

H

GCSE (9–1)

Chemistry A (Gateway Science)

J248/03: Paper 3 (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.















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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 |

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1. 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 |

2. 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. |

SECTION A

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 | C ✓ | 1 | 2.2 | |
| 2 | B ✓ | 1 | 1.2 | |
| 3 | B ✓ | 1 | 2.1 | |
| 4 | D ✓ | 1 | 1.1 | |
| 5 | C ✓ | 1 | 1.1 | |
| 6 | C ✓ | 1 | 2.1 | |
| 7 | C ✓ | 1 | 1.1 | |
| 8 | D ✓ | 1 | 1.1 | |
| 9 | A ✓ | 1 | 1.1 | |
| 10 | D ✓ | 1 | 2.2 | |
| 11 | A ✓ | 1 | 2.1 | |
| 12 | B ✓ | 1 | 2.2 | |
| 13 | D ✓ | 1 | 1.1 | |
| 14 | D ✓ | 1 | 1.1 | |
| 15 | B ✓ | 1 | 2.1 | |

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| Question | | | Answer | Marks | AO element | Guidance |
|----------|-----|-------|--|-------|------------|---|
| 16 | (a) | (i) | Ionic ✓ oppositely charged ions ✓ | 2 | 1.1 | ALLOW oppositely charged particles / has + and - particles IGNORE contains anions and cations (in diagram) IGNORE oppositely charged atoms / molecules DO NOT ALLOW positive nucleus and negative electrons Mark independently |
| | | (ii) | Any two from: Idea of many strong ✓ covalent bonds ✓ (which) require a lot of energy to break ✓ | 2 | 1.1 | Reference to intermolecular forces / bonds / molecular forces scores 0 for question ALLOW many covalent bonds break at high temperatures for 2 marks ALLOW idea that each atom has 4 strong covalent bonds for 2 marks ALLOW giant covalent structure for 1 mark |
| | | (iii) | No delocalised electrons / no sea of electrons / no mobile charge carriers / ions / electrons / structure contains atoms ✓ | 1 | 1.1 | IGNORE just free electrons |
| | (b) | | Layers / metal ions ✓ slide over each other ✓ | 2 | 1.1 | IGNORE metal atoms / electrons Mark independently |

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| Question | | Answer | Marks | AO element | Guidance |
|----------|-----|---|-------|------------|--|
| 17 | (a) | <p>Any two from:</p> <p>In order of (increasing) atomic mass / weight ✓</p> <p>In groups showing similar <u>chemical</u> properties ✓</p> <p>Left gaps for elements that had not been discovered ✓</p> | 2 | 1.1 | <p>ALLOW (increasing) mass number</p> <p>IGNORE just in order of mass</p> |
| | (b) | In order of (increasing) atomic number / proton number ✓ | 1 | 1.1 | <p>IGNORE electrons</p> <p>DO NOT ALLOW atomic mass</p> |
| | (c) | (i) Germanium ✓ | 1 | 3.1a | |
| | | (ii) <p>Idea of similar atomic mass / 72.6 is closest to 72 / closest atomic mass ✓</p> <p>Idea of similar density / 5.35 is closest to 5.5 // closest density ✓</p> | 2 | 2 x 3.2a | <p>ALLOW (Relative) atomic mass of 72.6 is very close to 72</p> <p>IGNORE just atomic masses are 72 and 72.6</p> <p>ALLOW density of 5.35 is very close to 5.5</p> <p>IGNORE just densities are 5.35 and 5.5</p> <p>IGNORE comments about melting point or colour</p> <p>If no marks awarded, ALLOW 1 for density and relative atomic mass and not melting point</p> |
| | (d) | (i) <u>Unreactive</u> ✓ | 2 | 2.1 | ALLOW doesn't bond / doesn't lose or gain electrons / doesn't share electrons |
| | | Full outer shell (of electrons) ✓ | | 1.1 | ALLOW (argon has a) stable electronic structure / 8 electrons in outer shell |

