

# Foundation

## GCSE

### Chemistry B Twenty First Century Science

#### J258/03: Breadth in Chemistry (Higher Tier)

General Certificate of Secondary Education

**Mark Scheme for June 2023**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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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## MARKING INSTRUCTIONS

## PREPARATION FOR MARKING

## RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

## MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed Out Responses**  
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

**Rubric Error Responses – Optional Questions**

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor,

which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

### **Multiple Choice Question Responses**

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate). *When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.*

### **Contradictory Responses**

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

### **Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

### **Short Answer Questions** (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

### **Longer Answer Questions** (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the

candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
- there is nothing written in the answer space.

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

**The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

**The lower mark** should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.















**In summary:**

**The skills and science content determines the level.**

**The communication statement determines the mark within a level.**

Level of response questions on this paper are **X** and **X**

## 11. 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                                 |

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

| <b>Annotation</b>   | <b>Meaning</b>                                                |
|---------------------|---------------------------------------------------------------|
| /                   | alternative and acceptable answers for the same marking point |
| ✓                   | Separates marking points                                      |
| <b>DO NOT ALLOW</b> | Answers which are not worthy of credit                        |
| <b>IGNORE</b>       | Statements which are irrelevant                               |
| <b>ALLOW</b>        | Answers that can be accepted                                  |
| ( )                 | Words which are not essential to gain credit                  |
| —                   | Underlined words must be present in answer to score a mark    |
| <b>ECF</b>          | Error carried forward                                         |
| <b>AW</b>           | Alternative wording                                           |
| <b>ORA</b>          | Or reverse argument                                           |

### 13. 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.

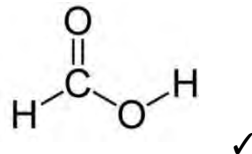
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New 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 B:

|              | <b>Assessment Objective</b>                                                                                                                           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>AO1</b>   | <b>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</b>                                          |
| AO1.1        | Demonstrate knowledge and understanding of scientific ideas.                                                                                          |
| AO1.2        | Demonstrate knowledge and understanding of scientific techniques and procedures.                                                                      |
| <b>AO2</b>   | <b>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</b>                                       |
| AO2.1        | Apply knowledge and understanding of scientific ideas.                                                                                                |
| AO2.2        | Apply knowledge and understanding of scientific enquiry, techniques and procedures.                                                                   |
| <b>AO3</b>   | <b>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</b> |
| <b>AO3.1</b> | Analyse information and ideas to interpret and evaluate.                                                                                              |
| AO3.1a       | Analyse information and ideas to interpret.                                                                                                           |
| AO3.1b       | Analyse information and ideas to evaluate.                                                                                                            |
| <b>AO3.2</b> | 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.                                                                                                    |
| <b>AO3.3</b> | 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                                               | (a)      | low boiling/melting point / does not conduct electricity / poor heat conductor / low density / colourless / odourless ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1     | 1.1        | <b>IGNORE</b> non-metal / full outer shell<br><b>ALLOW</b> gas (at room temperature) / insulator                                                                                                                                                                                                       |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
|                                                 | (b)      | Argon has a full outer shell / has 8 electrons in the outer shell / has a stable electronic structure/arrangement ✓<br><br>Chlorine gains one electron (to give a full (outer) shell) ✓                                                                                                                                                                                                                                                                                                                                                                                 | 2     | 2.1        | <b>IGNORE</b> argon does not gain/lose electrons<br><br><b>IGNORE</b> chlorine has 7 electrons in the outer shell alone / chlorine does not have a full outer shell / is missing an electron<br><b>DO NOT ALLOW</b> chlorine loses or gains electrons<br><b>ALLOW</b> chlorine needs to gain electrons |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
|                                                 | (c)      | (i) <table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>True</th> <th>False</th> </tr> </thead> <tbody> <tr> <td>X is a metal.</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td>X is in the first period of the Periodic Table.</td> <td></td> <td style="text-align: center;">✓</td> </tr> <tr> <td>X forms X<sup>-</sup> ions.</td> <td></td> <td style="text-align: center;">✓</td> </tr> <tr> <td>X loses one electron when it reacts.</td> <td style="text-align: center;">✓</td> <td></td> </tr> </tbody> </table><br>✓✓ |       | True       | False                                                                                                                                                                                                                                                                                                  | X is a metal. | ✓ |  | X is in the first period of the Periodic Table. |  | ✓ | X forms X <sup>-</sup> ions. |  | ✓ | X loses one electron when it reacts. | ✓ |  | 2 | 3.2a | All 4 correct = 2 marks<br>Any 2 correct = 1 mark |
|                                                 | True     | False                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |            |                                                                                                                                                                                                                                                                                                        |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
| X is a metal.                                   | ✓        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |            |                                                                                                                                                                                                                                                                                                        |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
| X is in the first period of the Periodic Table. |          | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |            |                                                                                                                                                                                                                                                                                                        |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
| X forms X <sup>-</sup> ions.                    |          | ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |       |            |                                                                                                                                                                                                                                                                                                        |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
| X loses one electron when it reacts.            | ✓        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |       |            |                                                                                                                                                                                                                                                                                                        |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
|                                                 | (ii)     | Sodium / potassium ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1     | 3.2b       | <b>ALLOW</b> rubidium / caesium /francium<br><b>IGNORE</b> hydrogen/ Group II<br><b>IGNORE</b> fluorine                                                                                                                                                                                                |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |
|                                                 | (d)      | 22 ✓                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 1     | 1.2        | <b>ALLOW</b> 21.9                                                                                                                                                                                                                                                                                      |               |   |  |                                                 |  |   |                              |  |   |                                      |   |  |   |      |                                                   |

