# GCSE
# CHEMISTRY
# 8462/1H

Paper 1 Higher Tier

**Mark scheme**

June 2023

Version: 1.0 Final

236G8462/1H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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# Information to Examiners

## 1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make their judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

## 2. Emboldening and underlining

**2.1** In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

**2.2** A bold **and** is used to indicate that both parts of the answer are required to award the mark.

**2.3** Alternative answers acceptable for a mark are indicated by the use of **or**.
Alternative words in the mark scheme are shown by a solidus eg allow smooth / free movement.

**2.4** Any wording that is underlined is essential for the marking point to be awarded.

# 3. Marking points

## 3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

**[1 mark]**

| Student | Response | Marks awarded |
|---|---|---|
| 1 | green, 5 | 0 |
| 2 | red*, 5 | 1 |
| 3 | red*, 8 | 0 |

Example 2: Name **two** magnetic materials.

**[2 marks]**

| Student | Response | Marks awarded |
|---|---|---|
| 1 | iron, steel, tin | 1 |
| 2 | cobalt, nickel, nail* | 2 |

## 3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

## 3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks are **not** awarded for a correct final answer from incorrect working.

## 3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

### 3.5 Errors carried forward

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

### 3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **unless** there is a possible confusion with another technical term.

### 3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

### 3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

### 3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

### 3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

### 3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

## 4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and, if necessary, annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

**Step 1: Determine a level**

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level.

The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

**Step 2: Determine a mark**

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

**Question 1**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.1** | a ball of positive charge<br><br>with (negative) electrons embedded | do **not** accept references to protons, nuclei, neutrons | 1<br><br>1 | AO1<br>4.1.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.2** | (earliest) electrons<br>protons<br>(latest) neutrons | | 1 | AO1<br>4.1.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.3** | (number of outer shell electrons) 7<br><br>(reason) (tennessine is in) Group 7 | <br><br>allow the number of outer electrons is the same as the group number<br>allow tennessine is a halogen<br><br>MP2 is dependent on MP1 being awarded | <br>1<br><br>1 | AO2<br>4.1.2.1<br>4.1.2.6 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.4** | (time needed for) peer review | allow the idea that other scientists had to check the results | 1 | AO3<br>4.1.2.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **01.5** | ($A_r$ =)<br><br>$\frac{(6 \times 7.6) + (7 \times 92.4)}{100}$ | allow $\frac{45.6 + 646.8}{100}$<br><br>allow (6 × 0.076) + (7 × 0.924)<br><br>allow 0.456 + 6.468 | 1 | AO2<br>4.1.1.6 |
| | = 6.924 | | 1 | |
| | = 6.9 | allow an answer correctly rounded to 1 decimal place from an incorrect calculation which uses all the data in the table | 1 | |

| **Total Question 1** | **9** |
|---|---|

**Question 2**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.1** | (independent variable)<br>mass (of ammonium nitrate)<br><br>(dependent variable)<br>(lowest) temperature (reached by solution) | <br><br><br>allow change in temperature (of solution) | 1<br><br><br>1 | AO1<br>4.5.1.1<br>RPA4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.2** | all 6 points plotted correctly<br><br><br><br>line of best fit | allow a tolerance of ± ½ a small square<br><br>allow **1** mark for 4 or 5 points plotted correctly | 2<br><br><br><br>1 | AO2<br><br><br><br>AO3<br><br>4.5.1.1<br>RPA4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.3** | line extrapolated to *y*-axis<br><br>(initial temperature)<br>value for temperature where extrapolated line meets *y*-axis | <br><br>allow a tolerance of ± ½ a small square | 1<br><br>1 | AO3<br><br>AO2<br><br>4.5.1.1<br>RPA4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.4** | temperature decreased | ignore correct references to energy transfer | 1 | AO1<br>4.5.1.1<br>RPA4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.5** | (0.3 °C) is the uncertainty<br><br>(because 0.3 °C) is the range about the mean value | <br><br>allow values are (a maximum of) 0.3 (°C) either side of the mean<br><br>allow (because)<br>16.8 = 16.5 + 0.3<br>**and**<br>16.2 = 16.5 – 0.3 | 1<br><br>1 | AO2<br>4.3.1.4<br>4.5.1.1<br>RPA4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **02.6** | random error | | 1 | AO3<br>4.5.1.1<br>RPA4 |