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| Question | | | Answer | | | Marks | AO element | Guidance | | | | | | | | | | | | | |
|----------|-----------------------|-----------------------|--|--|-----------------------|-----------------------|------------|----------|----|---------|----|----|----------|----|----|---|---|---|---|-----|---------------------|
| | | (ii) | <table border="1"> <thead> <tr> <th></th> <th>$^{20}_{10}\text{Ne}$</th> <th>$^{22}_{10}\text{Ne}$</th> </tr> </thead> <tbody> <tr> <td>Proton</td> <td>10</td> <td>10</td> </tr> <tr> <td>Neutron</td> <td>10</td> <td>12</td> </tr> <tr> <td>Electron</td> <td>10</td> <td>10</td> </tr> </tbody> </table> | | $^{20}_{10}\text{Ne}$ | $^{22}_{10}\text{Ne}$ | Proton | 10 | 10 | Neutron | 10 | 12 | Electron | 10 | 10 | ✓ | ✓ | ✓ | 3 | 2.1 | 1 mark for each row |
| | $^{20}_{10}\text{Ne}$ | $^{22}_{10}\text{Ne}$ | | | | | | | | | | | | | | | | | | | |
| Proton | 10 | 10 | | | | | | | | | | | | | | | | | | | |
| Neutron | 10 | 12 | | | | | | | | | | | | | | | | | | | |
| Electron | 10 | 10 | | | | | | | | | | | | | | | | | | | |

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| Question | | | Answer | Marks | AO element | Guidance |
|----------|-----|-------|---|-------|--------------------|---|
| 18 | (a) | (i) | $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$ Reactants ✓ Balancing ✓ | 2 | 2.2 | ALLOW any correct multiple, including fractions ALLOW = OR = 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 $\text{Zn} + 2\text{HCL} \rightarrow \text{ZnCl}_2 + \text{H}_2$ |
| | | (ii) | Exothermic ✓ | 1 | 1.1 | |
| | (b) | | Energy required to start the reaction / energy required for a successful collision to occur / AW ✓ | 1 | 1.1 | IGNORE energy needed to activate the reaction / amount of energy for the reaction to take place |
| | (c) | (i) | Bond breaking is endothermic / takes in energy ✓ Bond making is exothermic / gives out energy ✓ More energy is given out (during bond making) than is taken in (during bond breaking) ✓ | 3 | 2 x 1.1 2.1 | DO NOT ALLOW ideas about more bonds IGNORE idea that more energy is used during bond making than is taken in during bond breaking IGNORE idea that it takes more energy to make bonds than to break bonds |
| | | (ii) | $\text{C-H: } 4 \times 413 = 1652$ AND $\text{O=O: } 2 \times 498 = 996$ Total energy = $1652 + 996 = 2648$ (kJ/mol) ✓ | 1 | 1.2 | |
| | | (iii) | $\text{C=O: } 2 \times 805 = 1610$ AND $\text{O-H: } 4 \times 464 = 1856$ Total energy = $1610 + 1856 = 3466$ (kJ/mol) ✓ | 1 | 1.2 | |
| | | (iv) | Energy change = $2648 - 3466 = -818$ (kJ/mol) ✓ | 1 | 1.2 | Answer MUST show – sign for mark ALLOW ECF from parts (ii) & (iii) |

| Question | | Answer | Marks | AO element | Guidance |
|----------|------|---|-------|------------|---|
| 19 | (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) Detailed evaluation of the advantages and disadvantages of <u>all</u> of the pH testing kits A-E AND Suggested pH kit the farmer should use <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) Evaluation of the advantages and disadvantages of some of the pH testing kits A-E OR Detailed evaluation of the advantages of <u>all</u> of the pH testing kits A-E OR Detailed evaluation of the disadvantages of <u>all</u> of the pH testing kits A-E AND Suggested pH kit the farmer should use OR Detailed evaluation of the advantages and disadvantages of <u>all</u> of the pH testing kits A-E <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i></p> | 6 | 6 × 3.2a | <p>AO3.2a Analyse information and ideas to make a judgement of which pH testing kit the farmer should use</p> <p>Advantages</p> <ul style="list-style-type: none"> • A is one of the least expensive testing kits • A changes colour across the pH scale • A can be used in acidic and alkaline soils • D is the least expensive <p>Disadvantages</p> <ul style="list-style-type: none"> • Idea that B and D only have two possible colours and therefore cannot tell you the pH • Idea that C and E don't change colour past pH 7, therefore is no use in alkaline soils • E is the most expensive <p>Choice</p> <ul style="list-style-type: none"> • A should be used by the farmer |