|   | Question |      | Answer                                                                            | Marks | AO element | Guidance                                                                                                                                                                                                                                                           |
|---|----------|------|-----------------------------------------------------------------------------------|-------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | (a)      | (i)  |  | 1     | 1.2        | <b>DO NOT ALLOW</b> -OH                                                                                                                                                                                                                                            |
|   |          | (ii) | Methanoic acid ✓                                                                  | 1     | 1.1        |                                                                                                                                                                                                                                                                    |
|   | (b)      |      | 1 - 6.9 ✓                                                                         | 1     | 1.1        | <b>ALLOW</b> 0                                                                                                                                                                                                                                                     |
|   | (c)      | (i)  | Carbon dioxide ✓                                                                  | 1     | 1.2        | <b>ALLOW</b> CO <sub>2</sub><br><b>DO NOT ALLOW</b> CO <sup>2</sup>                                                                                                                                                                                                |
|   |          | (ii) | Ca(HCOO) <sub>2</sub> ✓                                                           | 1     | 2.1        | <b>ALLOW</b> correct formula in any attempt at an equation<br><br><b>ALLOW</b> CaH <sub>2</sub> C <sub>2</sub> O <sub>4</sub> / Ca(HCO <sub>2</sub> ) <sub>2</sub> / Ca <sup>2+</sup> (HCOO <sup>-</sup> ) <sub>2</sub>                                            |
|   | (d)      |      | Filtration/filter ✓<br><br>to remove calcium carbonate from the mixture ✓         | 2     | 3.3b       | <b>ALLOW</b> filtration given in explanation but <b>DO NOT ALLOW</b> 'filter to remove crystals' (=0)<br><br><b>IGNORE</b> to remove solids/insoluble solids/excess substances<br><br>Mark point 2 for identifying calcium carbonate as the impurity to be removed |
|   | (e)      | (i)  | Evaporation/evaporate (AW) ✓                                                      | 1     | 1.2        | <b>IGNORE</b> filtration / boiling / heating / crystallisation / put in an oven                                                                                                                                                                                    |

|  |  |                                                                                                                                                                                                                                                                  |   |     |                                                                                 |
|--|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|---------------------------------------------------------------------------------|
|  |  | (ii) <b>First check the answer on answer line<br/>If yield = 30(%) award 3 marks</b><br><br>20g of calcium carbonate gives 26g of calcium formate /<br>actual yield for 10g is 3.9 g ✓<br><br>$\% = 7.8/26 \times 100$ or $3.9/13 \times 100$ ✓<br><br>= 30(%) ✓ | 3 | 2.2 | <b>ALLOW (2)</b> for 60<br><b>ALLOW (2)</b> for 0.3<br><b>ALLOW (1)</b> for 0.6 |
|--|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|---------------------------------------------------------------------------------|