| **Total Question 2** | **11** |
|---|---|

**Question 3**

| Question | Answers | Mark | AO/ Spec. Ref |
|---|---|---|---|
| **03.1** | **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced. | 5–6 | AO1<br>4.4.2.2<br>4.4.2.3<br>RPA1 |
| | **Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced. | 3–4 | |
| | **Level 1**: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative content**<br><br>• use zinc carbonate and hydrochloric acid<br><br>• **add zinc carbonate to the (hydrochloric) acid**<br>• in a beaker<br>• stir<br><br>• **continue adding until the zinc carbonate is in excess**<br>• shown by excess solid<br>• and no more effervescence<br><br>• **filter (the reaction mixture)**<br>• to remove the excess zinc carbonate<br><br>• **heat the solution**<br>• using a water bath or electric heater<br>• to crystallisation point<br><br>• **leave the solution to crystallise**<br>• pat crystals dry with filter paper | | |

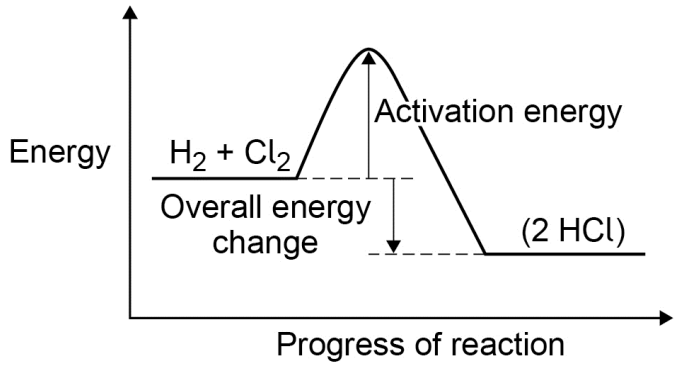
| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **03.2** | any **two** from:<br>• zinc<br>• zinc oxide<br>• zinc hydroxide | <br>allow Zn<br>allow ZnO<br>allow $Zn(OH)_2$ | 2 | AO2<br>4.4.2.3 |

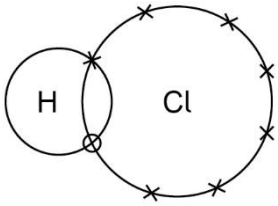
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|---|---|
| **Total Question 3** | **8** |

**Question 4**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.1** | 436 + 346 − (2 × 432) kJ/mol | | 1 | AO2<br>4.5.1.3 |

| Question | Answers | Extra | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.2** | energy is needed to break bonds<br>**and**<br>energy is released when bonds form<br><br>(and) the energy released is greater than the energy needed | <br><br><br><br>allow the energy transferred in bond making is greater than the energy transferred in bond breaking<br><br>allow 2 x 432 (kJ/mol) is greater than 436 + 346 (kJ/mol)<br><br>allow the overall energy change is negative | 1<br><br>1 | AO1<br>4.5.1.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.3** | | ignore arrow heads | | |
| | profile completed with product energy below reactant energy | | 1 | AO1 |
| | activation energy labelled from reactant energy to top of curve | | 1 | AO1 |
| | overall energy change labelled from reactant energy to product energy | | 1 | AO2<br>4.5.1.2 |
| | an answer of<br><br><br>scores **3** marks | | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.4** | | allow any combination of x, o, $e^{(-)}$, • for electrons<br><br>do **not** accept molecules containing more than 2 atoms | | AO1<br>4.2.1.4 |
| | bonded pair of electrons in the overlap | | 1 | |
| | chlorine with 6 non-bonded electrons | do **not** accept if extra electrons on H<br><br>an answer of<br><br><br><br><br>scores **2** marks<br>**or**<br>an answer of<br><br><br><br><br>scores **2** marks | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **04.5** | (methane)<br><br>methane has (much) smaller molecules<br><br>(so) has weaker intermolecular forces<br><br>(so the intermolecular forces) need less energy to overcome<br><br>(so) the boiling / melting point is lower (and methane is a gas)<br><br>**OR**<br><br>(poly(ethene))<br><br>poly(ethene) has (much) larger molecules (1)<br><br>(so) has stronger intermolecular forces (1)<br><br>(so the intermolecular forces) need more energy to break (1)<br><br>(so) the melting / boiling point is higher (and poly(ethene) is a solid) (1) | <br><br><br>do **not** accept reference to weak(er) covalent bonds<br><br>do **not** accept reference to breaking covalent bonds<br><br><br><br><br><br><br>do **not** accept reference to weak(er) covalent bonds<br><br>do **not** accept reference to breaking covalent bonds | <br><br>1<br><br>1<br><br>1<br><br>1 | AO1<br>4.2.2.4<br>4.2.2.5 |

