e. 0.0503 moles of H ₂ ALLOW ECF from incorrectly calculated moles of Zn
		(ii)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 1.2 award 2 marks Volume = mol x 24 / 0.05 x 24 ✓ = 1.2 (dm ³) ✓	2	1.2 2.2	ALLOW ECF from (b)(i), ie Vol = (b)(i) x 24 unit not needed
	(c)	(i)	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 17.6(%) award 3 marks Atom economy = $\frac{6}{(28 + 6)} \times 100$ / $\frac{6}{34} \times 100$ ✓ = 17.647... (%) ✓ 3 sig figs = 17.6 (%) ✓	3	2.2 2.2 1.2	ALLOW atom economy formula in words for one mark i.e. atom economy = $\frac{\text{total Mr of desired products}}{\text{total Mr of all products}} \times 100$ OR atom economy = $\frac{\text{total Mr of desired products}}{\text{total Mr of all reactants}} \times 100$ ALLOW ECF from incorrect RFMs DO NOT ALLOW 17.7 (%) for sig figs mark

Question			Answer	Marks	AO element	Guidance
		(ii)	ANY THREE FROM: (%) yield ✓ Usefulness of by-products ✓ Rate of reaction ✓ Equilibrium position (for reversible reactions) ✓ Cost of raw materials / reactants ✓ Energy requirement ✓	3	3 x 1.1	ALLOW idea of cost of disposal of waste products IGNORE ideas about harming the environment IGNORE length of time for reaction ALLOW cost of catalyst ALLOW cost of (generating) high temperature / high pressure ALLOW idea that use of a catalyst reduces temperature needed IGNORE cost of equipment / plant / manufacturing costs / cheapest IGNORE ideas about safety

Question			Answer	Marks	AO element	Guidance
22	(a)		(carbon to carbon) double bond / C=C ✓	1	1.1	ALLOW (butene is) unsaturated
	(b)		C _n H _{2n} ✓	1	1.1	ALLOW H _{2n} C _n DO NOT ALLOW C ⁿ H ²ⁿ / C _n H _{2n}
	(c)		Correct displayed formula ✓ Use of brackets and 'n' ✓	2	2 x 2.1	ALLOW square or round brackets ALLOW 'n' in front of the brackets Second mark is dependent on first
	(d)		Nucleotides ✓	1	1.1	ALLOW phonetic spelling IGNORE bases / names of bases
	(e)	(i)	2 / two ✓	1	1.1	
		(ii)	Correct linkage ✓ Rest of structure correct, including 'end' bonds ✓	2	1.1	ALLOW diagram without brackets and n DO NOT ALLOW -COO- / H - Second mark is dependent on first
		(iii)	H ₂ O ✓	1	1.1	ALLOW 2H ₂ O DO NOT ALLOW water

Question			Answer	Marks	AO element	Guidance
	(f)	(i)	ANY THREE FROM: Idea of pouring hexanedioyl dichloride on top of the (diamine) solution (so that mixing is minimised) ✓ Use of glass rod or pouring down side of beaker to minimise mixing ✓ Idea of picking up (film of) nylon at interface (of layers with tweezers) ✓ Idea of lifting and drawing out thread of nylon (slowly) from beaker ✓ Idea of washing the thread of nylon (to remove any corrosive chemicals) ✓	3	3 x 1.2	ALLOW idea of pouring one solution on top of the other solution IGNORE just mixing the solutions ALLOW idea of (film of) nylon formed at the interface (of layers)
		(ii)	ANY THREE FROM: Avoid naked flames or sources of ignition because solvent is highly flammable ✓ Wear (disposable nitrile) gloves because reagents are corrosive ✓ Wear eye protection because reagents are corrosive ✓ Lab well ventilated / use of fume cupboard because of fumes from chemicals ✓	3	1.2 x 2 2.2	Safety precaution must be linked to correct explanation for the mark IGNORE avoid heat sources IGNORE idea of wearing gloves simply to stop reagents getting on hands or to protect hands, BUT ALLOW idea of wearing gloves to avoid damage to skin (by chemicals) IGNORE idea of wearing eye protection simply to stop reagents getting in eyes or to protect eyes, BUT ALLOW idea of wearing eye protection to avoid damage to eyes (by chemicals)

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