| Question | Answer                                                                                                                                                                                                                                                                                                                                     | Marks    | AO element                              | Guidance                                                                                                                                                                                                                                                                                                            |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>3</b> | <p><b>(a)</b></p> <p>CO<sub>2</sub> concentration has increased (over the last 20 years) ✓</p> <p>use of coal has (increased then) stayed (approximately) the same/constant/has not changed/has not increased/has decreased ✓</p> <p>(in the last 20 years) use of oil/gas/ use of other fossil fuels has increased (more than coal) ✓</p> | <b>3</b> | <b>3.1b</b>                             | <p><b>IGNORE</b> statements about any changes / increase in CO<sub>2</sub> before 2000 / increased 'carbon emissions'</p> <p><b>ALLOW</b> we use more oil/gas/other fossil fuels than coal / use less coal than other fossil fuels</p> <p><b>ALLOW</b> values quoted from the graph to make comparisons</p>         |
|          | <p><b>(b)</b></p> <p><b>First check answer on answer line</b><br/><b>If answer = <math>1 \times 10^{11}</math> award 3 marks</b></p> <p>1350 kWh = <math>1350 \times 10^3 / 1\,350\,000</math> (Wh) ✓</p> <p>No. Solar panels = <math>135000 \times 10^{12} / 1350 \times 10^3</math> ✓</p> <p>= <math>1 \times 10^{11}</math> ✓</p>       | <b>3</b> | <p><b>1.2</b></p> <p><b>2.2 x 2</b></p> | <p><b>ALLOW (2)</b> for <math>1 \times 10^{14}</math> (no unit conversion) / <math>1 \times 10^{17}</math> (unit conversion inverted)</p> <p><b>ECF</b> for any calculated value with working given in standard form</p> <p><b>ALLOW MAX 2</b> for errors in standard form e.g. <math>0.1 \times 10^{12}</math></p> |

|     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                            |                                                                                                                                                                                                                                                                                                                          |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (c) | <p>2020 value is 415 (<math>\pm 5</math>) ✓</p> <p>and <b>EITHER</b></p> <p>works out percentage increase:<br/> <math>(415 (\pm 5) - 278) \times 100 / 278</math> ✓</p> <p>~49.1% ✓</p> <p><b>OR</b> works out total percentage increase<br/> <math>415 (\pm 5) / 278 \times 100</math> ✓</p> <p>= 149 % ✓</p> <p><b>OR</b> works out predicted 2020 value from 278<br/> <math>(278 \times 1.5)</math> or <math>(278/2 + 278)</math> ✓</p> <p>= 417</p> <p><b>OR</b> works out pre-industrial value from 2020 value<br/> <math>415 (\pm 5) \times 2/3</math> ✓</p> <p>= 276(.7) ✓</p> <p><b>OR</b> works out 50% increase and compares<br/> <math>(278/2) = 139</math> ✓</p> <p><math>(415 (\pm 5) - 278) = 137</math> ✓</p> | 3 | <p>3.1a</p> <p>2.2 x 2</p> | <p>Working must be shown<br/> <b>IGNORE</b> answers that divide 2020 value by 2</p> <p><b>ALLOW</b> values 410-420 for 2020 CO<sub>2</sub> concentration</p> <p><b>ALLOW</b> values 47.5 – 51.1</p> <p><b>ALLOW</b> values 147.5 – 151.1</p> <p><b>ALLOW</b> values 273.3 - 280.0</p> <p><b>ALLOW</b> values 132-142</p> |
|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|  |     |                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |     |                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | (d) | <p>(i) <b>Any three from:</b><br/>                 UV radiation/radiation from the Sun passes through the atmosphere/reaches the Earth ✓</p> <p>Earth emits IR ✓</p> <p>radiation emitted by the Earth/IR is absorbed by greenhouse gas/CO<sub>2</sub> ✓</p> <p>radiation is (re)radiated/emitted (from the Earth) in all directions ✓</p>                                                                                              | 3 | 1.1 | <p><b>IGNORE</b> references to the ozone layer<br/> <b>ALLOW</b> light for radiation for M1 only<br/> <b>IGNORE</b> heat</p> <p><b>ALLOW</b> wrong verb in place of ‘emits’ e.g. reflects/refracts etc for M2 and M3</p> <p><b>IGNORE</b> ‘reflected’ in place of ‘absorbed’<br/> <b>ALLOW</b> trapped<br/> <b>ALLOW</b> ECF for incorrect radiation named in M2</p> <p><b>IGNORE</b> temperature increase/warming/global warming</p> |
|  |     | <p>(ii) <b>Any three from:</b><br/>                 increase in (global) temperature ✓</p> <p>extreme weather patterns / hurricanes/tornadoes ✓</p> <p>increased/decreased rainfall/monsoons / increased flooding (due to rain) / droughts / rise in sea level / melting ice caps ✓</p> <p>increase risk of (forest) fires ✓</p> <p>crop failure / famine / extinction ✓</p> <p>change to ocean currents (e.g. Gulf Stream slows) ✓</p> | 3 | 1.1 | <p><b>IGNORE</b> climate change<br/> <b>ALLOW</b> global warming/ ‘becomes hotter’</p> <p>e.g. very hot summers/very cold winters / more storms</p> <p><b>ALLOW</b> wetter/drier/desertification</p>                                                                                                                                                                                                                                  |