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| Question | | Answer | Marks | AO element | Guidance |
|----------|-----|--|----------|---|--|
| | | <p>Level 1 (1–2 marks) Evaluation of the advantages of some of the pH testing kits A-E OR Evaluation of the disadvantages of some of the pH testing kits A-E OR Evaluation of the advantages and disadvantages of some of the pH testing kits A-E AND Suggested pH kit the farmer should use.</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 <i>No response or no response worthy of credit.</i></p> | | | |
| | (b) | <p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 297 award 3 marks</p> <p>Relative formula mass of $\text{MgCO}_3 = 24.3 + 12 + 16 \times 3$ $= 84.3 \checkmark$</p> <p>Number of moles = $25 \times \frac{1000}{84.3} = 296.5599051 \checkmark$ $= 297 \checkmark$ (to 3 sig fig)</p> | 3 | <p>2.2 x 2</p> <p>1.2</p> | <p>DO NOT ALLOW 84</p> <p>ALLOW ECF from incorrect RFM of MgCO_3 eg RFM of 84, number of moles = 298</p> <p>ALLOW ECF for sig fig mark</p> |

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| Question | | | Answer | Marks | AO element | Guidance |
|----------|-----|-------|---|-------|---------------------------|---|
| 20 | (a) | (i) | <p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 0.62 award 3 marks</p> <p>$R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}} = 37/60 \checkmark$</p> <p>= 0.61666.... \checkmark</p> <p>= 0.62 (2 significant figures) \checkmark</p> | 3 | 1.1 2.2 1.2 | <p>ALLOW ECF for use of correct calculation from incorrect measurements</p> <p>ALLOW 0.59 – 0.67 ALLOW ECF for sig fig mark</p> |
| | | (ii) | A and B | 1 | 3.2a | Both needed for the mark |
| | | (iii) | <p>Idea that D forms weak(er) bonds with the mobile phase than C /</p> <p>Idea that D forms strong(er) bonds with stationary phase than C /</p> <p>D is less polar than C / ORA \checkmark</p> | 1 | 2.1 | ALLOW C is more soluble (in the solvent) than D / ORA |
| | (b) | (i) | <p>Similarity: Both have stationary and mobile phases / both use silica in the stationary phase \checkmark</p> <p>Difference: Thin-layer uses liquid for mobile phase / gas chromatography use gas for mobile phase \checkmark</p> | 2 | 2 x 1.1 | ALLOW the mobile phases are different states |
| | | (ii) | <p>Thin-layer chromatography is used to separate solids /</p> <p>gas chromatography is used to separate gases (in a gas mixture) \checkmark</p> | 1 | 2.1 | ALLOW idea that the tomato sauce is a liquid or not a gas |

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| Question | | Answer | Marks | AO element | Guidance | | | |
|----------|-----|---|-------|------------|---|---|-------------------|---|
| 21 | (a) | <p>Outer shells correctly drawn ✓ Correct charges ✓</p> | 2 | 2.1 | <p>ALLOW all dots / all crosses / mix of dots and crosses</p> <p>ALLOW eight electrons shown on outer shell of sodium ion</p> <p>ALLOW just one sodium ion drawn</p> <p>If inner shells are drawn, they must be correct</p> <p>ALLOW 1 mark for correct diagram of either a Na⁺ or O²⁻ ion, if no other mark awarded</p> | | | |
| | (b) | (i) | | | <p>$\text{Na}_2\text{O (s)} + \text{H}_2\text{O (l)} \rightarrow 2\text{NaOH (aq)}$</p> <p>Formulae ✓ Balancing ✓ State symbols ✓</p> | 3 | 2.1 1.2 2.1 | <p>ALLOW any correct multiple, including fractions</p> <p>ALLOW = OR \rightleftharpoons instead of \rightarrow</p> <p>DO NOT ALLOW and / & instead of '+'</p> <p>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. $\text{NAO} + \text{H}_2\text{O} \rightarrow 2\text{NaOH}$</p> <p>State symbols mark is independent of formulae & balancing marks</p> |
| | | (ii) | | | Hydroxide / OH ⁻ ions ✓ | 1 | 1.1 | |
| | | (iii) | | | Sodium sulfate ✓ | 1 | 2.1 | <p>ALLOW Na₂SO₄</p> <p>IGNORE incorrect formulae if correct name is given</p> |