| **Total Question 4** | **12** |
|---|---|

**Question 5**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.1** | (the acid is only) partially ionised (in aqueous solution) | | 1 | AO1 4.4.2.6 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.2** | the mass of acid dissolved is doubled and the volume of the solution is halved | | 1 | AO2 4.3.2.5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.3** | methyl orange<br><br>from yellow to red / orange / pink<br><br>**OR**<br><br>phenolphthalein (1)<br><br>from pink to colourless (1)<br><br>**OR**<br><br>litmus (1)<br><br>from blue to red (1) | MP2 is dependent on the award of MP1<br><br>if no other marks awarded, allow **1** mark for universal indicator turns from purple / blue to green / yellow / orange / red | 1<br><br>1 | AO1 4.4.2.5 RPA2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.4** | $OH^-$ | | 1 | AO1 4.4.2.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.5** | (moles $Na_2CO_3 = \frac{25.0}{1000} \times 0.124$)<br>= 0.0031(0) | | 1 | AO2<br>4.3.4<br>4.4.2.5<br>RPA2 |
| | (moles $HNO_3 = 2 \times 0.0031(0)$)<br>= 0.0062(0) | allow correct use of an incorrectly determined number of moles of $Na_2CO_3$ | 1 | |
| | (concentration =) $\frac{0.0062(0)}{23.6} \times 1000$ | allow correct use of an incorrectly determined number of moles of $HNO_3$ | 1 | |
| | = 0.262711864 | | 1 | |
| | = 0.263 ($mol/dm^3$) | allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question | 1 | |
| | **alternative approach:** | | | |
| | $\left(\text{ratio } \frac{\text{moles } HNO_3}{\text{moles } Na_2CO_3} = \right)$ | allow inverted expression | | |
| | $\frac{2}{1} = \frac{23.6 \times \text{concentration}}{25.0 \times 0.124}$ (2) | allow **1** mark for the expression with an incorrect mole ratio | | |
| | (concentration =)<br>$\frac{2 \times 25.0 \times 0.124}{23.6}$ (1) | allow correct use of the expression with an incorrect mole ratio | | |
| | = 0.262711864 (1) | | | |
| | = 0.263 ($mol/dm^3$) (1) | allow an answer correctly rounded to 3 significant figures from an incorrect calculation which uses all the data in the question | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.6** | $3.16 \times 10^{-3}$ ($mol/dm^3$) | | 1 | AO2<br>4.4.2.6 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **05.7** | argon / Ar | | 1 | AO2<br>4.1.2.4<br>4.2.1.2 |

| **Total Question 5** | **12** |
|---|---|

**Question 6**

| Question | Answers | Mark | AO/ Spec. Ref |
|---|---|---|---|
| 06.1 | **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given. | 3–4 | AO3<br>4.2.2.7<br>4.2.2.8<br>4.4.1.2 |
| | **Level 1:** Relevant points are made. They are not logically linked. | 1–2 | |
| | **No relevant content** | 0 | |
| | **Indicative content**<br><br>**relevant points**<br><br>• silver is the best electrical conductor<br><br>• aluminium is the least dense<br>• aluminium is the least expensive<br><br>• copper is a better conductor than aluminium<br>**or**<br>copper is almost as good a conductor as silver<br>• copper is much less expensive than silver<br><br>• overhead power cables need a low density metal<br>• wiring in homes needs to be affordable<br>• printed circuit boards only require small amounts of material<br><br>**judgements**<br>• use aluminium for overhead wires because of aluminium's low density and/or lower cost<br><br>• use copper for domestic wiring because copper is a very good conductor and not too expensive<br><br>• use silver only for small uses such as circuit boards due to high cost<br><br>• copper is a good compromise between electrical conductivity and cost | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.2** | (metals have) delocalised electrons | | 1 | AO1<br>4.2.1.5<br>4.2.2.8 |
| | the electrons carry (electrical) charge | ignore current / electricity for charge | 1 | |
| | the electrons move through the structure / metal | ignore throughout for through | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **06.3** | in alloys different sized atoms distort the layers / structure | | 1 | AO3<br>4.2.2.7<br>4.2.2.8 |
| | (so) the movement of (delocalised) electrons is restricted | | 1 | |