| Question |     |      | Answer                                                                                                                                                                                                                                                                   | Marks | AO element                | Guidance                                                                                                                                                                                                                                                                                                                                                               |
|----------|-----|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4        | (a) | (i)  | <p><b>Any one from:</b><br/>           Only number of neutrons differs in isotopes ✓<br/><br/>           Number of protons is equal to number of electrons (in an isotope/atom) ✓</p>                                                                                    | 1     | 1.2                       | <p><b>IGNORE</b> if they were different it would be a different element / changing the electrons changes the group/changes the element<br/> <b>IGNORE</b> electrons (and protons) do not change/stay the same in isotopes (rewords the question)<br/> <b>IGNORE</b> 'because the atomic/proton number is the same' alone / 'because they are all the same element'</p> |
|          |     | (ii) | <p>electron arrangement 2.6 ✓</p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>Nucleus containing:<br/>             8 (protons)<br/>             10 (neutrons)<br/>             ✓</p> </div>                                              | 2     | 2.2                       |                                                                                                                                                                                                                                                                                                                                                                        |
|          | (b) |      | <p><b>First check answer on answer line<br/>           If answer = 50 (m) award 3 marks</b></p> <p>unit conversion cm:m <math>0.5/100 = 5 \times 10^{-3}</math> or 0.005m ✓</p> <p>scales up to model: <math>\times 1 \times 10^4</math> ✓</p> <p>answer: = 50 (m) ✓</p> | 3     | <p>1.2</p> <p>2.2 x 2</p> | <p><b>ALLOW M1</b> for <math>\div 100</math> anywhere in answer</p> <p><b>ALLOW (2)</b> for 5000m (no unit conversion)<br/> <b>ALLOW ECF</b> for M2 and M3 on incorrect unit conversion</p>                                                                                                                                                                            |

| Question |     | Answer | Marks                                                                                                                                                                        | AO element | Guidance                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|-----|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5        | (a) | (i)    | labelled evaporating basin/dish / beaker ✓<br><br>Bunsen burner / other heat source (under open vessel containing mineral water) ✓                                           | 2          | 3.3a<br><b>IGNORE</b> basin/bowl alone<br><b>IGNORE</b> conical flask / test-tube / boiling tube<br><b>DO NOT ALLOW</b> distillation                                                                                                                                                                                                                                                                                   |
|          |     | (ii)   | Ca(OH) <sub>2</sub> ✓<br><br>(s) ✓                                                                                                                                           | 2          | 1.2<br><b>DO NOT ALLOW M1</b> if equation is unbalanced by additional numbers<br><b>DO NOT ALLOW M1</b> if additional products are given<br><b>DO NOT ALLOW</b> Ca <sup>2+</sup> (OH) <sup>-</sup> <sub>2</sub> / CaO <sub>2</sub> H <sub>2</sub><br><br><b>ALLOW</b> (s) symbol on any compound of calcium, even if formula is incorrect                                                                              |
|          | (b) |        | Sodium (is also present) ✓                                                                                                                                                   | 1          | 1.2                                                                                                                                                                                                                                                                                                                                                                                                                    |
|          | (c) | (i)    | spectroscopy ✓                                                                                                                                                               | 1          | 1.2<br><b>IGNORE</b> spectrum                                                                                                                                                                                                                                                                                                                                                                                          |
|          |     | (ii)   | Calcium (ions) present in the mineral water ✓<br><br>Mineral water contains element(s)/minerals/metal (ions) other than calcium / unknown element(s)/minerals/metal (ions) ✓ | 2          | 3.2b<br><b>ALLOW</b> it contains calcium chloride / it contains 'the solution' / it contains the same minerals as the solution<br><br><b>IGNORE</b> it is a mixture/is not pure/contains other substances<br><b>IGNORE</b> chlorine/chloride/ other anions/other ions<br><b>IGNORE</b> it has additional lines<br><b>ALLOW</b> it contains sodium (ions)/magnesium<br><b>ALLOW</b> it contains other minerals/elements |