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| Question | | Answer | Marks | AO element | Guidance |
|----------|------|--|-------|------------|--|
| | (iv) | <p>FIRST CHECK ANSWER ON ANSWER LINE If answer = 100 award 2 marks</p> <p>pH increased by 2 concentration decreases by a factor of 10×10 ✓</p> <p>100 ✓</p> | 2 | 2.2 | ALLOW for 1 mark pH increase by 1, so concentration decreased by a factor of 10 |

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| Question | | | Answer | Marks | AO element | Guidance | |
|----------|-----|--|--|---------|--|---|---|
| 22 | (a) | (i) | x- axis: mass of copper carbonate (g) AND y-axis: mass of copper oxide(g) ✓ Appropriate scale ✓ All points plotted correctly ✓ Line of best fit through the points ✓ | 4 | 4 x 2.2 | ALLOW correct formulae, ie CuCO ₃ and CuO ALLOW just copper carbonate (g) AND copper oxide(g) ALLOW ± ½ square 1.2 ALLOW line that starts at (1, 0.7) and does not go through (0,0) ALLOW correctly drawn line of best fit through incorrectly drawn points; this may be a curve | |
| | | (ii) | 3.8(0) (g) ✓ | | 1 | 3.1a | ALLOW ± ½ square ALLOW ECF from graph |
| | | (iii) | Idea that carbon dioxide (gas) escapes ✓ | | 1 | 3.2b | ALLOW idea that a gas is produced / escapes, but DO NOT ALLOW incorrectly named gas |
| | (b) | FIRST CHECK ANSWER ON ANSWER LINE If answer = 373 (tonnes) award 4 marks $M_r \text{ CaCO}_3 = 100.1$ and $M_r \text{ CaO} = 56.1$ ✓ 209 g of calcium oxide = $\frac{100.1}{56.1} \times 209$ ✓ = 372.9215686 (g) ✓ = 373 (g) (3 significant figures) ✓ | 4 | 3 x 2.2 | Need both relative formula masses for 1 mark DO NOT ALLOW 100 or 56 ALLOW ECF from incorrect RFMs ALLOW ECF 1.2 ALLOW ECF for sig fig mark | | |

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| Question | | | Answer | Marks | AO element | Guidance | |
|----------|-----|-----|--|--|------------|--|--|
| 23 | (a) | (i) | Cu^{2+} , SO_4^{2-} , H^+ , OH^- | 2 | 2.2 | All 4 ions correct for 2 marks 2 or 3 ions correct for 1 mark | |
| | | (b) | Idea that inert electrodes do not react with the electrolyte / inert electrodes are unreactive ✓ | 1 | 1.2 | ALLOW so that electrodes do not take part in the reaction | |
| | | (c) | (i) | Copper sulfate ✓ | 1 | 3.2a | |
| | | | (ii) | Copper chloride produces chlorine which is a toxic gas / copper sulfate does not produce chlorine which is a toxic gas ✓ Zinc bromide / sulfuric acid do not have copper <u>ions</u> OR copper sulfate / copper chloride contain copper <u>ions</u> ✓ | 2 | 2 × 3.2b | IGNORE idea that chlorine gas is dangerous / hazardous ALLOW idea that the solution contains copper <u>ions</u> |
| | | (d) | (i) | Oxygen / O_2 ✓ | 1 | 3.2a | IGNORE O |
| | | | (ii) | Hydrogen is less reactive than sodium / ORA ✓ | 1 | 3.2b | Assume unqualified answer refers to hydrogen (gas) |

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| Question | | Answer | Marks | AO element | Guidance |
|----------|-------|--|-------|------------|---|
| | (iii) | $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$ Formula ✓ Balancing ✓ | 2 | 2.1 1.2 | <p>ALLOW any correct multiple, including fractions ALLOW = OR \rightleftharpoons instead of \rightarrow DO NOT ALLOW and / & instead of '+' ALLOW e for e^-</p> <p>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. $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$</p> |
| | (e) | Aqueous solutions contain H^+ and OH^- ions / molten state does not contain H^+ and OH^- ions ✓ | 1 | 1.2 | |

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

www.ocr.org.uk

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