| | |
|---|---|
| **Total Question 6** | **9** |

**Question 7**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.1** | $Al^{3+}$ + **3** $e^-$ → Al | allow multiples | 1 | AO2<br>4.1.1.1<br>4.4.3.3<br>4.4.3.5 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.2** | sodium is more reactive than aluminium | | 1 | AO3<br>4.4.3.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.3** | | allow hydroxide ions for $OH^-$ throughout | | AO1<br>4.4.3.4 |
| | water (molecules) break down | | 1 | |
| | (to) produce ($H^+$ and) $OH^-$ (ions) | | 1 | |
| | (so) $OH^-$ (ions) are attracted / move to the positive electrode | | 1 | |
| | (where) $OH^-$ (ions) are discharged / oxidised to give oxygen (molecules) | allow (where) $OH^-$ (ions) lose electrons to give oxygen (molecules) | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.4** | | allow (inverted) burettes for measuring cylinders<br>allow gas syringes for measuring cylinders | | AO3<br>4.4.3.4 |
| | (change)<br>use measuring cylinders (instead of test tubes) | | 1 | |
| | (reason)<br>because there is a scale (on the measuring cylinders) | allow measuring cylinder(s) measure volume | 1 | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **07.5** | 10 $cm^3$ | | 1 | AO2<br>4.3.5 |

| | |
|---|---|
| **Total Question 7** | **9** |

**Question 8**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.1** | (atoms of) argon have a stable arrangement of electrons<br><br>(so) argon (atoms) do not share / transfer electrons | allow (atoms of) argon have a full outer shell (of electrons) | 1<br><br>1 | AO1<br>4.1.2.3<br>4.1.2.4<br>4.2.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.2** | $PH_3$ | allow $H_3P$ | 1 | AO2<br>4.1.2.1<br>4.2.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.3** | | MP2 is dependent upon MP1 being awarded | | AO3 4.1.2.3 |
| | yes, because tellurium is towards the right of the periodic table | allow yes, because tellurium is in Group 6 | 1 | |
| | (so) tellurium is a non-metal | allow (so) tellurium will gain electrons (from a metal) | 1 | |
| | **OR** | | | |
| | yes, because tellurium is in the same group as oxygen / sulfur (1) | | | |
| | (and) oxygen / sulfur will react with metals (1) | allow (so) tellurium is a non-metal<br>allow (so) tellurium will gain electrons (from a metal) | | |
| | **OR** | | | |
| | no, because tellurium is towards the bottom of the periodic table (1) | | | |
| | (so) tellurium is a metal (1) | allow (so) difficult for tellurium to gain electrons (from a metal) (1) | | |
| | **OR** | | | |
| | cannot predict as tellurium is towards the bottom and to the right of the periodic table (1) | | | |
| | (so) don't know whether tellurium is a metal or non-metal (1) | allow (so) don't know whether tellurium will gain electrons | | |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.4** | any **two** from:<br>• effervescence / fizzing / bubbles<br>• barium disappears<br>• forms a colourless solution<br>• temperature increases | ignore references to floating / flames<br><br>ignore produces a gas<br><br>allow barium gets smaller<br><br>allow barium moves around | 2 | AO3<br>4.1.2.1<br>4.4.1.2<br>4.4.2.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **08.5** | $Ba + 2\ HCl \rightarrow BaCl_2 + H_2$ | allow multiples<br><br>allow **1** mark for $BaCl_2$<br>allow **1** mark for $H_2$<br><br>ignore state symbols | 3 | AO2<br>4.1.1.1<br>4.4.1.2<br>4.4.2.1 |