| Question |     | Answer                                                                                                                                                          | Marks | AO element | Guidance                                                                                                                                 |
|----------|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|------------------------------------------------------------------------------------------------------------------------------------------|
|          | (e) | hydrogen gas forms (at the cathode) ✓<br><br>(because) aluminium is more reactive than hydrogen / aluminium is above hydrogen in the reactivity series<br>ORA ✓ | 2     | 2.1        | <b>For M2</b> must have comparison of reactivity of hydrogen and aluminium                                                               |
|          | (f) | Aluminium ('it') is more reactive than carbon / aluminium is above carbon in the reactivity series ✓                                                            | 1     | 2.1        | <b>IGNORE</b> aluminium is a very reactive metal / too reactive / reactive<br>Must have comparison of reactivity of carbon and aluminium |

| Question |     |      | Answer                                                                                                                                                                                                                                            | Marks | AO element | Guidance                                                                                    |
|----------|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|---------------------------------------------------------------------------------------------|
| 7        | (a) | (i)  | Top label: Metal ion / positive ion / cation ✓<br>Lower label: electron(s) ✓                                                                                                                                                                      | 2     | 1.1        | <b>DO NOT ALLOW</b> positive atoms                                                          |
|          |     | (ii) | Particle X/metal ions/positive ions do not move/only vibrate (AW) ✓<br>Particle Y electrons move (through the structure) ✓                                                                                                                        | 2     | 1.1        | <b>ALLOW ECF</b> on incorrect name for X e.g. atoms/protons<br><b>IGNORE</b> 'carry charge' |
|          | (b) |      | Atoms/ions (of Al and Mg) are different sizes ✓<br>The (aluminium) lattice is distorted/not regular AW ✓<br>(In the alloy) layers/atoms cannot move over each other (easily) / in pure aluminium layers/atoms can move over each other (easily) ✓ | 3     | 1.1        | <b>ALLOW MAX 2</b> if answer refers to covalent/ionic bonds or intermolecular forces        |

|  |     |      |                                                                                                                                                                                                                                                                                                         |   |     |                                                                                                                                                                                                                                                                                                                                                      |
|--|-----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | (c) | (i)  | (Copper/zinc act as a) barrier / prevents contact ✓<br><br>to oxygen <b>AND</b> water ✓                                                                                                                                                                                                                 | 2 | 1.1 | <b>IGNORE</b> coating (in the question)<br><b>IGNORE</b> sacrificial protection arguments/reactivity<br><br><b>IGNORE</b> air<br><b>ALLOW M2</b> for 'oxygen in the water'                                                                                                                                                                           |
|  |     | (ii) | <b>A</b> rusts because copper is below iron in the reactivity series / unreactive / does not react (with the oxygen/water) ✓<br><br><b>B</b> does not rust because zinc is above iron in the reactivity series / more reactive than iron / provides sacrificial protection / reacts instead of iron / ✓ | 2 | 2.1 | <b>For (2) marks</b> rust/does not rust must be stated for <b>either</b> A or B<br><br><b>IGNORE</b> zinc rusts<br><b>IGNORE</b> copper is less reactive than zinc<br><b>ALLOW M2</b> only Max (1) for 'both copper and zinc are more reactive than iron/act as sacrificial metals/react instead of iron (correct for zinc but incorrect for copper) |

| Question |     | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                               | Marks | AO element | Guidance                                                                                                                                                                                                                                                   |
|----------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8        | (a) | Carbon monoxide: incomplete combustion (of hydrocarbons/fuel)/burns without enough oxygen ✓<br><br>Nitrogen monoxide: nitrogen (from air) and oxygen ✓<br><br>--react at high temperatures (in the car engine) ✓                                                                                                                                                                                                                                     | 3     | 1.1        | <b>DO NOT ALLOW</b> incomplete combustion of carbon<br><br><b>DO NOT ALLOW</b> nitrogen from the fuel<br><b>DO NOT ALLOW</b> combustion/incomplete combustion of nitrogen<br><b>ALLOW</b> $N_2 + O_2 \rightarrow 2NO$<br><br><b>IGNORE</b> heat/hot engine |
|          | (b) | $2CO + 2NO \rightarrow N_2 + 2CO_2$ ✓ ✓                                                                                                                                                                                                                                                                                                                                                                                                              | 2     | 2.1        | Correct formulae = 1 mark<br>Correct equation = 1 mark<br><b>ALLOW</b> multiples                                                                                                                                                                           |
|          | (c) | (i) <b>First check the answer on answer line</b><br><b>If answer = 0.9 (%) award 2 marks</b><br><br>shows in working $9000 \times 10^{-4}$ / $9000/10^4$ /<br>states that 1 ppm = $1 \times 10^4$ pph /<br>states that 1 ppm = 10 000 pph /<br>states that 1pph = $1 \times 10^{-4}$ ppm /<br>states that 1pph= 1/10000 ppm;<br>✓<br><br>=0.9% ✓<br><br><b>OR</b><br><br>$(9\ 000/1\ 000\ 000 / 9\ 000 \times 10^{-6}) \times 100$ ✓<br><br>= 0.9% ✓ | 2     | 1.2        |                                                                                                                                                                                                                                                            |

|  |  |                                                                                                                                                                                                                                                                                |   |                           |                                                                                                                            |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------------|----------------------------------------------------------------------------------------------------------------------------|
|  |  | <p>(ii) <b>First check answer on answer line</b><br/> <b>If answer = 92.9(%) award 3 marks</b></p> <p>both 2800 <b>and</b> 200<br/> <b>or</b> 2600 alone shown in working ✓</p> <p><math>2600/2800 \times 100 = 92.85714286</math> ✓</p> <p><math>= 92.9\%</math> (1 dp) ✓</p> | 3 | <p>2.2 x 2</p> <p>1.2</p> | <p><b>ALLOW ECF</b> on incorrect readings from graph</p> <p><b>ALLOW M3</b> for incorrect answer, with working to 1 dp</p> |
|--|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------------|----------------------------------------------------------------------------------------------------------------------------|

| Question |     | Answer                                                                                                                                                                                                                                                                                                      | Marks | AO element | Guidance                                                                                                                                                               |
|----------|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9        | (a) | <p><b>First check answer on answer line</b><br/> <b>If answer = 99.5(%) award 2 marks</b></p> <p><math>1.99/2 \times 100 \checkmark</math></p> <p><math>= 99.5(\%) \checkmark</math></p>                                                                                                                    | 2     | 2.2        | <p><b>If no other marks awarded</b>, allow (1) for a correct mass of <math>\text{SO}_3</math> i.e. 80 / 79.6 / 160 / 159<br/> <b>IGNORE</b> decimal place for RFMs</p> |
|          | (b) | <p>More moles/molecules/particles on the left-hand side/as reactants ORA <math>\checkmark</math></p> <p>Equilibrium moves to right / favours forward reaction / favours products <math>\checkmark</math></p>                                                                                                | 2     | 2.1        |                                                                                                                                                                        |
|          | (c) | <p><b>Any two from:</b><br/> A lot of energy/fuel is needed (to maintain the pressure) <math>\checkmark</math></p> <p>high pressures are difficult to maintain/cause safety problems/damage or wear to equipment <math>\checkmark</math></p> <p>idea that yield is already high <math>\checkmark</math></p> | 2     | 2.1        | <p><b>IGNORE</b> cost</p> <p><b>ALLOW</b> high pressures are hazardous/dangerous/cause explosions</p>                                                                  |

|  |     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |      |                                                                                                                                                                                                                                                                                                                                                                                                       |
|--|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | (d) | <p>As temp increases, % decreases ✓</p> <p>Between 200-400 °C, percentage converted decreases slightly idea / percentage is above 90% /<br/>                     Between 400-800 °C, percentage converted decreases by a large amount / drops from approximately 90% to less than 20% /<br/>                     Between 800-1000 °C, percentage decreases less / less than 20% converted /<br/>                     At 200 °C almost 100% conversion / at 1000 °C less than 10 %<br/>                     ✓</p> | 2 | 3.1b | <p><b>IGNORE</b> decrease in percentage causes the temperature to increase<br/> <b>IGNORE</b> highest percentage at low temperatures / lowest percentage at high temperatures alone (need both for M1)<br/> <b>DO NOT ALLOW M1</b> for proportional / inversely proportional<br/> <b>IGNORE</b> correlation</p> <p><b>ALLOW</b> decreases slowly/quickly for decreases slightly/by a large amount</p> |
|--|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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