| **Total Question 8** | **10** |
|---|---|

**Question 9**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.1** | (substance reduced) $Fe_2O_3$<br><br>(reason)<br>($Fe_2O_3$) loses oxygen | allow iron oxide<br><br>MP2 is dependent upon MP1 being awarded<br><br>ignore $Fe^{3+}$ gains electrons | 1<br><br>1 | AO2<br>4.4.1.1 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.2** | $\frac{3}{2}$ × 12g | | 1 | AO2<br>4.3.1.1<br>4.3.2.1<br>4.3.2.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.3** | **A** loses electrons and $\mathbf{B}^+$ gains electrons | | 1 | AO2<br>4.4.1.4 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.4** | **D** | | 1 | AO3<br>4.4.1.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.5** | (metal) **C**<br><br>(explanation) aluminium forms ions with a charge 3+<br><br>(so) 3 nitrate ions are needed for 1 aluminium ion | <br><br>allow aluminium forms $Al^{3+}$ (ions)<br><br>allow (so) 3 nitrate ions are needed to balance the 3+ charge on 1 aluminium (ion) | 1<br><br>1<br><br>1 | AO3<br>4.4.1.2<br>4.4.3.3 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **09.6** | (percentage atom economy =)<br>$\frac{A_r\mathbf{X}}{A_r\mathbf{X} + 54} \times 100 = 77.3$ | | 1 | AO2<br>4.3.3.2 |
| | 100 $A_r$**X** = 77.3 ($A_r$**X** + 54) | allow $A_r$**X** = 0.773 ($A_r$**X** + 54)<br><br>allow correct use of an incorrectly determined value of the $M_r$ of the non-useful reactant atoms | 1 | |
| | 22.7 $A_r$**X** = 4174.2 | allow 0.227 $A_r$**X** = 41.742 | 1 | |
| | $A_r$**X** = 184 | allow 183.8854626 correctly rounded to at least three significant figures | 1 | |
| | **alternative approach 1:**<br><br>($3M_r$ $H_2O$ = (3 × 16) + (6 × 1) =) 54<br>**and** (percentage = 100 – 77.3 =) 22.7% (1) | | | |
| | (total $M_r$ of reactants =)<br>$\frac{100}{22.7} \times 54$ (1) | allow correct use of an incorrectly determined value for $3M_r$ $H_2O$ and/or percentage of unwanted products | | |
| | = 238 (1) | | | |
| | ($A_r$**X** = 238 – 54)<br>**or**<br>$\left(A_r\mathbf{X} = 238 \times \frac{77.3}{100}\right)$<br>= 184 (1) | allow correct use of an incorrectly determined value of total $M_r$ of reactants and/or value for $3M_r$ $H_2O$<br><br>allow 183.8854626 correctly rounded to at least three significant figures | | |

| | | | | |
|---|---|---|---|---|
| | **alternative approach 2:**<br><br>($3M_r$ $H_2O$ = (3 × 16) + (6 × 1) =) 54<br>**and** (percentage = 100 – 77.3 =) 22.7% (1)<br><br>$\left(\frac{1}{22.7} \times 54 =\right)$ 2.3788546 (1)<br><br>2.3788546 × 77.3 (1)<br><br>= 184 (1) | <br><br><br><br>allow correct use of an incorrectly determined value for $3M_r$ $H_2O$ and/or percentage of unwanted products<br><br>allow correct use of an incorrectly determined value for 1% of the total $M_r$ of reactants<br><br>allow 183.8854626 correctly rounded to at least three significant figures | | |

| | |
|---|---|
| **Total Question 9** | **12** |

**Question 10**

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **10.1** | (nanoparticles)<br>any **two** from:<br>• have a higher surface area to volume ratio<br>• less (material) needed (for the same effect)<br>• more light gets through | allow converse arguments for fine particles<br><br><br><br>allow a thinner coating is needed | 2 | AO3<br>4.2.4.2 |

| Question | Answers | Extra information | Mark | AO / Spec. Ref. |
|---|---|---|---|---|
| **10.2** | ($M_r$ $TiO_2$ =) 80 | | 1 | AO2<br>4.3.1.2 |
| | (conversion 100 kg =) 100 000 (g) | | 1 | 4.3.2.1<br>4.3.2.2<br>4.3.5 |
| | $\left(\text{moles } TiO_2 = \frac{100\,000}{80} =\right)$ 1250 | allow correct use of an incorrectly determined $M_r$<br>allow correct use of an incorrect / no conversion of mass | 1 | |
| | (moles $Cl_2$ = 1250 × 2 =) 2500 | allow correct use of an incorrectly determined number of moles of $TiO_2$ | 1 | |
| | (volume $Cl_2$ =) 2500 x 24 | allow correct use of an incorrectly determined number of moles of $Cl_2$ | 1 | |
| | = 60 000 ($dm^3$) | | 1 | |

| **Total Question 10** | **8** |
|---|---|